INFLUENCE OF NATURAL AND ARTIFICIAL HABITAT ON THE GROWTH OF *ETROPLUS SURATENSIS*

DISSERTATION SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE AWARD OF THE DEGREE OF

MASTER OF SCIENCE IN ZOOLOGY

UNIVERSITY OF CALICUT

By

ASHIKHA FARSANA P J

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JUNE 2024

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DECLARATION

I, Ashikha Farsana P. J, do hereby declare that the dissertation entitled **INFLUENCE OF NATURAL AND ARTIFICIAL HABITAT ON THE GROWTH OF *ETROPLUS SURATENSIS*,** is an authentic record of original work carried out by me under the guidance of Dr.Sr. Dilla Jose, Assistant Professor, Christ College Irinjalakuda and that no part of the thesis has been presented for the award of any other degree or diploma in any University.

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ACKNOWLEDGEMENT

I feel the inadequacy in expressing my sincere heartfelt gratitude towards **Dr. Sr.Dilla Jose**, Assistant professor, Department of Zoology, Christ College (Autonomous), Irinjalakuda for suggesting me this topic and for encouraging me throughout the course of my study. Without his expert guidance and dedicated involvement at each and every step, this research work would not have never been accomplished in the present from.

I would like to express my indebtedness and deep sense of gratitude to **Dr.Sudhikumar A.V,** Head of the Department of Zoology, Christ College, Irinjalakuda for all his support and the facilities provided to me in the department.

My heartfelt thanks to **Rev. Dr. Jolly Andrews**, Principal, Christ College, Irinjalakuda for granting me all the facilities for the work.

I also thank **Dr. Lalitha Vijayan**, Director, Salim Ali Foundation, Kannimangalam, Thrissur and **Miss. Vidhya Shaji**, project instructor Salim Ali Foundation, Konothukunnu, Thrissur and Farmers of kannimangalam, Thrissur for helping me in the culture of *Etroplus suratensis.*

Also I would like to thank the farmers of Vellangallur Grama Panchayat including Muraleedharan M., Viswambaran, Kadarkunji and Syam Mohan C. for helping me by providing their ponds for the study and giving necessary information and guidance.

I am indebted to all the teaching and non-teaching staff of the department and to my friends for their timely help and encouragement.

Finally, I recall with sincere gratitude to my parents, friends and all those who have helped me in one or other way in my endeavour and above all, almighty God.

CONTENTS

INFLUENCE OF NATURAL AND ARTIFICIAL HABITAT ON THE GROWTH OF *CHANNA STRIATA*

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I further certify that no part of the work has been presented before for the award of any other degree/ diploma.

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I feel the inadequacy in expressing my sincere heartfelt gratitude towards **Dr.Sr.Dilla Jose**,Assistant professor, Department of Zoology, Christ College (Autonomous), Irinjalakuda for suggesting me this topic and for encouraging me throughout the course of my study. Without his expert guidance and dedicated involvement at each and every step, this research work would not have never been accomplished in the present from.

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Also, I would like to thank the farmers of Vellangallur Grama Panchayath including Mr. Kadar Kunji, Mr. Syam Mohan C and Mr. Viswambaran for keeping me by providing their ponds for the study and giving necessary information and guidance.

I am indebted to all the teaching and non-teaching staff of the department and to my friends for their timely help and encouragement.

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CONTENTS

A COMPARATIVE STUDY OF ODONATES IN SELECTED AREAS OF KUNNAMKULAM, THRISSUR, KERALA

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My heartfelt thanks to **Rev. Dr. Jolly Andrews**, Principal, Christ College(Autonomous), Irinjalakuda for granting me all the facilities for the work.

I am sincerely thankful to **Mr.Vivek Chandran,** Research scholar, Christ college (Autonomous),Irinjalakuda for guiding me and helping me in identifying the species which are not known for me. Also extend my sincere thanks to **Ms.Anagha Chelat**, B.Ed. student, Jamiya Nadawiyya college, Edavanna, Malappuram for valuable suggestions .

I am indebted to all the teaching and non-teaching staff of the department and to my friends for their timely help and encouragement. Finally, I recall with sincere gratitude to my parents, friends and all those who have helped me in one or other way in my endeavour and above all, almighty God.

CONTENTS

TAXONOMIC STUDIES ON MOTHS (LEPIDOPTERA: HETEROCERA) FROM IRINJALAKUDA MUNCIPALITY, THRISSUR DISTRICT

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I further certify that no part of the work has been presented before for the award of any other degree/ diploma.

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I hereby declare that this is an authentic record of the work carried out by me under the supervision of **Dr. Abhilash Peter, Assistant Professor, Department of Zoology, Christ College, Irinjalakuda** and no part of dissertation has previously formed the basis for the award of any Degree or Diploma as stipulated in the statutes of the University of Calicut.

Maria Sico

ACKNOWLEDGEMENTS

I am deeply grateful to Dr. ABHILASH PETER, Assistant Professor & Research Supervisor, Post Graduate and Research Department of Zoology, Christ College, Irinjalakuda, for suggesting this topic and for his unwavering encouragement throughout my study. Without his expert guidance and dedicated involvement at every step, this research work would not have been accomplished in its present form.

I would like to express my profound gratitude to the Principal and Christ College management for providing the necessary facilities for this project. My heartfelt thanks also go to the Head of the Department of Zoology for the resources and support provided, which were crucial for the completion of this work.

My sincere thanks to Mr. Adarsh P. K. and Ms. Joslin Treesa Jacob, Research Scholars of Entomo Taxonomy Lab, Zoology department, for their assistance during the project. I am also indebted to all the staff members, lab attenders of the department and my classmates for their timely help and encouragement.

Finally, I extend my heartfelt gratitude to my loving parents, my friends, and all those who have supported me in various ways throughout this endeavour, and above all, to Almighty God.

Maria Sico

CONTENTS

INTRODUCTION-1

Biological diversity encompasses the variety among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems (Harper and Hawksworth, 1994). This diversity spans within species, between species, and across ecosystems. It represents the entirety of organisms, their ecological complexity within their environments, and all associated ecological processes (Primack, 1993; Liu, 1999). Globally, there are approximately 30 million species, of which about 1.4 million have been briefly described; among these, around 750,000 are insects (Cheng, 1976).

Insects are recognized as the most successful and diverse animals on Earth, having adapted to nearly every conceivable environment—from the equator to the Arctic, from sea level to the highest mountain snowfields, on land, in the air, and in water. It is estimated that insects comprise more than 75 percent of known animal species. Approximately 0.9 million species of insects have been described worldwide, with 59,353 species belonging to 27 orders known in India (Varshney, 1998). They are invaluable as model organisms, especially in the fields of genetics, development, behaviour, neurobiology, and evolutionary biology. Insects play a vital role in ecosystem functions and services, directly impacting human well-being and health.

Insects constitute more than half of the world's known animal species (Wilson, 1992), with Lepidoptera being the second largest and most diverse order within the class Insecta (Benton, 1995). The term "Lepidoptera" derives from the Latin word equivalent to lepido- and the ancient Greek words lepis and pteron, meaning scales and wings, respectively, thus referring to insects with scaly wings. Lepidoptera is the second largest and most diverse insect order within the class Insecta of the phylum Arthropoda. Linnaeus (1707–1778) categorized them into three groups: butterflies, skippers, and micro- and macro-moths. This order comprises 126 families and 46 superfamilies (Table 1) and can be differentiated by their morphological, anatomical, behavioural, and ecological characteristics. There are more than 175000 described species of Lepidoptera, including 70,820 species of butterflies and remaining moths worldwide. Additionally, about 165,000 species of moths, encompassing both micro- and macro-moths, have been identified. In nature, Lepidoptera are considered symbols of beauty and grace, known for their striking appearance. The order

Lepidoptera, which includes butterflies and moths, is among the most common insects in forest ecosystems and agricultural fields, often serving as biological indicators of ecosystem health. Lepidoptera plays a crucial role in the herbivore community. The larval stage of these insects acts as prey for various predators, while adult Lepidoptera primarily feed on plants and serve as key pollinators. Many biological researchers use Lepidoptera as model organisms to assess the impact of human activity, pollution, and forest management practices (Willott et al., 2000; Lewis, 2001). Recently, scientists have estimated that there are 174,250 species of Lepidoptera worldwide, encompassing 126 families and 46 superfamilies. In India, approximately 12,000 species of moths from 41 families have been recorded (Chandra, 2007). Lepidoptera heavily depend on local vegetation patterns and climate factors such as temperature, humidity, rainfall, wind speed, and direction for their survival and food requirements. It is predicted that global average temperatures will rise by between 1.4ºC and 5.8ºC over the next century due to climate change (IPCC, 2007). India, with its diverse physical features, climate, and vegetation, boasts one of the richest and most varied arrays of flora and fauna in the world. The Western Ghats is a region of exceptional biological diversity and conservation importance, known as one of the major tropical evergreen forest regions in India. Lepidoptera, associated primarily with angiosperm plants, is the most diverse order of insects, with approximately 160,000 named species, making it one of the largest insect orders.

Moths, belonging to the order Lepidoptera, are characterized by their drab-coloured scales, the presence of an epiphysis on the foreleg, their phytophagous diet, and predominantly nocturnal behaviour. They are highly sensitive to climate changes and vegetation alterations, making them crucial indicators for monitoring climate and habitat changes (Thomas, 2005). Moths play essential roles in ecosystem services, acting as agricultural pests (Sharma and Bisen, 2013), providing food for mammals (Vaughan, 1997) and birds (Wilson et al., 1999), and serving as night pollinators (Macgregor et al., 2015). Moths and butterflies belong to the order Lepidoptera. There are about 127,000 species of moths worldwide, found everywhere except in the polar regions and very hot deserts. In India, over 12,000 species of moths have been reported.

Moths and butterflies differ in their scales, wing colours, antennae structures, abdomens, pupation methods, and eye structures. Moths, particularly those in the Arctiidae family, are fascinating creatures. This family includes over 11,000 species, known for their

dark wings with bright stripes of orange, red, and white. These moths, often called tiger moths or Isabella tiger moths, have a wingspan of up to 50 mm and a thick, furry body. Unlike nsects that enter homes, moths are gentle and do not harm humans.
In most instances, an adult moth does not live longer than a year. Factors such as harsh weather conditions and the presence of predators contribute to their limited lifespan. The average adult moth measures up to 3 cm, but there are other moth species that are significantly largerThe average adult moth measures up to 3 cm, but there are other moth species that are significantly larger.

The body of moths is divided into several parts mainly head, thorax, abdomen, wings and jointed legs. Lepidoptera's head is the feeding and sensory centre, with distinctive features like frons, clypeus, labrum, mandibles, and maxillary palps aiding species identification. They have siphoning mouthparts in adults for nectar feeding, and varied antennae shapes that help in species differentiation. Their compound eyes provide a mosaic view, and simple eyes or ocelli perceive UV light. The thorax has three jointed segments and legs with unique structures that detect vibrations. Wings, essential for complex flight, vary in shape and pattern, influencing taxonomical analysis. The abdomen consists of segments allowing movement, with some caterpillars having prolegs for walking. Covered in scales that provide coloration and aid in various functions, Lepidoptera also produce sounds using tympanal organs, crucial for detecting threats and communication.

The life cycle of a moth consists of several stages mainly four stages that is egg, caterpillar, pupa and adult. First, after mating, the female moth lays her eggs near plant-filled areas, where they develop into larvae over about 30 days. These larvae, or caterpillars, hatch from the eggs and consume their shells before moving on to feed on nearby plants. As they grow through multiple instars, shedding their skins in the process, they eventually spin a silk cocoon and enter the pupa stage. Inside the cocoon, involves histolysis, where the moth stops feeding and becomes motionless. the caterpillar undergoes metamorphosis, transforming into a fully developed moth. After about two weeks, the adult moth emerges from the cocoon, initially with crumpled wings that eventually harden. The moth then takes flight to feed and mate, with its lifespan varying by species, ranging from weeks to months.

Moths are important as they serve as environmental indicators because of their extensive distribution across several habitats and intimate contact with different plants [4], rendering them sensitive to environmental changes. Many plant species rely on different moth species for pollination, highlighting the need of sustaining moth populations and variety in order to preserve vegetative health. To guarantee long-term growth, a complete biodiversity checklist must be used when developing a conservation strategy. Furthermore, moths perform a variety of ecological functions, including functioning as agricultural pests and supplying critical food supplies for amphibians, bats, small mammals, and many bird species. They also function as measures of environmental health and fitness.

OBJECTIVES-2

- To provide an updated systematic status of moths in Irinjalakuda municipality.
- To identify and document common moth species from study area.

REVIEW OF LITERATURE-3

International

"The Lepidoptera of Ceylon" by Frederic Moore (1885) is a significant work focusing on the butterflies and moths of Ceylon (modern-day Sri Lanka). G.F. Hampson (1898) in the Journal of Natural History details a collection of Heterocera (moths) from Transvaal. W.F. Kirby ([1892]) in "A Synonymic Catalogue of Lepidoptera Heterocera (Moths): Vol. 1. Sphinges and Bombyces," catalogues various moth species. "The New Eastern Heterocera" by Charles Swinhoe (1892) covered various regions including India, China, and Japan. The "Handbook of British Lepidoptera" by Edward Meyrick (1895) is a comprehensive guide on British butterflies and moths. C.G. Barrett (1895) in *The Lepidoptera of the British Islands: Heterocera, Sphinges, Bombyces*, details the moths of the British Isles. "The Moths of the British Isles" by Richard South (1907) provided comprehensive descriptions and illustrations of moth species in the British Isles. "The Moths of Borneo" by J.D. Holloway (1989) covered the moths fauna of Borneo. The study "Diversity of moths in forest plantations and natural forests in Sabah," by V.K. Chey, J.D. Holloway, and M.R. Speight (1997), investigates moth species diversity in Sabah, Malaysia. The study "Aspect diversity in moths: a temperate-tropical comparison," by R.E. Ricklefs and K. O'Rourke (1975), compares moth diversity between temperate and tropical regions. "The Families of Malesian Moths and Butterflies" by J.D. Holloway, G. Kibby, and D. Peggie (2001) is a comprehensive guidebook on Malesian moths and butterflies. "The Geometrid Moths of Europe. Volume 4: Larentiinae II (Perizomini and Eupitheciini)" by Axel Hausmann (2004) is a detailed reference on geometrid moths in Europe. The study "Montane Andean rain forests are a global diversity hotspot of geometrid moths" by G. Brehm, L.M. Pitkin, N. Hilt, and K. Fiedler ([2005]) highlights the diversity of geometrid moths in the Andean rain forests. "A Guide to Australian Moths" by Paul Zborowski and Ted Edwards ([2007]) provides detailed information on Australian moth species. "Moths of Thailand" by V.S. Kononenko and A. Pinratana (2013) is an extensive guide to Thai moths. "A Review of the Status of the Macro-Moths of Great Britain" by R. Fox, M.S. Parsons, and C.A. Harrower (2019) assesses the conservation status of macro-moth species in Great Britain. "The Lives of Moths: A Natural History of Our Planet's Moth Life" by Andrei Sourakov and Rachel Warren Chadd (2022) explores moths in various ecosystems. "British Pyralid Moths" by B. Goater, G. Senior, and R. Dyke (2023) is a comprehensive guide to Britain's pyralid moth

species. The article "New Records of Macroheterocera (Insecta, Lepidoptera) on the South of West Siberia: Result of Expeditions in 2022–2023" by S.A. Knyazev, S.M. Saikina, and V.V. Ivonin (2024) reports new species from the Omsk and Novosibirsk Regions of Russia.

National

In the article "New and Little-known Moths from India and Australia" by Charles Swinhoe (1901), a range of moth species from both India and Australia are described. In "Fruit-sucking Moths of South India" by P. Susainathan (1924), presented at the Proceedings of the 5th Entomological Meeting in Pusa, the author discusses the species of moths that feed on fruit in South India. In the study "Biodiversity in the Western Ghats-A study with reference to moths (Lepidoptera: Heterocera) in the Silent Valley National Park, India," conducted by G. Mathew and V.K. Rahmathulla (1995), the authors investigated the moth diversity within the Silent Valley National Park. In the paper titled "On little known moths (Lepidoptera: Heterocera) from Arunachal Pradesh, India," authored by I.J. Gupta and J.P.N. Shukla (1977), the authors explored the diversity of lesser-known moth species in Arunachal Pradesh, India. The article "On little known moths (Lepidoptera: Heterocera) from Arunachal Pradesh, India" by I.J. Gupta and J.P.N. Shukla (1977), published in the News Letter of the Zoological Survey of India, reported the collection of 14 moth species from the Siang district of Arunachal Pradesh during the period of September to November 1966. In "Fauna of Orissa (Part 3), State Fauna Series-1," published by D.K. Mandal and D.R. Maulik (1991), the authors focussed on the Lepidoptera order, specifically Noctuidae, Sphingidae, and Geometridae families. The study "On Little-Known Moths of Tripura, India" by D.K. Mandal and S.K. Ghosh (1991published in the Records of the Zoological Survey of India, provides an extensive survey of the lesser-known moth species found in Tripura. The study "Moths of Great Nicobar Biosphere Reserve, India" by K. Chandra (1996), published in the Malayan Nature Journal, provided a comprehensive survey of moth species in the Great Nicobar Biosphere Reserve. In "Fauna of Madhya Pradesh (including Chhattisgarh), State Fauna Series, 15(Part-l)," published by Kailash Chandra and D.K. Nema (2007) of the Zoological Survey of India, the authors focus on the Insecta order, specifically Lepidoptera: Heterocera (Moths). The article titled "Inventorization of Gelechiid Moths Diversity (Gelechiidae: Micro Lepidoptera) from Himachal Pradesh, India" by P.C. Pathania (2010), published in the Journal of Insect Science, documents the collection and identification of 44 species of Gelechiidae moths from various parts of Himachal Pradesh. The study "Diversity of Noctuid moths (Lepidoptera: Noctuidae) in Tamil Nadu part of Western Ghats (Nilgiris

biosphere and Kodaikanal hills), India" by K. Sivasankaran, S. Gnanasekaran, D. Parandhaman, and S. Ignacimuthu (2010), published in Elixir Bio Diversity, investigates the diversity of Noctuid moths in the Nilgiri Biosphere and Kodaikanal Hills. The study "Diversity, species richness and evenness of wild silk moths collected from Khasi hills of Meghalaya, North East India" by Jane Wanry Shangpliang and S.R. Hajong (2015), investigates wild silk moths over three years in four districts of Khasi Hills. The article titled "The moths (Lepidoptera: Heterocera) of Vagamon hills (Western Ghats), Idukki district, Kerala, India" by P. Mathew, S. Anand, K. Sivasankaran, *et al.* (2018), published in the International Journal of Fauna and Biological Studies, explored the moth diversity in the Vagamon hills of the Western Ghats. The study by Sondhi, Sondhi, Karmakar, and others (2018), provides an updated assessment of moth diversity (Lepidoptera) in Shendurney and Ponmudi within the Agastyamalai Biosphere Reserve, Kerala, India. The article titled "Moth diversity (Lepidoptera) of Shendurney and Ponmudi in Agastyamalai Biosphere Reserve, Kerala, India: an update" by S. Sondhi, Y. Sondhi, T. Karmakar, and others (2021), published in Tropical Lepidoptera Research, presents an updated checklist of moth species The report titled "A report on the moth (Lepidoptera: Heterocera) diversity of Kavvai River basin in Kerala, India" by C.J. Alex, K.C. Soumya, and T.V. Sajeev (2021), published in the Journal of Threatened Taxa, documents a significant diversity of moths in the Kavvai River basin. . The study titled "Erebid moths in the agroecosystems of northern Kerala" by K. Swafvan and P.M. Sureshan (2022), published in the Indian Journal of Entomology, focuses on the diversity and ecological roles of erebid moths.The article titled "New record of moths (Lepidoptera) from India" by J. Ahmad, S.K. Shah, P. Mishra, R. Joshi (2023), published in the Records of the Zoological Survey of India, highlights new findings in moth diversity from the Valmiki Tiger Reserve (VTR) in Bihar, India.

MATERIALS AND METHODS-4

STUDY AREA

Thrissur, situated in Kerala, India, lies adjacent to the majestic Western Ghats, renowned for their lush forests and biodiversity. Positioned around 10.52°N latitude and 76.21°E longitude, Thrissur shares borders with neighbouring states like Tamil Nadu and Karnataka. While it is inland, Thrissur is not far from the Arabian Sea coast, offering easy access to coastal areas. Covering an area of approximately 3032 square kilometres, Thrissur experiences a tropical monsoon climate, with heavy rainfall influenced by the southwest and northeast monsoons. The collection of moths was specifically carried out in the Irinjalakuda municipality in Thrissur district. Irinjalakuda is located in the Thrissur district of Kerala, India. The distance between Irinjalakuda and Thrissur city, the district headquarters, is approximately 23 kilometres by road. Irinjalakuda covers an area of approximately 15.44 square kilometres within the Thrissur district of Kerala, India. This area includes the municipality itself, as well as surrounding villages and suburban areas that fall under its jurisdiction.

IRINJALAKUDA MUNCIPALITY

Irinjalakuda Municipality, situated in Kerala's Thrissur district, is positioned between 10.35°N latitude and 76.21°E longitude. Irinjalakuda Municipality experiences a tropical climate with hot and humid conditions prevailing for most of the year. The temperature typically ranges from around 25°C to 35°C during the daytime, with slightly cooler temperatures at night. Located along the southern banks of the Chalakudy River, it thrives on its abundant water resources, supporting local agriculture amidst lush greenery, coconut groves, and paddy fields. Bordered by Kodungallur, Chalakudy, and Mukundapuram, its proximity to major cities like Thrissur and Kochi ensures easy accessibility. The region experiences a tropical climate, characterized by hot and humid conditions year-round, with monsoon rains from June to September. The Chalakudy River and its surrounding areas provide habitats for aquatic plants and vegetation, contributing to the overall biodiversity of the region. The region is home to a diverse range of insects and butterflies, adding to its ecological richness.

COLLECTION METHODS: Moth specimens were gathered primarily through handpicking, complemented by light traps and insect sweep nets for capturing fast-flying individuals.

LIGHT TRAPS: Utilizing the nocturnal nature of moths, light traps were employed. Collections were made using a mercury vapor light source. These traps consisted of a white cloth sheet supported by wooden poles, with a 60-watt light bulb positioned in the centre to attract moths. Moths drawn to the light were collected using a killing jar prepared with ethyl acetate-soaked cotton.

INSECT SWEEP NETS: Specially crafted insect sweep nets were utilized to capture swift-flying moths. Careful handling was exercised during collection to minimize any damage to their delicate wings.

PRESERVATION: Live specimens were euthanized using a killing jar, then dried under a 60-watt incandescent lamp. Subsequently, they were preserved in airtight insect boxes containing naphthalene balls to maintain their condition.

IDENTIFICATION: Moth identification was done through a combination of offline literature research and online resources. Photographs were taken using a mobile camera to aid in the identification process. Species were identified with the help of Labomed Microscope.

RESULT AND DISCUSSION-5

1. Superfamily: Noctuiodea

1.1 Family: Erebidae

The Erebidae (Lepidoptera: Noctuoidea) is the largest moth family, encompassing 24,569 species across eighteen subfamilies worldwide the name Erebidae was coined for the "quadrifid noctuids,". The Erebidae family is comprised of several subfamilies, totaling around 14 recognized subfamilies. The Erebidae family encompasses several subfamilies, including Aganainae,Calpine , Catocalinae, Erebinae, Eublemminae, Herminiinae, Hypeninae, Hypenodinae, Hypocalinae, and Rivulinae.

The family Erebidae is defined by: i) the hindwing's vein M2 strongly developed in the lower part of the cell, resembling a four-branched cubital vein; ii) the absence of basal abdominal brushes, a trait uncommon in most Noctuidae subfamilies; and iii) scales on the ventral half of the frons that quickly fall off, leaving the area bare in most Erebids. Erebidae larvae are mainly phytophagous, while adults feed on nectar, serving as herbivores, pollinators, and prey. They are also among the most damaging groups of agricultural pests (Reiger et al., 2009). Some genera of adult Erebidae can harm fruit crops by piercing the skin to suck juice (Banziger, 1982).

1.1.1 Subfamily: Arctiinae

The Arctiinae, previously known as the family Arctiidae, are a large and diverse subfamily of moths comprising around 11,000 species worldwide, with 6,000 species found in the Neotropical region. The most distinctive feature of this subfamily is the tymbal organ located on the metathorax. This organ contains membranes that vibrate to produce ultrasonic sounds. Additionally, they possess thoracic tympanal organs for hearing, a trait found fairly broadly in Lepidoptera, but with a unique location and structure specific to this subfamily. Other distinguishing characteristics include specific setae (hairs) on the larvae, unique wing venation, and a pair of glands near the ovipositor.

1.1.1.1 Genus: *Cretonotus* (Linnaeus,1763)

Creatonotos is a genus of tiger moths in the family Erebidae. They have short, porrect palpi and hind tibiae with one pair of spurs. The forewings are relatively narrow. In some species, the forewings have vein 10 originating from the cell and vein 5 in both wings, sometimes emerging from above the angle of the cell.

1.1.1.1.1 *Cretonotus transiens (*Walker ,1855)

The palpi are very minute and orange-colored. The antennae are minutely ciliated in both sexes. The head and thorax are dirty white with hairy tegulae. The abdomen is orange on the top and white on the bottom, featuring dorsal and ventral series of black spots. The hind tibiae have a minute terminal pair of spurs. The forewings are narrow and very pale fuscous, with the costa and base of the inner margin being whitish and black spots in and just beyond each angle of the cell. The hindwings are pale fuscous, with some specimens displaying a black submarginal spot above vein 5 and two spots near the anal angle.

1.1.2 Subfamily: Aganainae

The subfamily Aganainae, belonging to the family Erebidae (Fibiger & Lafontaine, 2005; Zahiri et al., 2012), comprises about 109 described species distributed among 11 genera worldwide (Zahiri et al., 2012). Often considered a separate family, Hypsidae (e.g., Holloway, 1976; Inoue et al., 1982), these moths are typically large, robust, and colorful both as larvae and adults. Like many species with poisonous larval hosts, they are often brightly colored day flyers (Kitching and Rawlins, 1998). The subfamily is distinguished by unique characteristics (Holloway, 1988; Zahiri et al., 2012): 1) long, upward labial palpus with a long, slender third segment, 2) forewing vein M2 arises closer to the origin of M3 than M1, in the lower part of the discal cell, giving the cubital vein a four-branched appearance, and 3) presence of M2 in the hindwing, also giving vein Cu a four-branched appearance. Aganainae species are known to feed on lactiferous plant families containing cardenolides, such as Moraceae, Apocynaceae, and Asclepiadaceae (Holloway, 1988; Common, 1990). The larvae of Aganainae possess fully developed or only slightly reduced abdominal prolegs (Zahiri et al., 2012).

1.1.2.1 Genus: *Asota* (Hubner,1819)

The genus *Asota* belongs to the subfamily Aganinae within the family Erebidae. With 51 species worldwide (Zwier, 2008; Bayarsaikhan et al., 2016), eight Asota species have been identified in India. These moths are characterized by their large size and vibrant colors. Forewings display a combination of yellow, brown, and dark brown with spots, wedges, and elongated patches, while hindwings exhibit yellow, orange, and white colors with spots and bands. Unique features include a small oval orange-yellow patch of scent scales anterior to the center of the hindwing subcostal on the upper side, and males have fasciculate antennae, whereas females have ciliated antennae (Holloway, 1982). In terms of wing structure, the forewing vein 5 emerges from the lower angle of the cell or slightly above it, and the 6th

vein unfolds from the top angle or lower. In the hindwing, vein 5 originates just above the lower angle of the cell, while veins 6 and 7 emanate from the upper angle.

1.1.2.1.1 *Asota caricae* (Fabricius, 1775)

The palpi are upturned, with the antennae being fasciculate in males and ciliated in females. The head, thorax, and abdomen are orange, with black spots on the palpi's 1st and 2nd joints, and a black spot on the tegulae. The abdomen often displays a dorsal series of black spots, sometimes forming bands. Forewings are brownish fuscous, featuring a basal orange patch with one basal and two sub-basal black spots, along with a series of three on its outer edge. Veins are streaked with white, and a white spot is present at the lower angle of the cell. Hindwings are orange-yellow, with a black spot at the end of the cell, one beyond it, and one below vein 2. Moreover, a submarginal irregular series, occasionally forming a nearly complete marginal band, with yellow veins crossing it.

1.1.3 Subfamily: Calpinae

The Calpinae are a subfamily of moths within the family Erebidae. The Calpinae subfamily, within the family Erebidae, comprises around 70 genera. They are known as fruit piercing moths.They are characterized by the presence of socketed tearing hooks on the proboscis, which are used for piercing the skin of fruits and mammals (Bänziger 1968, 1971, 1979a, 1982; Zaspel et al. 2007, 2008; Zaspel, in press). Unlike most moths that feed on nectar, both sexes of Calpinae adults can pierce ripening fruit and penetrate the skin and pulp with their modified, saw-toothed proboscis to withdraw juice. Calpini moths are cosmopolitan. Accordingly, unlike other groups of agriculturally important *Lepidoptera*, it damage crops, which in this case takes place due to rotting agents such as fungi and bacteria that penetrate the holes that they leave onto the fruit skin.

1.1.3.1. Genus: *Eudocima* (Billberg ,1820)

The fruit-piercing moth genus *Eudocima* Billberg, 1820 (Erebidae, Calpinae) includes around 50 species found in tropical and subtropical regions worldwide (Zaspel and Branham 2008, Zilli et al. 2017), with eight species present in the Neotropics (Zilli and Hogenes 2002). These moths are generally large and exhibit varied color patterns, with cryptic forewings and bright yellow-orange hindwings. In the Neotropics, the species typically have dark spots or bands on their hindwings. In Asian countries and Pacific islands, fruit-piercing *Eudocima* are often reported as crop pests, whereas in the Americas, they are only occasionally noted as pests.

1.1.3.1.1 *Eudocima phalonia* (Linnaeus 1763)

Eudocima phalonia, the common fruit-piercing moth, is part of the Erebidae family. Males have red-brown heads and thoraxes suffused with plum color, orange abdomens, and forewings that are red-brown with a greenish tinge and dark specks. Their hindwings are orange with a black lunule and a black marginal band. Females have more variegated forewings with dark red-brown striations, a dark reniform, and often a triangular white mark. Both sexes have similar hindwings, with males having a wingspan of 90-103 mm and females 94-110 mm.

1.1.4 Subfamily: Erebinae

The subfamily Erebinae is particularly noteworthy for its species richness and taxonomic complexity. It is most diverse in tropical regions, where a significant portion of the fauna remains undescribed. Species in this subfamily feed on a wide range of host plants, with significant radiations observed on grasses and legumes, and some species are considered pests in agriculture and forestry. Moths within the Erebinae subfamily are known for their remarkable predator defense adaptations. Adult moths vary greatly in size, ranging from small to verylarge, with wingspans ranging from under 2cmto nearly 30 cm.

1.1.4.1 Genus: *Bastilla* (Swinhoe,1918)

Bastilla is a genus characterized by distinctive morphological features. These moths typically exhibit intricate wing patterns with a variety of colors, including bands, spots, or lines. The wings are usually elongated, with slightly curved outer margins on the forewings and broader hindwings. The body is slender, with distinct segments, and they possess relatively long legs and antennae, which may be filiform or slightly clubbed. This combination of unique wing patterns, body structure, and size distinguishes *Bastilla* moths within the family.

1.1.4.1.1. *Bastilla amygdalis* (Moore,1885)

Its wingspan measures approximately 52 mm. The body is dark red-brown with a lilac-grey suffusion. The forewings feature an antemedial line that bends outward below the cell. The apical streak has an indented outer edge, and there are three white specks visible on the costa before the apex. The hindwings have a notably paler central part in the outer area. It is found in the Indian subregion, Sri Lanka, Taiwan, Thailand, Sumatra, and Borneo.

1.1.5 Subfamily: Lymnatriinae

Lymantriinae (Noctuoidea: Erebidae), commonly known as tussock moths due to their distinctive hair tufts, are characterized by a metathoracic tympanum, a defining feature of the group (Yela and Zahiri, 2011). This subfamily includes over 2,500 described species across 360 genera globally (Wang et al., 2015), with 216 species under 46 genera reported

in India (Gupta, 1992). Initially classified as the family Lymantriidae by Hampson (1893) in "The Fauna of British India," it was later reclassified as the subfamily Lymantriinae under Erebidae (Lafontaine and Fibiger, 2006). This reclassification was supported by the hindwing venation of quadrifine, with vein M2 and molecular studies involving one mitochondrial and seven nuclear genes (Lafontaine and Schmidt, 2010; Zahiri et al., 2011, 2012). Several species within this subfamily are significant agricultural pests, causing substantial economic losses (Goldstein, 2017).

1.1.5.1 Genus: *Leucoma* (Linnaeus,1758)

The genus Leucoma comprises approximately 15 known species. The palpi point upwards, reaching the top of the head. Both male and female antennae have branches, with longer ones in males and shorter ones in females. The hind tibia has a pair of spurs. On the forewings, vein 3 starts before the corner of the cell, while veins 4 and 5 start at the corner, and vein 6 starts at the top corner. Veins 7 to 9 are joined together. On the hindwings, vein 3 also starts before the corner of the cell, while vein 5 starts above the corner. Veins 6 and 7 are either joined together or start from the cell.

1.1.5.1.1 *Leucoma salicis* (Linnaeus ,1758)

Leucoma salicis L. (Lepidoptera, Erebidae, Lymantriinae), is also known as white satin moth. It is a notable defoliator primarily found in Europe and Asia. However, it was also introduced to North America in the 1920s.It a pest. White in color, occasionally with hints of ochreous, or even blackish on the costal margin in males; the head, collar, and the pectinations of the antennae are dark.

1.1 Family: Noctuidae

The Noctuidae, often referred to as owlet moths, cutworms, or armyworms, is the most debated family within the superfamily Noctuoidea due to the frequent reorganization of its clades, along with those of other Noctuoidea families. Presently, Noctuidae ranks as the second-largest family in Noctuoidea, encompassing around 1,089 genera and 11,772 species. Most noctuid adults possess wings in a range of browns, grays, and other varied hues. They are distinguished by a structure in the metathorax known as the nodular sclerite or epaulette, which separates the tympanum from the conjunctiva in the tympanal organ. This structure helps prevent parasites (Acari) from entering the tympanal cavity. Additionally, a notable feature in this group is the trifine venation of the hindwings, characterized by the reduction or absence of the second medial vein (M2)

1.1.1 Subfamily: Nolidae

The Nolidae family, also referred to as tuft moths, includes approximately 1,700 identified species globally. These moths are generally small and exhibit dull colors. Their primary distinguishing feature is a silk cocoon with a vertical exit slit. The family Nolidae is defined by two unique morphological characteristics: the creation of a ridged, boat-shaped cocoon with a vertical exit slit at one end, and two other morphological traits: an elongated forewing retinaculum that becomes bar-like or finger-like and the presence of a postpiracular counter-tympanal hood.

1.2.1.1 Genus: *Spodoptera* (Guenée, 1852)

Spodoptera is a genus of moths that includes 30 species globally, with 10 species found in North America. The larvae are commonly referred to as armyworms, while the adults are known as armyworm moths (Nendick-Mason, 2004). These moths typically have greyish or brownish hues and often exhibit distinctive patterns. Tufts are located on the metathorax, and the scales are significantly smoother. The abdominal tufts are minimal, while the fore tibial tufts are highly developed. The cilia are slightly scalloped, and the antennae are nearly simple. The genus Spodoptera comprises several significant polyphagous insect species that serve as primary and secondary pests for numerous crops, including asparagus, cabbage, pepper, tomato, lettuce, celery, strawberry, eggplant, sugar beet, alfalfa, cotton, corn, and tobacco.

1.2.1.1.1.1 *Spodoptera litura* (Fabricius,1775)

Spodoptera litura Fabricius, commonly known as the tobacco caterpillar, is a versatile pest known to cause significant damage to crops such as soybean, cotton, and various vegetables. Males and females of *S. litura* exhibit slight but noticeable differences in morphology, facilitating easy differentiation between the sexes. Male forewings typically measure 14–17 millimeters (1⁄2–5⁄8 in) in length, whereas females have slightly larger forewings, measuring 15–18 millimeters (5⁄8–3⁄4 in). Moreover, the orbicular spot on the forewing is more pronounced in males. Tufts are located on the metathorax, and the scales are significantly smoother. The abdominal tufts are minimal, while the fore tibial tufts are highly developed. The cilia are slightly scalloped, and the antennae are nearly simple.

1.2.2 Subfamily: Bagisarinae

Crumb (1956) established this subfamily based on the presence of toothed crochets on larval prolegs. In typical *Bagisara* Walker species, males have a slightly curved interior flange on the basal sternite, a paddle-shaped tergite on the eighth segment, and an enlarged sac-like sternite with a single corema. Females lack distinctive features but have a globular appendix bursa on a narrow tube from the corpus bursae, sometimes containing spines.

1.2.1.1 Genus: *Pardoxia* (Vives Moreno & González Prada, 1981)

The genus *Paradoxia* within the family Erebidae, first described by Walker in 1855, includes moths known for their distinctive wing patterns and coloration. A notable species, *Paradoxia graellsii*, has a wingspan of about 52 mm and features a dark red-brown body suffused with lilac-grey. The forewings display an antemedial line bent outward below the cell, an indented apical streak, and three white specks on the costa before the apex, while the hindwings are paler in the central outer area. This genus is found in regions such as the Indian subregion, Sri Lanka, Taiwan, Thailand, Sumatra, and Borneo. *Paradoxia* moths are significant for their unique morphological features and broad geographical distribution, contributing to the diversity within the Erebidae family (Holloway, 1982; Walker, 1855; Zilli & Hogenes, 2002).

1.2.2.1.1 *Pardoxia graellsi* (Feisthamel,1837)

Paradoxia graellsii is a moth of the family Erebidae, first described by Graells in 1849. It is found across a wide range, including regions such as the Indian subregion, Sri Lanka, Taiwan, Thailand, Sumatra, and Borneo. This species is recognized for its distinctive dark red-brown body suffused with lilac-grey. The forewings display an antemedial line that bends outward below the cell and an apical streak with an indented outer edge, accompanied by three white specks on the costa before the apex. The hindwings are characterized by a paler central part in the outer area. Its wingspan is approximately 52 mm. This species' diverse distribution and unique morphological features make it a notable member of the Erebidae family.

2.Superfamily: Geometroidea

2.1 Family: Geometridae

Geometrids are a species-rich group of moths that act as reliable indicators of environmental changes. Geometrid moths (Geometridae), one of the largest families within Lepidoptera, are notable for their species richness and distinct appearance. They have frequently been used in studies as indicators of environmental shifts. With around 23,000 described species (Scoble, 1999; Scoble & Hausmann, 2007), Geometridae is one of the three most species-rich families of Lepidoptera. The caterpillars, commonly known as loopers or inchworms, exhibit a distinctive looping gait due to their reduced number of abdominal prolegs. While Geometridae are found worldwide, the Neotropical region boasts the highest species diversity, particularly in the wet tropical Andes, which is recognized as the global diversity hotspot for this family (Brehm et al., 2016). The family is well-defined by certain

apomorphies, such as a tympanal organ (with an "ansa") at the base of the adult moth's abdomen and the reduction of larval prolegs (e.g., Minet & Scoble, 1999).

2.1.1 Subfamily: Geometrinae

The subfamily Geometrinae commonly referred to as emerald moths, ranks as the third largest subfamily within Geometridae, encompassing over 2,500 described species across 268 genera globally (Scoble & Hausmann, 2007). Geometrinae exhibits considerable diversity, particularly in tropical regions, with caterpillars primarily feeding on various trees and shrubs (Pitkin, 1996). Summarized by Holloway (1996) and Pitkin (1996), the key defining features of Geometrinae include the predominance of the green pigment geoverdin, which is a synapomorphic trait (Cook et al., 1994), and the shape of the ansa of the tympanal organ, supporting the monophyly of Geometrinae (Hausmann, 2001). Other characteristics include predominantly green wings, a reduced frenulum, the third sternite of the male typically having a pair of seta patches, well-developed socii in male genitalia, a distally cruciform vinculum, reduced sclerotization of the aedeagus to a ventral strip, and female genitalia featuring oblique and papillate ovipositor lobes with a bicornute signum. Both Hausmann (2001) and Han & Xue (2011a) noted venation characteristics: the forewing usually lacks an areole, and the hindwing has vein M2 positioned close to M1 and distant from M3. Beljaev (2008) added to the understanding by summarizing 12 apomorphies of Geometrinae, based on his study of the skeleto-muscular system of the male genitalia.

2.1.1.1 Genus: *Thalassodes* (Guenee,1857)

Thalassodes is a genus within the subfamily Geometrinae, known for its bright green wings due to the pigment geoverdin, a characteristic feature of the group. These moths typically exhibit intricate wing patterns with occasional white or other colored markings, aiding in their camouflage. They have a slender body, a reduced frenulum, and distinctive genitalia, with males having well-developed socii and a distally cruciform vinculum, and females featuring oblique and papillate ovipositor lobes with a bicornute signum. *Thalassodes* moths are found primarily in tropical regions, inhabiting forests and shrubby areas where their larvae feed on various trees and shrubs. . The genus contributes significantly to the diversity of the Geometrinae subfamily (Scoble & Hausmann, 2007; Holloway, 1996; Pitkin, 1996; Hausmann, 2001).

2.1.1.1.1 Thalossodes quadraria (Guenee,1857)

Thalassodes quadraria is a species within the genus *Thalassodes* of the Geometrinae subfamily, commonly known as emerald moths. This species, like others in it s genus, exhibits a striking green coloration due to the presence of the pigment geoverdin.

Thalassodes quadraria is primarily found in tropical regions, where it plays a role in the ecosystem by feeding on various trees and shrubs during its larval stage. The moths of this species display key characteristics typical of the Geometrinae subfamily: they have predominantly green wings, a reduced frenulum, seta patches on the third sternite of males, well-developed socii in the male genitalia, and a distally cruciform vinculum. The female genitalia are notable for having oblique and papillate ovipositor lobes and a bicornuate signum. Additionally, the venation patterns of *Thalassodes quadraria* align with those of the subfamily, with forewings usually lacking an areole and hindwings featuring vein M2 close to M1 and far from M3.

2.1.2 Subfamily: Ennominae

The Ennominae, the most expansive subfamily in the Geometridae, is renowned for its wide range of morphologies. These moths are recognized for their slim bodies and medium to large wingspans. Ennominae stands as the largest subfamily within the Geometridae, encompassing more than 9,700 species worldwide. One notable distinguishing characteristic for identification is the absence of the M2 vein as a tubular vein in the hindwing (Minet and Scoble, 1999).

2.1.2.1 Genus: *Hypomecis* (Hübner,1821)

Hypomecis is a genus within the Ennominae subfamily of the Geometridae family, which includes a diverse group of moths characterized by their slender bodies and medium to large wingspans. The Ennominae subfamily is the largest within the Geometridae, comprising over 9,700 species worldwide. *Hypomecis* moths are found across various regions of the world. One of the distinctive features used to identify moths of the *Hypomecis* genus is the absence of an M2 vein as a tubular vein in the hindwing, according to Minet and Scoble (1999).

2.1.2.1.1 *Hypomecis procursaria* (Walker,1860)

Hypomecis procursaria is a species within the *Hypomecis* genus of the Ennominae subfamily, part of the Geometridae family. These moths, like others in their genus, are known for their slender bodies and medium to large wingspans. *Hypomecis* moths, including *Hypomecis procursaria*, are distributed across various regions worldwide. One of the key identifying features of *Hypomecis procursaria* is the absence of an M2 vein as a tubular vein in the hindwing, a trait noted by Minet and Scoble (1999).

3.Superfamily: Pylaroidae

3.1 Family: Crambidae

The Crambidae, which belong to the Superfamily Pyraloidea, comprise over 11,500 described species globally. This group of moths, with more than 10,000 species worldwide, has evolved a wide range of morphological and ecological characteristics. The distinguishing features of Crambidae include an "open type" tympanal organ, characterized by a broad anteromedial opening, the presence of a praecinctorium, and the conjunctiva and tympanum not being in the same plane (Minet, 1982**).**

3.1.1 Subfamily: Spilomelinae

Spilomelinae, a subfamily within the Crambidae family, includes over 4,000 species of moths known for their vibrant colors and intricate wing patterns. These moths, commonly referred to as grass moths or webworm moths, are most diverse in tropical and subtropical regions. Morphologically, Spilomelinae moths have brightly colored and patterned wings, aiding in camouflage and mimicry. Their antennae are typically thread-like, and their larvae exhibit diverse forms and unique adaptations, such as leaf-rolling or web-spinning behaviors. Larvae are versatile feeders, consuming various plants, including many crops, making some species significant agricultural pests

3.1.1.1 Genus: *Pygospila* (Guenee,1854)

The genus *Pygospila*, within the Crambidae family, is distinguished by its striking wing patterns, typically featuring a mix of brown, white, and sometimes metallic hues, with distinctive markings such as bands, spots, or lines. The forewings are elongated with slightly curved outer margins, while the broader hindwings often exhibit different patterns or colors. These moths have slender, elongated bodies with a noticeable difference between the thorax and abdomen, and possess relatively long legs and filiform antennae. They are generally medium-sized and have tympanal organs of the 'open type' with a broad anteromedial opening, a characteristic feature of Crambidae moths**.**

3.1.1.1.1 *Pygospila tyres* (Cramer,1780)

Pygospila tyres is distinguished by its black wings adorned with prominent white spots and a moderate wingspan of approximately 4 centimeters. The wings are elongated with slightly curved outer margins, typical of the genus *Pygospila*. The body is slender with a noticeable distinction between the thorax and abdomen, featuring relatively long legs and filiform antennae. Additionally, *Pygospila tyres* possesses tympanal organs of the 'open type' with a broad anteromedial opening, characteristic of the Crambidae family. These distinctive morphological features make Pygospila tyres easily identifiable within its genus.

DISCUSSION

Moths identified as part of this study belong to the following families-

1.Erebidae

2.Noctuidae

3.Geometridae

4.Crambidae

A total of 10 subfamilies are identified based on published literatures namely, Arctinae, Aganaine, Calpinae, Erebinae, Lymnatriinae, Nolidae, Bagisarinae, Geometrinae, Ennominae and Spilomelinae. Out of this, Arctiinae, Aganainae, Calpinae, Erebinae, Lymnatriinae falls under family Erebidae.Nolidae and Bagisarinae are under the family Noctuidae. Whereas Geometrinae and Ennominae come under the Geometridae. Spilomelinae falls under Crambidae. Ten genera of moths belonging to 4 families have been identified which are as follows: *Cretonotus, Asota, Eudocima, Bastilla, Leucoma* from family Erebidae. *Spodoptera* and *Pardoxia* from Noctuidae. *Thalassodes* and Geometridae belong to family Geometridae. *Pygospila* belongs to Crambidae. The species are identified are given as checklist (table 1) for quick reference.

A total of 5 species are reported from the family Erebidae which dominated among the other groups. This is followed by the families Geometrinae and Ennominae, each of them having 2 species and 1 species for the family Crambidae. Percentage distribution of species collected during the study is given below (figure1) for quick comparison.

Pie chart representing the percentage distribution of species among families collected during study

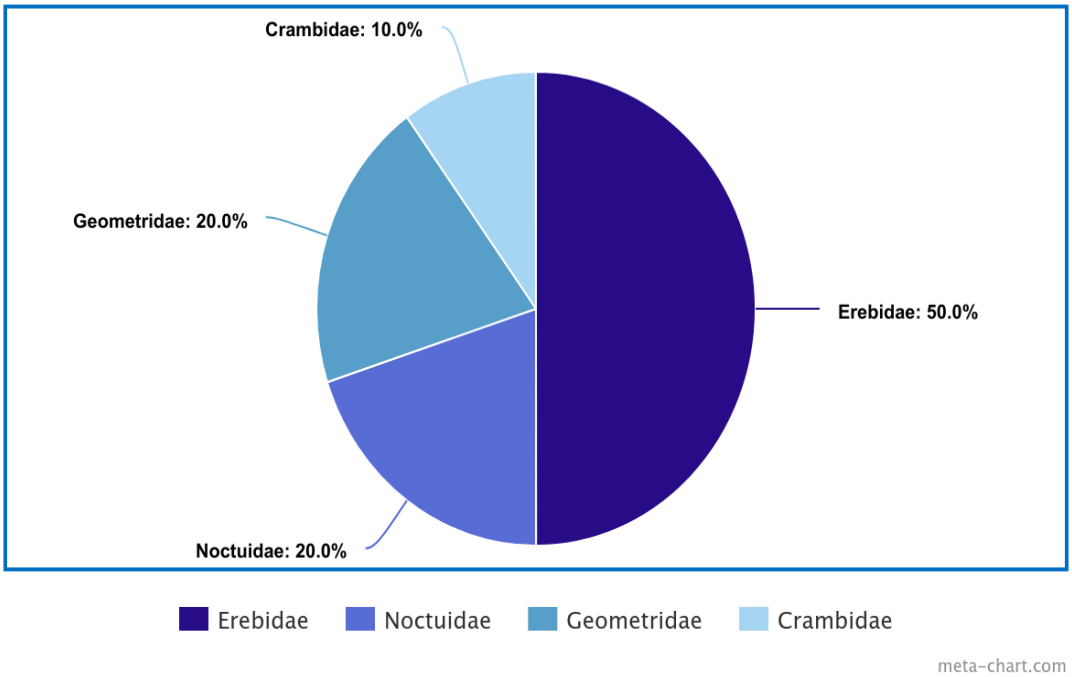

FIGURE 2 GRAPH REPRESENTING FAMILY DIVERSITY OF MOTHS

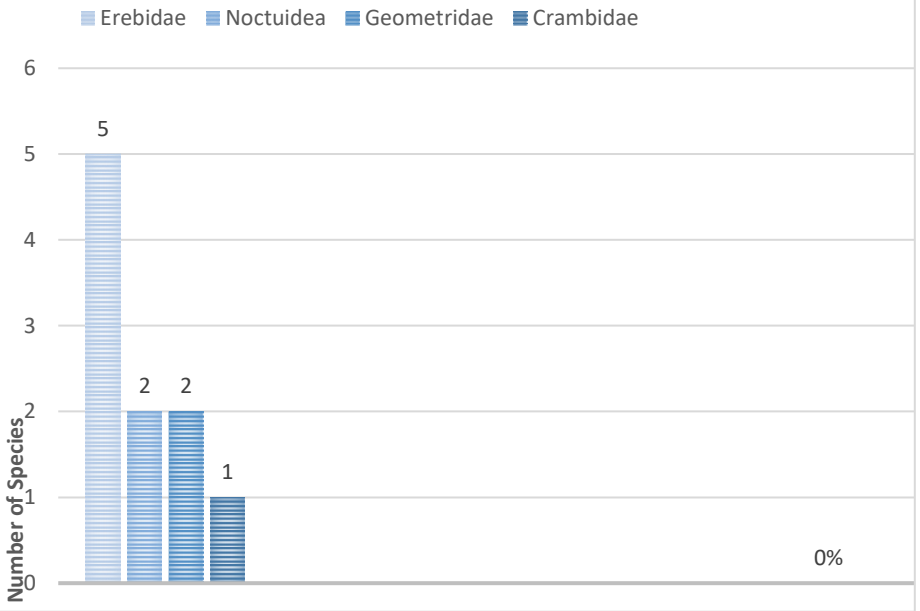

Table 1: Checklist showing the number of species, genera, subfamilies, families and superfamilies recorded from Irinjalakuda municipality.

Superfamily	**Family**	**Sub -family**	**Genus**	**Species**
Noctuoidea	Erebidae	Arctiinae	*Cretonotos*	*Cretonotos transiens*
		Aganainae	*Asota*	*Asota caricae*
		Calpinae	*Eudocima*	*Eudocima phalonia*
		Erebinae	*Bastilla*	*Bastilla amygdalis*
		Lymantriinae	*Leucoma*	*Leucoma salicis*
	Noctuidae	Nolidae	*Spodoptera*	*Spodoptera litura*
		Bagisarinae	*Pardoxia*	*Pardoxia graellsi*
Geometriodea	Geometridae	Geometrinae	*Thalossoides*	*Thalossodes quadraria*
		Ennominae	*Hypomecis*	*Hypomecis procursaria*
Pyraloidea	Crambidae	Spilomelinae	*Pygospila*	*Pygosphila tyres*

CONCLUSION-6

The study aimed to update the systematic status of moths in Irinjalakuda Municipality, located in Thrissur District, Kerala. Moth collection was primarily conducted from September 2023 to March 2024 using various methods such as light traps, handpicking, and insect sweep nets. A total of 45 specimens were collected and identified to the species level. The family Erebidae had the highest species count with five species, followed by Noctuidae and Geometriodea with two species each, and Pyraloidae with one species.

The rich vegetation of Irinjalakuda Municipality, which includes a variety of shrubs and trees, likely contributes to the high diversity of moths in the area. Since many moths are agricultural pests, accurate identification is crucial for their control using natural predators. Despite their harmful aspects, some moths benefit the environment by pollinating night-blooming flowers, and certain species serve as good indicators of pollution. Taxonomic studies of moths are essential to understand the causes behind the rapid changes in moth diversity and to devise conservation strategies, particularly habitat conservation, as moths are a food source for many animals.

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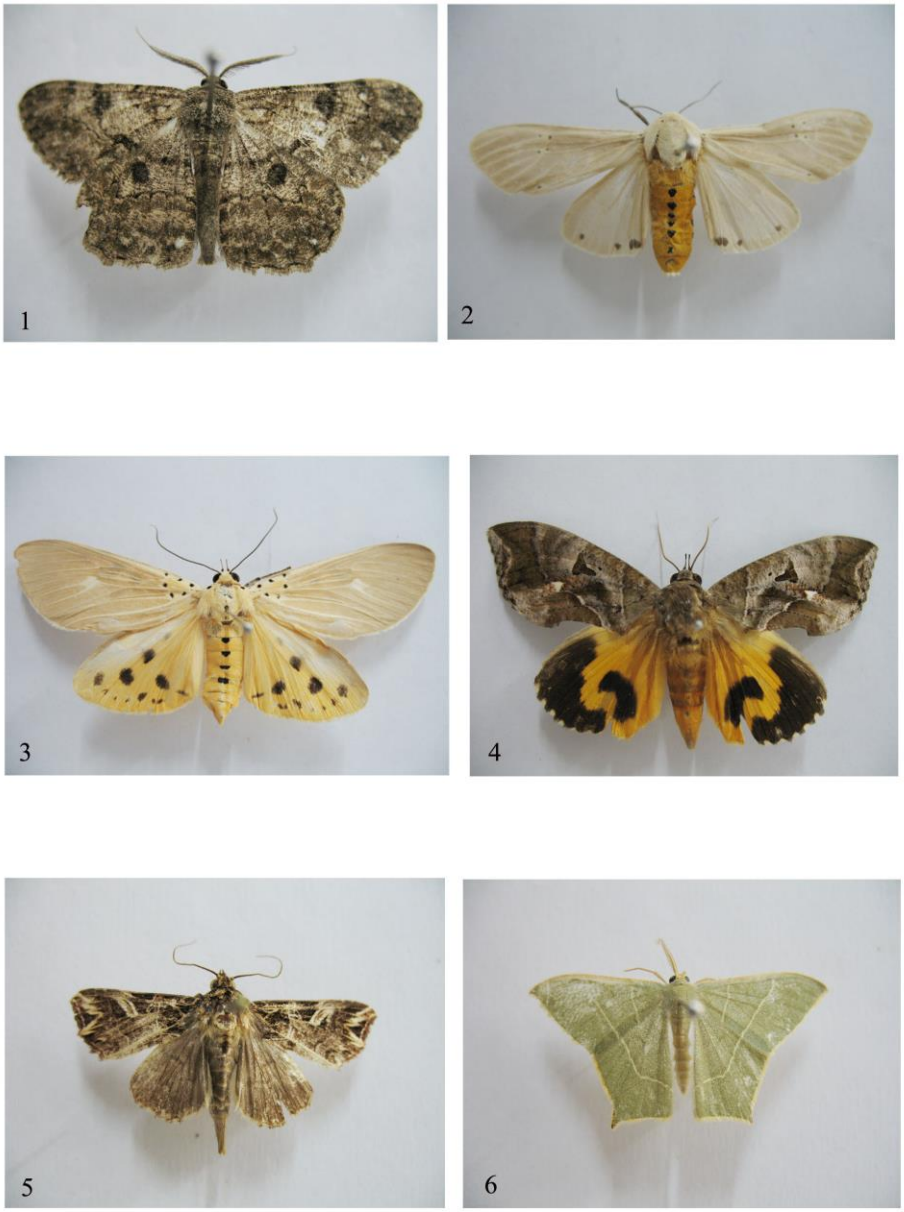
PLATE 1



1. *Hypomecis procursaria* 2. *Cretonotos transiens* 3. *Asota caricae*
4. *Eudocima phalonia* 5. *Spodoptera litura* 6. *Thalossodes quadraria*

AN INVENTORY OF MOTHS (LEPIDOPTERA: HETEROCERA) FROM GURUVAYUR, THRISSUR DISTRICT

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1) Name & Signature of Examiner 1

2) Name & Signature of Examiner 2

CHRIST COLLEGE, IRINJALAKUDA

DEPARTMENT OF ZOOLOGY

CERTIFICATE

This is to certify that the project work entitled **"AN INVENTORY OF MOTHS (LEPIDOPTERA: HETEROCERA) FROM GURUVAYUR, THRISSUR DISTRICT"** is an authentic record of research work carried out by **Mithu Manoj C.,** as part of the M.Sc dissertation work during the year 2023-2024 and the results of this work has not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda **Dr. Leyon Varghese**

Date: 21-06-2024 **Head of Department**

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Dr. Abhilash Peter
Assistant Professor
& Research Supervisor

CERTIFICATE

This is to certify that the contents of this dissertation work entitled **"AN INVENTORY OF MOTHS (LEPIDOPTERA: HETEROCERA) FROM GURUVAYUR, THRISSUR DISTRICT"** is the original research work done by **Mithu Manoj C.,** under my supervision and guidance at the Department of Zoology, Christ College, Irinjalakuda.

I further certify that no part of the work has been presented before for the award of any other degree/ diploma.

Place: Irinjalakuda
Date: 21-06-2024

DECLARATION

I hereby declare that this is an authentic record of the work carried out by me under the supervision of **Dr. Abhilash Peter, Assistant Professor, Department of Zoology, Christ College, Irinjalakuda** and no part of dissertation has previously formed the basis for the award of any Degree or Diploma as stipulated in the statutes of the University of Calicut.

Mithu Manoj C.

ACKNOWLEDGEMENTS

I am deeply grateful to Dr. ABHILASH PETER, Assistant Professor & Research Supervisor, Post Graduate and Research Department of Zoology, Christ College, Irinjalakuda, for suggesting this topic and for his unwavering encouragement throughout my study. Without his expert guidance and dedicated involvement at every step, this research work would not have been accomplished in its present form.

I would like to express my profound gratitude to the Principal and Christ College management for providing the necessary facilities for this project. My heartfelt thanks also go to the Head of the Department of Zoology for the resources and support provided, which were crucial for the completion of this work.

My sincere thanks to Mr. Adarsh P. K. and Ms. Joslin Treesa Jacob, Research Scholars of Entomo Taxonomy Lab, Zoology department, for their assistance during the project. I am also indebted to all the staff members, lab attenders of the department and my classmates for their timely help and encouragement.

Finally, I extend my heartfelt gratitude to my loving parents, my friends, and all those who have supported me in various ways throughout this endeavour, and above all, to Almighty God.

Mithu Manoj C.

CONTENTS

INTRODUCTION-1

As the foundation of human survival, biodiversity is the variety of life and its processes, encompassing the range of living things, their genetic variations, and the ecosystems and communities in which they coexist. Species diversity is the number of distinct species found in a given population (domestic or wild) within a certain geographic area. This encompasses diversity within species, between species, and of ecosystems. In simpler terms, it's the rich tapestry of life on Earth, from the smallest microorganisms to the largest animals, and everything in between. Biodiversity includes all forms of life, from microscopic bacteria to towering trees, and everything in between. It encompasses plants, animals, fungi, and microorganisms, as well as their interactions within ecosystems. Additionally, it encompasses genetic diversity within species, species diversity within ecosystems, and diversity of ecosystems themselves

Insects belong to the phylum Arthropoda, which is one of the largest and most diverse groups of animals on Earth. Arthropods are characterized by their segmented bodies, exoskeletons made of chitin, and jointed appendages. This phylum includes insects, as well as other closely related organisms such as spiders, scorpions, centipedes, and crustaceans. Class Insecta comprise about 90% of tropical forest biomass (Fatimah & Catherine 2002). Megadiverse groups like the insects form a major component of biodiversity of any particular area. The number of described insect species has been estimated to be 5 million (chapman 2009). Insects are incredibly diverse creature with over a million species identified so far. They play crucial role in ecosystem as pollinators, decomposers and prey for other species, some are essential for agriculture and food production. In terms of species richness, five orders of insects stand out. Diptera, Coleoptera, Hemiptera, Lepidoptera and Hymenoptera.

Lepidoptera, one of the main plant eating groups of insects in the world, which contain day flying butterflies and the mostly nocturnal moths (Heppner *et al.*). Order Lepidoptera is the second largest in the class Insecta which included in phylum Arthropoda. Total number of species in Lepidoptera are 1,57,424 under 15,578 genera of 133 families (Nieukerken 2011). Moths are diverse than butterflies. 88% of lepidoterans are moths. Lepidopterans are characterized by their four scale-covered wings, which are often brightly coloured and patterned. They undergo complete metamorphosis with four distinct stages: egg, larva (caterpillar), pupa (chrysalis or cocoon), and adult. They play significant roles in ecosystems as pollinators, herbivores, and as a food source for other animals (Babuthangadurai 2015).

Moths are mostly phytophagous leaf-feeders during their larval stage, while some moth caterpillars also fall into other guilds, including detrivors of plant and animal material, predators of flowers, fruits, and seeds, stem borers, browsers of lichen and algae, fungal feeders, and insectivores. The larvae of most moths and a small number of butterflies are major pests in forestry and agriculture. lepidopterans are ecologically significant as pollinators, integral components of food webs, bioindicators, contributors to biodiversity, and bearers of cultural and economic value, Butterflies and moths are almost similar but they have distinguishable Characters. Butterflies are primarily diurnal, being active during the day, while moths are predominantly nocturnal, active at night. Butterflies typically have thin, slender antennae with clubbed tips and hold their wings vertically over their backs when at rest, whereas moths often have feathery or filamentous antennae and spread their wings flat or fold them tent-like over their bodies. Butterflies tend to have thinner, smoother bodies and are usually more brightly coloured, while moths have bulkier, fuzzier bodies and more subdued coloration.

Members of the order Lepidoptera, or moths, have a number of important external morphological traits that are specific to their life cycle and ecological roles (Chapman1998). Body of moth consist of head, thorax and abdomen. The head of moth contain major sense organ and feeding organ. Typically head has two palpi, two compound eyes, two antennae and a proboscis. Although some species have smaller mouthparts as adults, moth heads normally include big compound eyes for nighttime vision, coiled proboscis for sucking nectar, and filiform or bipectinate antennae. Thorax comprises of three segments the prothorax, metathorax and mesothorax. The thorax bears the legs and wings, the organs used by insects for mobility. The prothorax gives rise to the forelegs, the mesothorax bears the forewings and middle pair of legs, and the metathorax bears the hindwings and hindlegs. Segmental and intra segmental sclerites make up the terga and sterna, the upper and lower portions of the thorax, respectively. In Lepidoptera, these sclerites exhibit significant alteration and secondary sclerotization. Of the three segments, the mesothorax is the most developed, and the prothorax is the shortest and most basic. Moth wings have smaller hindwings for manoeuvring and larger, stronger forewings utilised for flying (Scoble1995). Adult Lepidoptera have two pairs of membrane-covered wings that are typically entirely coated in tiny scales. A wing's structure is made up of two membranes: the upper and lower, which are joined by tiny fibres and fortified by a network of thicker, hollow ribs that are sometimes mistakenly called "veins" despite the fact that they can also encompass blood vessels, nerve fibres, and tracheae. The membranes are covered in tiny scales that are attached by hooks and have hairs or jagged ends. The quick contraction and

expansion of the thoracic muscles moves the wings. The unique venation patterns on the wings help identify the species The wing venation in Lepidoptera is a diagnostic for distinguishing between the taxa as also the genera and families. The abdomen consists of ten segments with series of sensory scale and glandular organs. Genitalia arise from tenth segment of abdomen. The arrangement of genitalia during courtship and mating is crucial because it inhibits hybridization and cross-specific mating. The morphological study of genitalia is one of the most crucial keys in the taxonomic identification of taxa below the family level because of the uniqueness of each species' genitalia. Together, these physical characteristics allow moths to successfully navigate their habitats and fulfil.

Moths act as environmental indicator (Merckx 2015). Environmental factors like food plants, nectar sources, temperature, humidity, and wind speed are all positively correlated with the number of moths. This means that they make excellent subjects for environmental monitoring because of their brief and healthy life cycle, which suggests the presence of beneficial environmental variables in the surroundings. But moths are considered as pest (Babuthangadurai, 2015) because most caterpillars of moths consume their host plants, which frequently includes crops. Body of moths are not suited for pollination, but some species play important role in pollination. As food source moth support wide range of predator including birds, bats and other insects, thus playing an integral part in food web.

The presence and abundance of moth populations serve as markers of environmental changes, indicating the effects of variables like habitat loss and climate change. The dynamics of their population and life cycles are strongly influenced by the climate, vegetation, and pollution levels. Furthermore, the existence or lack of a certain species of moth might reveal details about the quality of the air and water in an area. Scientists can obtain important information on the health of ecosystems and the wider effects of environmental changes by keeping an eye on moth populations climate change. In general, moths are essential to biodiversity and ecological balance

OBJECTIVES-2

- To provide an updated systematic status of moths in Guruvayur municipality.
- To identify and document common moth species from the study area.

REVIEW OF LITERATURE-3

International

The research provided taxonomic characters and keys to the species, enhancing the understanding of this family's systematic position. Owen (1972) provided estimates of species diversity for Sphingidae moths in Sierra Leone, highlighting the high species richness in tropical regions and the influence of seasonal variations on moth abundance. Pitkin (1996) outlined the geometrinae 's neotropical genera classification, identifying 38 genera. In a book by Solis (1997), several moths in the family Pylaroidae were described, along with 1600 species that have been documented in this family. Chey and Holloway (1997) examined the diversity of macromoths in a variety of rapidly expanding exotic tree plantations and natural secondary forests in Sabah, Malaysia. The effects of the establishment of two distinct plantations on the diversity and population of geometrid moths were discussed by Intachat and Chey (1999). Hawes (2009) collected 335 species of moths from various families during his study on the diversity and composition of Amazonian moths in primary and secondary forests. Ferro and Romanoswki (2012) compared the diversity of grassland and forest ecosystems and examined the diversity and composition of tiger moths in a section of southern Brazil's Atlantic Forest. In a temperate forest on Changbail Mountain, Zou and Sang (2016) examined the diversity and phylogenetic composition of a species-rich geometrid moth assemblage. The study by Hampson (2016) on the Chrysauginae subfamily of Pyralidae moths exemplifies traditional taxonomy, focusing on morphological traits to classify species within this subfamily There are 9285 geometrid moths collected, and they show a broad range of elevation distribution. Antolik and Lamp (2017) studied moth species diversity across different habitat types in the South African savanna, highlighting the high species richness and the importance of habitat heterogeneity for biodiversity conservation Burner *et al.* (2021) conducted a long-term study in Norway, documenting a decline in moth species richness and diversity over 30 years. This decline was observed across different habitats, highlighting the widespread nature of biodiversity loss in temperate regions. Belijaev (2023) offers new information on the taxonomy, ecology, and distribution of geometrid moths from Sakhalin and Moneron Island. This information includes descriptions of novel moth species and the correction of previously incorrectly identified ones. Piccini *et al*. (2023) assessed macro-moth diversity in the Western Italian Alps, recording 442 species. This study provides a baseline for understanding the impact

of habitat management on moth communities and highlights the importance of ecological corridors for maintaining biodiversity.

National

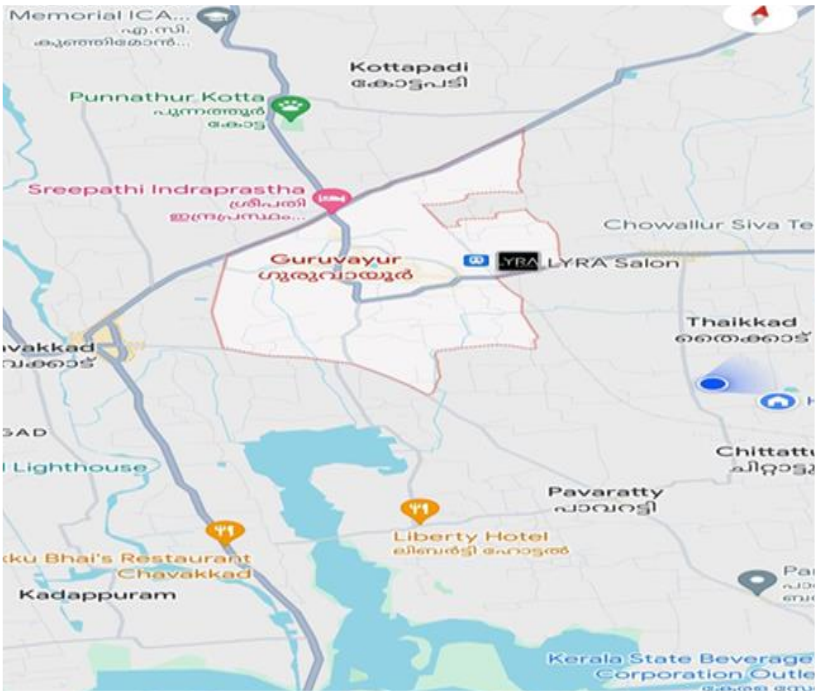
Hampson made a significant contribution to the moth fauna of British India. He published five volumes of "Fauna of British India" between 1892 and 1896 as a result of his research. A comprehensive list of 415 species of moths from Andaman and Nicobar Island is provided by Kailash Chandra and Kumar (1992). Of them, forty-one are endemic to this island. Out of the 500 species that were collected from Silent Valley, George Mathew *et al.* (1994) identified 15 families, with Pyralidae and Noctuidae being the dominant ones. From the Parambikulam Wildlife Sanctuary in Kerala, George Mathew and Sudheer Kumar (1999) collected 277 moths belonging to various families. Subhalaxmi (2011) identified 418 species of moths from eight locations in northern West Bengal, India, which are belongs to 28 families. Various moths in different families from Uttarakhand's protected areas were reported by Unniyal *et al*. (2016) He provided details on its potential as a tool for conservation in various Uttarakhand protected areas. In Amaravathi, Maharashtra, Gandhikar *et al.* (2011) recorded various species of moths belonging to different families. Navneeth Singh *et al*. (2017) provide information based on 81 species in 70 genera of moths from Jharkhand. Up to 20 species have been identified for the first time from the Gangetic plain and Jharkhand. Sivasankaran and colleagues (2017) carried out research in Nilgiri. They noted Noctuid diversity. There are 188 species known from the Noctuidae family. In a three-year period, Sondhi *et al.* (2018) identified 282 species of moth in Kerala's Ponmudi and Shendhuruney Wildlife Sanctuary. 112 moth species, representing 16 families, were listed by Sivasankharan *et al*. (2018) after conducting research at Vagamon Hill Station The state of Kerala first recorded 15 species. Alex *et al.* (2021) reports the presence of 503 species of moth that belongs to371 genera under 42 families from Kavvai river basin, Northern Kerala. According to Afaq and Khowaja (2021), moths exhibit alterations in reproduction and are impacted by even the smallest changes in climate. Moreover, explain moths as ecological indicators. In all, 154 species from 129 genera and 19 families were identified by Nivedita *et al*. (2021) in Bhubaneswar, Odisha. The highest moth recorded belongs to the family Crambidae. Dar and Jamal (2021) provide a detailed list of 758 moth specimens from three separate Aravalli hill range sites, categorised into five families and thirteen subfamilies. According to Rahul Joshy *et al*. and Navneeth Singh (2022), the Gangetic Plain, a biogeographic zone of India, is the site to 749 species of moths that belong to 445 genera divided into 26 families and 17 superfamilies. The moth diversity found in India's

Deccan Penisular Biogeographic Zone is reported by Navneeth Singh *et al.* (2022). This reports a total number of 1122 moth species under 608 genera, which are divided into 94 subfamilies and 29 families. From Guindy, Chennai, Bhavaragavam *et al*. (2023) recorded 100 species from 52 genera in 11 families. New records of moths from the Valmiki Tiger Reserve are provided by Jalil Ahmad *et al.* (2023) and listed13 species in 6 families.

MATERIALS AND METHODS-4

STUDY AREA

Guruvayoor is a municipal town which are 27 km away from Thrissur towards north west. It is situated at latitude:10.52763 N and longitude 76.2144 E. The total area is 3,032 square kilometres, out of which an area of 1,024 square kilometres is covered by forest. Thrissur district is bordered by Malappuram district towards north, Palakkad district towards east, Ernakulam district towards south and Arabian sea towards west. It is 27km away from



Thrissur and 7.6 km away from Kunnamkulam, bordered north by Kottapadi municipality and Chowannur panchayath, east by Mammiyoor municipality and Chavakkad panchayath, South by Pavaratty panchayath, west by Thaikkad municipality. The area is diverse with various fauna and flora.

The rainy season in Guruvayoor is characterised by heavy rainfall and high humidity level, various dry season is relatively dry and low humidity. The temperature normally ranges 68°F to 95°F. Moths specimens are collected mainly by handpicking method. Light traps and sweeping nets were also used to collect moths.

LIGHT TRAPS

Moths are mainly nocturnal creatures that are attract to bright light. The light traps consist of a white fabric held by two wooden poles on each side, with a 60-watt light bulb

placed in the centre. Moths attracted to light and those rested on white sheet were collected and killed using a killing jar. To make a killing jar, soak cotton in ethyl acetate and place it inside a plastic jar.

SWEEP NET

The moths, which rest on walls and buildings were captured using insect sweep nets. Commercially available net was used for the collection. Because these nets are prone to damage, much care was taken to ensure that the moths' wings were not harmed in the process of catching them.

PRESERVATION

Live specimens were killed using a killing jar, dried under 60-watt incandescent lamp and preserved in air tight insect box filled with naphthalene balls.

IDENTIFICATION

Identification of moth was done by researching published literatures, particularly Hampson’s Fauna of British India including Ceylon and Burma and also with the help of online resources. Labomed microscope was used to identify the species. Photographs were taken with the help of a mobile camera.

RESULTS AND DISCUSSION-5

1. Superfamily : Noctuoidea

1.1Family: Erebidae

The family comprises the following: fruit-piercing moths (Calpinae and others); micronoctuoid moths (Micronoctuini); snout moths (Hypeninae); underwings (Catocala); litter moths (Herminiinae); tiger, lichen, and wasp moths (Arctiinae); tussock moths (Lymantriinae), including the arctic woolly bear moth (Gynaephora groenlandica); and zales, though many of these common names can also refer to moths outside the Erebidae (for example, crambid snout moths). Owlets are the name given to certain erebid moths. The adult moths vary greatly in size, with the “black witch having a wingspan of almost 5 inches (127 mm), while some of the Micronoctuini have the lowest wingspan of any macromoth, measuring only 0.25 inches (6 mm). The adults' coloration ranges from brilliant, striking, and colourful (such as Aganainae and tiger moths) to dull, drab, and camouflaged (as Zale lunifera and litter moths). The Moths are found on all continents except antarctica.

1.1.1 Subfamily: Arctiinae

Members of this family are commonly referred to as tiger moths, lichen moths, or woolly bears in their caterpillar stage. The most distinctive feature of the subfamily is the tympanal organ on the metathorax. Tiger moths are notable for their vivid coloration, serving as a warning to predators about their potential toxicity, a phenomenon known as aposematism. The woolly bear caterpillars are often hairy and can sometimes cause skin irritation. These moths inhabit a range of environments, from forests to grasslands, showcasing their adaptability and ecological diversity.

1.1.1.1 Genus : *Creatonotos* (Hubner ,1819)

The genus *Creatonotos* includes several vividly colored moth species known for their unique behaviors, particularly among males. These moths typically exhibit bright, contrasting colors with patterned forewings and more uniformly colored hindwings. Males are notable for their large, inflatable scent organs called coremata, which release pheromones to attract females. The polyphagous larvae feed on a wide variety of plants, showcasing their adaptability.

1.1.1.1.1. *Creatonotos gangis* (Linnaeus,1763)

The adult moth has average wingspan of 4cm.The forewings appear brown, and the hind wings are white, with all four of them having dark streaks running across. When closed, the appearance does not change though the dark streaks get partially visible. Their abdomen that is red, and sometimes even yellow is bigger and rounder in males. Males are particularly notable for their coremata, inflatable scent organs that release pheromones to attract females. Palpi are short and smokey black, with black antennae. The head and thorax are pale pinkish ochreous, with a broad dorsal stripe on the latter. The legs are smoky black, and the femora is yellow; the hind tibia has one pair of spurs; the abdomen is crimson above, with dorsal and lateral black dots. The fore wings are pale pinkish ochreous with a broad black fascia below the median nervure, two black dots at the end of the cell, and a broad streak beyond the lower angle. The hind wings are pale or dark fuscous. Some specimens exhibit a submarginal series of black patches.

1.1.1.2 Genus: *Olepa* (Watson,1980)

These moths are recognized for their distinctive larvae adorned with tufts of hair or bristles along their bodies, serving as a defensive mechanism against predators. Adult tussock moths often exhibit wings with muted colors, blending into their surroundings for camouflage. Their larvae are typically polyphagous, feeding on a wide variety of plants, including trees, shrubs, and sometimes agricultural crops, which can lead to certain species being considered pests.

1.1.1.2.1 *Olepa toulgoeti* (Orhant,1986)

The adult average wingspan of 35 to 40 mm. The forewings exhibit a soft, velvety grey interspersed with delicate black lines that form a subtle lace-like pattern. In striking contrast, the hindwings are a pale, buttery yellow, creating a visually dramatic effect that is particularly noticeable during flight. The body is densely covered in fine scales, imparting a plush, furry texture that provides protective insulation. The moth's feathery, finely segmented antennae enhance sensory perception. Additionally, the legs and head, similarly covered in scales that often match the body and wings, feature prominent, rounded eyes that facilitate night-time navigation.

1.1.2. Subfamily: Lymantrinae

The Lymantrinae subfamily exhibits several distinctive features. These moths are characterized by both their adult and larval stages. Adult moths often display wings with muted colors, aiding in camouflage within their habitats. Some females are flightless, while others have smaller wings. Females usually have a big tuft at the end of their abdomens. Males, at least, have

tympanal organs. They are usually nocturnal, but some species are diurnal. Their larvae, however, are more visually striking, adorned with tufts of hair or bristles along their bodies, serving as a defence mechanism against predators. This subfamily is widely distributed across diverse habitats worldwide, including forests, grasslands, and urban areas.

1.1.2.1 Genus: *Leucoma* (Hubner,1822)

Leucoma moths possess a head with filiform or bipectinate antennae, compound eyes, and a proboscis adapted for nectar feeding, although some adults have reduced mouthparts. Their wings are notable for being white or pale-colored with a silky appearance, especially prominent in species like *Leucoma salicis*, the white satin moth. The abdomen consists of multiple segments housing the reproductive organs, covered in fine scales. The larvae, which are often hairy, can feed on a variety of trees and shrubs, sometimes becoming pests in forestry and agriculture. Leucoma moths usually inhabit wooded areas, gardens, and places where their host plants are abundant.

1.1.2.1.1 *Leucoma salicis* (Linnaeus,1758)

Leucoma salicis is also known as white adult satin moths are silvery-white with a black body thickly coated in white hairs, giving them a largely white look with some dark showing through. It has a wingspan of around 1 ½ to 2 inches (30 - 50mm) and a body length of 15 to 20mm. Male adult moths have antennae that resemble feather tufts, whilst female antennae are more thread-like. The satin moth pupa is lustrous black and yellow, measuring 15 to 20mm long. Pupae are frequently discovered inside curled leaves, wrapped in a white silk cocoon. In the larval stage, they are pale to medium grey-brown with a darker head and back. Along the centre of the back satin moth. In the centre of the back, there is a row of huge circular, double patches that are lustrous milk-white or yellow. In addition to these patches, there are two sub-dorsal broken yellowish lines and two lateral and sub-dorsal rows of reddish-brown tufts. Finally, the eggs of *Leucoma salicis* are flattened, pale green, and deposited in one to two layers. The round masses typically contain 150-200 eggs that are coated in a white discharge.

1.1.3 Subfamily: Calpinae

Many species of moths in this family have sharp and barbed proboscis that allow them to pierce the skin of fruit to feed on juice, or, in the case of the calyptra vampire moth, to puncture the skin of an animal to feed on blood. This subfamily includes several large moths with wingspan

of greater than 5cm.The Calpinae are most closely related to the Erebidae clade, which includes the Eulepidotinae and Hypocalinae taxa.

1.1.3.1 Genus: *Eudocima* (Billberg,1820)

The head and thorax are reddish brown, with plum coloured suffusion. The orange colour on the abdomen. The forewings are reddish brown with a greenish tint and black specks. There is an obligatory antimedial line, which is normally black and indistinct but can also be pale and obvious. An oblique streak from the apex nearly always intersects a curve postmedial line. The orange hindwings have a large black lunule beyond the cell's bottom angle. From the costa to vein 2, a marginal black band with cilia pale spots runs. The forewings bear an orange postmedial band on the ventral side. The larvae's 11th somite has dilated and is now surrounded by a tubercle. From the sixth to the eleventh somite, the body is purplish brown with a brown dorsum. The adult is regarded as an agricultural pest because it damages many fruit crops by piercing them with its powerful proboscis and sucking juice. Adult bait, egg parasites and larval parasitoids have all used to try to manage them.

1.1.3.1.1 *Eudocima materna* (Linnaeus,1767)

Eudocima materna is known as “dot underwing moth”. The wingspan ranges from 60 to 96 mm. Palpi have a long third joint and spit at the extremity. Both sexes have forewings with crenulate cilia. Male thorax and head are greenish-grey in colour. Orange belly. Greenish-grey forewings with an abundance of thin, striated reddish lines. At the end of the cell, three rufous spots are visible. dark, oblique line running from inner margin centre to almost apex. a silvery patch on vein 1 and another beneath the cell's lower angle. a thin black band with an inner crenulated border. A number of white cilia spots are present. Orange is the ventral side. Costa on forewings, rufous blotches on apical area. One can observe black bands that are obliquely postmedial and subapical. Apical region of hindwings blotched with rufous. There is a black spot on the costa and another one outside the cell's lower angle. From vein 5 to the anal angle, there is a thin black band. The female's forewings are rufous in colour and have much more noticeable striating. Large silvery patches were located below and beyond the cell, and they were connected by white streaks that crossed vein 2 and the cell.

1.1.4 Subfamily: Erebinae

Erebinae moths have cryptic or camouflaged coloration and patterns, helping them blend into their surroundings and avoid detection by predators during the day. This camouflage is often

essential for their survival, as it allows them to remain hidden from predators such as birds and other insect-eating animals. The wingspans of many species in the subfamily range from 7 to 10 cm (3 to 4 inches), with the white witch moth (*Thysania agrippina*) having the greatest wingspan of any Lepidoptera at over 30 cm. Erebine caterpillars consume a wide variety of plants; numerous species graze on legumes and grasses, and a few are pests of rice, sugarcane, castor beans, pistachios, and blackberries.

1.1.4.1 Genus: *Ischyja* (Hubner,1823)

Adult wingspan of moths in the genus *Ischyja* can vary, but they are generally medium to large-sized moths. Typically, the wingspan ranges from about 50 to 80 millimeters (approximately 2 to 3 inches), though there can be some variation among different species within the genus. These moths exhibit distinct wing patterns and coloration. The forewings are usually mottled with shades of brown, grey, and black, featuring intricate lines, spots, and patches that provide effective camouflage against tree bark and other surfaces. In contrast, their hindwings often display striking colours such as white, orange, or red, which are usually concealed when at rest but can be exposed to startle predators. Males of the genus often have bipectinate (feather-like) antennae for detecting female pheromones, whereas females typically have simpler, thread-like antennae. Palpi with a broad, rectangular-scaled second joint that extends to the head's vertex. Long, nude, and angled third joint. In males, antennae became thicker and fasciculate. Abdomen and thorax scaled smoothly. Tibia is spineless. tibia anterior with a triangular hair tuft. slightly fringed mid-tibia. Long hair covering the hind tibia. Forewings with acutely pointed, highly arched costa towards the apex. obliquely curving outer margin. very short cell on the hindwings. Male with two to four veins that are near the outer edge and run closely together. Four pairs of abdominal prolegs on a larva. The larvae are generally smooth-bodied and may exhibit a variety of colours and patterns that aid in their camouflage on host plants.

1.1.4.1.1 *Ischyja manila* (Cramer,1776)

The female has a wingspan of 96–112 mm, while the male's spans 80–100 mm. The male's thorax and head are both reddish-brown. Fuscous or red-brown abdomen. There are white patches on the outer spur of the midlegs and the outer medial spur of the hindlegs, as well as at the base of the hind tibia. Dark brown, olive brown, or pale reddish-brown forewings that are coated with dark particles. Antemedial and medial waved lines are still visible. There is a postmedial line that is straight and oblique. either in the shape of deep black quadrate spots

with white edges, orbicular and reniform, greyish or ochreous. Above the anal angle, there is a black spot with a pale streak. White, asymmetrical postmedial band extending from the costa to vein 2 on the ventral side of the forewing. Dentate postmedial line visible in hindwings. The female's forewings lack the black patches and have a much more uniform colour. The slanted line is noticeable. broad and more regular band on the hindwings. Above the anal angle, there is no visible mark. The colour can be extremely dark. The larvae have short black streaks that sporadically mark their ochre and purplish brown colour. Their head is speckled with brown and ochre.

1.2 Family : Noctuidae

The Noctuidae is a family of moths that is also referred to as armyworms, cutworms, and owlet moths. Because many of the clades, along with the other families of the Noctuoidea, are constantly changing, they are regarded as the most controversial family within the superfamily Noctuoidea. It was long regarded as the largest family in Lepidoptera, but the current title belongs to the family Erebidae, which was formed by combining the families Lymantriinae, Catocalinae, and Calpinae. As of right now, Noctuoidea's Noctuidae family is the second largest.As additional differences between Noctuidae and Erebidae continue to emerge, this classification is still subject to change. While the majority of nocturnal adults have wings that range widely in colour from brown to grey to other hues, certain subfamilies, like Acronictinae and Agaristinae, have extremely colourful wings. A claviform (club-shaped) stigma, horizontally oriented with the thicker end closer to the wing's outer edge, is located posterior to a discal (round) stigma on the forewing, extending from the basal location to the outer edge (proximal to distal). A reniform (kidney-shaped) stigma, which is usually oriented with its concave side facing the wing's outer edge, follows these distally. Many times, not every specimen or species has all of the stigmata visible. Crosslines or crossbands that run longitudinally from the leading to the trailing edge of the wing may be present .

1.2.1 Subfamily: Noctuinae

Members of the Noctuinae subfamily typically exhibit dull or cryptic coloration, which helps them blend into their surroundings. The wingspans can range from about 25 mm (1 inch) to over 60 mm (2.5 inches), depending on the species. Forewings have cryptic coloration with shades of brown, gray, or black. Patterns often include streaks, spots, and wavy lines that provide camouflage. Hindwings typically lighter than the forewings, often white or pale gray, sometimes with darker bands or spots. In males, the antennae can be bipectinate (comb-like)

or filiform (thread-like), while in females, they are typically filiform. Labial palps are usually prominent and forward-projecting, often covering the mouthparts. The larvae, commonly known as cutworms or armyworms, are often more economically significant due to their feeding habits on crops. Larva are mostly polyphagous, feeding on a wide variety of plants, which can include grasses, crops, and garden plants. usually cylindrical, smooth, and come in various colors.

1.2.1.1 Genus: *Polytela* (Guenee,1852)

Moths in this genus are medium-sized, with a wingspan typically ranging from 30 to 40 mm, and have a robust body structure. The forewings of *Polytela* species are generally elongated and narrow, displaying dark coloration with prominent and distinctive markings, including shades of brown, black, and sometimes metallic colours. Notably, they exhibit prominent orbicular (round) and reniform (kidney-shaped) spots that often contrast sharply with the surrounding wing colour. The hindwings are usually paler, often grey or white, with darker veins and marginal bands. Some species have additional distinct markings or metallic scales that can appear as silvery or golden spots or streaks on the forewings. Larvae of *Polytela* are smooth-bodied, cylindrical, and typically exhibit longitudinal stripes or spots, with well-developed prolegs with crochets that help in gripping the substrate and aiding in movement. These caterpillars are usually polyphagous, feeding on a variety of herbaceous plants and sometimes crops.

1.2.1.1.1 *Polytela gloriosae* (Fabricus,1781)

Polytela gloriosae is known Indian Lilly moth with an average wingspan of 29 to 35mm. It can be identified by its distinctive dark brown to black forewings adorned with metallic blue or green spots, along with well-defined white or yellowish orbicular and reniform spots. The pale grey to white hindwings with darker veins and semi-transparent base further distinguish it. It has a fully developed proboscis and hairy eyes. Roughly scaled and palpi porrect (extending forward). Black and blue in the head and thorax. Orange antennae. There are three orange spots on the metathorax. blackish abdomen with orange segments at the end. Black and blue forewings. At the base, there is a speck of orange. There are two black and pink lunules that run towards the inner edge. Orbicular has a ring mark and is yellow. Reniform pale yellow. The outer angle and apex have large orange patches. Fuscous hindwing. The caterpillar is purple-black in colour and smooth. White spots in a row on the sublateral, lateral, and dorsal surfaces. Lateral purplish blotches on the thoracic somites. Legs and head are ruddy. Instars are more

ruddy-brown in the beginning. The caterpillar's body colour darkens as it reaches later instars, and its tiny, yellow eggs are spherical in shape. They are polyphagous, feeding on a variety of herbaceous plants, with a preference for lilies and other related plants.

2.Superfamily: Pyraloidea

Pyraloidea Superfamily around 17,800 species in two families exist in the world. The majority have two tympanal organs on the first abdominal segment. Adults are typically long-legged and slender-bodied, and many have narrow forewings and broad, frequently folded hind wings. It is third largest superfamily in Lepidoptera. Generally, they are small in size. Pylaroidea moths generally have slender bodies. The wings are typically held roof-like over the body when at rest. Wing shapes and patterns can vary significantly, often featuring intricate and cryptic patterns that provide camouflage. Labial Palps are Prominent and often upward-pointing, the labial palps give many members of this superfamily the appearance of having a "snout," which is especially noticeable in the Pyralidae family. Most species' larvae are leaf rollers, leaf webbers, leaf miners, borers, root feeders, and seed feeders that feed on live plants either internally or externally. Certain species feed on scale insects (Phycitinae), live parasitically in ant nests (Wurthiini), or inhabit bee nests (Galleriinae). Certain Phycitinae and Pyralinae are adapted to very dry environments, and their larvae feed on stored food products. The larvae of the Acentropinae are suited to life underwater. Some consume animal waste, including carrion and faeces.

2.1 Family: Pyralidae

Pyralid moths are commonly known as grass moth or snout moth. Whose members, in general, have long, narrow forewings, wider hindwings, and a wingspan of 18 to 35 mm (0.75 to 1.5 inches); a small number can reach up to 75 mm (3 inches). With the exception of vivid metallic markings, the colouring is dull. The habitats of adults and larvae differ significantly. While the majority of species are dull grey or brown in colour, some have unique patterned wings. Typically, the labial palps extend upward or forward. There are three anal veins on the hind wings. The Pyralidae family contains a large number of species that are regarded as serious agricultural pests. For instance: One significant pest of maize is the European maize borer, or *Ostrinia nubilalis*. In stored grain products, the Indian meal moth (*Plodia interpunctella*) is a frequent pest. Their larvae have the ability to seriously harm crops, which can result in economic loss.

2.1.1 Subfamily: Pyralinae

The Pyralinae are a common subfamily of snout moths in the Pyralidae family. They are found almost everywhere, sometimes due to unintentional human introduction. However, their diversity in the Australian region is also limited, and they are rather uncommon in the Americas. This subfamily consists primarily of medium-sized to smallish moths with somewhat cryptic colours, usually varying shades of brownish colours. With the exception of *Cardamyla* and *Embryoglossa*, adult female Pyralinae are distinguished by their short genital ductus bursae, with their corpus bursae hardly extending forward past abdominal segment 7. Other than that, they are rather unremarkable mid-sized moths (big by Pyralidae standards), though occasionally they can be identified from their relatives by having unjoined hindwing veins 7 and 8 and forewing vein 7. Both the meal moth (*Pyralis farinalis*) and the grease moth (Aglossa pinguinalis) are pests of stored food products, including fats (which the adult moths also consume). These pests have been unintentionally carried nearly everywhere by the transportation of such goods. The caterpillars of most other species feed on leaves.

2.1.1.1 Genus: *Endotricha* (Zeller,1847)

Endotricha is the genus of snout moth with wingspan ranges from 18 to 30 mm. Usually having narrow, elongated forewings that exhibit complex patterns and colours ranging from brown and beige to more vivid hues, these moths have slender, elongated bodies. They have larger, frequently less patterned hindwings. *Endotricha* moths rest with their wings folded over their bodies like a roof. Typically, the antennae are filamentous and straight, and the forward-projecting, prominent labial palps resemble a snout. well-developed the proboscis is utilised to feed on nectar. The smooth, cylindrical caterpillars feed on a variety of plant materials, such as leaves, stems, and seeds. They are frequently camouflaged to blend in with their host plants consume a variety of plant materials, such as seeds, stems, and leaves. For protection, many larvae roll leaves into shelters or weave silken structures. *Endotricha* species are widely distributed, mostly in tropical and subtropical regions but also extending into temperate zones, and can be found in a variety of habitats, including forests and grasslands.

2.1.1.1.1 *Endotricha mesentralis* (Walker,1859)

Endotricha mesentralis is a snout moth with average wingspan is about 10mm. The forewings of *Endotricha mesentralis* are typically marked with a mix of browns, beiges, and occasionally reddish or pinkish hues. These wings often display complex patterns, including wavy lines, spots, and patches that help break up the outline of the moth and blend into the background, such as tree bark, leaves, or other natural substrates The hindwings are usually less elaborately

patterned compared to the forewings. They are often a lighter, more uniform colour, which can range from beige to light brown, and sometimes have a slight sheen. The body of the moth is generally coloured to match the wings, with shades of brown and beige predominating the patterns may also serve as a form of mimicry, where the moth's appearance imitates natural elements like dried leaves or bark, further aiding in its concealment. The larvae of *Endotricha mesentralis* are herbivorous and feed on a variety of plant materials. They often create silken shelters or roll leaves to protect themselves while feeding. This behaviour provides them with a safe environment from predators and environmental hazards. The adults act as pollinators while feeding on nectar, and the larvae contribute to plant matter decomposition and serve as a food source for various predators.

2.2 Family: Crambidae

Crambidae moths are commonly known as grass moths. The family Crambidae is rich in species, with approximately 10,347 species spread across 1,017 genera globally. The adult and larval morphologies of the Crambidae support their monophyletic status. Members of this family vary greatly in size and appearance. Many have slender bodies and wings that are either narrow or broad. They can exhibit vibrant colours or subtle patterns, depending on their species. The praecinctorium is present, the conjunctiva and tympanum are positioned in a different plane, the larval eighth abdominal segment lacks the sclerotized ring surrounding the base of SD1, and the molecular data sets are among these characteristics of the open type of tympanal organ. The habitats of crambid larva range greatly, from freshwater to very dry conditions, and their food sources include detritus, lichens, mosses, ferns, conifers etc.

2.2.1 Subfamily: Spilomelinae

The forewing span varies from 11.5 mm in *Metasia* to 50 mm in robust-bodied *Eporidia*. In resting position, the moths have a distinctive triangular shape, with the wings folded over the abdomen and the forewings covering the hindwings. Some Spilomelinae deviate from this common resting pattern, such as Maruca with widely spread wings and *Atomopteryx* and *Lineodes* with narrow wings folded along their bodies. All Spilomelinae moths have well developed compound eyes, antennae, and mouthparts, but in the genera *Niphopyralis* and *Siga*, the proboscis is loss. The subfamily's synapomorphic characteristics include minute or obsolete maxillary palpi, ventrally projecting fornix tympani, and female genitalia ductus bursae with weak sclerotization or granulose texture. The moths are also distinguished by their frequently bilobed praecinctorium, pointed spinula, and lack of chaetosemata and a retinacular hook. A

gnathos or pseudognathos can be present or absent, and thus has little diagnostic value, except for several genera of Agroterini, where the gnathos has a well-developed medial process. Spilomelinae are classified as "pest species" because their larvae feed on a wide range of economically important crops. *Cnaphalocrocis* and *Marasmia* damage Poaceae like Oryza, Sorghum, and Zea, the legume pod borers of the genus *Maruca* on Fabaceae and Amaranthaceae, and Spoladea, which feeds on a variety of different agriculturally important plant families.

2.2.1.1 Genus: *Cnaphalocrocis* (Lederer,1863)

Adult moths of this genus are relatively small to medium-sized, with a wingspan ranging from about 10 to 30 mm. The forewings are typically narrow and elongated, often with a distinctive pattern of lines and spots that can vary between species. The hindwings are generally broader and may also feature patterns or marking. The coloration of the wings can range from pale yellow or brown to darker shades, with some species exhibiting a metallic sheen or iridescence. These moths are primarily recognized for their larvae, which are the most damaging stage, feeding on the leaves of host plants such as rice and various grasses. For example, *Cnaphalocrocis medinalis*, commonly known as the rice leaf folder, is notorious for infesting rice crops, causing significant damage by folding and rolling the leaves. Effective control methods include cultural practices like crop rotation and field sanitation, biological controls involving natural predators and parasitoids, and chemical controls, although integrated pest management strategies are preferred for their reduced environmental impact.

2.2.1.1.1 *Cnaphalocrocis medinalis* (Guenee,1854)

This moth typically has a wingspan of about 16 millimetres. The adult moth is distinguished by its bright yellow or straw coloration and distinct wavy lines on the forewings and hindwings. Dult rice leafrollers are typically 7 to 9 millimetres long, with a wingspan of 13 to 18 millimetres. They have a flaxen coloration and three brown transverse belts on their prothorax, one of which is relatively coarse and short. Male moths have a shining and concave eyespot on the central part of the prothorax's leading edge, whereas female moths lack it. Larvae develop through 5 to 6 instars before pupating within folded leaves for 6 to 7 days. Fully grown caterpillars are green and measure approximately 16.5. Rice leafrollers are harmful in the larval stage. A single larva can consume about 25 square centimetres (4 square inches) of leaf tissue, which is less than 40% of a normal rice leaf. In general, the first-instar larva crawled into the heart leaf or the nearby leaf sheath, while the second-instar larva began to spin silk at the leaf

tip, eventually turning into a small insect bud. Food intake in the fourth and fifth instars accounts for more than 90% of the larva's total food intake. They resulting in significant yield loss.

3. Superfamily : Geometroidea

Adult moths typically have slender bodies and broad wings that are often held flat when at rest. These wings frequently feature intricate and delicate patterns, including wavy or scalloped edges, which serve as effective camouflage against predators by blending into their natural surroundings like tree bark or leaves. The colouration of these moths can range widely, from muted browns and greens that provide excellent concealment, to more vivid hues and striking patterns that may serve in mate attraction or as warning signals to potential predators. The forewings and hindwings are often similar in appearance, contributing to their seamless, cryptic look when at rest. Another distinctive characteristic is the presence of a tympanal organ located at the base of the abdomen, which is used for detecting ultrasonic sounds and evading bats. The larval stage, known as inchworms or loopers, also has a distinctive appearance. These caterpillars are characterized by their elongated, cylindrical bodies and lack of prolegs in the middle segments, causing them to move in a looping fashion. Their colours and patterns are equally diverse, often mimicking twigs, leaves, or other parts of their habitat, further aiding in their camouflage.

3.1 Family: Geometridae

Many geometrids have slender abdomens and broad wings that are typically held flat, with the hindwings visible. As a result, they resemble butterflies, but are otherwise typical moths. The majority of flights occur at night. They have a frenulum to connect the wings, and the males' antennae are often feathered. They typically blend into the background, with intricate, wavy patterns on their wings. In some species, females have smaller wings. Most are moderately sized, with wingspans of about 3 cm (1.2 in), but there is a range of sizes, from 10-50 mm (0.39-1.97 in), and a few (e.g., *Dysphania* species) can grow even larger. They have unique paired tympanal organs at the base of the abdomen. Geometrid larvae are known as loopworms or inchworms due to the way they move. The larvae do not have the full complement of proleg, with only two or three pairs at the posterior end instead of the usual five. A caterpillar, with appendages at both ends of the body, clasps its front legs and draws up the hind end, then clasps with the hind end (prolegs) and reaches out for a new front attachment, giving the impression that it measures its journey.

3.1.1 Subfamily: Ennominae

Ennominae moths typically have broader wings with intricate, cryptic patterns and scalloped edges, in contrast to the narrower wings. The most common characteristics of this subfamily are a transversal setal comb on the third abdomen sternite of males and a prominent signum in the bursa of females. The presence of a fovea or hyaline membrane on the underside of the forewing acting as tympanum in males of many species is rare in other groups of Lepidoptera. The absence of vein M2 on the hindwing is a diagnostic characteristic for species. Their bodies are generally more robust compared to the more delicate structures of other geometrid subfamilies. The larvae, known as inchworms or loopers, are characterized by their looping movement due to the absence of prolegs in the middle segments, and they often exhibit exceptional camouflage by mimicking twigs or leaves. It involves notorious defoliating pest. This level of mimicry and the diversity of host plants they utilize are particularly notable in Ennominae. In terms of habitat, Ennominae moths are highly adaptable, thriving in environments ranging from tropical to temperate regions, which contrasts with the more specialized ecological niches of other subfamilies.

3.1.1.1Genus: *Hyposidra* (Guenee,1857)

Moths in the *Hyposidra* genus typically have a moderate to large wingspan, ranging from approximately 30 mm to 60 mm. The coloration of *Hyposidra* moths is generally muted and cryptic, aiding in their camouflage. Common colours include various shades of brown, grey, and green. These colours often incorporate intricate patterns, including lines, spots, and scalloped edges, which mimic the textures and hues of their natural surroundings such as tree bark, leaves, and stems. Hairy palpi that extend past the frons. Male antennae typically have long branches up to 3/4 of an inch long, resembling a comb on both sides. Occasionally does the hind tibia dilate and become hairy. Male fovea on the forewings. The costa curved towards the apex, where a lot of production occurs. Just before the cell's angle is vein 3. Below vein 5, the disco cellulars angled. Veins 7 to 9 are curved, stalked, and originate from the upper angle. Typically, veins 10 and 11 stalked. Female with equidistant costa. the outer edge cut away below the peak. Vein 5 obsolescent and vein 3 from the cell's angle. Ten and eleven veins coincide. the hindwings with vein 3 from the cell angle.

3.1.1.1.1 *Hyposidra talaca* (Walker,1860)

With a wingspan of roughly 30 mm. Ground colour of the wings is blackish-grey, antennae are bipectinate, both wings are somewhat irrorated and have a grey suffusion, and there are only

faint indications of medial and crenulate post-medial lines. The forewing apex is falcate and slightly produced, with faint ante-medial line traces. The underside is simple, with less pronounced crenulate postmedial lines. The larva is a looper with a body that is pinkish olive green, black spots irrorated throughout, and dark patches on its fourth and sixth somites. Afterwards, the instars are all brown. *Hyposidra talaca*, commonly known as the Black V moth, is a significant agricultural pest, particularly in tea plantations across South and Southeast Asia. Its status as a pest is primarily due to the feeding behavior of its larvae, which can cause substantial damage to tea crops and other plants. The larvae are well-camouflaged, making them difficult to detect and control. Effective management requires a multifaceted approach combining cultural, biological, and chemical control methods. Understanding the lifecycle and behaviour of this pest is crucial for developing and implementing strategies to mitigate its impact and protect valuable agricultural crops

4. Superfamily : Zygaenoidea

The Zygaenoidea is the superfamily of moths that includes relatives, forester moths, and burnet moths. Adults are usually woolly, with robust bodies and males having bipectinate antennae and females occasionally have bipectinate antennae as well. Their forewing lengths (base to apex) range from 4 mm to 4 0 mm, making them small to medium large in size. Broad to very broad wings with short fringes present. some primitive characteristics in the larva, pupae, and adults. Pupae are highly mobile. Caterpillars of Zygaenoidea can be quite distinctive, often covered with hairs or spines, which in some species can deliver venom or cause irritation. Pupation usually occurs in a cocoon, which may be spun in the soil, leaf litter, or on the host plant. Many Zygaenoidea caterpillars and adults possess chemical defences. For example, some Zygaenidae species can sequester cyanogenic compounds from their host plants, making them unpalatable to predators.

4.1 Family: Limacodidae

Limacodidae moths are known as slug moth because they are similar to slugs. These are small, hairy moths with fringed wings and either a reduced or absent mouthpart. Their abdomens protrude 90 degrees from their thoraces and wings when they perch. Males have bipectinate antennae. In general, broad bipectination only covers the basal half to two thirds. Typically, the forewings are triangular, with the vein M stem splitting the cell in the fore- and hindwings. This family of moths is also called "Cup Moths" is due to the fact that their pupal cocoons resemble cups. Larva Typically adorned with sharp spines that can severely irritate skin,

earning them the nickname "nettle-grubs. Most species larvae seem to be polyphagous, feeding on a variety of plant families. Usually round and wooden, their cocoons are affixed to a twig of the food plant. The cocoon resembles the gum tree fruit that grows on the leaves that they eat.

4.1.1 Subfamily: Limacodinae

The adult members of the Limacodinae family are typically small to medium-sized, with robust bodies and broad, colourful wings covered in smooth, glossy scales. In males, the bipectinate antennae are more prominent. The larvae glide along a lubricated ventral surface to move about, resembling slugs in appearance and lacking the prolegs that other caterpillars typically have. As a defence mechanism against predators, many larvae have urticating hairs or stinging spines that are frequently brightly coloured. Limacodinae moths are found all over the world, although they are more prevalent in tropical and subtropical regions. In terms of ecology, the larvae are herbivores that eat plant matter and act as prey for parasitoids and predators. Certain species, however, harm crops and trees and are major pests in forestry and agriculture.

4.1.1.1 Genus: *Miresa* (Walker,1855)

A central white triangle is often associated with a silvered white postmedial, which is a diagnostic feature of this genus. Species with dull yellowish bodies, pale yellow hindwings, and rufous brown forewings with yellowish patches are included in this group. The palps are slightly upcurved, the antennae are widely bipectinate over the basal half, and the third segment is barely noticeable. The female genitalia have a spiral ductus, typical of the bisignate group, and the male genitalia are typical of the limacodid ground plan, lacking major modifications.

4.1.1.1.1 *Miresa bracreata* (Butler,1880)

Adult with wingspan of 30to 40 mm with a ground colour of yellowish brown. In the basal region, the male antennae are widely bipectinate. The third segment of the labial palps is extremely small and slightly upcurved. Typically, the thorax is pale brown or yellow. A medial silver spot, terminal fascia, and an S-shaped post-median fascia are among the distinctive silver patterns seen on the forewings; certain species lack some of these patterns. Below the cell, the forewing ground colour is paler. The vein R1 in the forewing is slightly bent and near Sc; the veins R3 and R4 branch off at R5; and the medial stem remains unbroken. Some Limacodidae have only one pair of spurs on the hind tibia, though two pairs are also frequently seen.

<u>Discussion</u>

Moths identified as part of this study belong to following families:

1.Erebidae

2.Notuidea

3.Geometridae

4.Limacodidae

5.Crambidae

6.Pyralidae

A total of 9 subfamilies are identified namely Calpinae, Arctinae, Lymantrinae, Erebinae, Noctuinae, Ennominae, Limacodinae, Spilomelinae, Pyralinae. Of these, Calpinae, Arctinae, Lymantrinae, Erebinae comes under the family Erebidae. Noctuinae belongs to Family Noctuidea. Subfamily Ennominae belongs to family Geometridae. Subfamily Limacodinae belongs to family Limacodidae. Subfamily Spilomelinae belongs to family Crambidae and subfamily Pyralinae belongs to Family Pyralidae.

Ten genera of moths belonging to 6 families have been identified which are as follows: *Eudocima, Olepa, Creatonotos, Leucoma, Polytela, Ischyja, Hyposidra, Miresa, Cnaphalocrocis* and *Endotricha*. Of these *Eudocima* belongs to subfamily Calpinae, *Olepa* and *Creatonotos* belongs to subfamily Arctinae. *Leucoma* belongs to Subfamily Lymantrinae. *Ishyja* belongs to subfamily Erebinae. *Polytela* belongs to Noctuinae. *Hyposidra* belongs to Ennominae. *Miresa* belongs to Limacodinae. *Cnaphalocrocis* belongs to spilomelinae and *Endotricha* belongs to Pyralinae. The species identified are given as check list (Table 1) for quick reference.

A total of 5 species are reported from the family Erebidae which is the dominant family among other groups. This is followed by other families with 1 species each for Noctuidae Geometridae, Limacodidae, Crambidae and Pyralidae respectively. Percentage distribution of species collected during study is given below (figure 1) for quick comparison. Guruvayoor is rich with vegetation which could be the reason for such a diverse and rich moth fauna. Further studies are required to study more about moths in this area.

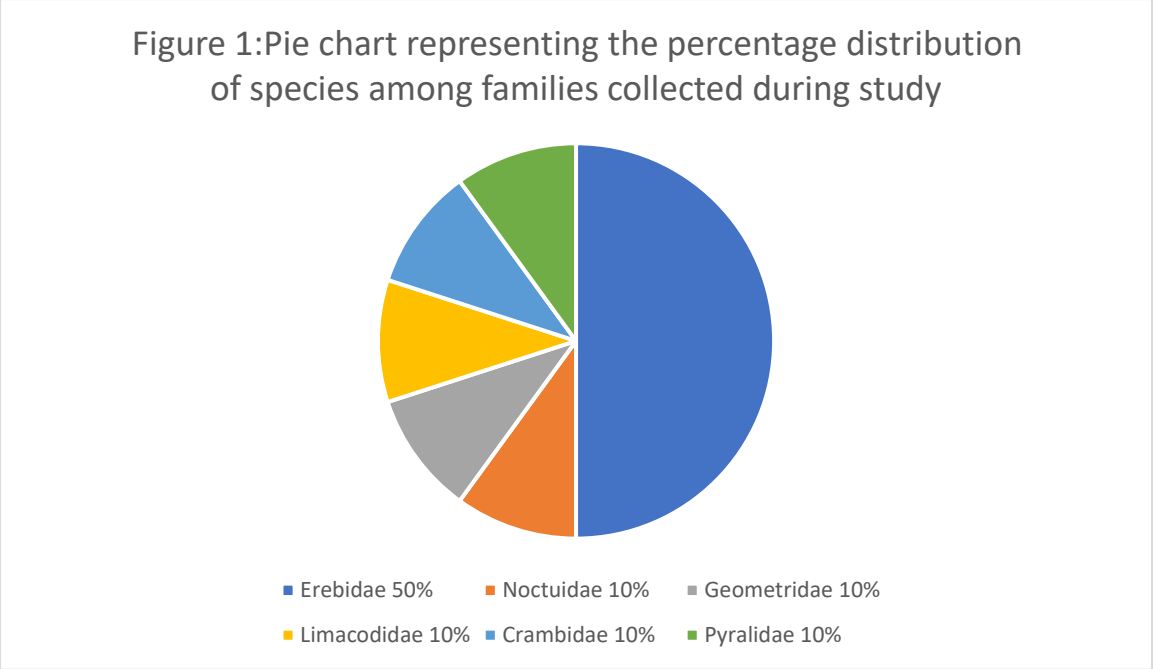


Figure 2:Graph representing family diversity of moth

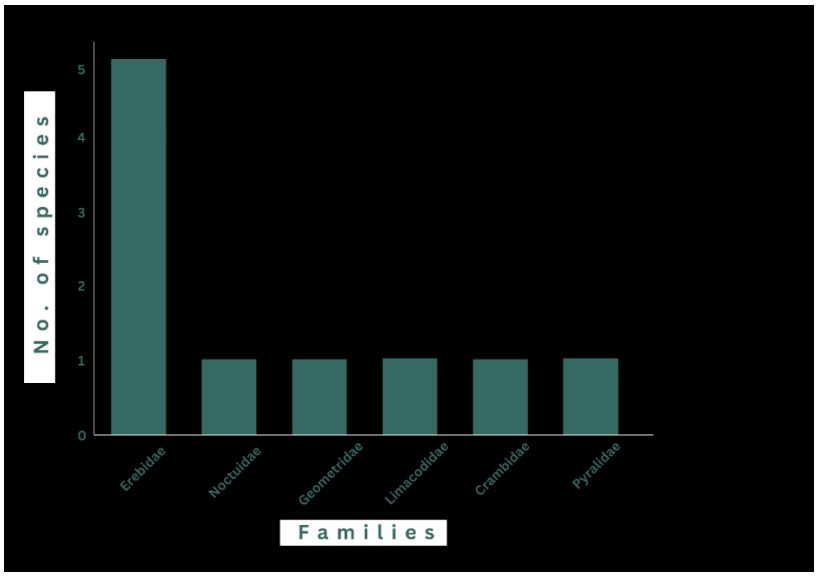


Table 1:Checklist showing the number of species ,genera,subfamilies,families, and superfamilies recorded from Guruvayoor muncipality

Superfamily	Family	Subfamily	Species
Noctuidea	Erebidae	Calpinae	Eudocima materna
		Arctinae	Olepa toulgoeti
			Creatonotos gangis
		Lymantrinae	Leucoma salicis
		Erebinae	Ischyja manila
	Noctuidae	Noctuinae	Polytela gloriosae
Geometridae	Geometridae	Ennominae	Hyposidra talaca
Zygaenoidea	Limacodidae	Limacodinae	Miresa bracreata
Pyraloidea	Crambidae	Spilomelinae	Cnaphalocrocis medinalis
	Pyralidae	Pyralinae	Endotricha mesentralis

CONCLUSION-6

The study's objective was to present an updated, systematic status of the moth population in Guruvayoor, Thrissur district. The collection of moths was done mainly from September 2023 to February 2024 using various methods like light traps, hand picking method and insect sweep nets. A total number of 50 specimens were collected and documented up to species level. Family Erebidae showed highest no of species number with 4 species followed by other families with 1 each for Noctuidae, Geometridae, Limacodidae, Crambidae and Pyralidae.

Guruvayoor has a lot of vegetation, including trees and shrubs, this may contribute to the area's high heteroceran fauna. Since many moths are agricultural pests, it is crucial to correctly identify the pest in order to use natural enemies to control it. Some of them are helpful for pollinating flowers that bloom at night, even though they are harmful. However, very few species serve as reliable pollutant indicators. Taxonomic research on moths is in fact required to identify the causes of the abrupt shift in moth diversity and to develop strategies for their conservation, primarily through habitat preservation as they serve as a food source for numerous animals.

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PLATE 1

1. *Cnaphalocrocis medinalis* 2. I*schyja manlia* 3. *Polytela gloriosae*
4. *Hyposidra talaca* 5. *Olepa toulgoeti* 6. *Eudocima materna*

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1) Name & Signature of Examiner 1

2) Name & Signature of Examiner 2

CHRIST COLLEGE, IRINJALAKUDA

DEPARTMENT OF ZOOLOGY

CERTIFICATE

This is to certify that the project work entitled **"Life cycle of *Parotis marginata* (Hampson) (Crambidae: Lepidoptera) from Mathilakam panchayath with notes on distribution, host plants and associated parasitoids"** is an authentic record of research work carried out by **Nefla Muhamed** as part of the M.Sc. dissertation work during the year 2023-2024 and the results of this work has not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda **Dr. Leyon Varghese**

Date: 21-06-2024 **Head of Department**

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CERTIFICATE

This is to certify that the contents of this dissertation work entitled **"Life cycle of *Parotis marginata* (Hampson) (Crambidae: Lepidoptera) from Mathilakam panchayath with notes on distribution, host plants and associated parasitoids"** is the original research work done by **Nefla Muhamed,** under my supervision and guidance at the Department of Zoology, Christ College, Irinjalakuda.

I further certify that no part of the work has been presented before for the award of any other degree/ diploma.

Place: Irinjalakuda
Date: 21-06-2024

DECLARATION

I hereby declare that this is an authentic record of the work carried out by me under the supervision of **Dr. Abhilash Peter, Assistant Professor, Department of Zoology, Christ College, Irinjalakuda** and no part of dissertation has previously formed the basis for the award of any Degree or Diploma as stipulated in the statutes of the University of Calicut.

Nefla Muhamed

ACKNOWLEDGEMENTS

I am deeply grateful to Dr. ABHILASH PETER, Assistant Professor & Research Supervisor, Post Graduate and Research Department of Zoology, Christ College, Irinjalakuda, for suggesting this topic and for his unwavering encouragement throughout my study. Without his expert guidance and dedicated involvement at every step, this research work would not have been accomplished in its present form.

I would like to express my profound gratitude to the Principal and Christ College management for providing the necessary facilities for this project. My heartfelt thanks also go to the Head of the Department of Zoology for the resources and support provided, which were crucial for the completion of this work.

My sincere thanks to Mr. Adarsh P. K. and Ms. Joslin Treesa Jacob, Research Scholars of Entomo Taxonomy Lab, Zoology department, for their assistance during the project. I am also indebted to all the staff members, lab attenders of the department and my classmates for their timely help and encouragement.

Finally, I extend my heartfelt gratitude to my loving parents, my friends, and all those who have supported me in various ways throughout this endeavour, and above all, to Almighty God.

Nefla Muhamed

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