Biology and Damage Dynamics of the Banana Skipper, *Erionota torus* (Evans) (Lepidoptera: Hesperiidae)

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Abstract: *The banana (Musa sp.) is a vital crop in tropical agriculture with significant economic and cultural importance in India, widely cultivated across states like Andhra Pradesh, Karnataka, Kerala, Maharashtra and Tamil Nadu. Although it holds significant nutritional value and economic importance, banana crops face severe challenges from insect pests, notably the banana skipper (Erionota torus). This lepidopteran pest has been a major threat in South India, causing extensive defoliation that greatly reduces photosynthetic efficiency and fruit yield. The larvae's destructive behaviour includes cutting leaf edges to construct cylindrical shelters for feeding and development, exacerbating crop damage. This study investigates the life cycle, morphology, and damaging behaviour of E. torus which is examined by rearing the pests under the controlled conditions of a laboratory, to observe infestation patterns. Laboratory-reared specimens revealed detailed developmental stages with males completing their life cycle in 56.10 ± 2.30 days and females in 57.90 ± 2.00 days. Erionota torus adults lay pale yellow eggs that eventually mature turning light pink with a black top. The larvae go through five distinct instars, each characterized by unique morphological traits, such as waxy coatings and varying head capsule colours. Adults also displayed sexually dimorphic traits, with males being slenderer compared to females. Severe infestations resulted in defoliation rates that significantly impacted yield losses of up to 28% observed at 50% defoliation rate. This research highlights the urgent need for targeted pest control measures to safeguard banana cultivation, ensuring the crop's sustainability and viability in India.*

Key words: **Banana skipper, Defoliation, Pest management, Life cycle, Economic impact**

1. Introduction

The banana (*Musa* sp.), a cornerstone of tropical agriculture, holds immense cultural and economic significance, particularly in India. Revered as "Kalpataru" (celestial tree) and "Tree of Paradise," this versatile fruit, native to Southeast Asia and the Western Pacific, provides sustenance, income, and cultural value to millions[1]. Its cultivation spans across India, with prominent growing regions including Tamil Nadu, Kerala, Maharashtra, Gujarat, Andhra Pradesh, and Karnataka, contributing significantly to the nation's agricultural GDP[2][3]. Beyond its economic importance, the banana offers a nutritional treasure trove, rich in carbohydrates, vitamins, and essential minerals like potassium, phosphorus, calcium, and magnesium. Moreover, its abundance of phenolic compounds and flavonoids contributes to its antioxidant properties, making it a valuable component of a balanced diet[4].

Karnataka grows bananas on 53,000 hectares, accounting for 2.28 million tons, or 7.66%, of the nation's total output[5]. However, this valuable crop faces a multitude of challenges, including a diverse array of insect pests. Out of the 470 insect and mite species documented on banana, nearly 250 species primarily feed on its foliage[6]. The banana skipper, *Erionota torus* (Evans), is a commonly found Lepidopteran in South India and has recently exhibited sudden and sporadic appearances in the southern regions of the country[7][8].

The banana skipper, aptly named for the distinctive feeding behavior of its larvae, poses a significant threat to banana plantations. These voracious caterpillars meticulously cut the edges of banana leaves and construct cylindrical shelters within them, utilizing these self-made enclosures for feeding and development[9]. This destructive feeding habit can lead to severe defoliation, significantly impacting the plant's photosynthetic capacity. Consequently, affected plants exhibit reduced growth rates, delayed fruit maturation, and a substantial decline in fruit size and weight, ultimately resulting in a considerable decrease in overall yield[10]. The impact of severe banana skipper infestations can be devastating for banana growers. This economic loss can have a significant impact on the livelihoods of banana farmers, particularly small-scale producers who are heavily reliant on banana cultivation for their income.

Initially confined to Southeast Asia and parts of Northeast India, the banana skipper has exhibited a concerning southward expansion in recent years, causing widespread damage in regions like Karnataka, Kerala, Tamil Nadu, Maharashtra, and Andhra Pradesh. This unexpected outbreak has significantly impacted banana growers in these regions, who were previously accustomed to managing more traditional banana pests[11]. Banana crops in the Mysuru, Belgaum, Bagalkot, and Koppal regions of Karnataka continue to face a serious threat from the severe infestation of *Erionota* species that was earlier recorded in other regions of Karnataka like Dakshina Kannada, Udupi, Kodagu, and Chitradurga.

The sudden emergence of the banana skipper in South India highlights several critical factors contributing to its rapid rise. Traditional pest management strategies in banana cultivation have historically focused primarily on addressing diseases and nutrient deficiencies, with less emphasis on lepidopteran pests. The outbreak of *E. torus* underscores the urgent need for a revised approach to pest control in banana plantations, incorporating strategies specifically designed to manage this emerging threat[12]. Furthermore, climate change may be playing a crucial role in the expansion of the banana skipper now to Bangalore region of Karnataka also. Shifts in temperature and rainfall patterns could have created more favorable conditions for the pest's survival, reproduction, and dispersal. The absence of effective natural enemies in the newly invaded regions may also be contributing to the rapid population growth of the banana skipper[13].

Controlling the banana skipper requires an integrated approach to effectively manage its impact on banana cultivation. Regular field surveys are vital for early detection of infestations, enabling timely interventions to minimize crop damage[14]. Implementing cultural practices, such as removing and destroying infested leaves, can significantly reduce populations of pest. Using natural enemies like parasitoids and predators is a solid, eco-friendly way to handle pests without relying on chemicals. In cases of severe infestations, insecticides may be necessary, but it is essential to select products that target the banana skipper specifically, while minimizing harm to beneficial insects and the environment. Given the widespread use of banana leaves as plates in India, spraying chemicals on leaves is not advisable due to potential health and ecological risks[15].

Understanding the biology, ecology, and distribution of the banana skipper is fundamental to developing effective and sustainable pest management strategies. Continued research and monitoring are imperative to mitigate the impact of this pest and ensure the long-term productivity and sustainability of India's banana industry. Combining innovative pest management techniques with a deeper understanding of the factors driving the banana skipper's expansion is crucial for safeguarding this essential fruit crop for future generations. Despite its significance as a pest of bananas in India, research on the development and biology of *E. torus* remains limited[16]. Thus, this study aimed to investigate the growth of immature stages, life cycle, and destructive behavior of *E. torus* raised on banana in a controlled laboratory setting.

2. Materials And Methods

Laboratory rearing of pests

Adults and larvae of *E. torus* were gathered from banana plantations near the Jyoti Nivas College Garden in Bengaluru (12° 9′N; 77° 6′E) and reared on small banana plants in a controlled laboratory setting. Identification of the specimens was based on the examination of male and female genitalia, using the classification key by [17]. The study was conducted under an average temperature of 29.0 ± 2.6 °C and a relative humidity of 43.5 ± 5.9%. Adults that emerged in the lab were placed in a nylon mating cage (75.5 × 75.5 × 75.5 cm) lined with white cloth and provided with a 10% honey solution for nourishment (Figure 1a and 1b). Eggs laid by the adults were kept separately with fresh banana leaves to document the duration and number of larval instars. The newly hatched larvae remained in the same cage and were fed fresh banana shoots until they reached the pupation stage.

Life Cycle and Damage Symptoms

Rearing cages were monitored daily for exuviae and head capsules to confirm larval molting. The duration of each developmental stage—including egg, larva, prepupa, and pupa—was recorded, along with the number of larval instars. Measurements of eggs, larval instars, prepupae, pupae, and adults were taken using a calibrated eyepiece micrometer under a stereo zoom microscope. The external morphology of each stage was also documented. Additionally, regular surveys were conducted in various parts of Bangalore throughout the study to evaluate the extent and pattern of pest damage.

Newly emerged male and female adults of uniform size and age were individually placed in nylon cages (30 cm × 30 cm × 30 cm) to assess the impact of nutrition on longevity. Each adult was provided with one of three dietary treatments: 10% honey solution, tap water, or 10% honey supplemented with vitamin E. A control group was maintained without access to food or water. Mortality rates across all dietary groups, including the control, were recorded at 24-hour intervals.

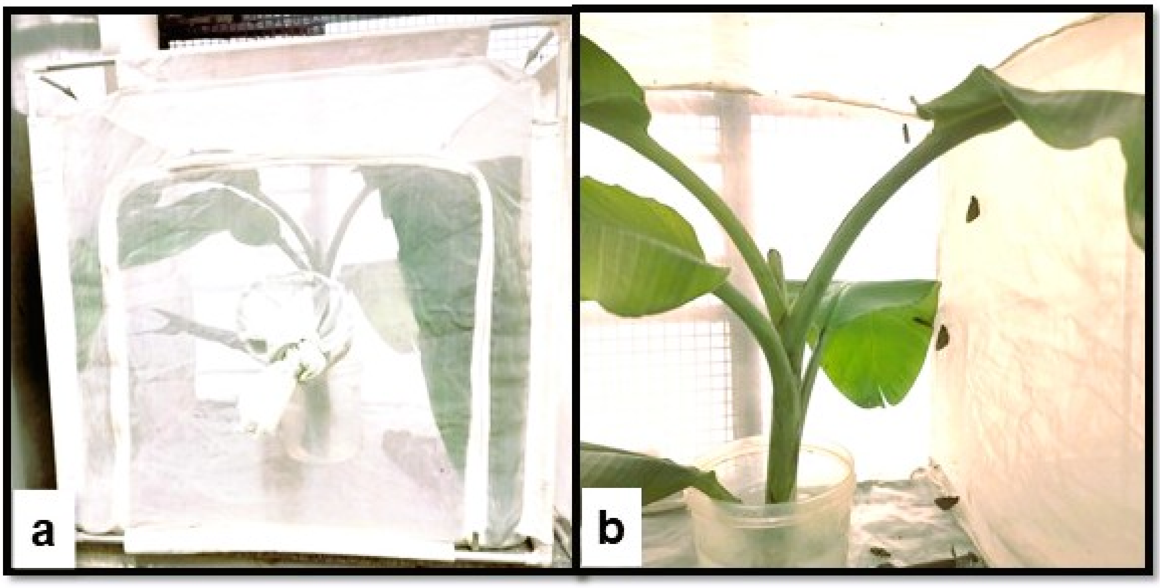

Figure. 1 The Nylon mating cage with banana plant (a) and b) Banana plant used as a oviposition substrate.

Data analysis

The variations in wingspan and body length between female and male *E. torus* were assessed using the Student's t-test. To examine differences in the lifespan of male and female *E. torus* subjected to various diets, a one-way ANOVA followed by Tukey's HSD test was performed. Statistical analyses were conducted using SPSS software (version 21)

Result and Discussion

Morphology

Adult butterflies, most active during the morning and evening hours, laid small, pale yellow eggs on the underside of leaves. As the eggs matured, their color gradually changed from yellow to orange, then pinkish-red, and finally light pink with a distinct black patch on top (Fig. 2a-2f).

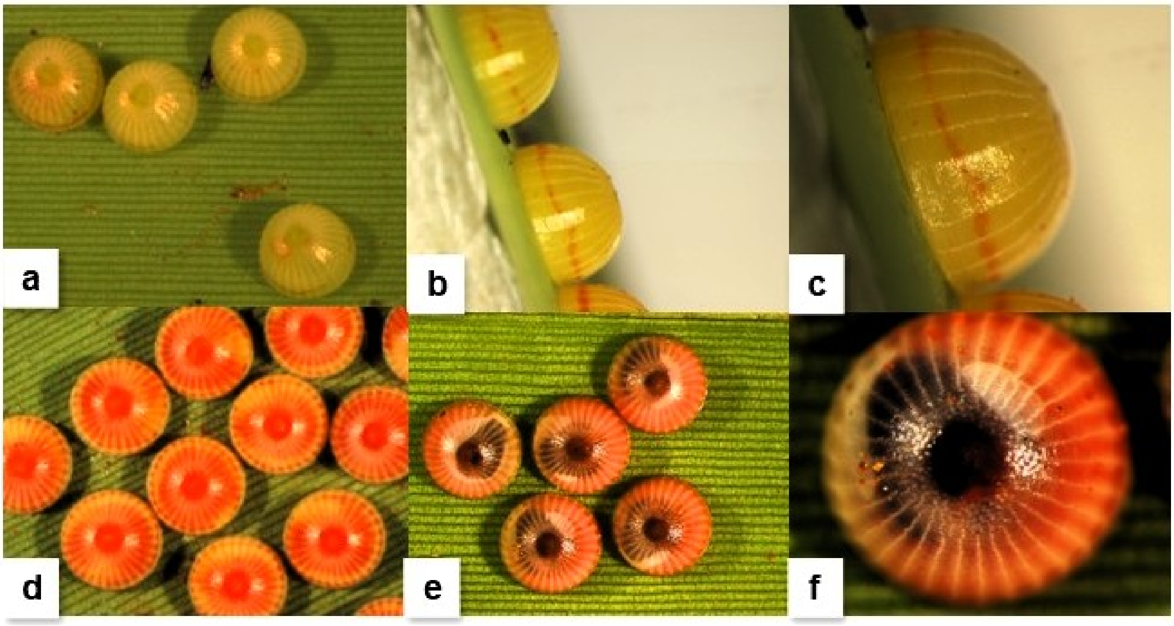

Figure. 2: Various Developmental Stages of *Erionota torus*. a) Newly laid eggs on the underside of a banana leaf lamina, b) Lateral view of the eggs, c) Enlarged view of an egg displaying fine white ribs, d) Late-stage eggs turning light pink, e-f) Egg just before larval hatching

Eggs were laid either individually or in clusters of 10 to 25. The upper surface of the egg featured approximately 29 ± 3.10 fine white ribs. The eggs measured 0.13 ± 0.04 mm in height and 0.18 ± 0.04 mm in length. Larvae underwent four molts, progressing through five distinct instars. The measurements of length, width, and head capsule width for each larval instar are presented in Table 1.

Table 1. Measurements of the larva, prepupa, pupa and head capsule of *erionota torus*

Stages	n	Length (cm)	Width (cm)	Head capsule width (cm)
		Mean + SD	Mean + SD	Mean + SD
I instar	25	0.58 ± 0.06	0.21 ± 0.23	0.08 ± 0.003
II instar	25	1.11 ± 0.30	1.01 ± 0.21	0.13 ± 0.007
III instar	25	2.73 ± 0.31	1.17 ± 0.20	0.19 ± 0.003
IV instar	25	3.59 ± 0.29	2.76 ± 0.17	0.29± 0.02
V instar	25	6.39 ± 0.41	3.79 ± 0.33	0.60 ± 0.02
Prepupa	25	5.10 ± 0.35	3.42 ± 0.32	
Pupa	25	4.78 ± 0.31	1.64 ± 0.11	
Male	25	3.50 ± 0.32	0.84 ± 0.12	
Female	25	3.90 ± 0.33	0.77 ± 0.13	

The first instar larva has a yellowish body with a black head capsule (Figure 3a). It moves toward the leaf margin, where it begins feeding and constructs a shelter by folding the leaf edge and securing it with a sticky thread secreted by the larva. The second instar larva was pale green with a black head capsule, narrow "neck", partially covered with white waxy powder-like substances (Figure 3b). The third instar head capsule shiny black and is ashy green with white powdery waxy coating (Figure 3c). The fourth instar had a head capsule of ashy colour with thick white powdery waxy coating with cylindrical blunt posterior region, and head capsule (Fig. 3d).

The last i.e., 5th instar measured ashy green with many fine erect hair-like processes, white in appearance due to a thick coating of whitish waxy powder, with shiny black head capsule having many hairs partially buried with the white powder (Figure 3e). The larva showed reduced feeding activity and gradually stops feeding and enter into the prepupal stage (Figure 3f).

The posterior end of leaf rolls was very narrow and the anterior end is glued at the top, leaf side end, with pupation taking place in the green leaf roll. Pupa is object type, soft and light-yellow coloured and later turned into light brown and then to dark brown (Fig. 3h). Pupa is long, cylindrical with tapering ends, and roofed by the white waxy powder. During the pupation leaf roll turns yellow and finally necrotic brown; leaf rolls with prepupal and pupal stages get closed with black ball like excreta at the lower, hanging end and glued at their top, leaf side end. The pupae are sensitive to touch and will jerk aggressively if disturbed.

After moth emergence, a vertical slit was observed along the midpoint of the antennal suture at the median line on the dorsal side of the thorax, along with a transverse break at the anterior end of the pupal case (Figure 3i). The newly emerged adult stays close to the leaf roll for a few minutes, occasionally fluttering its wings (Figure 3j).

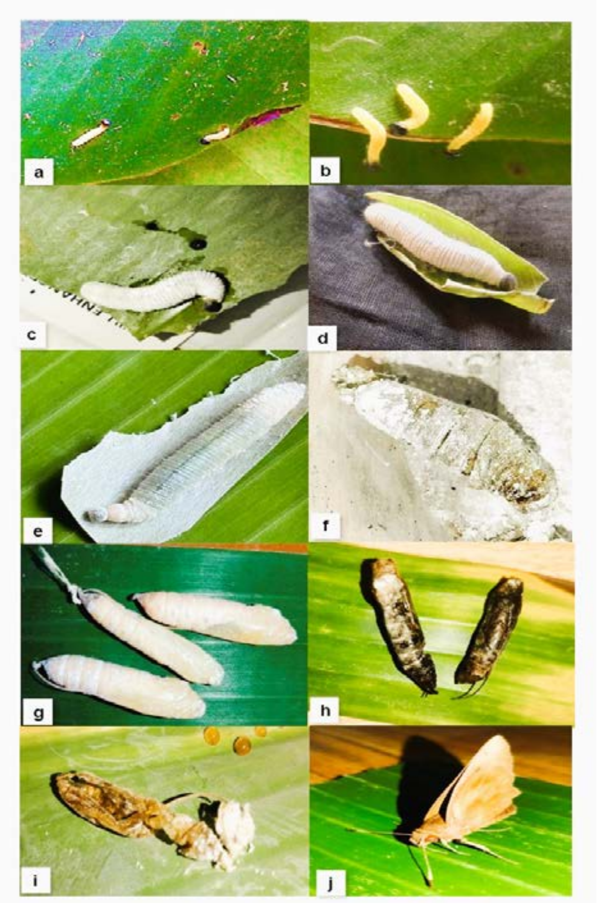

Figure 3: Various Life Stages of *Erionota torus*. (a) First instar larva, (b) Second instar larva, (c) Third instar larva, (d) Fourth instar larva, (e) Fifth instar larva, (f) Pre-pupa, (g-h) Pupa, (i) Pupal case, (j) Winged adult.

The adults of *E. torus* are characterized by brown bodies, large heads, prominent red eyes, and thickened antennae with curved tips. Their forewings feature three distinct yellow patches, with a rounded and relatively larger outer margin. In males, the apex lacks white coloration on both the upper and lower sides. The hind wings are comparatively broader, with a smoothly rounded outer margin. Additionally, the species has a robust body, and its antennae possess a shaft that is distinctly white on the underside throughout (Fig. 4b-4b).

Males were slightly smaller than females, with a more slender body and a pointed abdomen (Fig. 4c), whereas females had a broader body with a blunt abdomen (Fig. 4d). The average body length of females and males was 32.5 ± 0.25 mm and 30.71 ± 0.49 mm, respectively, while their wingspans measured 35.72 ± 0.72 mm for females and 33.71 ± 0.59 mm for males. A significant difference was observed between the sexes in both body length ($t = 4.1$, $P < 0.05$) and wingspan ($t = 3.6$, $P < 0.05$)

The findings of the current study about morphology of the pest align with previous studies, reinforcing the significance of effective pest management strategies to mitigate losses in banana production. The detailed examination of developmental stages of *E. torus* under laboratory conditions highlights its rapid growth and prolific reproduction, enabling it to complete 10–12 generations annually. This aligns with Cock (2015), who reported the high adaptability of *E. torus* to tropical conditions. The sexually dimorphic traits observed, such as the slender body of males and the larger size of females, are consistent with observations from similar species of the Hesperiidae family [9].

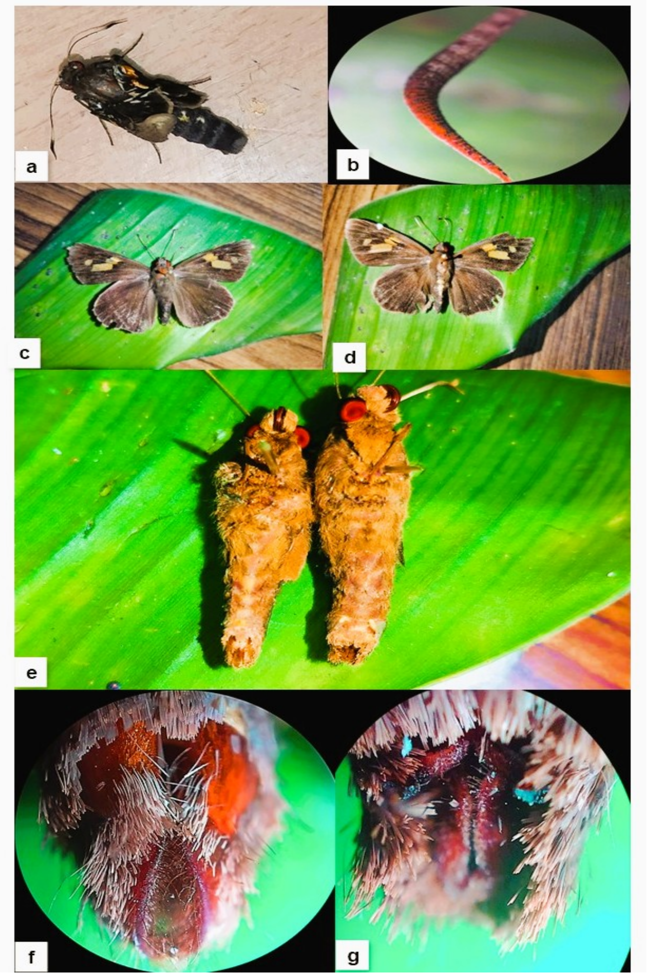

Figure 4. Morphology and Sexual Dimorphism in *Erionota torus*. a) Newly Emerged Adult, b) Antennal Tip, c) Adult Male, d) Adult Female, e) Comparison of Male and Female Abdominal Tips,f) External Genitalia of Adult Female, g) External Genitalia of Adult Male

Egg morphology and larval development, characterized by distinct instars, demonstrate the pest's adaptive feeding strategies. The eggs of *E. torus* are circular shaped and pale yellow coloured as reported by Deka et al. (1996) andVeenakumari and Mohanraj (1991). The transition of larvae through stages with waxy coatings and distinct coloration suggests an evolutionary adaptation for camouflage and protection against predators, as noted in by Irulandi et al. (2018). Additionally, the pupal stage enclosed within leaf rolls, which turn necrotic, highlights the pest's ability to exploit the host plant throughout its life cycle.

Life History

The duration of various life stages of *E. torus* is summarized in Table 2. Under laboratory conditions, the life cycle of male and female *E. torus* was completed in 56.10 ± 2.30 days and 57.90 ± 2.00 days, respectively. The total larval phase, including the prepupal stage, lasted for 44.46 ± 2.29 days. The species was observed to complete 10–12 generations annually.

The larval development of *E. torus* consisted of five instars, consistent with findings in *E. thrax* and *E. acroleuca apicalis* [20]. The measurements of larval instars and head capsule width in *E. torus* closely align with previous reports by Deka et al. (1996) and Veenakumari & Mohanraj (1991). The complete life cycle of *E. torus* spanned 30–40 days, in agreement with earlier studies by Abdul Jaleel et al. (2019) and Mahajan & Bankar (2023). While Abdul Jaleel & Ghosh (2020) documented a total larval period of 44.46 ± 2.29 days, Mahajan et al. (2023) reported a shorter duration of 30 days. Variations in larval development across species may be influenced by host plant characteristics and local climatic conditions.

The average prepupal duration of *E. torus* was observed to be 3.62 days, consistent with findings by Abdul Jaleel and Ghosh (2020), as well as similar reports by Chiang and Hwang (1991). The pupal stage of *E. torus* on banana plants also aligned with the observations of these studies. Additionally, the adult coloration pattern matched previous descriptions provided by Srinivasa Reddy and Hemadri (2018), Evans (1949), and Raju et al. (1941).

Table 2. Developmental period of different stages of *Erionota torus* under laboratory conditions

Stages	n	Duration of development (days)	
		Mean ± SD	Range
Egg	25	7.23 ± 0.63	5.28-8.25
I instar	25	2.99 ± 0.27	1.62-3.00
II instar	25	3.86 ± 0.84	2.99-4.25
III instar	25	4.19 ±0. 31	3.10-5.10
IV instar	25	5.73 ± 0.16	4.59-6.90
V instar	25	6.97 ± 0.23	6.49-7.28
Prepupa	25	3.62 ± 0.35	3.10-3.98
Pupa	25	9.87 ± 0.56	8.00-10.50
Egg to adult	25	44.46 ± 2.29	38.98-46.28

Damage

The pre-flowered plants exhibited a high degree of infestation compared to flowered plants. Each pre-flowered plant had an average of 8 ± 3 leaf rolls (Fig. 5), with the length of fifth instar larval and pupal leaf rolls measuring 15 ± 3 cm. The lengths of the leaves used to construct the fifth instar larval and pupal shelters were 21 cm, 18 cm, and 3 cm, respectively. Severely affected leaves displayed a grazed appearance, with only the midrib remaining intact (Fig. 5).

The first instar larva moves to the leaf edges and cuts the leaves to construct the leaf roll structures that hang from the midribs and are kept together by silky threads. The larvae feed within the leaf rolls (shelters) and create new rolls as needed. During the prepupal and pupal stages, the leaf rolls turn yellow, then necrotic brown, and are closed with black ball like excreta at the lower end.

Feeding and leaf rolling by pests significantly damage banana leaves, leading to reduced photosynthetic efficiency, smaller bunch sizes, lighter fruits, and substantial declines in fruit yield. While banana plants can tolerate up to 20% defoliation, severe infestations destroyed entire leaves, leaving only the midrib intact. Leaf defoliation caused by leaf roller larvae result in approximately 28% yield loss when defoliation reaches 50%. Additionally, the frequency of leaf coiling increases with the duration of the larval instars.

Figure 5. Damage symptoms of *Erionota torus* on banana leaf

The study underscores the severe defoliation caused by *E. torus*, leading to a significant reduction in photosynthetic efficiency and subsequent yield losses. The 28% yield loss observed at a 50% defoliation rate corroborates earlier findings by Irulandi et al. (2018) and Ostmark (1974), who reported similar impacts on banana crops in Southeast Asia. This defoliation not only affects fruit size and weight but also delays maturation, compounding the economic burden on farmers.The damage symptoms, including grazed leaves and necrotic leaf rolls, are typical of *E. torus* infestations. The pest's behavior of cutting leaf edges to construct cylindrical shelters further exacerbates damage, as these structures become breeding grounds for subsequent generations. Similar feeding behaviors have been documented in related lepidopteran pests [9]. The recent southward expansion of *E. torus* to regions like Karnataka, Kerala, and Tamil Nadu indicates its ability to thrive under diverse agro-climatic conditions. Climate change, particularly shifts in temperature and rainfall patterns, may have facilitated this expansion. The absence of effective natural enemies in newly invaded areas further underscores the importance of biological control measures [27].

Longevity

Both male and female moths that emerged in the laboratory readily consumed liquid food. The lifespan of males and females under different dietary treatments is presented in Fig. 3. No significant difference in longevity was observed between the sexes across any diet. However, moths that were deprived of food had a shorter lifespan compared to those that received nourishment, regardless of the diet type. The longevity of both male and female moths varied significantly based on the diet provided (Tukey's HSD: males $F = 70.69$, $P < 0.05$; females $F = 21.32$, $P < 0.05$) (Figure 6). Moths that were fed the third diet, consisting of a 10% honey solution supplemented with vitamin capsules, exhibited the longest lifespan.

The study reveals critical insights into the life history, morphology, and damage caused by the banana skipper (*Erionota torus*), emphasizing its impact on banana cultivation. The findings align with previous studies, reinforcing the significance of effective pest management strategies to mitigate losses in banana production. The detailed examination of developmental stages of *E. torus* under laboratory conditions highlights its rapid growth and prolific reproduction, enabling it to complete 10–12 generations annually. This aligns with 1Cock (2015), who reported the high adaptability of *E. torus* to tropical conditions. The sexually dimorphic traits observed, such as the slender body of males and the larger size of females, are consistent with observations from similar species of the Hesperiidae family [9,30].

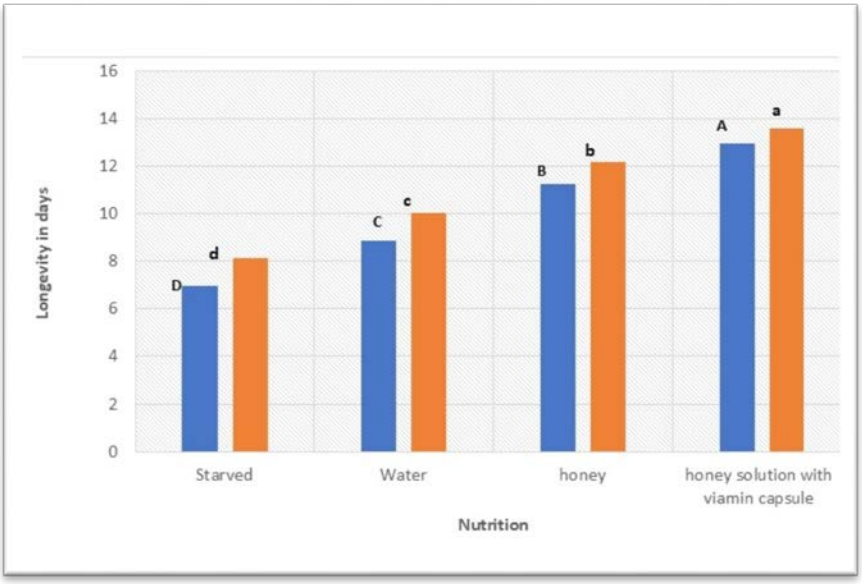

Figure 6. Longevity of *Erionota torus* adults fed on different nutrition

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Conclusion

The study reveals critical insights into the life history, morphology, and damage caused by the banana skipper (*Erionota torus*), emphasizing its impact on banana cultivation. This study offers a comprehensive account of the life cycle and seasonal occurrence of the banana skipper. The results emphasize the pressing need for developing integrated pest management (IPM) strategies specifically designed for *E. torus* (28.). Cultural practices, such as removing infested leaves, combined with the use of biological agents like parasitoids and predators, can effectively reduce pest populations. This aligns with the recommendations of ??Cock (2015) and Guru et al. (2018), who emphasized sustainable control methods. While chemical control methods may be necessary in severe infestations, their use should be minimized due to the widespread use of banana leaves as biodegradable plates in India. Ensuring the safety of consumers and the environment must remain a priority (29. 30.). This study provides a comprehensive understanding of the life history and damaging behavior of *E. torus*, emphasizing its significant threat to banana cultivation in India. By integrating cultural, biological, and chemical control measures, it is possible to mitigate the pest's impact and ensure the sustainability of banana production. Future research should focus on identifying natural enemies and exploring the genetic basis of the pest's adaptability to diverse environments.

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References

*[1] J. C. Robinson and V. G. Sauce, "Bananas and Plantains," 2nd ed., CAB International, (**2010**), p. 312.*
*[2] L. Bora, M. Kundu, R. M. Srivastava, and S. Chander, "Banana skipper: An emerging threat to banana leaf industry," Popular Kheti, vol. 5, no. 3, (**2017**), pp. 58–61.*
*[3] Nanaware, "A study on banana production technology by the farmers in Kolhapur district, Maharashtra," M.Sc. thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, (**2017**), p. 103.*
*[4] D. Mohapatra, S. Mishra, and N. Sutar, "Banana and its by-product utilisation: An overview," J. Sci. Ind. Res. India, vol. 69, (**2010**), pp. 323–329.*
[5] CABI, "Banana skipper: Erionota thrax; Banana skipper, banana leaf roller, hesperiid butterfly, palm redeye," https://doi.org/10.1079/pwkb.2018780 0446.
*[6] H. E. Ostmark, "Economic insect pests of bananas," Annu. Rev. Entomol., vol. 19, (**2003**), pp. 161–176.*
*[7] D. Srinivasa Reddy and T. Hemadri, "First occurrence of banana skipper (Erionota torus) in Kodur region of Andhra Pradesh, India," Int. J. Curr. Microbiol. Appl. Sci., vol. 7, no. 2, (**2018**), pp. 1081–1084.*
*[8] P. D. K. Jayanthi, P. V. R. Reddy, V. Kempraj, and P. R. Shashank, "Outbreak of banana skipper, Erionota torus Evans (Lepidoptera: Hesperiidae) in southern India: Evidence of expanded geographic range," Pest Manage. Hortic. Ecosyst., vol. 21, no. 1, (**2015**), pp. 95–97.*
*[9] P. N. Guru, R. Patil, R. K. Patil, and S. Chatter, "Bioefficacy of insecticides and biopesticides on banana leaf roller, Erionota torus (Evans.)," J. Entomol. Zool. Stud., vol. 6, no. 1, (**2018**), pp. 1343–1346.*
*[10] S. Irulandi, A. Aiyanathan, and S. S. B. Bhuvaneswari, "Assessment of biopesticides and insecticide against pseudostem weevil Odoiporus longicollis Oliver in red banana," J. Biopest., vol. 5, (**2012**), pp. 68–71.*
*[11] D. Srinivasa Reddy and T. Hemadri, "First occurrence of banana skipper (Erionota torus) in Kodur region of Andhra Pradesh, India," Int. J. Curr. Microbiol. Appl. Sci., vol. 7, no. 2, (**2018**), pp. 1081–1084.*
*[12] R. S. Mahajan and D. R. Bankar, "Life cycle and management of banana skipper, Erionota torus (Evans.)," Vigyan Varta, vol. 4, no. 8, (**2023**), pp. 94–97.*
*[13] M. Alotaibi, "Climate change, its impact on crop production, challenges, and possible solutions," Not. Bot. Horti Agrobo., vol. 51, no. 1, (**2023**), Art. no. 13020. https://doi.org/10.15835/nbha51113020*
*[14] S. Chatter, R. S. Patil, B. H., and A. Agasimani, "The comparative seasonal biology studies of banana leaf roller, Erionota torus Evans under laboratory conditions," J. Entomol. Zool. Stud., vol. 8, no. 3, (**2020**), pp. 1175–1179.*
*[15] K. K. Shah, B. Modi, H. P. Pandey, A. Subedi, G. Aryal, M. Pandey, and J. Shrestha, "Diversified crop rotation: An approach for sustainable agriculture production," Adv. Agric., vol. 2021, (**2021**), pp. 1–9.*
*[16] M. J. Cock, "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 Rev., vol. 10, no. 7, (**2015**), pp. 1–30.*
*[17] S. Inoué and A. Kawazoé, "Hesperiid butterflies from South Vietnam (5)," Tyo ta Ga, vol. 21, no. 1–2, (**1970**), pp. 1–14.*
*[18] K. C. Deka, S. K. Dutta, and M. M. Goswami, "Preliminary observations on Erionota thrax Linn. (Lepidoptera, Hesperiidae): A potential pest of banana in North East India," Insect Environ., vol. 2, no. 1, (**1996**), p. 11.*
*[19] K. Veenakumari and P. Mohanraj, "Erionota thrax L. (Lepidoptera: Hesperiidae), a new record to Andaman Islands," J. Andaman Sci. Assoc., vol. 7, no. 2, (**1991**), pp. 91–92.*
*[20] N. Chitra, K. Gunathilagaraj, S. Kuttalam, and K. Ramaraju, "Banana leafroller Erionota torus Evans (Lepidoptera: Hesperiidae) - a new threat," Indian J. Entomol., vol. 78, no. 4, (**2016**), pp. 378–380.*
*[21] S. S. Munj, S. S. Gurav, A. Y. Munj, R. S. Mule, K. V. Malshe, and M. V. Thakur, "Management of banana skipper, Erionota torus (Evans) (Hesperiidae: Lepidoptera) infesting banana under field conditions," The Pharma Innov. J., 11(11), (**2022**), pp. 1520–1524.*
*[22] K. A. Abdul Jaleel, S. Ghosh, and V. J. Joseph, "DNA barcoding and evolutionary lineage of banana skipper Erionota torus (Evans) (Lepidoptera Hesperiidae) from Malabar, a part of Southern Western Ghats, India," Int. J. Sci. Res. Biol. Sci., vol. 6, no. 4, (**2019**), pp. 29–32. https://doi.org/10.26438/ijsrbs/v6i4.2932*
*[23] H. Chiang and M. Hwang, "The banana skipper, Erionota torus Evans (Hesperidae: Lepidoptera): Establishment, distribution and extent of damage in Taiwan," Trop. Pest Manage., vol. 37, no. 3, (**1991**), pp. 207–210. https://doi.org/10.1080/09670879109371583*
*[24] W. H. Evans, "A Catalogue of the Hesperiidae from Europe, Asia and Australia in the British Museum (Natural History)," Trustees of the British Museum, London, (**1949**).*
*[25] D. Raju, K. Kunte, S. Kalesh, P. Manoj, H. Ogale, and R. Sanap, "Erionota torus Evans, 1941 – Rounded Palmredeye," in Butterflies of India, K. Kunte, P. Roy, S. Kalesh, and U. Kodandaramaiah, Eds., Indian Foundation for Butterflies, (**2015**).*
*[26] H. E. Ostmark, "Economic insect pests of banana," Annu. Rev. Entomol., vol. 19, (**1974**), pp. 161–176.*
*[27] T. Sivakumar, T. Jiji, and N. Anitha, "Field observations on banana skipper Erionota thrax L. (Hesperiidae: Lepidoptera) and its avian predators from southern peninsular India," Curr. Biotica, vol. 3, no. 8, (**2014**), pp. 220–227.*
*[28] G. C. Rathod, G. C. Mishra, and K. N. Singh, "Hybrid time series models for forecasting banana production in Karnataka State, India," J. Indian Soc. Agric. Stat., vol. 71, no. 3, (**2017**), pp. 193–200.*
*[29] J. K. Abdul and S. M. Ghosh, "Biology and damage of banana skipper Erionota torus (Evans) from Malabar region of Kerala," Indian J. Entomol., vol. 82, no. 3, (**2020**), p. 429. https://doi.org/10.5958/0974-8172.2020.00112.1*

*[30] J. Poorani, B. Padmanaban, S. De, Thanigairaj, and R. Gavas, "A review of the pest status and natural enemy complex of banana skipper Erionota torus Evans in South India and its management," Indian J. Entomol., vol. 82, no. 3, (**2020**), pp. 479–492. https://doi.org/10.5958/0974-8172.2020.00123.6*