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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Introduction

Bananas and plantains are the fourth most important crop of the developing countries (Padmanaban et al.,2001), are a primary source of carbohydrates, minerals and vitamins for more than 400 million people (McNicol 1989) and is a widely consumed fruit in the world (Hallam 1995).

Bananas make for 31.7 percent of overall fruit production in India, and they have a higher socioeconomic significance (Kathirvel. N. 2007). Bananas are attacked by about 200 insect and non-insect pest species (Simmonds, 1966 and Singh, 1970).

Insect attacks were observed at several stages of crop growth, from planting through harvesting. From planting to harvesting, 19 insect pests have been discovered in India related with bananas (Padmanaban et al., 2002) . Heavy infestation of *Erionota torus* Evans was reported from various banana cultivating region of Kerala (Jaleel et al., 2020).

Evans identified *Erionota torus*, a common banana pest, in 1941, and previous regional distribution data suggest that this skipper was first reported from Southeast Asia, extending Sikkim to south China ,Burma, Malaya, and Vietnam. This species was first described in India in Sikkim, and it has previously been found in the Himalayas to the east and southeast (Raju et al., 2015).

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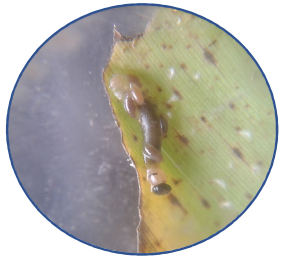
The pest has recently being observed in south Indian states such as Karnataka, Kerala, Tamil Nadu, Maharashtra, and Andhra Pradesh, as well as in isolated pockets, resulting in outbreaks mostly in Karnataka and Kerala (Kamala Jayanthi et al., 2015).

The various larval instars of *Erionota* feed on almost all cultivars of banana plantain and cause severe damage.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 aout 37% of infestation (Jaleel et al., 2020).



The new report of *E. torus* devastating bananas in the Western Ghats of India suggests that biological control should be considered .The biological control programme raised effective revenues for banana producers and consumers at all income levels (Cock.2015).

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" (Debach 1964).

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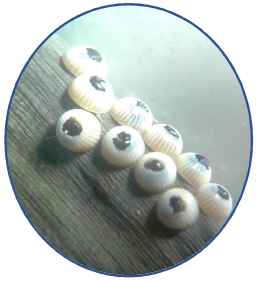
In studies conducted between 2015 and 2018, twelve insect parasitoids attacking the egg, larval, and pupal stages of *E. torus* were produced and reported in the states of Tamil Nadu, Kerala, and Karnataka in South India, as well as Mizoram, Assam, and Meghalaya in the northeast (Poorani et al., 2020).



Egg parasitoid *Ooencyrtus pallidipes* quickly provided effective biological control in Mauritius,Sumatra , Indonesia etc (Cock.2015).*Ooencyrtus pallidipes* (Ashmead) (Hymenoptera: Encyrtidae) was observed in south India a major parasitoids of *E. torus (*Poorani et al., 2020).

The species of the genus *Elasmus* are primary parasitoids of the larvae and prepupae of various Lepidoptera (Verma and Hayat, 1986). *Elasmus brevicornis* Gahan was first identified as one of *Erionata thrax* Linn's primary parasitoids. (Ferrieri, 1929 ,Peter &,David 1990).

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) etc

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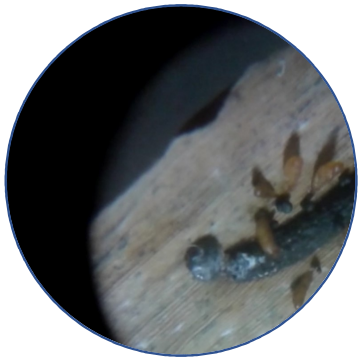
Eutectona machaeralis (Lepidoptera: Pyraustidae); *Lamprosema indicata* (Lepidoptera : Pyraustidae) ; *Lygropia quaternalis* (Lepidoptera : Pyraustidae);



Marasmia suspicalis (Lepidoptera : Pyraustidae); *Nausinoe geometralis* (Lepidoptera : Geometridae); *Sylepta derogata* (Lepidoptera : Pyraustidae) and *Apanteles machaeralis* (Hymenoptera) (Verma & Hayat, 1986 , Peter & David ,1990).

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. (Poorani et al., 2020).

The objectives of this study were to identify some of the major parasitoids of Erionata torus Evans and to study their infestation percentage .

Methodology

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 (Noyes 1982). The specimens were then identified with the help of a taxonomist at MCC Kozhikode, Kerala.

Methodology

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.

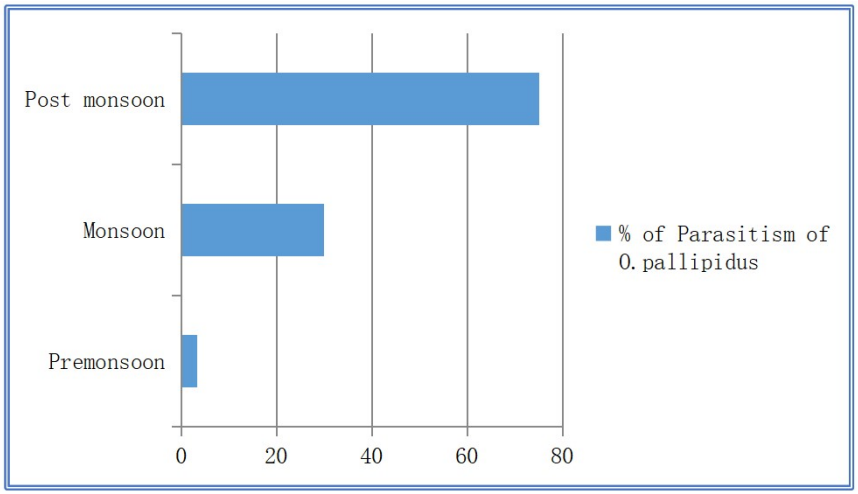
Eggs, second and third instar larvae obtained from the infested plants were selected to evaluate the percentage of parasitism .

The average percentage of parasitism was then calculated by applying the following formula:

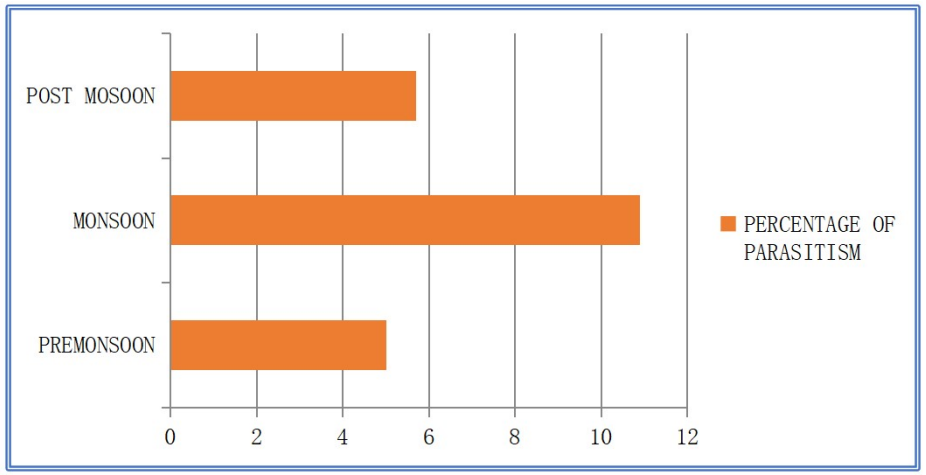
$$\text{Parasitism} = \frac{\text{No. of parasitized larvae}}{\text{Total no. of examined larvae}} \times 100$$

Results

Two species of parasitoids were identified from the Eggs and larvae of E torus from all the selected banana plantations .The first one was an Egg parasitoide *Ooencyrtus pallidipes* and the second one , the larval parasitoide *Elasmus bravicornis* .



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



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

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

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.

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

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

Discussions

Those parasitoids 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.

In Tamil Nadu also, randomly collected egg masses of E. torus showed high levels of parasitism (60-100%) in 2016-17 (Poorani et al., 2020).

They also stated that these observations clearly indicate O. pallidipes is the most effective parasitoid of E. torus in South India and it appears to have a wide distribution in India or probably spread on its own along with the host insect to different localities in South India as no deliberate attempts have been made to use biological control agents against E. torus in India.

Conclusion

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 natural percent parasitism of egg parasitoid *O.pallidipes* was 75+_7.5% and the 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 .

THANK YOU !