

## New host for Banana Skipper (*Erionota torus* Evans, 1941) in Andaman and Nicobar Islands, India

Neelam Purti<sup>1</sup> Lal Ji Singh<sup>3\*</sup> and Arun K. Pandey<sup>2</sup>

<sup>1</sup>Department of Environment and Forests, Manglutan Range, South Andaman Forest Division, Andaman & Nicobar Islands, India

<sup>2</sup>Department of Botany, Mansarovar Global University, Bhopal, Madhya Pradesh, India

<sup>3</sup>Botanical Survey of India, Andaman and Nicobar Regional Centre, Port Blair, Andaman and Nicobar Islands, India

\*Corresponding author's E-mail:- [laljisingh1970@rediffmail.com](mailto:laljisingh1970@rediffmail.com), Botanical Survey of India, Andaman and Nicobar Regional Centre, Port Blair, Andaman and Nicobar Islands, India

### Abstract

Banana skipper' or 'banana leaf roller, *Erionota torus* (Lepidoptera: Hesperiiidae) has been reported as a pest of *Musa* species of Musaceae in the Andaman and Nicobar Islands, India for the first time. Its impact on host species and conservation status are assessed. Wild banana species appear to be most susceptible to damage by its larvae, feeding on the leaves of the plant and affecting its growth. Larvae damage the leaves of *M. balbisiana* Colla, *M. acuminata* Colla and *M. indandamanensis* L.J. Singh are recorded here for the first time as new host plants and the species, *M. indandamanensis* L.J. Singh, endangered and endemic to the Andaman and Nicobar Islands is appear to be most susceptible to damage by its larvae, feeding on the leaves of the plant and affecting its growth.

**Key words:** *Butterfly, Conservation; Herbivory; Hesperiiidae; Musaceae; Lepidoptera.*

### Introduction

The most popular worldwide fruit plant, *Musa* L. (Musaceae) is the well-recognized host plants for *Erionota torus* (Lepidoptera: Hesperiiidae) in South-East Asia, and Pacific territories. *Erionota thrax* L. is recorded as a pest of diverse *Musa* spp. from various geographical regions and well recognized as a 'banana leaf roller' (Cock, 2015, Gunawardana *et al.*, 2015; Irulandi *et al.*, 2018). Besides *Musa*, the larvae of *E. torus* also claimed on many other important economic plants (Chiang and Hwang, 1991) but according to Cock (2015) records of this butterfly from palms and other plant groups are in error. The larvae of *E. torus* feed on *Musa* spp. as preferred host plant and pose a serious threat to banana population in *ex-situ* as well as *in-situ* habitats. Banana Skipper, *E. torus* has been distributed around South-East Asia, Taiwan, Japan (Cock, 2015) and indigenous in northern India (Chiang & Hwang, 1991). In India, its only preliminary account on infestations has been recorded on banana crop (cultivars of *Musa* spp.) and only one wild species, *M. balbisiana* Colla (Jayanthi *et al.*, 2015; Raju *et al.*, 2015; Karmakar *et al.*, 2018) and there are no detailed studies on infestations of *E. torus* on wild population of *Musa* spp. In the present

study *E. torus* is recorded as a pest of wild *Musa* spp. for the first time from the Andaman and Nicobar Islands (ANI) in great detail. In India, Populations of bananas were appeared to be severely fed by the larvae of *E. torus*, engenders a conflict between the need to protect the host species from damage within enveloping range. Various studies emphasized the arguable need to conserve the butterfly's dependence on the host plants (Marler *et al.*, 2012a,b; Purti *et al.*, 2022, 2023a, b). In view of this, the present study aims to document the pest of *Musa* and their impact on host species within India.

The genus *Musa* comprises of about 70 species, mainly distributed in the tropical Asia from Himalaya to Northern Australia (Singh *et al.*, 2020a, b). In India, wild species are distributed mainly in Eastern Ghats, Western Ghats, North Eastern India and in Andaman and Nicobar Islands (Singh *et al.*, 2020a,b). ANI (N6°45' to 13°41' and E92°12' to 93°57') is a phytogeographically important group of 572 Islands and islets and well recognized center of hot spots of plant diversity with a total land area of 8,249 km<sup>2</sup> with a coastline of 1,962 km (Singh *et al.*, 2014, 2021a,b; Singh and Ranjan, 2021). The Nicobar group of islands are separated from Andaman

group of Islands by 10-degree channel with heavy tidal flow which making the sea difficult for transportation. In ANI, the family Musaceae is represented by a single genus, *Musa* with very few population and confined distribution. Based on morphological and molecular analysis of internal transcribed spacer sequence (ITS) and trnL F gene the genus *Musa* is represented by four wild species viz., *M. acuminata* Colla, *M. balbisiana* Colla, *M. inandamanensis* L.J. Singh, *M. paramjitiana* L.J. Singh and two cultivated forms of *Musa* viz., *M. xparadisiaca* L. and *M. textilis* Nees in the ANI (Singh et al., 2020a,b; Maurya et al., 2023). The fast increasing human population and subsequent demand on natural resources including development related activities, other wild species of *Musa* are also vanishing from the ANI archipelago (Singh, 2014, 2017).

Additionally, invasive arthropod herbivores also threaten wild banana species. To date, no lepidopteran, Banana Skipper has been implicated as a pest of any naturally occurring *Musa* spp. in the ANI.

## Material and Methods

Observed live plant and butterfly specimens through ten field trips to localities where natural populations occur (Wimberlygunj, Humpfrygunj, Manglutan, Memyo, Pongibalu, Rutland, Little Andaman) as well as *ex-situ* *Musa* conservation sites (DEGCA, BSI, ANRC) throughout 2017–2022. Eggs of *E. torus* were collected along with the infested *Musa* leaf of *M. balbisiana* Colla, *M. acuminata* Colla and *M. inandamanensis* L.J. Singh. GPS (Garmin Montana 680) coordinates of the localities of wild population were recorded. *E. torus* eggs along with the host plants were placed in a separate sterile labeled plastic container. The droppings of the larva were cleaned periodically and fresh leaves of the host plants were replaced on daily basis. The larval stages of *E. torus* were monitored daily, documented, and photographed. The eggs of *E. torus* laid on the leaves of the plant were observed and photographed under a stereomicroscope (Olympus SZ 61) at the ANRC, BSI.

## Result

Based on field exploration conducted during the period 2017–2022, critical analysis of morphological

characters, and scrutiny of relevant literature, and examination of the herbarium specimens kept in Indian herbaria (PBL) and digital herbaria (e-Floras, 2008; WCSP, 2012; The Plant List, 2013; POWO, 2019; GBIF, 2020; JSTOR, 2020 & The Herbarium Catalogue, 2021), four wild species recorded in the Islands of which three species were recorded as a host plant for the butterfly, *E. torus* as mentioned below:

### Taxonomic Notes on host plants

*Musa* L. (Musaceae)

*Musa acuminata* Colla Mem. Reale Accad. Sci. Torino 25: 394 (1820)

It is recognized by yellowish green with brown or black blotched pseudostems up to 5 m height. Inflorescence ovate, red or dark purple bracts with often yellow blotched. Fruits linear, mostly curved with bottle necked apex, green to yellow-green, 5-angled when young, Seeds irregular in shape, angled, dull black in colour.

*Distribution / Locality selected for in-situ Observations:* East Island Wildlife Sanctuary and Saddle Peak of North Andaman, Kadamtala, Middle Andaman, Jirkatang and Tirur Reserved Forest of South Andaman, Navy Dera, Great Nicobar, Nicobar Islands, *ex-situ* Conservation sites: DEGCA, BSI, Nayashahar, South Andaman (Fig.1).

*Habitat:* Evergreen forests, Semi-evergreen forests

*Conservation status:* Earlier it was it was assessed as Least Concern (IUCN 3.1).

During botanical explorations conducted between 2019–2023 it was observed that the natural habitat is hill evergreen forest, stream margins and edges of open secondary forest which is very sparse in distribution and confined only in few localities. The natural habitat was threatened by anthropogenic activities such as developmental activities. The habitat situated in the fringe areas was under severe pressure of anthropogenic activities such as shifting of land for cultivation, construction of roads, over exploitation as decorative materials on auspicious occasions and many others. Because of the

low AOO (30 km<sup>2</sup>), decline of suitable habitats and only limited *ex-situ* conservation efforts in these islands, the Endangered (EN) category is applied (EN B2ab [ii]).

*Musa balbisiana* Colla Mem. Reale Accad. Sci. Torino 25: 384 (1820)

*Distinguishing features:* It is recognized by pseudostems up to 9 m long, stout, dark green or yellow-green, often with large, black markings, sometimes dull with powdery appearance, inflorescence with ovate to lanceolate bracts, bracts adaxially purple-red or brown purple with green striations and green tip outside when young or purplish maroon with striations, abaxially brownish purple to yellow-green and pruinose, fruits green or gray-green, obovoid or fingers pointed toward the peduncle, sometimes almost round, fruit pulp white or cream with brown, oblate numerous seeds.

*Distribution / Locality selected for in-situ Observations:* North Andaman: Jaganthdera, Middle Andaman: Near Panchawati, Kalsi, **South Andaman:** Badamash Pahar, Wandoor, Memyo, Lohabarrack, Tytlerghat, Little Andaman: Near Ramakrishnapur, Hutbay *ex-situ* Conservation sites: DEGCA, BSI, Nayasahar, South Andaman (Fig.1).

*Habitat:* Evergreen forests

*Conservation status:* Earlier it was it was assessed as Least Concern (IUCN 3.1).

During botanical explorations conducted between 2019–2023 it was observed that the natural habitat of this species is confines to the margins of water streams and edges of fringe forests. In the islands parts of this banana specially pseudostem, leaves, inflorescences are used as decorative materials on auspicious occasions. The people belonging to Bengali and Ranchi community consume inflorescence bud and fruits as vegetables. It was observed that there is a decline of suitable habitats due to anthropogenic pressure such as developmental activities, over exploitation etc. Because of the low AOO

(30 km<sup>2</sup>), decline of suitable habitats and only limited *ex-situ* conservation efforts in these islands, the Endangered (EN) category is applied [EN B2ab (ii)].

*Musa indandamanensis* L.J. Singh Taiwania 59: 27 (2014)

*Distinguishing features:* It is recognized by the plant stature up to 12 m height with girth of 45 to 110 cm, mature pseudostem robust, covered with brownish leaf sheath underlying colour yellowish green with brownish red/ or rusty red colour, young pseudostem light green with silvery white appearance, much long cylindrical inflorescence with dark green bracts, bracts deeply imbricate with incised apex, over 4 meter long infructescence (fruiting axis), Fruits golden yellow or orange when ripened with orange fruit pulp and plenty of viable seeds.

*Distribution/Locality selected for in-situ Observations:* Little Andaman: Krishnanallah, Prabhash Mundi, Nicobar Islands: 15-16 Km East-West Road, Great Nicobar, Campbell Bay, *ex-situ*

*Conservation sites:* DEGCA, BSI, Nayasahar, South Andaman (Fig.1).

*Habitat:* Evergreen forests

*Conservation status:* Earlier it was it was assessed as considered critically endangered and threatened (Singh 2014). During botanical explorations conducted between 2019–2023 in the natural habitat only three to four clumps of plants were seen in natural habitats with 5 to 6 individuals. There is a decline of suitable habitats due to anthropogenic pressure such as overexploitation for various purposes. All parts including pseudostems used as ornamentals on auspicious occasions, and leaf harvested for platter etc. Further it is noticeable that are continuous damage due to feeding behavior of the elephants in some of the natural habitats in the islands. Because of the low AOO (30 Km<sup>2</sup>) decline of suitable habitats and only limited *ex-situ* conservation efforts in these islands, the Endangered (EN) category is applied [EN B2ab (ii)].

**Table 1: Musa species that were recorded as larval host plant for *E. torus***

Sl. No.	Plant species	Family	Location where reported	Record of references
1.	<i>Musa acuminata</i> Colla	Musaceae	Group of Andaman Islands	<b>Present study</b>
2.	<i>Musa balbisiana</i> Colla	Musaceae	India (West Bengal), Andaman & Nicobar Islands	Karmakar <i>et al.</i> , 2018 <b>Present study</b>
3.	<i>Musa inandamanensis</i> L.J. Singh	Musaceae	Andaman & Nicobar Islands	<b>Present study</b>
4.	<i>Musa nana</i> Lour.	Musaceae	West Malaysia	Robinson <i>et al.</i> , 2010, 2023
5.	<i>Musa paradisiaca</i> L.	Musaceae	India (Eastern & Western Ghats, North-Eastern Region) Hong Kong Oriental Taiwan West Malaysia	Nitin <i>et al.</i> , 2018; Karmakar <i>et al.</i> , 2018; Sarang <i>et al.</i> , 2020 & Jambagi <i>et al.</i> , 2022 Robinson <i>et al.</i> , 2010, 2023
6.	No information about species has been reported in the literature.	Musaceae	India (Andaman & Nicobar Islands) India (Southern & North Eastern Region),  Taiwan	<b>Present study</b>  Jayanthi <i>et al.</i> , 2015 Raju <i>et al.</i> , 2015 Naik <i>et al.</i> , 2016 Sharanabasappa <i>et al.</i> , 2016 Reddy & Hemadri 2018 Jaleel & Ghosh 2020 Jaleel <i>et al.</i> , 2021 Tsai <i>et al.</i> , 1990 Chiang and Hwang (1991). Cock, 2015

**Note**

1. The local people are not concerned about the conservation of wild banana species since the fruit is not a choice local people because of the plenty of seeds and very less quantity of pulp. Therefore, it raises a serious concern about the conservation of wild germplasm of banana.
2. One of the wild banana species, *M. paramjitiana* L.J. Singh is only known from its type collections. Based on protologue and type specimens, it is characterized by the leaf habit intermediate; lamina 250–260 x 45–70 cm, obliquely subcordate at base, cuspidate at apex, petiole margins closed with imbricate and overlapping petiole bases, margins curved inwards, bases winged and clasping the pseudostem. Bract sage green, dimorphic, sterile bract with very long attenuate

apex; fertile bract with umbulate apex; adaxially sage/grey green, yellow green towards apex, base and margins scarlet (vivid red with a touch of yellow, and abaxially vermilion, sometimes ferruginous rust colour), Compound tepals, pandurate glove shaped, orange with prominent striations, fringed, 5-lobed (toothed) with cuspidate lateral lobes ending in a fine thread like structure. Free tepal with margins curved inwards and loosely clasping with two lateral horn like structures, fruits citrine, the dull greenish yellow peel turning golden yellow with brownish red blotches when mature, boat-shaped with persistent floral remains, apricot (orange pink) pulp and plenty of seeds. During field surveys it was observed that the natural habitat of this species was completely shifted in cultivation and pathway. There is no single living individual left in that locality and neither located in

any other locality. Due to non-availability of the plant individuals of *M. paramjitiana* L.J. Singh either in their natural habitats or in *ex-situ* conservation sites, the information about the infestation of larvae of *E. torus* could not be recorded. In the present study it was noticeable that the occurrence of the adult butterflies, along with immature life-stages, feeding in remarkably large numbers on banana leaves of cultivar plantation, from an area close to the earlier recorded natural habitat (now completely lost) of *M. paramjitiana* L.J. Singh. Besides, the infestations of *E. torus* were also observed in cultivated crops of *Musa* throughout the islands. As per DEGCA, BSI, ANRC record few rhizomes and seedlings (collected from type locality) of *M. paramjitiana* L.J. Singh were transplanted by the protologue author in 2013 but failed to survive. Gardener stated that it was noticed that leaves of seedlings were feeded by such type of larvae causing the death of plants. In the present study we have recorded the banana skipper' or 'banana leaf roller butterfly herbivory on other wild banana species at DEGCA grown under *ex-situ* conservation which indicates that it might be one of the reasons for non survival.

### Notes on pest of *Musa* spp. (Fig.2-5)

#### *Erionota torus* Evans, 1941 (Lepidoptera: Hesperidae)

The butterfly genus *Erionota* in the family Hesperidae was established by Mabille (1878) which is well known

as 'the banana skipper' or 'banana leaf roller'. It is a serious defoliator of banana in East Asian countries (Okolle *et al.*, 2006). *Erionota* Mabille (Lepidoptera: Hesperidae) consists of seven species and distributed in the oriental region of the world (Evans, 1949). In India the genus is represented by 03 species viz.: *E. thrax* (Linnaeus), *E. torus* Evans and *E. acroleuca* (Wood-Mason and de Niceville) (= *E. hiraca* (Moore) (Cock, 2015). Preliminary accounts by Veenakumari *et al.* (1991) claimed the distribution of sub species, *E. thraxthrax* L. in the ANI without appropriate observation (Cock 2015). The account by Naik *et al.*, (2016) mentions that the distribution range of *Erionota thrax* is North Eastern states (Assam, Manipur) of India and *Erionota torus* has prominence in the peninsular India. The butterfly is distributed to Uttarakhand to N.E. India; Karnataka, Kerala, Tamil Nadu (Varshney & Smetacek, 2015). In the present study the distribution of *E. torus* has been reported from ANI for the first time.

In the tropical zone of ANI more infestations on *Musa* host plants were recorded in dry season as comparison to the rainy season. During infestations the various predators viz. *Centropus andamanensis* (Andaman coucal), *Corvus splendens* (House crow), *Dicrurus paradiseus* (Greater Racket tailed drongo), *Oecophylla smaragdina*, *Heimdactylus frenatus* (common house gecko), parasitoids and spider etc were visited and observed that associated with damaging eggs and feeding of larvae.

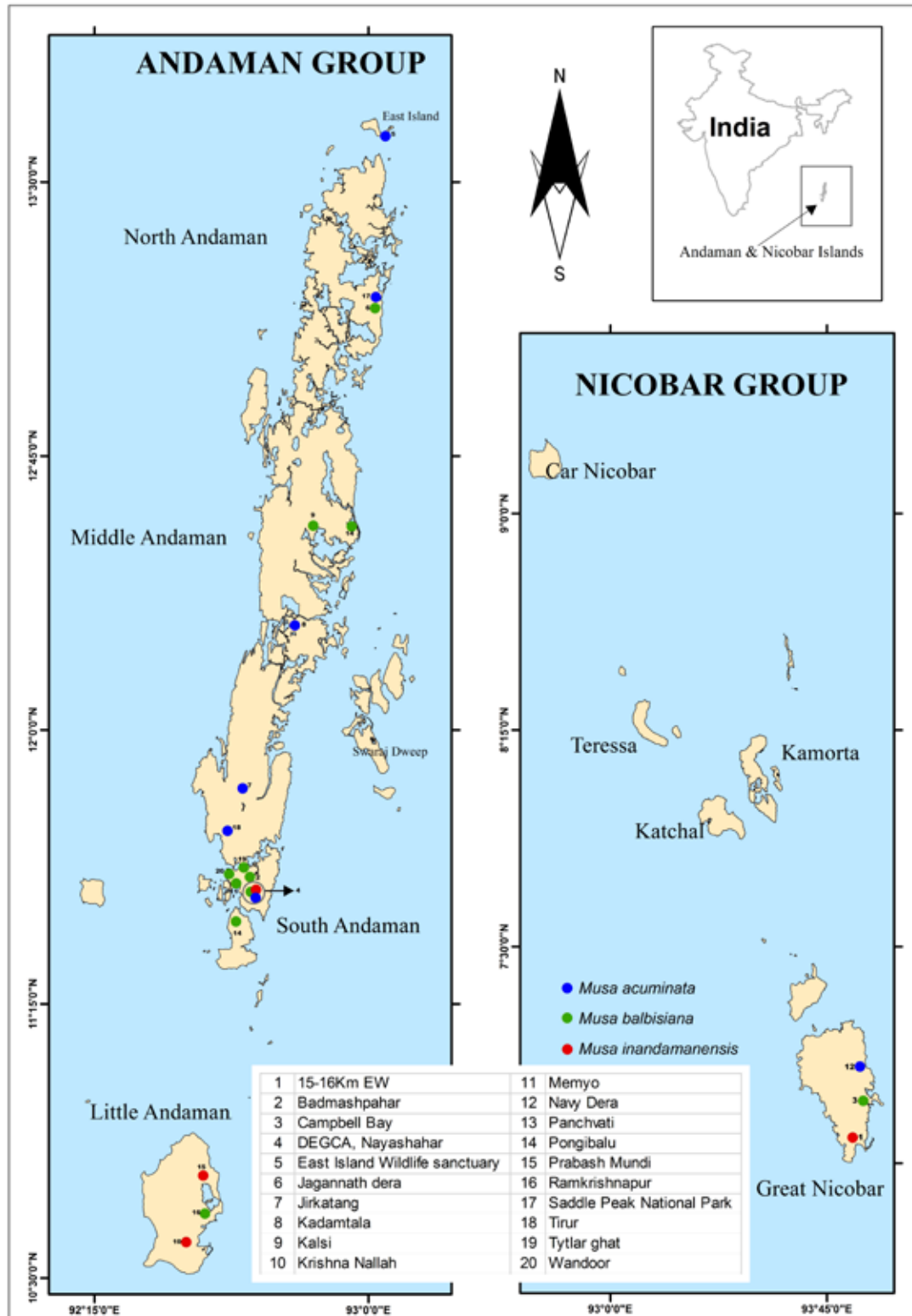


Fig.1. Distribution and study localities of *Musa* species used as food by *Erionota torus*

The banana skipper oviposits eggs singly or in clusters on the underside of the *Musa* leaf and sometimes on the upper surface of the leaf. After the larvae hatches out from the egg shell it starts feeding on the outer egg shell and thereafter moves towards the leaf edge. The larvae tear off the leaf thereby rolls up the leaf with the help of silk strands and lives inside the leaf roll and consumes the leaf from within. Thereafter a few days it converts into pupa stage and pupates. After a period of  $10 \pm 11$  days the butterfly emerges out.

The butterfly lays eggs on the mature leaves near to the tips of the leaves. After the emergence of the larvae from the eggs, these larvae consume the leaves and hide themselves while rolling the leaves. They extensively damage the broad lamina of the leaves making it unfit for use for human utilization. The broad leaves are cut and used as plates in various pujas and festivals. The damage of leaves by this larva.

### ***Life cycle of the E. torus***

**Eggs:** The female butterfly of *E. torus* lays eggs singly or in clusters on the underside of the leaf lamina. The clusters of egg may range to 13 to 22 in numbers. The eggs are dome shaped with 22 to 25 longitudinal lines running from the apex to the base. The diameter of the egg measured to be 1.94 mm. The eggs appear white with light pinkish in colour. The egg takes 6-7 days to hatch out. Before the hatching the eggs turn into white colour and the apex shows a black mark which is the black head of the developing larvae.

**First Instar:** The first instar larvae immediately after the emergence from the egg starts consuming the egg shell and thereafter move towards the edge of the leaf margin and cut the leaf and roll the leaf making a shelter and starts consuming the leaf from within the rolled-up *Musa* leaf. The fold of the leaf is simple with a single fold made concealed with silk strands. The larvae appear whitish or sometimes creamish yellow in colour with a black head and measures up to 6 mm in length.

**Second Instar:** The second instar is pale green in colour and a black head. It measures up to 10 mm in length.

**Third Instar:** The third instar larvae develop white powdery layer on its body and measures upto 11 mm in length.

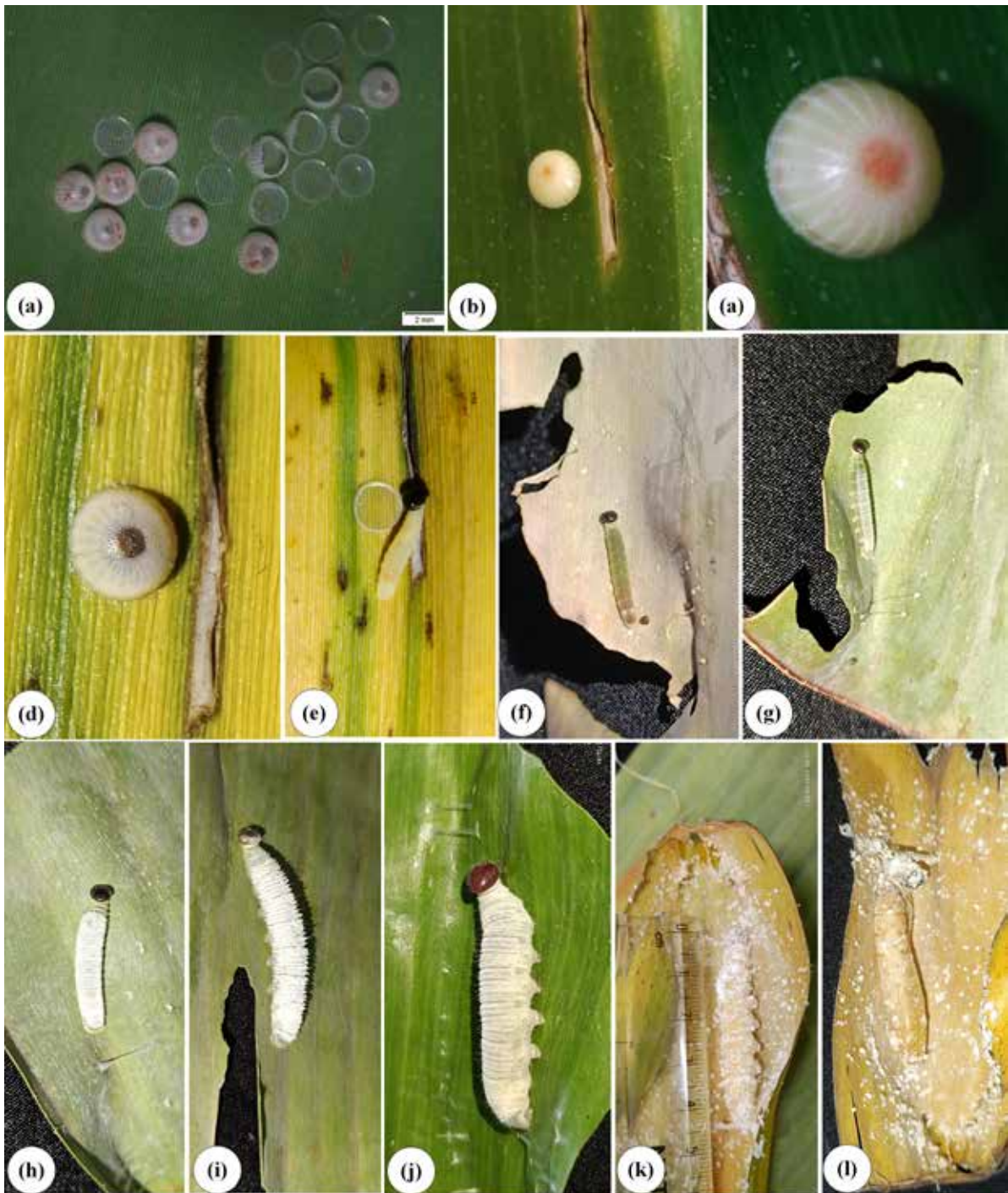
**Fourth Instar:** The fourth instar larvae head is reddish brown in colour. Later the body also gets covered with whitish powder and its length measures up to 35 mm in length.

**Fifth Instar:** The fifth instar is same as the fourth instar and length measures up to 55 mm in length.

**Pre-Pupa:** The pre pupa measures 45 mm in length and is pale brown in colour and is covered with whitish powder.

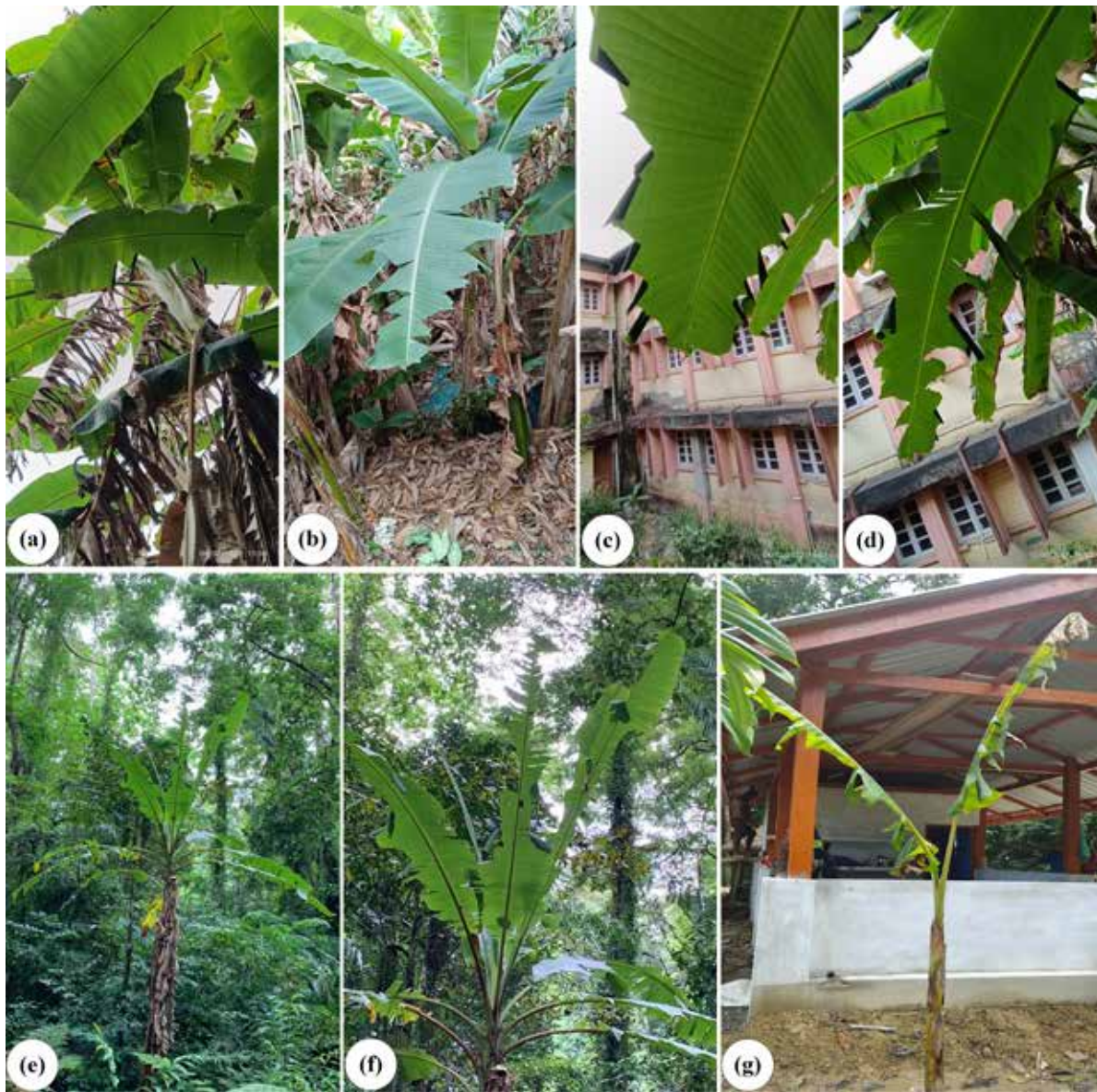
**Pupa:** Pupa is pale yellow covered with whitish powder and its length measures up to 4 mm in length. The pupa stage lasts up to 10 to 11 days. And thereafter the adult butterfly emerges out.

The butterfly is dark brown in colour with markings on forewing. It takes  $38 \pm 40$  of days to complete its life cycle on *Musa* leaves.



**Fig. 2.** Life history traits of *Erionota torus*; (a). eggs on underside of leaf lamina; (b). egg on upper side of leaf lamina; (c). view of enlarged egg; (d). view of egg before hatching of larva; (e). first instar larva; (f). second instar larva; (g). third instar larva; h. third instar larva showing development of powdery layer; (i). fourth instar larva; (j). fifth instar larva; (k). pre pupa; (l). pupa





**Fig.3. Damage to Musa leaves caused by *Erionota torus* herbivory; (a-b): *Musa acuminata* (c-d): *M. balbisiana*; (e-f): *M. inandamanensis*; (g): *M. x paradisiaca*.**

### ***Morphology and Description of butterfly***

The butterfly is dark brown in colour. The forewing shows 3 yellowish spots. The hind wing is plain brown in colour. The wingspan is 75 mm in length. The eyes of the butterfly show prominent rounded reddish in color with a black centre.

### ***Impact of E. torus on Host Plants***

The larvae of *E. torus* destroy the leaf lamina of *Musa* by making leaf rolls and continuously feeding on the mature leaves as a result of which the leaf area of the plant decreases as a result of which the photosynthetic activity is affected leading to poor fruit yield. The infected banana shows many leaf rolls on either side of the leaf lamina edges. As the female butterfly oviposits the eggs in masses on the underside of the leaf lamina,

the hatched-out larva after its emergence all move to the edges of the leaf lamina, each larva is seen making separate leaf rolls independently and eat leaf from within. The butterfly mostly attacks the mature leaves rather than the young ones. It is easy for them to make leaf rolls on mature leaves since they get a larger surface area of the leaf lamina for keep rolling the leaves and surviving within the roll till their life cycle is complete. The leaf roll provides the larvae shelter safeguarding them against hot sun and rains. The larvae roll the leaf with the help of silk strands and keep them secure from predators.

It has been observed that when the plant is growing isolate with few leaves on the banana and if the plant leaf infected. The whole leaf lamina is being consumed by the larvae leaving behind only the rachis which when left unmonitored lead to the death of the plant. The present study revealed that larvae of banana leaf roller butterfly, *E. torus* herbivory pose a grave threat to wild as well as cultivated population in the tropical ecosystem of ANI. *Musa indandamanensis* L.J. Singh was the most damaged species of ANI. Its population is very few and confined in distribution.

## Discussion

Studies on the wild banana species of ANI was carried out by various workers which includes morphological characterization, population assessment, molecular analysis (ITS and trn L-F gene, plastome analysis) and conservation assessment (Singh 2014, 2017; Singh et al. 2020a,b; Maurya et al. 2023). We recorded here for the first time *Musa* species as new host plants along with conservation status based on IUCN category (IUCN 2020) and life history traits of its pest in great detail from ANI, India.

During the present study it has been observed that some of the cultivated *Musa* which were growing adjacent to the BSI complex were found to be infected with the larvae of *E. torus*. After few days it was also observed that the wild germplasm that were planted in the garden of BSI complex were also found to be infected with the larvae as the many leaf rolls could be seen in the wild *Musa* spp. such as the *M. acuminata* Colla, *M. balbiasiana* Colla and *M. inandamanensis* L. J. Singh.



Fig. 4. *Erionota torus* butterfly: (a-b): adult butterfly; (c): upperside; (d): underside

Similar observations were made in DEGCA where the wild germplasms of *Musa* were infected from the adjacent infected cultivated *Musa* in the settlement areas. It is noticeable that the natural population of wild *Musa* sp. in the forest areas, situated near to the inhabited area practicing banana cultivation were severely attacked and damaged by *E. torus*. It is evident that *E. torus* herbivory pose a grave threat to wild *Musa* population. During field studies it was observed that there is a decline of suitable habitats of wild *Musa* population due to anthropogenic pressures.

During the field surveys found that the wild populations of *Musa* spp. are declining day by day due to anthropogenic pressures, an appropriate management and conservation strategies are required for avoiding further declining/ 'Extinction of the Wild population of *Musa*. This has already been stated earlier by Singh (2014 & 2017). Recently one of the critically endangered wild banana species *M. paramjitiana* L.J. Singh of Islands is known only by type collection and tagged as 'Possibly Extinct' (Singh et al. 2020b). During present study it was observed that the natural habitat of *M. paramjitiana* L.J. Singh was found disturbed substantially by the local inhabitants and cultivar of that area was infested by *E. torus*.

In the present study *ex-situ* conservation of wild *Musa*, DEGCA was also observed which is situated in close proximity of the inhabitants of Nayasahar village. The villagers cultivate the local variety of banana cultivars of banana which are infested by larvae of *E. torus*. In the DEGCA four wild *Musa* species viz. were transplanted, of which one of the species, *M. paramjitiana* L.J. Singh failed to survive. After inquiry and discussion with gardeners of DEGCA, after some months of plantation, the young leaves of the plant of this species were rolled out and consumed by some insect larvae which led to the death of the plant. Currently this species is neither located in any natural habitats nor at *ex-situ* conservation sites. Remaining three species are surviving. But in the present study it was found that the wild germplasm of *Musa* spp.

was under the infestation of *E. torus* larvae at this *ex-situ* conservation site. It is more possible that the butterfly *E. torus* has spread from the local cultivars of Nayashahar village and entered into the *ex-situ* site DEGCA. *M. paramjitiana* L.J. Singh were transplanted as a part of *ex-situ* conservation at DEGCA in 2013 but failed to survive. It seems that herbivory of *E. torus* might be one of the factors for its non survival. Insect herbivory at *ex-situ* site (DEGCA) and cultivar area situated near to natural habitat of *M. paramjitiana* L.J. Singh and other banana indicates that banana leaf roller butterfly, *Erionota torus* pose a grave threat to *Musa* population. It might be the one of the reason for disappearance of *M. paramjitiana* L.J. Singh from natural habitat. The present study revealed that the fast-increasing anthropogenic pressures in these islands which include development related activities, other wild species of *Musa* will also vanish from the ANI in near future. In addition to anthropogenic activities, invasive arthropod herbivory is one of the serious threats. The findings of the present study are relevant for the strategy and management plan of *in-situ* as well as *ex-situ* conservation of important wild gene-pools of *Musa* spp. in India.

In the present study, it was noticed that the among the three wild species of *Musa*, the *E. torus* larvae infection was found to be more on the leaf lamina on *M. balbisiana* Colla, as more leaf rolls on the leaf margins could be seen. The second most infested species was found to be on *M. acuminata* Colla and the third to be the *M. indandamanensis* L.J. Singh. The more leaf rolls in *M. balbisiana* Colla may be due to the broad leaf lamina which allows the larvae to completes its life cycle. The fruits of *M. indandamanensis* L.J. Singh are very sweet in nature and are frequently visited by birds, as a result of which the larvae are also predated and therefore the infection rate may be low. Moreover, as the leaf lamina is not so broad, the larvae have to make new rolls in order to survive. Sometimes when the leaf rolls are consumed and when the larvae go making a new roll in later stages, the larvae get exposed and are attacked and predated by birds, lizards, parasitoids and spider.



**Fig.5.** Predators of *Erionota torus*; (a): *Dicrurus paradiseus*; (b): *Centropus andamanensis*; (c-d): parasitoids.

### Conclusions

Banana skipper herbivory on wild banana species has been described in great detail for the first time in the present study however except for a few notable exceptions like *M. balbisiana* Colla (Karmakar *et al.*, 2018), majority of the studies have been recorded only on cultivars. Despite of having threats by natural predators, herbivory of *E. torus* poses a grave pressure to the both *ex-situ* and in situ population of *Musa* in the ANI.

The present study has revealed that the wild *Musa* spp. serve as preferred host for *E. torus* (Lepidoptera: Hesperidae). Three wild *Musa* spp.; *M. acuminata* Colla, *M. balbisiana* Colla and *M. inandamanensis* L.J. Singh have been reported here for the first time as larval host plants in the ANI, India of them *Musa inandamanensis* L.J. Singh severely infested endemic banana species in the ANI which is struggling for survival. Due to drastic disappearance of natural habitat and other anthropogenic impact the conservation status of these wild banana species

in the ANI is accessed here as ‘critically endangered and threatened’ as per the IUCN category (IUCN 2020). One of the wild banana species is tagged as ‘Possibly Extinct’ (Singh *et al.*, 2020b).

During field surveys of the present study *M. paramjitiana* L.J. Singh was not spotted from any natural locality and seems that failed to survive under *ex-situ* conservation due to herbivory by *E. torus* and. we revealed that banana leaf roller butterfly herbivory might be the one of the reason for disappearance of *M. paramjitiana* L.J. Singh from natural habitat.

According to Chiang (1988) the banana skipper infestation rates were higher in spring and autumn winter seasons. As the site of present study, ANI has impact of climate of tropical zone where severe infestations of *Musa* spp. was observed. It is noticeable that wild populations of *Musa* spp. growing adjacent to the cultivated ones are more widely affected than those growing in the interior wild *Musa* spp. in the ANI. The preference of wild

species may be indication of threat for extinction of wild germplasm of banana in the tropical zone. Therefore, invasive arthropod herbivory is one of the serious threats to wild banana population in these Islands. However, it is *E. torus* is a serious pest on banana cultivation. (Chiang & Hwang, 1991; Cock, 2015; Irulandi *et al.*, 2018). During the present study concluded that only those areas of wild banana species located near banana plantation (cultivars) are severely infested by *E. torus* only which indicates that the colonization of this pest species widespread from cultivation to wild habitats. Occurrence of banana skipper herbivory on wild banana species indicates the linkage of evolution of both pests and host species. The data presented here might be more significant in future study of biology and conservation strategy of host as well as butterfly.

### Acknowledgements

The authors are grateful to the Director, Botanical Survey of India, Kolkata for constant support. Authors are thankful to the Department of Environment and Forests, Andaman and Nicobar Islands for giving necessary permission and providing logistic support during the field studies. The authors are thankful to Dr. Debasis Bhattacharya, Editor in-Chief, Journal of Andaman Science Association and anonymous reviewers for critical comments and suggestions that helped to improve the manuscript. The authors are thankful to scientists and staff of Botanical Survey of India, Andaman and Nicobar Regional Centre (PBL), who have always shown readiness for help.

### References

- Chiang, H.S., & Hwang, M.T. (1991) The banana skipper, *Erionota torus* Evans (Hesperidae: Lepidoptera): establishment, distribution and extent of damage in Taiwan. *Tropical Pest Management*. 37: 207-210.
- Chiang, H.S. (1988) Bionomics and control of Banana skipper, *Erionota torus* Evans in Taiwan. *Chinese Journal of Entomology, Special Publication*. 2:67-174
- Cock, M.J. (2015) A critical review of the literature on the pest *Erionota* spp. (Lepidoptera-Hesperiidae): taxonomy, distribution, food plants, early stages, natural enemies and biological control. *CAB Reviews*. 10: 1-30.
- E-Floras (2008) Missouri Botanical Garden, St. Louis, M.O. & Harvard Univ. Herbaria, Cambridge, M.A.–<http://www.efloras.org>, accessed 9 September 2023.
- Evans, W.H. (1949) A Catalogue of the Hesperidae from Europe, Asia and Australia in the British Museum (Natural History). British Museum (Natural History), London. 502 pp, 53 plates.
- G.B.I.F. (2020). GBIF backbone taxonomy. <https://www.gbif.org/species>, accessed 13 January 2023.
- Gunawardana, B.R., Wijewardana, G.V.I.H., Herath, H.M.B.E., & Priyadarshana, T.M.T.S. (2015) *Erionota torus* Evans, 1941: A new record for Sri Lanka with notes on its biology (Lepidoptera: Hesperidae). *Wildlanka*, Vol. 3, No. 3, pp. 178–183.
- Irulandi, S., Manivannan, M.I., & Kumar, R.A. (2018) Bio-ecology and management of the banana skipper, *Erionota thrax* L. (Hesperiidae: Lepidoptera). *Journal of Entomology and Zoology Studies*. 6: 262-265.
- I.U.C.N., (2020). The IUCN red list of threatened species, ver. 2020–2. IUCN Red List Unit.
- Jaleel, K.A., & Ghosh, S.M. (2020). Biology and damage of banana skipper *Erionota torus* (Evans) from Malabar region of Kerala. *Indian Journal of Entomology*. 82: 429-434.
- Jaleel, K.A., Jayakrishnan, T.V, & Ghosh, S.M. (2021) Shelter building behaviour of *Erionota torus* Evans (Lepidoptera): Hesperidae) caterpillars feeding on banana leaves. Uttar Pradesh. *Journal of Zoology*. 42: 1-9.
- Jayanthi, P.D.K., Reddy, P.V.R., Kempraj, V., & Shashank, P.R. (2015) Outbreak of banana skipper, *Erionota torus* Evans (Lepidoptera: Hesperidae) in Southern India: Evidence of expanded geographic range. *Pest Management in Horticultural Ecosystems*. 21: 95-97.
- J.S.T.O.R., (2020) Global plants. Journal Storage, Ithaka, <https://plants.jstor.org>, accessed 28 July 2023.

- Karmakar, T., Nitin, R., Sarkar, V., Baidya, S., Mazumder, S., Chandrasekharan, V.K., Das, R., Kumar, G.S.G., Lokhande, S., Veino, J., Veino, L., Veino, R., Mirza, Z., Sanap, R.V., Sarkar, B., & Kunte, K. (2018) Early stages and larval host plants of some northeastern Indian butterflies. *Journal of Threatened Taxa*. 10: 11780–11799.
- Mabille, (1878) *Catalogue des Hespérides du Musée Royal d'Histoire Naturelle de Bruxelles. Annales de la Société Entomologique de Belgique*. 21: 12-44.
- Marler, T.E., Lindstrom, A.J., & Terry, L.I. (2012a) *Chilades pandava* damage among 85 *Cycas* species in a common garden setting. *Hortscience*. 47: 1832–1836.
- Marler, T.E., Lindstrom, A.J., & Terry, L.I. (2012b) Information-based or resource-based systems may mediate *Cycas* herbivore interactions. *Plant Signal & Behavior*. 7: 760–762.
- Maurya, S., Barvkar, V.T., Choudhary, R.K., Singh, L.J., Dwivedi, M.D., Naik, M.C., Ekka, G.A., Kandwal, M., Mathur, R.R., & Pandey, A.K. (2023) Plastome characterization of *Musa indandamanensis*, an endemic banana in Andaman and Nicobar Islands, India. *The Nucleus*. 66: 117-126.
- Naik, S.O., Jayashankar, M., & Sridhar, V. (2016) Incidence of Invasive Banana Skipper, *Erionotatorus* Evans (Lepidoptera: Hesperiiidae) in Karnataka. *The Bioscan*, 11: 2117-2120.
- Nitin, R., Balakrishnan, V.C., Churi, P.V., Kalesh, S., Prakash, S., & Kunte, K. (2018) Larval host plants of the butterflies of the Western Ghats, India. *Journal of Threatened Taxa*, 10:11495–11550.
- Okolle, J.N., Mansor, M., & Abu, H.A. (2006) Spatial distribution of banana leaf roller (*Erionota thrax* L.) (Hesperiiidae : Lepidoptera) and its parasitoids in a Cavendish banana plantation, Penang, Malaysia. *Insect Science*. 13: 381-389.
- P.O.W.O., (2019). *Plants of the World Online*. Facilitated by the Royal Botanic Gardens, Kew, [www.plants of the world online.org](http://www.plants of the world online.org), accessed 1 May 2023.
- Purti, N., Singh, L.J., & Pandey, A.K. (2023a) Life history traits of cycad blue butterfly, *Luthrodes pandava* Horsfield (Lepidoptera: Lycaenidae) on cycad hosts in an Island ecosystem. *Feddes Repertorium*. 135:44-58.
- Purti, N., Singh, L.J. & Pandey, A.K. (2023b). New hosts for the Andaman Baron butterfly, *Euthalia aconthea acontius* (Hewitson, 1874) (Lepidoptera: Nymphalidae) in an Island Ecosystem. *Journal of Andaman Science Association*. 28: 173-187.
- Purti, N., Singh, L.J., & Pandey, A.K. (2022) New hosts for the cycad blue butterfly, *Luthrodes pandava*, Horsfield (Lepidoptera: Lycaenidae) in an Island ecosystem. *Feddes Repertorium*.133: 234-243.
- Raju, D., Kunte, K., Kalesh, S., Manoj, P., Ogale, H., & Sanap, R. (2015) *Erionota torus* Evans, 1941 - Rounded Palm-red eye. Kunte, K., P. Roy, S. Kalesh & U. Kodandaramaiah (eds.). *Butterflies of India*, v. 2.20, Indian Foundation for Butterflies, a website. <http://www.ifoundbutterflies.org/sp/2756/Erionotatorus>, accessed 19 August 2023.
- Reddy, D.S., & Hemadri, T., (2018) First Occurrence of Banana Skipper (*Erionota torus*) in Kodur Region of Andhra Pradesh, India. *International Journal of Current Microbiology and Applied Sciences*. 7: 1081-1084.
- Robinson, G.S., Ackery, P.R., Kitching, I.J., Beccaloni, G.W., & Hernández, L.M. (2010) *HOSTS A Database of the World's Lepidopteran Host plants*. Natural History Museum, London. <http://www.nhm.ac.uk/hosts>, Electronic version accessed on 18 August 2023.
- Robinson, G.S., Ackery, P.R., Kitching, I.J., Beccaloni, G.W., & Hernández, L.M. (2023) *HOSTS (from HOSTS-a Database of the World's Lepidopteran Hostplants)*. [Data set resource]. Natural History Museum. <https://data.nhm.ac.uk/dataset/hosts/resource/877f387a-36a3-486c-a0c1-b8d5fb69f85a>
- Sarang, S., Chandorkar, N., Mehendale, T., Khule, G., Nair, A., Damle, O., & Kasambe, R. (2020) Distributional range extension of banana skipper *Erionota torus* (Lepidoptera: Hesperiiidae) to Thane and Palghar districts of Maharashtra, India with

- discussion about its harmful effects on local banana plantations. *Bionotes*. 22:158-162.
- Sharanabasappa, Kalleshwaraswamy, C.M., Nagarajappa, A, & Lavanya, M.N. (2016) Population dynamics and natural enemies of *Erionota torus* Evans (Lepidoptera: Hesperidae) on two cultivars of banana in Karnataka. *Pest Management in Horticultural Ecosystems*. 22: 34-39.
- Singh, L.J. (2014) *Musa indandamanensis* L.J. Singh, a new species of wild banana genus *Musa* (Musaceae) from Bay Islands, India. *Taiwania*. 59: 26–36.
- Singh, L.J. (2017) *Musa paramjitiana* sp. nov. (Musaceae) from Andaman and Nicobar Islands, India. *Nordic Journal of Botany*. 35: 77–84.
- Singh, L.J, & Ranjan, V. (2021) New vistas in Indian Flora.1 & 2. Bishen Singh Mahendra Pal Singh, Dehra Dun, Uttarakhand, India, pp. 417, 819.
- Singh, L.J., Murugan, C, & Singh, P. (2014) Plant Genetic Diversity of Endemic Species in the Andaman and Nicobar Islands. In: National Conference on Islands Biodiversity, U.P. State Biodiversity Board, Lucknow. 49–57.
- Singh, L.J., Dwivedi, M.D., Kasana, S., Naik, M. C., Ekka, G. A, & Pandey, A. K. (2020a) Molecular systematics of the genus *Musa* L. (Zingiberales: Musaceae) in Andaman and Nicobar Islands. *Biologia*. 75:1825–1843.
- Singh, L.J., Ekka, G.A., Mishra, S., Vivek, C. P., Shiva Shankar, V., Naik, M. C, & Saleem, F. (2020b) Habitat status of *Musa paramjitiana* L.J. Singh (Musaceae): a critically endangered, endemic species in Andaman and Nicobar Islands, India. *Pleione*. 14:121–127.
- Singh L.J., Ekka G.A., Vivek, C.P, & Misra, D.R. (2021a) Gymnosperms of the Andaman and Nicobar Islands: An Overview. In: Singh LJ, Ranjan V. (eds.), *New Vistas in Indian Flora*, Bishen Singh Mahendra Pal Singh, Dehra Dun, India, 1: 265–278.
- Singh, L.J., Ranjan, V., Sinha, B. K., Mishra, S., Purohit, C.S., Vivek, C.P., Naik M.C, & Ekka, G.A. (2021b) An Overview of Phytodiversity of the Andaman and Nicobar Islands. In: Singh, L.J. & Ranjan, V. (eds.), *New Vistas in Indian Flora*, Vol. 1. Bishen Singh Mahendra Pal Singh, Dehra Dun, pp. 381–399.
- The Herbarium Catalogue (2021) Royal Botanic Gardens, Kew, [www.kew.org/herbcat](http://www.kew.org/herbcat), accessed 9 September 2023.
- The Plant List (2013) Ver. 1.1. [www.theplantlist.org](http://www.theplantlist.org), accessed 1 January 2013.
- Tsai, Y.P., Hwang, M.T., Tsai, J.M, & Chang, H.S. (1990) Bionomics and biological control of banana skipper, *Erionota torus* Evans, in Taiwan. *Chinese Journal of Entomology*. 10:419–26.
- Varshney, R.K. & Smetacek, P. (eds.) (2015) *A Synoptic Catalogue of the Butterflies of India*. Butterfly Research Centre, Bhimtal and Indinov Publishing, New Delhi, pp.261.
- Veenakumari, K., & Mohanraj, P. (1991) *Erionota thrax* L. (Lepidoptera: Hesperidae), a new record to Andaman Islands. *Journal of the Andaman Science Association*. 7: 91–2.
- WCSP (2012). World checklist of selected plant families. Facilitated by the Royal Botanic Gardens, Kew, <<http://wcsp.science.kew.org> accessed 3 April 2023.