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First Record of the Egg Parasitoid *Ooencyrtus pallidipes* (Ashmead) (Hymenoptera: Encyrtidae) and Larval Parasitoid *Elasmus brevicornis* (Hymenoptera: Eulophidae) on Banana Skipper *Erionota torus* Evans (Lepidoptera: Hesperiidae) from Malabar Region of Kerala, India

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Abstract: *Erionota torus* Evans was first recorded in Kerala in 2014. Since then the pest has spread throughout the state. The larvae feed on all varieties of bananas, reducing fruit yields and preventing the traditional use of leaves for other purposes. The larva is a foliage feeder of banana which reduces the leaf area and bunch size of banana. In the present study for the first time, the egg parasitism of *E. torus* by *Ooencyrtus pallidipes* (Ashmead), and larval parasitoid *Elasmus brevicornis* (Gahan) are reported from Malabar region of Kerala. The natural percent parasitism of egg parasitoid *O. pallidipes* was 75 ± 7.5% and the percentage of parasitism of larval parasitoid *E. brevicornis* on *E. torus* was 7 ± 0.6 % in the banana field located at Payyannur, Kannur district, Kerala. Both these parasitoids significantly influence the field population of *E. torus*. Since these two parasitoids have served as an effective biological control agent for *E. torus* in other previously reported countries, there is the possibility of them to establish as a potential biological control agent against *E. torus* in Kerala, india.

Keywords: Erionota torus; Ooencyrtus pallidipes; Elasmus brevicornis

1. Introduction

Bananas and plantains are the fourth most important crop of the developing countries [1], and serve as primary source of carbohydrates, minerals and vitamins for more than 400 million people [2] and is a widely consumed fruit in the world [3]. Bananas make for 31.7 percent of overall fruit production in India, and they have a higher socioeconomic significance [4]. Banana is attacked by about 200 insect and non-insect pest species [5]. Insect attacks were observed at several stages of its growth, from planting through harvesting. From planting to harvesting, 19 insect pests have been discovered in India attacking bananas [1]. Heavy infestation of *Erionota torus* Evans was reported from various banana cultivating region of Kerala [6]. Evans identified *Erionota torus*, a common banana pest, in 1941, and the previous regional distribution data suggests that this skipper was first reported from Southeast Asia, extending Sikkim to south China, Burma, Malaya, and Vietnam [7]. This species was first described in India in Sikkim, and it has previously been found in the Himalayas to the east and southeast [8]. The pest has recently been observed in south Indian states such as Karnataka, Kerala, Tamil Nadu, Maharashtra, and Andhra Pradesh, as well as in isolated pockets, resulting in outbreaks mostly in Karnataka and

Kerala [9]. The various larval instars of *Erionota* feed on almost all cultivars of banana plantain and cause severe damage. This lowers banana yields by delayed fruit maturity, reduced bunch size and preventing the traditional use of leaves. The percentage of infestation was more during monsoon and post monsoon seasons, ranging from 10 to 40% and up to 50% loss of plant leaf area. The pre-flowered plant showed 37% of infestation [6]. The new report of *E. torus* devastating bananas in the Western Ghats of India suggests that biological control should be considered for its management.The biological control programme raised effective revenues for banana producers and consumers at all income levels [10]. Biological control is defined as "the action of parasitoids, predators or pathogens in maintaining another organism's population density at a lower average than would occur in their absence"[11]. In studies conducted between 2015 and 2018, twelve insect parasitoids attacking the egg, larval, and pupal stages of *E. torus* were produced and reported in the states of Tamil Nadu, Kerala, and Karnataka in South India, as well as Mizoram, Assam, and Meghalaya in the northeast [12]. Egg parasitoid *Ooencyrtus pallidipes* quickly provided effective biological control in Mauritius,Sumatra , Indonesia etc [10]. *Ooencyrtus pallidipes* (Ashmead) (Hymenoptera: Encyrtidae) was observed in south India a major parasitoids of *E. torus* [12]. The species of the genus *Elasmus* are primary parasitoids of the larvae and prepupae of various Lepidoptera [13]. *Elasmus brevicornis* Gahan was first identified as one of *Erionata thrax* Linn's primary parasitoids [14 -15]. It is widely distributed in India, Burma, Java and Malaya. In India, it is known to parasitize many species including *Aproaerema modicella* (Lepidoptera : Gelechiidae) ; *Cnaphalocrocis medinalis* (Lepidoptera: Pyrasutidae) ; *Eutectona machaeralis* (Lepidoptera: Pyraustidae); *Lamprosema indicata* (Lepidoptera : Pyraustidae) ; *Lygropia quaternalis* (Lepidoptera : Pyraustidae); *Marasmia suspicalis* (Lepidoptera : Pyraustidae); *Nausinoe geometralis* (Lepidoptera : Geometridae); *Sylepta derogata* (Lepidoptera : Pyraustidae) and *Apanteles machaeralis* (Hymenoptera)[13-14]. In surveys done in Tamil Nadu, *Elasmus brevicornis* was identified as the most prevalent early larval parasitoid, and it appears to be a major regulating element, parasitizing the early larval stages by up to 25%. Six to eleven mature parasitoids emerged from each parasitized host collected in Tamil Nadu [12]. The objectives of this study were to identify some of the major parasitoids of *Erionata torus* Evans and to study their infestation percentage .

2. Materials and Methods

The rearing material was collected from the banana plantation from Payyanur , Kerala by hand collecting. Every banana leaf, especially the undersides, was observed carefully to find eggs, larvae, and pupae of banana skipper. Using scissors or by hand, all eggs, larvae, and pupae were taken off the leaf and placed in a plastic bag. All the collected eggs, larvae, and pupae are then transferred into a small plastic jar in which only one specimen placed in each jar covered with muslin cloth. The plastic jar were all kept in the rearing room with the room temperature of 27-30°C, and 80 % relative humidity. The size of culture plastic jar was 8 cm in diameter and 12 cm in height. Any parasitoids emerged from the eggs, larvae, and pupae were then killed by ethyl acetate and were removed into vials with 70% alcohol inside. Representative specimens were mounted as pinned specimens, and the minute specimens (less than 5 mm) were mounted on the rectangle card [15]. The specimens were then identified with the help of a taxonomist at MCC Kozhikode, Kerala. The voucher specimens are deposited in Research Laboratory Museum of Government College, Kasaragod, Kerala. The percentage of parasitism by all parasitized species obtained from the collected samples was calculated.Eggs, second and third instar larvae obtained from the infested plants were selected to evaluate the percentage of parasitism . The average percentage of egg /larval parasitism was then calculated by applying the following formula:

$$\text{Parasitism} = \frac{\text{No. of parasitized egg / larva}}{\text{Total no. of examined larvae}} \times 100$$

3. Results

Two species of parasitoids were recovered from the Eggs and larvae of *E torus* from all the selected banana plantations .The first one was an Egg parasitoid *Ooencyrtus pallidipes* and the second one , the larval parasitoid *Elasmus bravicornis* .The average percentage of parasitism in the study area by *O pallidipes* was 75 ± 7.5% during post monsoon season (Table-1). The average percentage of parasitism of larval parasitoid *E. brevicornis* in the study area about 7 ± 0.6% during the period 2017-18. The nature of parasitism of *O. pallidipes* an *E. brevicornis* is shown in the figure 1 and 2. *O. pallidipes* parasitism is more during post monsooseason (Fig.3). The infestation of *E. brevicornis* is more during monsoon and post-monsoon season (Fig.4).

4. Discussion

The parasitoids identified have been known to be economically important species. The samples identified from the selected site of Malabar region of Kerala, undoubtedly indicate the richness of parasitoids on banana cultivating plots. These data can play a significant role in the biological control programs of the banana-skipper *Erionota torus*. *O. pallidipes* had previously been found on various lepidopteran hosts in Indian states Karnataka, Assam, and Andhra Pradesh [16]. *O. pallidipes* was discovered in Karnataka and natural parasitism was found to be 80-82 percent in Shivamogga district [17] .*O. Pallidipes* parasitized the eggs of a mixed population of *Erionota* from Meghalaya in October 2018 [18].During the years 2016-17 and 2017-18 , natural parasitism of *E. torus* eggs by *O pallidipes* was found in a few locations throughout five Karnataka districts.In 2016-17, randomly collected *E. torus* egg masses in Tamil Nadu revealed 60-100 percent parasitism and cocluded that these observations clearly indicate *O. pallidipes* is the most effective parasitoid of *E. torus* in South India [12] .Ferriere (1929) described two species as new and recorded *E. brevicornis* Gahan from

India [].*E torus* was reported as a new host record of *Elasmus* (Hymenoptera: Eulophidae) from Karnataka.They also redescribed and illustrated Elasmus brevicornis_ Gahan (Chalcidoidea: Eulophidae:Eulophinae)[19].Egg and larval parasitoids play a critical role as biological control agents for a variety of agricultural pests, ensuring the long-term viability of agricultural crops.

Table 1. Table showing the number of eggs examined, number of eggs infested and percentage infestation of *O.pallipidus on E.torus* in the selected banana plantation at Payyannur during post monsoon period.

Number of eggs examined	Number of eggs parasitized	Percentage parasitism
23	18	78.2
23	19	82
22	19	86
18	13	72
24	17	70
21	18	85
25	18	75
25	19	76
23	19	82
18	11	61
27	17	70
25	17	65

Figure 1. a. & b. Normal eggs of *E.torus* c , d & e. *O. pallipidus* parasitized eggs , f. Adult *O. pallipidus.*

Figure 2. a.Normal second instar larva of *E.torus* b , c d & e. *E. brevicornis* parasitized second instar larva f. Adult *E.brevicornis* .

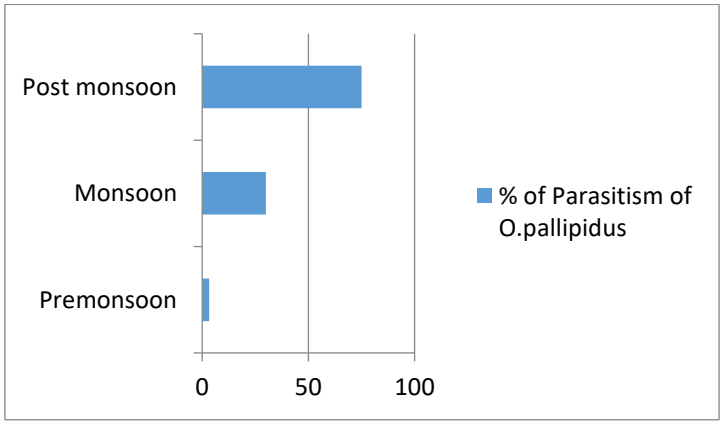

Figure 3. Average percentage of parasitism of *O.pallipidus* on *E. torus* in the selected banana plantation at Payyannur during 2017-18 .

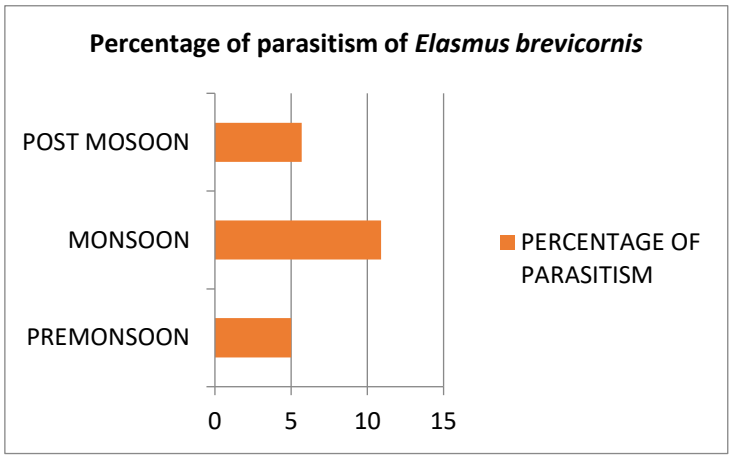

Figure 4. Average percentage of parasitism of *E.brevicornis* on *E. torus* in the selected banana plantation at Payyannur during 2017-18 .

5. Conclusions

The present study reported the presence of egg parasitoid Ooencyrtus pallidipes (Ashmead), and larval parasitoid Elasmus brevicornis (Gahan) for the first time from Malabar region of Kerala as the parasitoides of banana skipper Erionota torus. The average natural percentage parasitism of egg parasitoid O. pallidipes was 75+_7.5% during the post mosoon season and the average percentage of parasitism of larval parasitoid E. brevicornis was 7 ± 0.6 % in the selected banana plantation located at Payyannur, Kannur district, Kerala. However, this may have been influenced by the population size of the eggs and larvae collected. Both the parasitoids are significantly influences the field population of E. torus. Since these two parasitoids have served as an effective biological control agent for E. torus in other previously reported countries, there is the possibility that they can also establish as a potential biological control agent in Kerala, India .However, further detailed studies needed to identify more parasitoid species and to clearly understand their biology and population dynamics .

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