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Lepidopteran pest complex of *Dhataki*, *Woodfordia fruticosa* with special reference to occurrence of leafroller, *Strepsicrates* sp. in India

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ABSTRACT: Surveys were conducted to record pest complex damaging a forest medicinal plant dhataki, *Woodfordia fruticosa*. Four lepidopteran defoliators were observed as pests causing significant damage to the plants. The leaf roller, *Strepsicrates* sp. was reported as a major defoliator of *dhataki* and the identity of the pest was confirmed through male and female genitalia and amplified product of *Cytochrome c oxidase subunit I (COI) gene* (GenBank no. OP648297). Further, the biology, morphometry, seasonal incidence and natural enemy complex of the leaf roller were recorded in the present study. The detailed information on different aspects like bio-ecology, seasonality and biocontrol of this leafroller, *Strepsicrates* sp. can be utilized for further development of viable management strategy as this was already reported as one of the major pests in economic plants like guava and eucalyptus in other countries.

Keywords: Dhataki, *Woodfordia fruticosa*, defoliators, *Strepsicrates* sp., bio ecology, seasonal incidence

INTRODUCTION

Woodfordia fruticosa (L.) Kurz. (Family: Lythraceae) is a forest medicinal plant, locally known as *Dhataki* or *Dhaiphul.* It is a spreading, deciduous shrub, distributed throughout India, but rarer in Southern India and the plant has a long history of use in traditional medicine to treat bowel disorders (Das *et al.,* 2007). The plant grows in Gangetic plains, North-Eastern states and in West Bengal, it is limited to the northern part adjacent to Sikkim, where folks use the leaves to relieve fever (Tayab *et al.,* 2021). The flowers are tubular, attractive and crimson red in colour, borne on twigs near the leaf axil as clusters (2 to 16 flowered cymes) with short stalks, hence it is known as fire flame bush (Kumar, 2016). The flowers possess great therapeutic potential and both in its fresh and dried powder forms are used to heal cut wounds on skin. Flower and leaf extracts have several phytochemical compounds such as anthraquinones, flavonoids, glycosides, tannins and polyphenols responsible for properties like antimicrobial, hepato protective, cardio protective, antioxidant, antiulcer, immune-modulatory, antifertility and anti-tumor (Thakur *et al.,* 2021).

Earlier studies reported many larval lepidopterans were found destructive to several forest trees and also emphasized that the importance of identification, biodiversity, biology, nature of damage and management of these pests are necessary for conservation of forest plants (Sathe and Pandharbale, 2008). *W.fruticosa* is a major non-timber forest product (NTFP) in the West Bengal especially in sub Himalayan region (Ghoshal, 2010). Hence, it is essential to study the abiotic and biotic stresses inflicting damage and threatening the survival of plants in their natural habitat. In the present study, attempts have been made to survey and record the major insect pests feeding on the plants. Detailed studies on biology, morphometry, seasonal incidence and natural enemy complex of *Strepsicrates* sp. were carried out.

MATERIALS AND METHODS

Study site

The surveys on lepidopteran pest complex on dhataki, the occurrence of *St. repsicrates sp.* its seasonal incidence, and the natural enemy complex were carried out in the medicinal plants garden, UBKV, Pundibari, Coochbehar, West Bengal during 2021-2022. The experiments on morpho-taxonomical identification, life history, and morphometric studies of *St. repsicrates sp.* were conducted at the entomology laboratory, Regional Research Station (TZ), Directorate of Research, UBKV, Pundibari, Coochbehar, West Bengal from May to August 2022.

Table 1. Lepidopteran pest complex recorded on *dhataki* during 2021 and 2022

Order	Family	Common name	Scientific name	Occurrence	Relative abundance*	Pest status**
Lepido-ptera	Nolidae	Defoliator	*Selepa discigera*	Throughout the year	+++	Major, polyphagous
	Tortricidae	Leaf webber	*Strepsicrates* sp.	January - May	+++	Major, polyphagous
	Geometridae	Looper	*Pingasa alba*	June- September	++	Moderate, polyphagous
	Erebidae	Yellow tussock moth	*Artaxa guttata*	January- March	+	Minor, polyphagous

* +: 1-2 individuals per plant; ++: 2-5 individuals per plant; +++: 5-10 individuals per plant
**Minor: Upto 10%; Moderate: 10-30%; Major: more than 30% plant infestation.

Survey of pest complex

The field was monitored regularly at alternative days for the observation of insect pests on the crop. The immature stages of the pests were collected and brought to the laboratory for rearing them by providing their respective host plants. After the emergence of adult insects, they were collected and killed in killing bottle, mounted either on insect pins or paper points depending on their size and labelled properly. The common specimens were identified by comparing with previous collections in the Entomology lab, Regional Research Station (TZ), Directorate of Research, UBKV, Pundibari and Department of Entomology, Faculty of Agriculture, UBKV, Pundibari as well as available literature *viz.,* Japir *et al.* (2018) and Srikumar *et al.* (2022). Furthermore, these specimens were sent to experts at ICAR-NBAIR for molecular confirmation of the insect species. The pest status was judged based on percent incidence on the crop.

Biology and morphometric studies

The leafroller infested leaves were collected from the field and carried to the laboratory to rear them individually in petri dishes into adults at 24±2°C and 70±5 % RH. The fresh dhataki leaves were provided daily till pupation and allowed to emerge as adults. A newly emerged male and female adult pair was collected into plastic jars of 10×5 cm size and observed for mating. Terminal shoot buds along with two to three tender leaves placed in a micro vial containing water was provided at the bottom of the jars to facilitate egg laying. Total ten such pairs were maintained to observe egg incubation period, fecundity, and adult longevity. Insect rearing was done by following the methodology of Shivakumara *et al.* (2021). A cotton swab dipped in a 10% honey solution was provided as food for adults. The fresh shoot tips were placed on alternative days and the replaced shoots were examined under the stereo zoom microscope daily for the presence of eggs.

The shoots containing freshly laid eggs were collected and transferred into a petri dish for observing egg hatching and to record the incubation period. After hatching, the neonate larvae (n=15) were transferred individually into individual Petri dishes (9 cm dia.) containing tender leaves carefully with the help of a fine hairbrush. The tips of the leaves were covered with a moistened cotton swab to avoid desiccation. The larvae were reared to the pupal stage on *dhataki* leaves and they were monitored regularly to notice moulting which was indicated by the presence of left overhead capsules and exuviae. The observations on number of larval instars, larval and pupal periods were taken, also the morphometric parameters viz. head capsule width, body length, and width of each successive larval instars, pupae, and adults (male and female) were recorded. The same microscope mentioned previously, fitted with Carl Zeiss Zen 2.5 lite (blue edition) imaging and calibration software was used to take morphometric measurements of body parts of the insect.

Seasonal incidence

To study the percent plant incidence around 20 plants of *W. fruticosa* were selected randomly andto assess the leaf injury, a total of a hundred randomly selected leaves covering all directions of the plant were observed. The meteorological data for two years (rainy season) of the survey period i.e., 2021 and 2022 were collected to correlate the pest population with various

Table 2. Duration of various life stages of leaf webber, *Strepsicrates* sp. on dhataki

Stages	Range (days)	Mean ± SE
Egg period (days)**	4-6	5.10±0.70
1st Instar*	3-4	3.46±0.48
2nd Instar*	3-4	3.66±0.47
3rd Instar*	4-5	4.40±0.48
4th Instar*	4-5	4.33±0.47
5th instar*	4-5	4.66±0.47
Total larval period (days)*	18-23	20.53±1.62
Pupal period (days)*	8-11	9.73±0.99
Total life cycle (days)*	36-49	43.40±4.37
Adult longevity*	6-9	7.93±1.06
Fecundity (Nos.)**	42-57	50.80±4.85

* Mean of 15 observations **Mean of 10 observations

SE- Standard Error

weather parameters like maximum temperature (X1), minimum temperature (X2), maximum relative humidity (X3),minimum relative humidity (X4) and rainfall (X5) to understand the effect of various weather parameters on the population of *St. repsicrates sp.*

Natural enemies

The larvae (n = 50) of *St. repsicrates sp* were collected from the field and brought to the laboratory, where they were reared individually in Petri dishes by providing fresh dhataki leaves daily till they reach the pupal stage. Natural larval parasitization was observed in larvae while rearing. The Petri dishes containing parasitized host larvae were separated and allowed for emergence into adult parasitoids. The adult parasitoids that emerged were killed and collected into collection vials containing 70% alcohol. The preserved parasitoid specimens were examined under a ZEISS Stemi508 stereo zoom microscope. Photographs of the wasps were taken using a stereo-zoom micro scope fitted with a ZEISS Axiocam 105 color camera and Carl Zeiss Zen 2.5 lite (blue edition) imaging software. The parasitoid specimens were sent for identification to the experts at ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Bangalore, India.

RESULTS AND DISCUSSION

The medicinal shrub *dhataki* was observed to be attacked by several lepidopteran pests, among which four species (Fig. 1) were found more dominant and were reported in this study. Detailed description of pest species and its nature of damage has been documented (Table 1).

Biology and morphometry of leaf roller

The biological cycle of leaf roller *Strepsicrates* sp. was studied on their host plant dhataki. To study the biology and morphometry of the pest, duration of different life stages *i.e.,* egg, larva, pupa and adult (Table 2) and also observation of morphometric characteristics *viz.,* head capsule width, larval body length and body width measurements were taken from 15 individuals. The eggs were very minute and scaly with an incubation period ranging between 4-6 days and on average 5.10±0.70 days required to hatch out of the neonate larva from the egg.

Table 3. Morphometry of different life stages of *Strepsicrates* sp. on *dhataki*

Stage	Width of head capsule (mm) Mean ± SE	Length of body (mm) Mean ± SE	Width of the body (mm) Mean ± SE
Egg		0.23±0.01	0.21±0.01
		Larva	
1st instar	0.19±0.02	1.75±0.16	0.57±0.04
2nd instar	0.30±0.02	2.99±0.30	0.81±0.06
3rd instar	0.54±0.02	5.59±0.17	1.25±0.07
4th instar	0.84±0.02	8.60±0.14	1.62±0.16
5th instar	1.13±0.01	12.23±0.74	2.07±0.11
Pupa	-	6.38±0.15	1.52±0.01
Adult	-	6.96±0.07	1.71±0.08

Mean of 15 observations SE – Standard Error

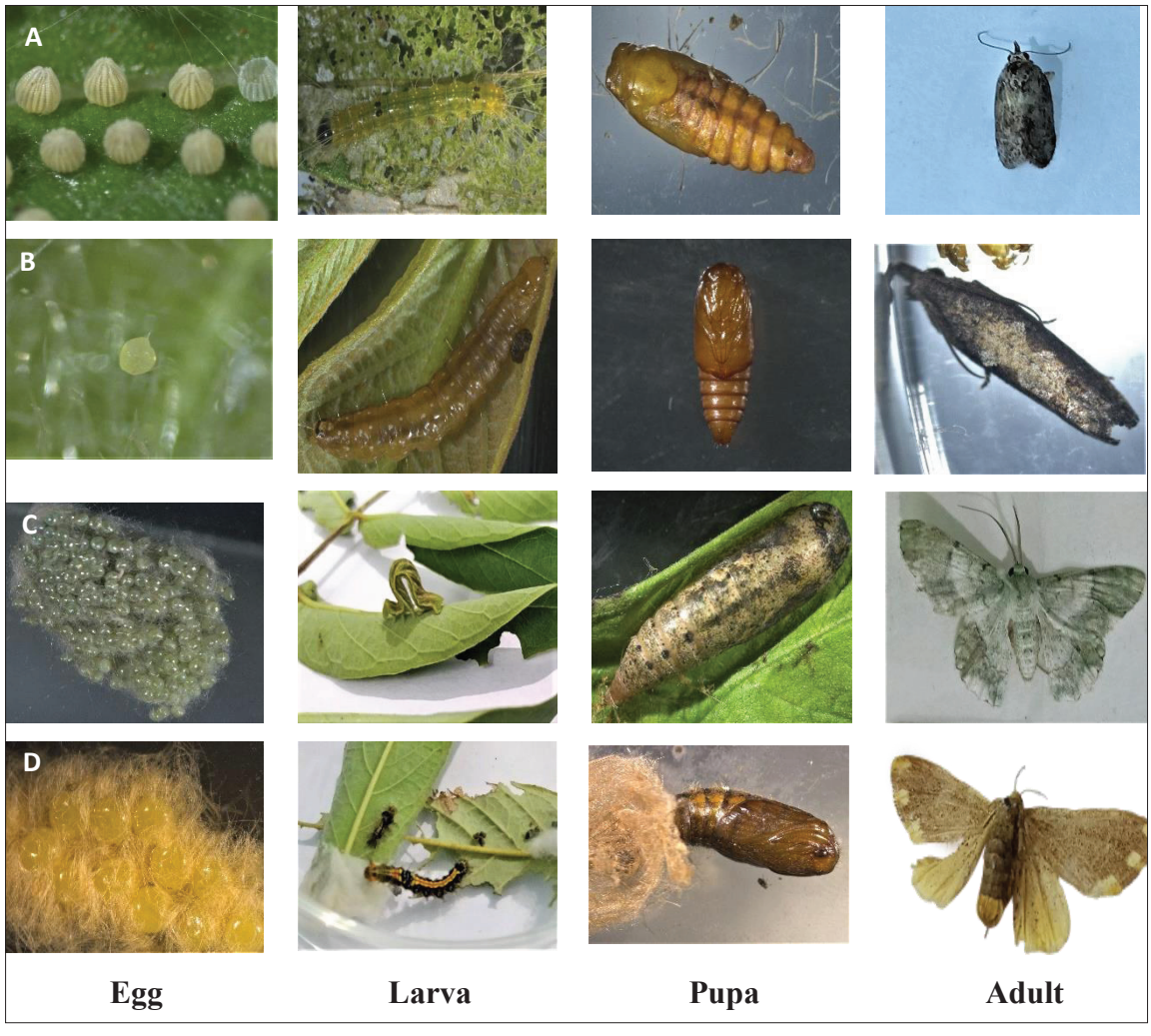

Fig. 1. Life stages of lepidopteran defoliators on *Woodfordia fruticosa*
A) *Selepa discigera* B) *Strepsicrates* sp. C) *Pingasa alba* D) *Artaxa guttata*

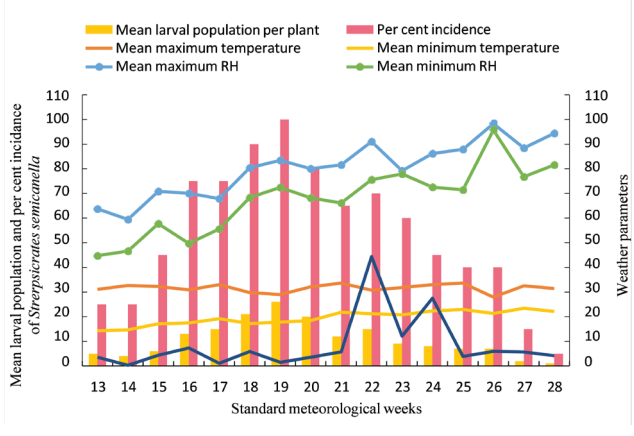

Fig. 2. Seasonal incidence of leaf roller (2021)

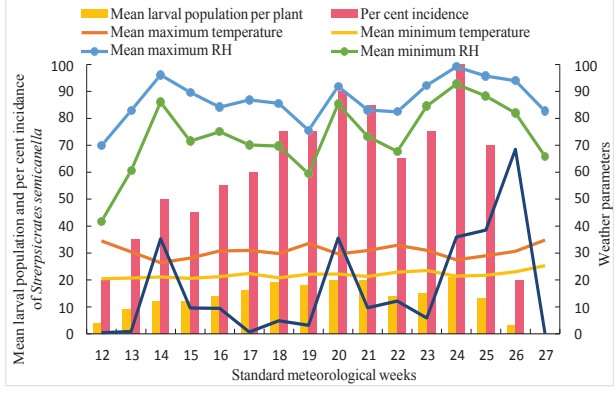

Fig. 3. Seasonal incidence of leaf roller (2022)

The young larvae were pale yellowish to green in colour with a sub dorsal line, as they become old the body colour turned into dark pinkish tinge. The mean larval duration of 1st, 2nd, 3rd, 4th and 5thinstars were 3.46±0.48 days, 3.66±0.47 days, 4.40±0.48 days, 4.33±0.47 days and 4.66±0.47 days, respectively. The pupa was brownish in colour with a row of spines on dorsal side of each abdominal segment and also there were few hook-like hairs at the end of the abdomen. The mean pupal period recorded was 9.73±0.99 days with a range of 8-11 days.

The total life cycle was completed in 36-49 days with an average of 43.40±4.37 days. The adult moth was small sized, body including head, antenna, legs were greyish brown in colour. The average number of eggs laid by a female was 50.80±4.85 eggs. The eggs were spherical, small, creamy white in colour and the average length and width of an egg was 0.23±0.01 mm and 0.57±0.04 mm, respectively. The larva was medium sized with hard yellowish head capsule and a small pro-thoracic sclerite. The width of head capsule of each successive instars was recorded *viz.,* 0.19±0.02 mm, 0.30±0.02 mm, 0.54±0.02 mm, 0.84±0.02 mm and 1.13±0.01mm for 1st, 2nd, 3rd, 4th and 5th instars, respectively. The mean body length and width of egg, larvae, pupae and adults were showed in the table 3.

Seasonal incidence of leaf webber, *Strepsicrates* sp. on *dhataki*

In the first year, the leafroller infestation started during 13th SMW with 25 per cent plant infestation and mean larval population of 5 per plant. The infestation continued till 28th SMW (Standard Meteorological Week) when the per cent infestation was 5% and mean larvae was 1 per plant. The peak percent infestation was observed during 19th SMW when the 100% infestation was noticed and the average larval population per plant was also observed during the same period having approximately 26 larvae per plant. The pest population was gradually reduced and became the minimum during the 28th SMW and terminated by 29th SMW of 2021 (Fig. 2). In the second year, the trend followed a different pattern; the infestation started early in the 12th SMW with 20 per cent plant infestation and 3 larvae per plant on an average. The peak infestation (100%) was noticed during 24th SMW, also maximum mean larval population *i.e.,* 21 larvae per plant occurred during the same period and then the population drastically reduced by 26th SMW when only 20 per cent plants were infested with a minimum larval population per plant *i.e.,* 3 per plant (Fig. 3).

The correlation analysis between the population of leafroller and weather parameters revealed a strong positive association between per cent plant infestation and minimum relative humidity (r=0.500*). Both mean larval population and per cent plant infestation had a weak negative association with maximum and minimum temperatures. Whereas, the number of larvae per plant showed a weak negative association with total weekly rainfall (r=-0.045 NS) but the percent plant infestation registered a non-significant positive correlation with rainfall (r=0.092NS).

Natural enemy complex of leafroller, *Strepsicrates* sp. on *dhataki*

Two larval parasitoids *viz.*, *Mesochorus* sp. (Ichneumonidae: Hymenoptera) and *Pholestesor*sp. (Braconidae: Hymenoptera) (Fig. 4) were found attacking the larvae of *St. repsicrates sp.* on dhataki. The natural parasitism due to *Mesochorus* sp. and *Pholestesor*sp. were recorded at 12% and 18%, respectively. The adult parasitoid emergence from host larvae was 80% and 70% for *Mesochorus*sp. and *Pholestesor* sp., respectively.

Japir *et al.* (2018) reported that the caterpillars of *Woodfordia* defoliator, *Selepa discigera* was found to feed on the forest tree, *Terminalia copelandi* in Sabah, Malaysia. The species was found to be distributed in the oriental tropics of India and Srilanka (Koçak and Kemal, 2012). The alluvial forests were reported as a habitat of leafroller *St. repsicrates sp.* (Razowski, 2013). Besides *Woodfordia fruticosa,* the other host plants known to attacked by the larvae were *Eukalyptus* and *Psidium* (Nasu *et al.,* 2004; Wakamura *et al.,* 2005). The looper *Pingasa alba* has been reported from Bonai forest of Odisha (Kumar *et al.,* 2022). The tussock moth *Artaxa guttata* are commonly found in India (Sondhi and Sondhi, 2016), Bangladesh and Srilanka. It was considered as a minor pest of several agricultural, horticultural and forest plants such as castor, pigeon pea, rose, jasmine, mango, citrus, ber, oak, sal, *Terminalia myriocarpa* and *T.tomentosa* (Robinson *et al.,* 2010 and Singh *et al.,* 2019).

The male and female genitalia of leafroller *St. repsicrates sp.* which were dissected during the course of the present study, were compared with previous literature *viz.,* Nasu *et al.* (2004); Rose and Pooni (2005); Deng *et al.* (2011) and there was similarity with present findings which confirmed the identity of the pest species concerned. Biology of *St. repsicrates sp.* on woodfordia has been studied for the first time during this study. However, Mauchline (2000) studied life history of *S. macropetana* on the host eukalyptus and recorded that approximately 54 days were required for completion of its life cycle. The average fecundity observed was 40 eggs per female. The biology and life history of leaf roller *S. rhothia* has been studied on guava in Karachi, Pakistan

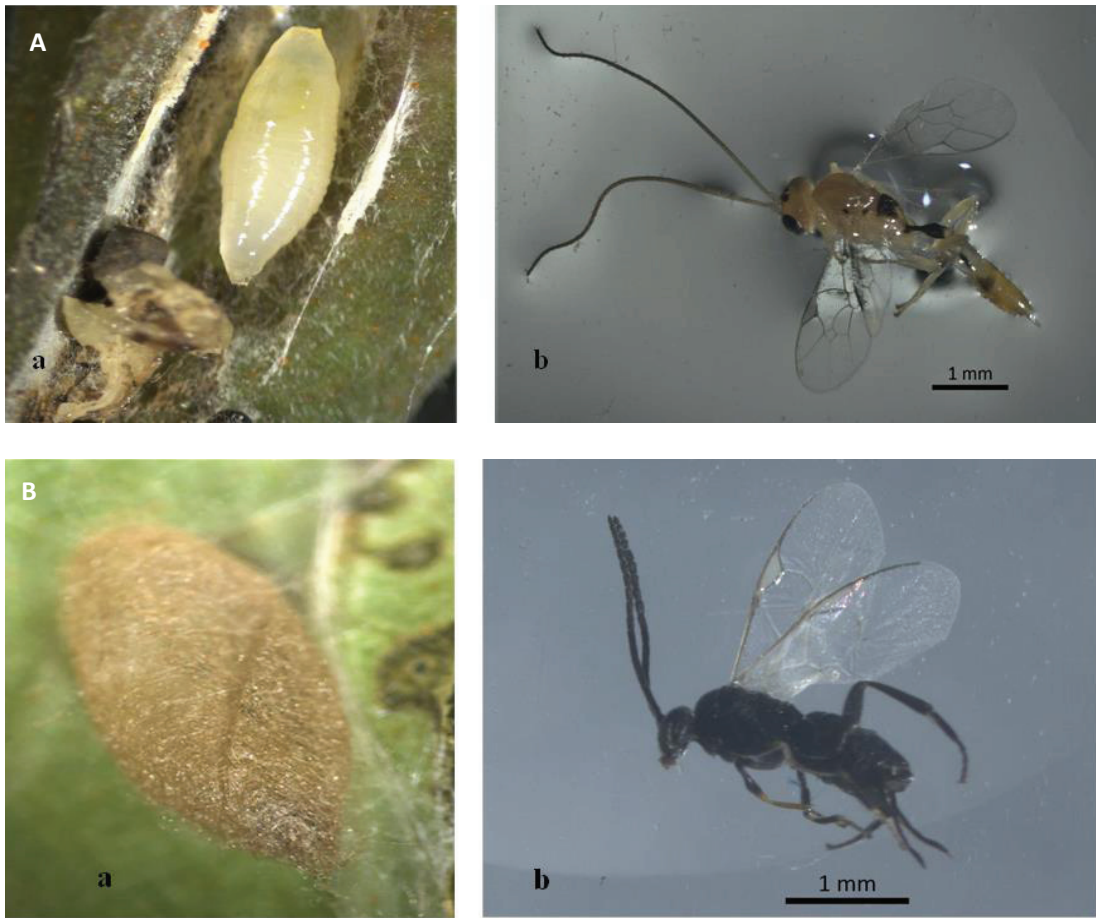

Fig. 4. Natural enemy complex of leafroller *Strepsicrates* sp. A) *Mesochorus* sp. B) *Pholestesor* sp.: a) Parasitoid pupa b) Adult parasitoid

by Ahmad (1972). Canacuán-Nasamuez, and Carabalí-Muñoz (2015) reported that the leaf roller *S. smithiana* caused economic damage to guava in Columbia. They conducted the biological studies and their results were consistent with our present study on *St. repsicrates sp.* on *Woodfordia fruticosa*. The larva had five instars and the total duration of life cycle was approximately 42.93 days while the incubation period was 5.07 days. The average duration of larval, pupal and adult stages was recorded as 18.17 ± 2.03; 10.57 ± 1.04 and 5.87 ± 1.2 days, respectively. These studies suggested more or less similar trend to the present investigation results on biology of *St. repsicrates sp.* on dhataki.

The leafroller infestation on dhataki was noticed for a specific period during the present study under sub-tropical humid climatic conditions of sub-Himalayan West Bengal. This observation is partly supported by earlier reports of Srikumar*et al.* (2022) who found infestation of *St. repsicrates sp.* on Eucalyptus plantations throughout the year in the tropical forests of Indonesia. The number of generations of pests and its period of occurrence mainly depend on the prevailing climatic conditions. The species *S. mecropetana* went through many more generations, perhaps six and eight depending on climate (Miller, 1925; Mauchline *et al.,* 1999). There were at least four generations of *S. macropetana* in the study at Bay of Plenty, New Zealand (Mauchline, 2000).

The ichneumonid *Mesochorus* sp. and braconid *Pholestesor*sp. has been reported to parasitize the leaf roller *Strepsicrates sp.* for the first time from forest cum medicinal plant *Woodfordia fruticosa.* Previously, Nuttall (1983) reported that the population of eucalyptus leafroller *Strepsicrates macropetana* was significantly reduced (45% natural parasitism was recorded) by pupal parasitoid *Trigonospila brevifacies* which was introduced into New Zealand for the control of leafrollers of forest and horticultural ecosystems. Also, the association of ichneumon wasp *Xanthopimpla rhopaloceros* has been observed with larvae of *S. macropetana*. Braconid *Dolichogenideata smanica* was reported as an efficient biocontrol agent for management of tortricid moth the apple leaf roller *Epiphyaspost vittana* (Scarratt, 2005).

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