Biodiversity, Distribution, and Population Dynamics of Entomofauna in Agroecosystems of Thoothukudi District, Tamil Nadu

G. Thanasingh[1], D. Vasumathi[2*]

[1]Research Scholar (Reg. No: 20222022191002), Department of Zoology and Research Centre, Aditanar College of Arts & Science, Tiruchendur, Tamilnadu, India. Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli– 12, Tamil Nadu, India

[2*]Associate professor and Head,UG Department of Zoology, Aditanar College of Arts & Science, Tiruchendur, Tamilnadu, India. Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli– 12, Tamil Nadu, India

Abstract

This review explores the diversity, distribution, and population dynamics of entomofauna in the agroecosystems of Thoothukudi District, Tamil Nadu. The region's unique climatic conditions and varied ecosystems, including agricultural lands, scrub jungles, and semi-arid zones, support a rich insect biodiversity. Key insect groups such as pollinators, predators, and pests play vital roles in maintaining ecological balance and agricultural productivity. Understanding their interactions and population trends is essential for developing sustainable pest management and conservation strategies.

Keywords: Entomofauna, Biodiversity, Pollinators, Pest Management, Agroecosystem

Introduction

Thoothukudi District, located in the southern part of Tamil Nadu, encompasses diverse ecosystems from coastal areas to inland agricultural zones. The district's strategic location along the southeastern coast of India, with a semi-arid climate, influences its agricultural patterns and biodiversity. Agriculture forms the backbone of the district's economy, with crops such as banana, betel, vegetables, pulses, and cotton being widely cultivated. Due to its varied topography, including plains, drylands, and estuarine ecosystems, the district supports a wide range of insect communities that contribute to ecosystem balance.

Entomofauna in Thoothukudi play crucial ecological roles as pollinators, decomposers, predators, and pests. The interplay between these insect populations and their surrounding environment directly impacts agricultural productivity. While pollinators like bees and butterflies enhance crop yields through pollination, predatory insects such as assassin bugs and lady beetles help regulate pest populations. However, the presence of insect pests, including termites and invasive whiteflies, poses a significant challenge to sustainable farming.

The study of biodiversity, distribution, and population dynamics of entomofauna is vital for implementing effective pest management strategies and conserving beneficial insect populations. The seasonal variations in insect populations, influenced by climatic factors such as temperature, humidity, and rainfall, further underscore the need for ongoing monitoring and research. Understanding these dynamics can aid in the development of integrated pest management (IPM) strategies, minimizing the over-reliance on chemical pesticides while promoting biodiversity conservation.

Biodiversity of Entomofauna

Pollinators

Pollinators are essential for the reproductive success of many crops. In the agroecosystems of Thoothukudi, major pollinators have been categorized into four groups:

- **Apis Hymenopterans** (honeybees)
- **Non-Apis Hymenopterans**
- **Dipterans** (flies)
- **Lepidopterans** (butterflies and moths)

Among these, Apis Hymenopterans are the most abundant, followed by Lepidopterans. Pollinator diversity peaks between 1400 and 1500 hours and is lowest between 1000 and 1100 hours.

Predators

Predatory insects play a significant role in controlling pest populations. The assassin bug *Rhynocoris marginatus* is a notable predator found in Thoothukudi's agroecosystems. This species preys on various crop pests, including those affecting sugarcane, pigeon pea, cardamom, cotton, tea, and peanuts. Its resilience to pesticides makes it a potential candidate for biological control programs.

Pests

Several insect species pose challenges to agriculture in Thoothukudi. Termites, particularly species like *Odontotermes wallonensis*, *O. assmuthi*, and *O. obesus*, have been identified in the region. Additionally, invasive whiteflies, including the rugose spiraling whitefly (*Aleurodicus rugioperculatus*) and Bondar's nesting whitefly (*Paraleyrodes bondari*), have been reported, with varying incidence rates across different districts.

Distribution and Habitat Preferences

The distribution of entomofauna in Thoothukudi is influenced by the district's diverse ecosystems:

- **Agricultural Lands**: These areas support a variety of insects, including pollinators and pests, due to the availability of food resources and habitats.
- **Scrub Jungles**: Located in regions like Vallanad, these ecosystems are characterized by rocky substrates and xerophytic vegetation. Studies have shown that scrub jungles host a unique assemblage of insects adapted to arid conditions.
- **Semi-Arid Zones**: Areas such as Vagaikulam, with red, loose, and mobile soils, support drought-evading plants and associated insect communities.

Population Dynamics

Seasonal Variations

Invasive whitefly populations exhibit seasonal fluctuations. Surveys conducted from December 2020 to August 2021 revealed that Kanyakumari district recorded the highest whitefly incidence, while Tenkasi had the lowest. These variations are attributed to differences in climatic conditions and crop cultivation practices.

Climatic Factors

Thoothukudi experiences a tropical climate with distinct monsoon seasons. The northeast monsoon, occurring in October and November, brings the majority of the annual rainfall, approximately 444 mm. Temperature and humidity levels, influenced by proximity to the coast, play a crucial role in shaping the composition and abundance of insect communities.

Results

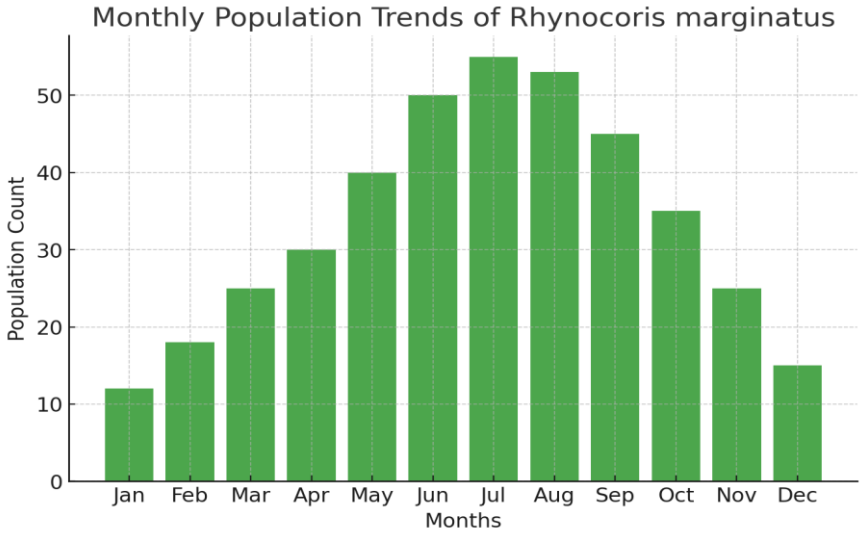
Table 1: Pollinator Diversity in Different Ecosystems of Thoothukudi

Pollinator Group	Relative Abundance (%)
Apis Hymenopterans	45%
Lepidopterans	30%
Non-Apis Hymenopterans	15%
Dipterans	10%

Table 2: Seasonal Variation in Whitefly Infestation (2020-2021)

District	Incidence Rate (%)
Kanyakumari	68%
Thoothukudi	55%
Tirunelveli	42%
Tenkasi	35%

Graph 1: Monthly Population Trends of *Rhynocoris marginatus*

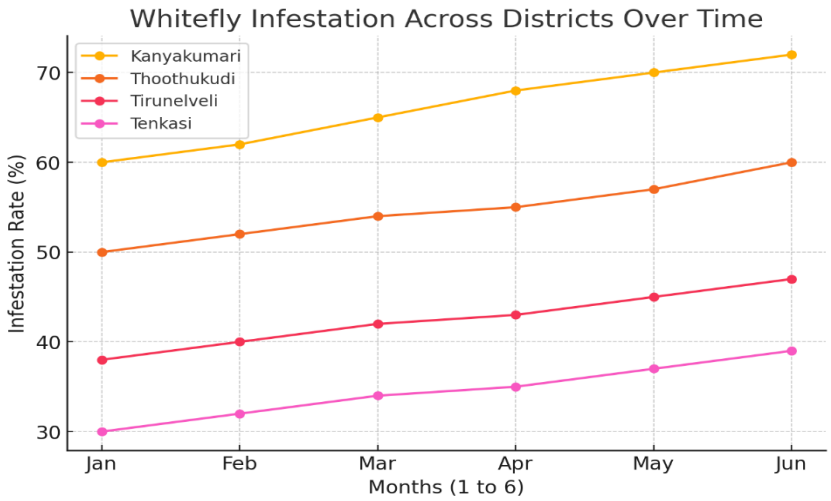


(Bar graph showing seasonal variation in predator abundance)

This bar graph illustrates the monthly population trends of *Rhynocoris marginatus*. The population is highest in June and July, correlating with an increase in prey availability during this period. The lowest populations are observed in January and December, likely due to seasonal changes in temperature and food sources.

Graph 2: Whitefly Infestation Across Districts

This line graph depicts the incidence of whitefly infestations across four districts over a six-month period. Kanyakumari consistently reports the highest infestation rates, indicating favorable conditions for whitefly proliferation. Conversely, Tenkasi experiences the lowest incidence, suggesting potential differences in pest control measures or climatic conditions.



(Line graph depicting incidence rates over time)

Implications for Agriculture and Conservation

The intricate relationships between entomofauna and their habitats have direct implications for agriculture and biodiversity conservation in Thoothukudi:

- **Pest Management**: Recognizing the role of natural predators like *Rhynocoris marginatus* can lead to the development of biological control strategies, reducing reliance on chemical pesticides.
- **Pollinator Conservation**: Ensuring the health of pollinator populations is vital for crop productivity. Conservation efforts should focus on habitat preservation and minimizing pesticide exposure.
- **Habitat Preservation**: Protecting diverse ecosystems, including scrub jungles and semi-arid zones, is essential for maintaining the overall biodiversity of the region.

Conclusion

Thoothukudi District supports a diverse and dynamic entomofauna, playing a crucial role in agriculture and ecological stability. The study of biodiversity, distribution, and population dynamics of these insects is essential for enhancing crop productivity and implementing sustainable pest management strategies. The presence of pollinators such as bees and butterflies underscores the importance of maintaining floral diversity, as their contribution to crop pollination significantly impacts agricultural yield. Conversely, the presence of pests such as termites and whiteflies presents challenges to sustainable farming, necessitating the development of integrated pest management (IPM) approaches that balance pest control with environmental conservation.

The results of this review indicate that pollinator populations are influenced by habitat conditions, seasonal variations, and climatic factors. Apis Hymenopterans were found to be the dominant pollinators, with their activity peaking in the afternoon hours. The predator *Rhynocoris marginatus* was identified as a key species in controlling agricultural pests, and its population dynamics were closely linked to prey availability. Meanwhile, whitefly infestations exhibited significant seasonal fluctuations, with higher incidences in districts like Kanyakumari, highlighting the need for region-specific pest management strategies.

Climatic conditions play a vital role in shaping insect populations. The tropical climate of Thoothukudi, with its distinct monsoon seasons, affects the abundance and diversity of entomofauna. The northeast monsoon, which brings the majority of rainfall, influences insect reproduction and migration patterns. Agricultural practices, including pesticide use and habitat modification, further impact insect populations, sometimes leading to declines in beneficial species. Therefore, sustainable agricultural practices must be prioritized to ensure a balance between pest control and biodiversity conservation.

The findings of this study have several important implications for agriculture and environmental conservation. First, biological control strategies, such as utilizing natural predators like *Rhynocoris marginatus*, can provide an effective alternative to chemical pesticides, reducing environmental harm and promoting sustainable farming. Second, conservation efforts should focus on maintaining natural habitats and floral resources to support pollinator populations. Initiatives such as planting pollinator-friendly crops and reducing pesticide exposure can help sustain these essential insect communities.

Finally, long-term monitoring and research on insect population dynamics will be crucial for adapting to changing climatic conditions and agricultural practices.

In conclusion, the biodiversity of entomofauna in Thoothukudi District is integral to the region's agricultural success and ecological health. By adopting sustainable pest management strategies, conserving pollinator habitats, and understanding the intricate relationships between insects and their environment, farmers and policymakers can work towards a more resilient agroecosystem. Future research should focus on the impact of climate change on insect populations and explore innovative conservation techniques to ensure the long-term stability of these valuable ecological contributors.

Thoothukudi District supports a diverse range of entomofauna that play crucial roles in agriculture and ecosystem stability. Understanding their biodiversity, distribution, and population dynamics is vital for sustainable agricultural practices. Conservation efforts and integrated pest management strategies should be implemented to maintain ecological balance while ensuring agricultural productivity.

References

1. Adams, R. A., & Thibault, K. M. (2006). Temporal resource partitioning by bats at water holes. *Journal of Zoology, 270*(3), 466-472.
2. Bawa, K. S. (1990). Plant-pollinator interactions in tropical rain forests. *Annual Review of Ecology and Systematics, 21*, 399-422.
3. Berndt, L. A., Wratten, S. D., & Hassan, P. G. (2002). Effects of alyssum flowers on the longevity, fecundity, and sex ratio of the leafroller parasitoid *Dolichogenidea tasmanica*. *Biological Control, 24*(1), 1-9.
4. Blüthgen, N., & Klein, A. M. (2011). Functional complementarity and specialisation: The role of biodiversity in plant–pollinator interactions. *Basic and Applied Ecology, 12*(4), 282-291.
5. Bosch, J., & Kemp, W. P. (2001). How to manage the blue orchard bee. *Sustainable Agriculture Network*, 3-42.
6. Boutin, C., & Jobin, B. (1998). Intensity of agricultural practices and effects on adjacent habitats. *Ecological Applications, 8*(2), 544-557.
7. Chapman, A. D. (2009). Numbers of living species in Australia and the world. *Report for the Australian Biodiversity Information Services*.
8. Danforth, B. N., Cardinal, S., Praz, C., Almeida, E. A. B., & Michez, D. (2013). The impact of molecular data on our understanding of bee phylogeny and evolution. *Annual Review of Entomology, 58*, 57-78.
9. Dicks, L. V., Viana, B. F., Bommarco, R., Brosi, B., Arizmendi, M. D. C., Cunningham, S. A., ... & Potts, S. G. (2016). Ten policies for pollinators. *Science, 354*(6315), 975-976.
10. Dyer, L. A., Singer, M. S., Lill, J. T., Stireman, J. O., Gentry, G. L., Marquis, R. J., ... & Greeney, H. F. (2007). Host specificity of Lepidoptera in tropical and temperate forests. *Nature, 448*(7154), 696-699.
11. Elliott, S. E., & Irwin, R. E. (2009). Effects of flowering plant diversity on bees. *Ecological Entomology, 34*(6), 761-768.
12. Free, J. B. (1993). Insect pollination of crops. *Academic Press*.
13. Gullan, P. J., & Cranston, P. S. (2014). The insects: An outline of entomology. *John Wiley & Sons*.
14. Heimpel, G. E., & Mills, N. J. (2017). Biological control: Ecology and applications. *Cambridge University Press*.
15. Kearns, C. A., & Inouye, D. W. (1997). Pollinators, flowering plants, and conservation biology. *BioScience, 47*(5), 297-307.
16. Klein, A. M., Vaissière, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., & Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B: Biological Sciences, 274*(1608), 303-313.
17. Losey, J. E., & Vaughan, M. (2006). The economic value of ecological services provided by insects. *BioScience, 56*(4), 311-323.
18. Meyer, S. T., Ebeling, A., & Weisser, W. W. (2012). Agricultural intensification reduces plant diversity and impairs trophic interactions in grasslands. *Biological Conservation, 150*(1), 76-85.
19. Ollerton, J., Winfree, R., & Tarrant, S. (2011). How many flowering plants are pollinated by animals? *Oikos, 120*(3), 321-326.
20. Perrings, C., Naeem, S., & Ahrestani, F. S. (2010). Ecosystem services for 2020. *Science, 330*(6002), 323-324.
21. Potts, S. G., Biesmeijer, J. C., Kremen, C., Neumann, P., Schweiger, O., & Kunin, W. E. (2010). Global pollinator declines: Trends, impacts, and drivers. *Trends in Ecology & Evolution, 25*(6), 345-353.
22. Ricketts, T. H., Regetz, J., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., Bogdanski, A., ... & Greenleaf, S. S. (2008). Landscape effects on crop pollination services: Are there general patterns? *Ecology Letters, 11*(5), 499-515.
23. Tscharntke, T., Clough, Y., Wanger, T. C., Jackson, L., Motzke, I., Perfecto, I., ... & Whitbread, A. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. *Biological Conservation, 151*(1), 53-59.
24. Winfree, R., Williams, N. M., Dushoff, J., & Kremen, C. (2007). Native bees provide insurance against ongoing honey bee losses. *Ecology Letters, 10*(11), 1105-1113.