Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2024; 12(3): 20-28

Received: 04-02-2024
Accepted: 05-03-2024

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Entomofaunal diversity and prey-predator relationship associated with organic paddy field at mahadare conservation reserve, Satara District, Maharashtra

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DOI: https://doi.org/10.22271/j.ento.2024.v12.i3a.9314

Abstract
Paddy fields are natural wetland ecosystems that supply rice for the people and provide the shelter to wildlife especially insect diversity of different functional aspects. In the present study, we investigated entomofaunal diversity in organic paddy field at Mahadare conservation reserve, Satara district Maharashtra. A total of 275 insects belonging to 56 species and eight orders, *viz*., Coleoptera (10), Diptera (1), Hemiptera (4), Lepidoptera (24), Mantodea (2), Odonata (10), Orthoptera (4), and Thysanoptera (1) were recorded. The most abundant order was Lepidoptera and the least one was Diptera. The abundance of insects varying in different growth stages of the rice. Total (53%) insects act as pest and predators comprising (41%) individuals of insect pests with remaining (6%) were visitors of the paddy field. We concluded from our study that these rice fields were cultivated without use of any type of insecticide, pesticide or inorganic chemical fertilizer honouring traditional Indian culture. So, even the pest insects were diverse the predators serve as most effective agents for the biological control and farmers produces high crop yield.

Keywords: Prey-Predator, traditional knowledge, *Oryza sativa*, lepidoptera, organic farming

Introduction
India is the world's biggest producer of wheat, rice, sugarcane, fruits, vegetables, groundnuts, and cotton. Over ten million insect species, 100,000 infections, 30,000 weed species, and 1000 nematode species threaten the world's food plants (Dhaliwal *et al*. 2007) [22]. Rice is one of the important crops as it is the vital food source in the world and important part of Asian economy. Rice production in India predominantly depends on monsoon rains. It is frequently changing dense semi-aquatic, microclimatic habitat (Bahaar *et al*. 2011) [4] which provides biologically diversified involvement for microbials, invertebrate and vertebrate organisms to be flourished (Schnoenyl *et al*. 1998; Anbalagon *et al*. 2020) [20, 2]. The favourable conditions in the paddy field showing large diversified organisms especially insects which consume leaves, roots, burrowing into stems and extracting fluid sap from stem create a serious threat to the production of rice (Drechsler *et al*. 2001) [9]. Green revolution in India is initiated in 1960's (Andersen *et al*. 1985) [3] to enhance the food production and provide food for the malnourished people but it also made interventions traditional rice varieties and replaced them by (HYV) high yielding varieties (Beigh *et al*. 2015) [5]. So that, (Loevinsohn *et al*. 1988; Oka *et al*.1988 and Loevinsohn *et al*. 1994) [14, 16, 13] suggest restoring to traditional rice producing practices from the past. In Maharashtra crop cycle of *Oryza sativa* begins from June and lasts till October as it is the period of south west monsoon. Sowing seeds in the nursery bed is the first step of the aesthetic process of agricultural cropping in India with singing typical song, without using any type of chemical fertilizers for higher yield of crop farmers generally perform a traditional agricultural process known as 'Rab' in this technique, trees are cut down and burned on the ground to warm it up before rice crops are planted (Patil *et al*. 2013) [17]. The biodiversity of insects in India is categorized into 658 families and 27 orders. The notable 8 major orders of insects, includes 94% of all species, namely Coleoptera, Lepidoptera, Orthoptera, Hymenoptera, Diptera, Hemiptera, Odonata, and Thysanoptera (Chandra *et al*. 2011; Akhilandeshwari *et al*. 2022) [6, 1].

Having relatively versatile group of creatures because of their small size, which allows them to use niches that larger organisms cannot (Meeran *et al.* 2021) [15]. Although they are beneficial to nature but some of them also acts as a pest as they are herbivorous and polyphagous insects. Based on review of literature recorded 36 species of odonata which serves as predator in the paddy fields of Kolhapur district. Recorded 24 species of butterflies from paddy growing area concluding agroecosystem butterfly diversity is so high in Gondia district Maharashtra. Investigated 6 different paddy fields in Kerala as their Shannon index of species diversity is 0.995. Identified 5 lepidopteran species which accounts 189 individuals, where Crambidae and Noctuidae also the effective belongs to family stem borers of rice crop and act as pest. In Mahadare conservation reserve (Pawar *et al*. 2020) [18] recorded 40 moths of which some acts as pest. According to Meeran *et al.* (2021) [15] in any given area the insect abundance was highly associated with the type of ecosystem as they recorded 587 insects belonging to 9 orders at Uthamapalayam, Theni district, Tamil Nadu. Other than that, (Pawar *et al.* 2023) [19] studied parasitoids infesting lepidopteran pest in Mahadare forest and concluded that parasitoids also act as biological control agents.

In order to better understanding of diverse ecosystem of paddy field the present attempt was made in this study we examined diversity of insects along with their richness and population dynamics and their relationships as prey predator pest in organic paddy fields of Mahadare conservation reserve, District Satara, Maharashtra.

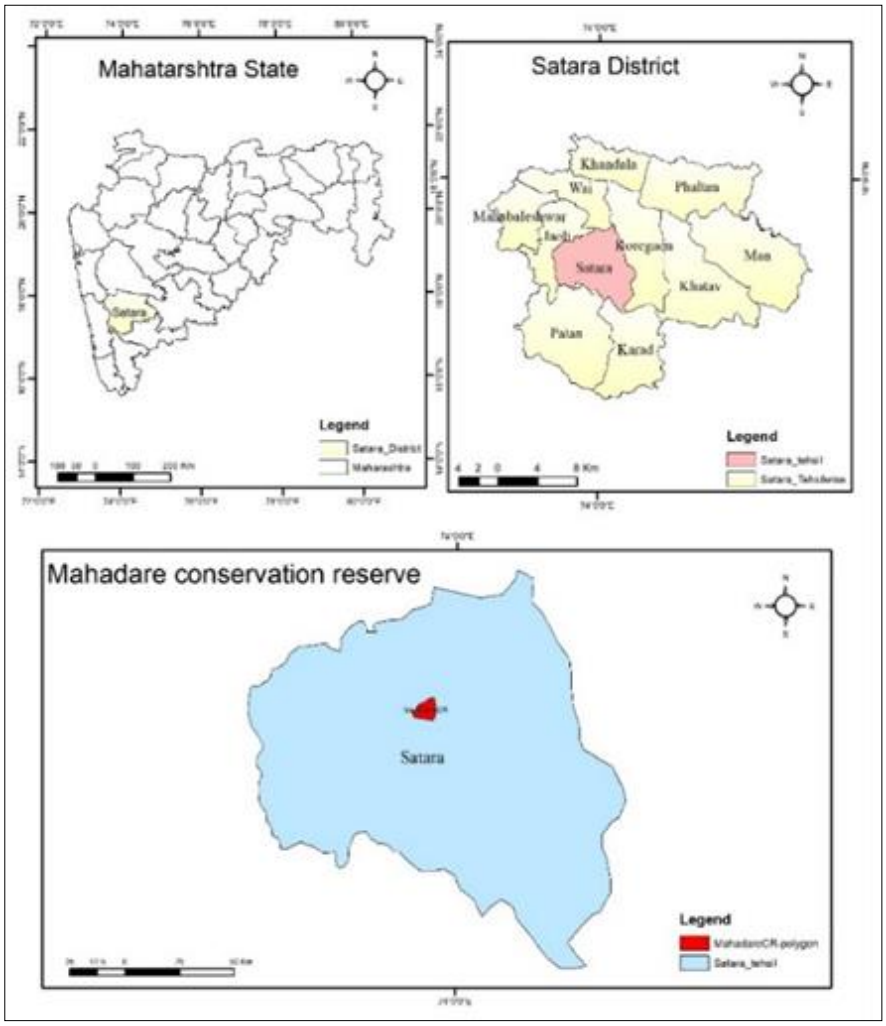

Fig 1: Map of Mahadare Conservation Reserve

Materials and Methods

Study area: Mahadare conservation reserve is located at 17°40'49.74"N, 73°57'47.14"E. It has an average elevation of 850 meters. Total area of 105 hectares. Mahadare is well known for its evergreen, semi-evergreen and is deciduous type of forest resulting in Eco tone which leads to trapped population and acts as a migration corridor and breeding ground for many organisms. Along with this it has huge paddy field area situated in the valleys with average rainfall of 1000-1200 mm which makes great favourable condition required for production of rice. Collection and identification of insects: starting from June 2022 to October 2023 only for the period of southwest monsoon season field visits were done weekly. Sweep net hand picking and the light trap technique were used for collection. Insects were kept in glass tubes filled with 70-90% ethyl alcohol. The standard keys accessible in taxonomic literature Kunte *et al.* (2000) [12], Subramanian, K. A., (2009) [21], David, K. J. (2005) [7], Gahan, C. J., 1906, Hampson, G.F. 1892-1896 and manuals were used for identification and labelling. Data Analysis: Species diversity and occurrence analysis was carried out by different statistical methods richness indices: Margalef index (R_1), Menhinick index (r^2) and Relative dominance.

Observation Tables

Table 1: Checklist of insects observed in paddy field of Mahadare conservation reserve

Order	Family	scientific name
Coleoptera	Coccinellidae	*Coccinella septempunctata* (Linnaeus, 1758)
		Coccinella transversalis Fabricius, 1781
		Illeis cincta (Fabricius, 1798)
		Harmonia octomaculata (Fabricius, 1781)
		Sitophilus oryzae (Linnaeus, 1763)
		Cheilomenes sexmaculata Fabricius, 1781
	Curculionidae	*Myllocerus* sp.
	Chrysomelidae	*Aspidimorpha sanctaecrucis* (Fabricius, 1792)
	Scarabaeidae	*Dyscinetus morator* (Fabricius, 1798)
	Dytiscidae	*Cybister sugillatus* Erichson, 1834
	Carabidae	*Apotomus testaceus* Devriena, 1905.
		Clivina fossor (Linnaeus, 1758)
Diptera	Syrphidae	*Eristalinus megacephalus* Rossi, 1794
Hemiptera	Scutelleridae	*Chrysocoris stolli* (Wolff, 1801)
	Pyrrhocoridae	*Probergrothius sanguinolens* (Amyot and Serville, 1843)
	Alydidae	*Leptocorisa oratoria* (Fabricius, 1764)
	Aleyrodidae	*Trialeurodes vaporarioum* Westwood, 1856
Lepidoptera	Crambidae	*Scirpophaga incertulas* (Walker, 1863)
		Chilo suppressalis (Walker, 1863)
	Erebidae	*Aloa lactinea* (Cramer, 1777)
		Psalis pennatula (Fabricius, 1793)
		Creatonotos gangis (Linnaeus, 1763)
		Mocis frugalis (Fabricius, 1775)
		Mocis undata (Fabricius, 1775)
	Hesperiidae	*Taractrocera ceramas nicevillei* (Hewitson, 1868)
		Borbo cinnara (Wallace, 1866)
		Borbo bevani (Moore, 1878)
		Telicota bambusae bambusae (Moore, 1878)
		Arnetta vindhiana (Moore, [1884])
		Telicota colon colon (Fabricius, 1775)
		Panara bada bada (Moore, 1878)
		Pelopidas mathias mathias (Fabricius, 1798)
		Pelopidas conjuncta narooa (Herrich-Schäffer, 1869)
		Ampittia dioscorides dioscorides (Fabricius, 1793)
	Nymphalidae	*Mycalesis perseus Tabitha* (Fabricius, 1775)
		Melanitis leda leda (Linnaeus, 1758)
		Lethe rohria neelgheriensis (Fabricius, 1787)
	Noctuidae	*Spodoptera litura* (Fabricius, 1775)
		Spodoptera frugiperda (J. E. Smith, 1797)
		Spodoptera Mauritia (Boisduval, 1833)
		Helicoverpa armigera (Hübner, [1808])
Mantodea	Mantidae	*Hierodula patellifera* Serville, 1839
		Schizocephala bicornis (Linnaeus, 1758)
Odonata	Chlorocyphidae	*Heliocypha bisignata* (Hagen, 1853)
	Coenagrionidae	*Ischnura aurora* (Brauer, 1865)
	Lestidae	*Lestes viridulus* Rambur, 1842
	Coenagrionidae	*Aciagrion occidentale* Laidlaw, 1919
	Libellulidae	*Acisoma variegatum* Kirby, 1898
		Diplacodes trivialis (Rambur, 1842)
		Trithemis kirbyi Selys, 1891
		Trithemis aurora (Burmeister, 1839)
		Orthetrum glaucum (Brauer, 1865)
		Orthretrum sabina (Drury, 1770)
Orthoptera	Acrididae	*Spathosternum prasiniferum* (Walker, 1871)
		Oxya sp.
	Pyrgomorphidae	*Atractomorpha crenulate* Fabricius, 1793
	Tettigoniidae	*Conocephalus maculatus* (Le Guillou, 1841)
Thysanoptera	Thripidae	*Stenchaetothrips biformis* (Bagnall, 1913)

Table 2: Total number of species diversity and percentage recorded in paddy field

Sr. No.	Order	No of Species	No of Individuals	Relative Dominance
1.	Coleoptera	10	40	14.545%
2.	Diptera	1	1	0.363%
3.	Hemiptera	4	19	6.909%
4.	Lepidoptera	24	108	39.272%
5.	Mantodean	2	10	3.636%
6.	Odonatan	10	71	25.818%
7.	Orthoptera	4	13	4.7227%
8.	Thysanoptera	1	13	4.7227%

Table 3: Overall presentation of Margalef index (R_1) and Menhinick index (r^2)

Sr. No.	Order	No of Species	No of Individuals	Margalef Index (R1)	Menhinick Index (R^2)
1.	Coleoptera	10	40	5.617	1.581
2.	Diptera	1	1	1.581	1
3.	Hemiptera	4	19	0	0.917
4.	Lepidoptera	24	108	1	2.309
5.	Mantodean	2	10	2.347	0.632
6.	Odonatan	10	71	0.917	1.186
7.	Orthoptera	4	13	11.313	1.109
8.	Thysanoptera	1	13	2.309	0.277

Fig 2: Representing an eco-friendly and non-toxic traditional method of rice cultivation. Image No. a) showing mixture of ash and hair around the perimeter of paddy field. b) Traditional method of sowing rice in semiaquatic habitat. c) and d) use of cloths to cover rice field

Results and Discussions

The investigation conducted in Mahadare forest's paddy fields from June 2022 to October 2023 revealed a comprehensive study encompassing 275 individuals across 56 species, representing 25 families and 8 orders (See Table No. 1). Remarkably, Order Lepidoptera boasted the highest species count, with 24 species and 193 individuals, constituting 39.27% of the total observed population over 5 families such as Hespiridae, Nymphalidae, Noctuidae, Crambidae and Erebidae. Margalef index (R_1) is 5.61 and Menhinick index (r^2) is 1.58. The butterfly namely *Arnetta vindhiana* commonly called as Vindhyan Bob is endemic to Western Ghats. All species belongs the order are phytophagous insects, moths namely *Spodoptera litura, Spodoptera frugiperda and Spodoptera mauritia* commonly called as fall-armyworm are the most serious pests of *Oryza sativa*.

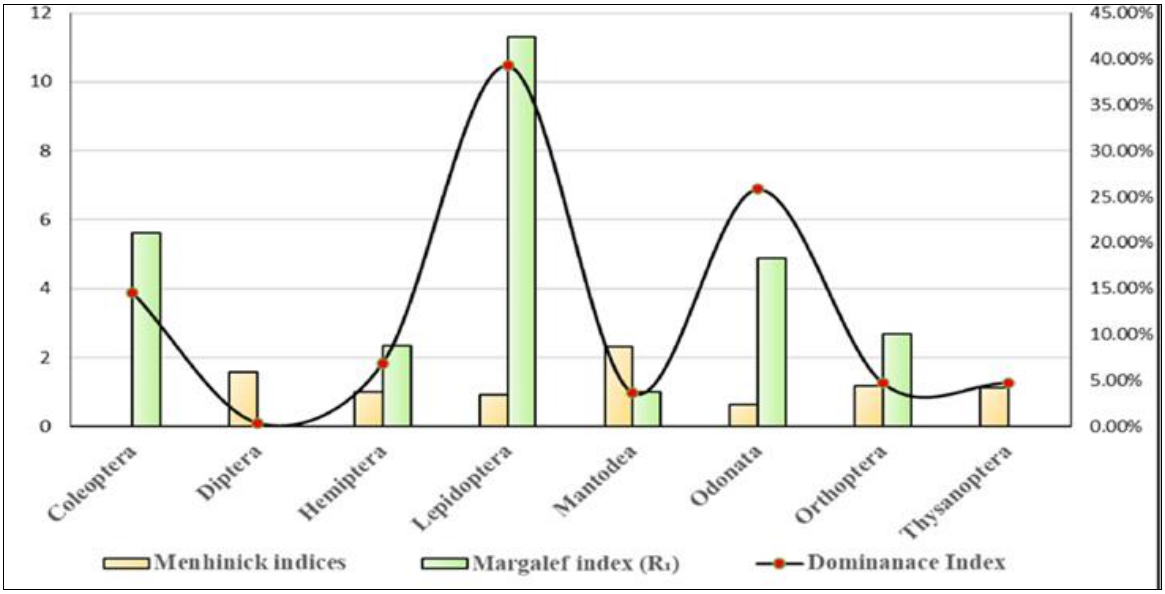

Fig 3: Menhinick, Margalef and Dominance indices of insect found in paddy field

Following the Order Odonata, there were 10 species comprising a total of 71 individuals, contributing to 25.81% of the observed diversity. These species were distributed across 5 families: Chlorocyphidae, Coenagrionidae, Coenagrionidae, Libellulidae, and Lestidae. Act as biological control agents that feed on pest of rice. The Margalef index (R_1) for this order is 4.86, while the Menhinick index (r^2) was 1.18. Similarly, the Order Coleoptera also featured 10 species, with a total of 40 individuals, contributing to 14.54% of the overall diversity. These species were spread across 6 families: Coccinellidae, Curculionidae, Chrysomelidae, Scarabaeidae, Dytiscidae, and Carabidae. The Margalef index (R_1) for this order was determined to be 5.61, with a Menhinick index (r^2) of 1.58. Notably, *Sitophilus oryzae* was identified as a significant pest affecting *Oryza sativa. Coccinella septempunctata* and *Coccinella transversalis* majorly feeds on members of order thysanoptera and also on the butterfly, moth eggs showing predatory behaviour. Order Hemiptera is next, with 4 species and 19 individuals, accounting for 6.91% of the total among 4 families, including Scutelleridae, Pyrrhocoridae, Alydidae, and Aleyrodidae. The Margalef index (R_1) is 2.34 and the Menhinick index (r^2) is 0.91. Order Orthoptera comes next with 4 species, 13 individuals, and 4.72% contribution over 3 families, including Acrididae, Pyrgomorphidae, and Tettigoniidae. The Margalef index (R_1) is 2.69 and the Menhinick index (r^2) is 1.11. Order Thysanoptera has 1 species, 13 individuals, accounting for 4.72% of the family Cecidomyiidae. Causing serious damage to leaves of young seedlings of rice. The Margalef index (R_1) is zero and the Menhinick index (r^2) is 0.27. Following that, the order Diptera stands afterwards, with 1 species and 1 individual, accounting for 0.36% of the total 1 family, the Cecidomyiidae. The Margalef index (R_1) is zero and the Menhinick index (r^2) is 1 (See Table No. 2 and Table No. 3; Fig. No. 6 Image no 1 to 21). Notably, *Sus scrofa* sightings increased during this time, and it was observed that the application of ash and hair around the perimeter of the paddy fields served as a natural deterrent for both *Lepus nigricollis* and *Sus scrofa*, representing an eco-friendly and non-toxic traditional method. (See Fig. No. 2, Image a-d). As shown in (Fig. No. 4) highest insect diversity was seen in the month of August followed by September. Southwest monsoon starts in June, the rice fields became inundated, creating a semi-aquatic environment that attracted various organisms including fish, amphibians, reptiles and birds. This period also marked the sowing of rice or the emergence of seedlings. The rice began to tiller and grow in July, pests and their natural predators became more prevalent. Additionally, certain insectivorous birds were observed frequenting the rice fields namely *Pelargopsis capensis*, *Merops persicus*, *Cyornis tickelliae*, *Pycnonotus cafer*, *Terpsiphone paradisi* and *Hypothymis azurea.* The most significant phase of rice reproduction occurred from August to the flowering stage, during which the highest diversity of insects was recorded, accompanied by a notable prey-predator ratio. Other organisms such as freshwater crab *Barytelphusa cunicularis*, reptiles such as *Xenochrophis piscator*, *Ptyas mucosa Eutropis carinata* and ampbhibians namely *Hoplobatrachus tigrinus*, *Polypedates maculatus* and *Duttaphrynus parietalis* were also observed during this period. As September approached and the rice reached its ripening stage, the diversity of insects gradually decreased. October marked the culmination of the study period, coinciding with the rice harvest. Based on (Fig. No. 5) species richness indices it was found that the pest community was most diverse during the flowering stage of crop total (53%) insects acts as pest and predators comprising (41%) individuals of insect pests pose significant threats to *Oryza sativa*, with remaining (6%) were visiting the paddy field. The paddy field thrives on a harmonious balance between prey and predator populations, a key factor in fostering optimal crop production. Despite this, the predators often find themselves as prey, creating a dynamic and interconnected food chain. Maintaining a roughly 1:1 ratio between prey and predator species, the ecosystem benefits from the predators' impressive adaptability, effective camouflage, and adept prey-capturing skills. This delicate balance ensures that despite the presence of pest insects, crop yields, especially for *Oryza sativa*, remain largely unaffected. Adoption of traditional agricultural practices by farmers, further enhance the ecosystem's resilience. This creates an environment conducive to the proliferation of diverse species, each playing a vital role in maintaining the delicate balance of the paddy ecosystem.

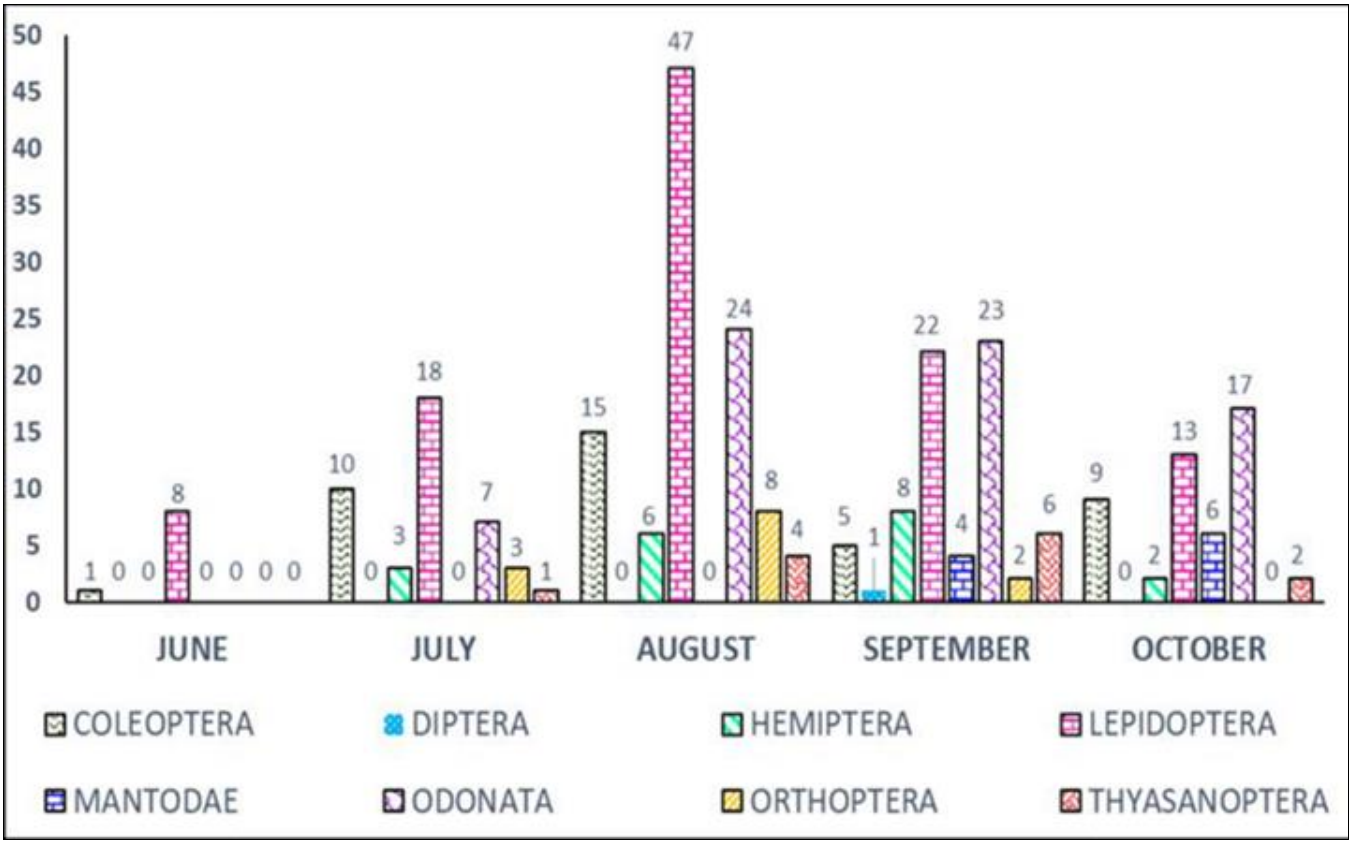

Fig 4: Month-wise data insect richness in paddy field

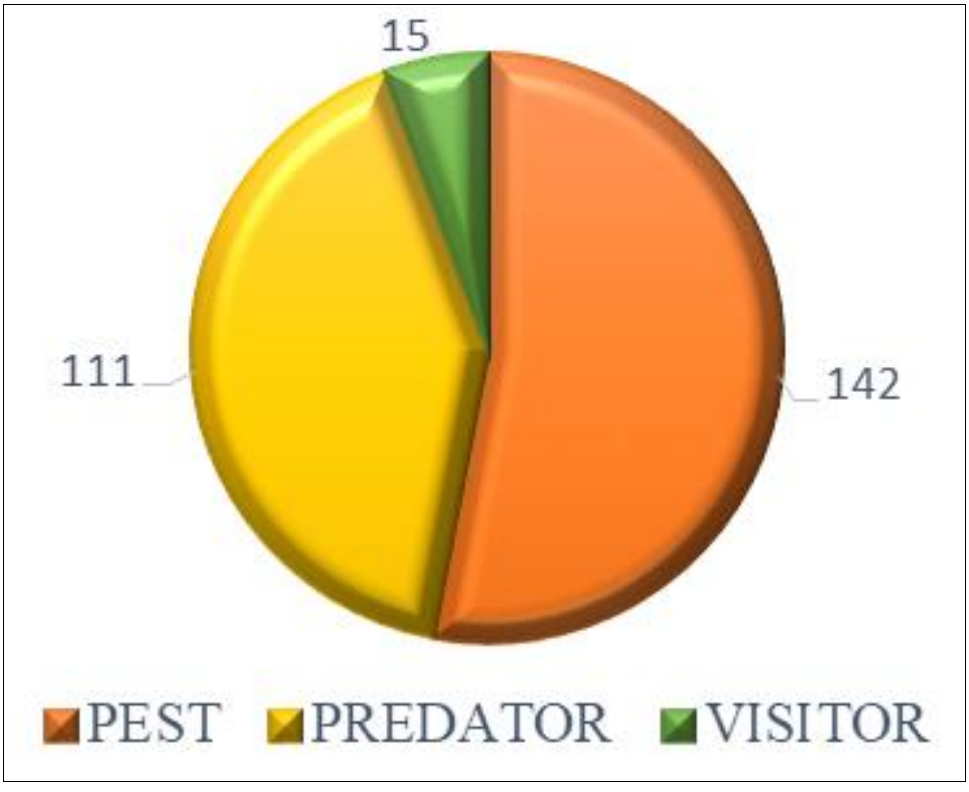

Fig 5: Showing prey predator diversity

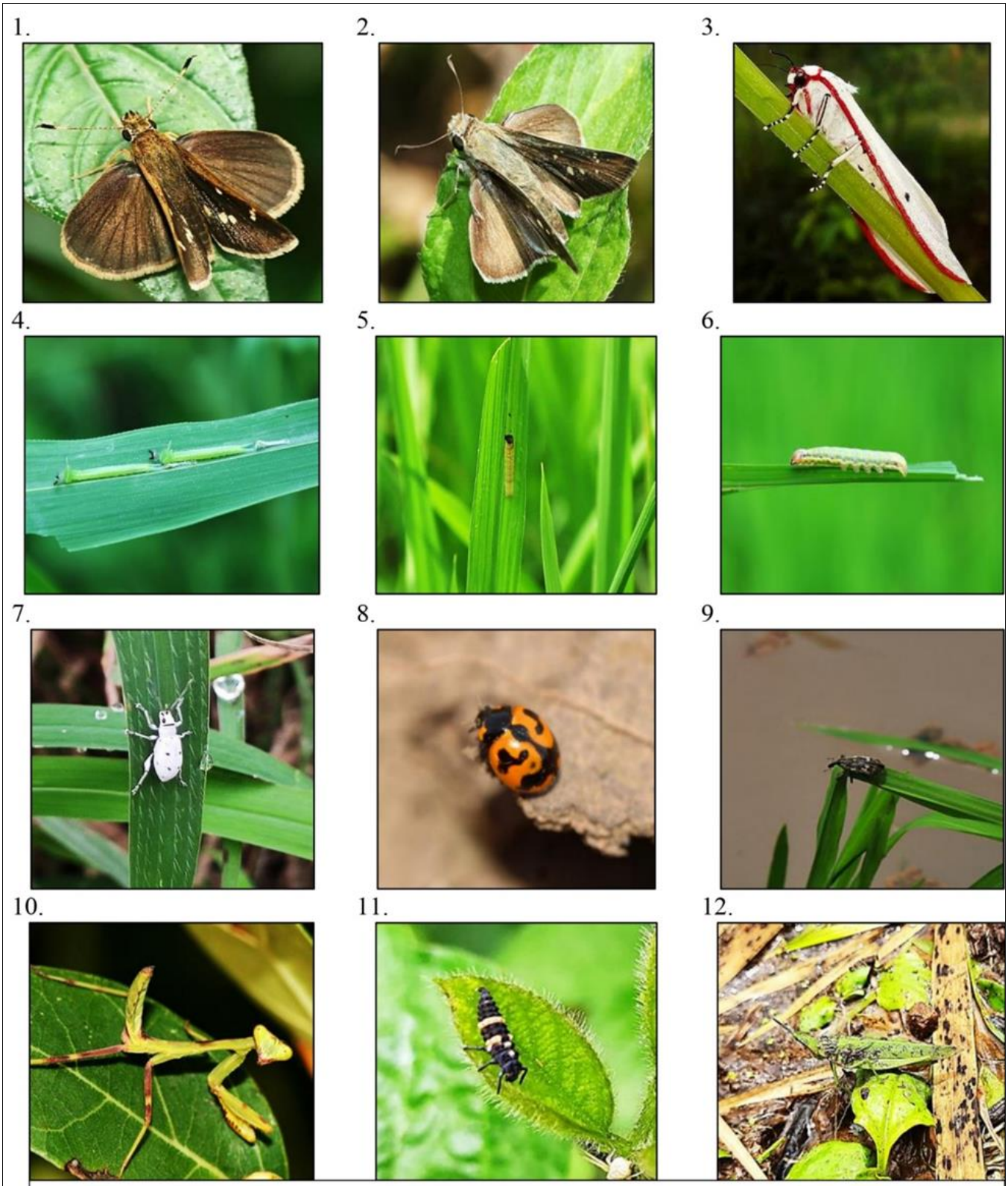

Plate no. 1: 1. *Arnetta vindhiana*, 2. *Borbo bevani*, 3. *Aloa lactinea*, 4. *Melanitis leda leda*, 5. *Borbo cinnara*, 6. *Helicoverpa armigera*, 7. *Myllocerus sp.*, 8. *Coccinella transversalis*, 9. *Sitophilus oryzae*, 10. *Hierodula patellifera*, 11. *Coccinella septempunctata*, 12. *Atractomorpha crenulate*

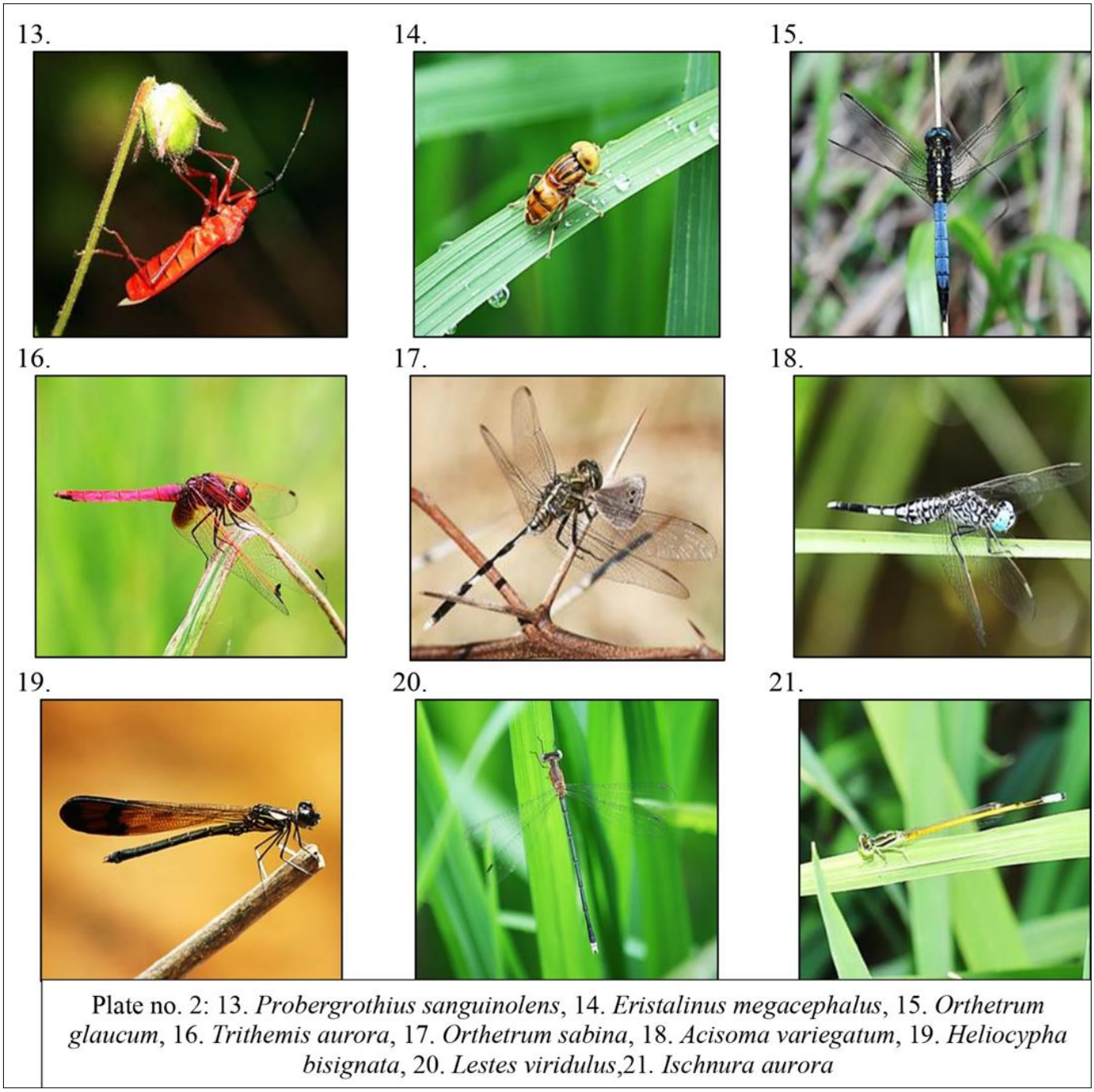

Fig 6: Images of pre-predator found in the paddy field of Mahadare conservation reserve

Conclusion

These rice fields were cultivated without use of any type of harmful chemical insecticides, pesticides and fertilizer honouring traditional Indian culture. Although abundance of herbivorous pest, farmers produce high crop yields and it is result of predator species which acts as biological control agents and they enhance a balanced ecosystem. The paddy shows favourable conditions that provides potential for ideal food chain which helps in conservation.

Acknowledgements

We extend our heartfelt gratitude to the Satara Forest Department (T) for their unwavering support and cooperation throughout our research endeavours. We would also like to express our sincere appreciation to the Mahadare Ecological Research Institute, Satara, for providing us with access to their resources and facilities, which significantly enriched our research experience. Additionally, we extend our thanks to DRONGO: Nisarga Sanshodhan, Sanvardhan vs Sanrakshan Sanstha Satara for their partnerhip in our conservation efforts.

References

1. Akhilandeshwari D, Aruna Sri I, Rao VV, Madhavi M, Sameer Kumar CV. Composition of Insect fauna in Rice Ecosystem in Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana. Biol Forum Int J. 2022;14(3):371-374.
2. Anbalagan V. Insect diversity and species distribution in rice field of Tharangambadi Taluk, Nagapattinam district, Tamil Nadu, India. Int J Entomol Res. 2020;5(3):29-32.
3. Andersen T. The Impact of the Green Revolution and Prospects for the Future. Food Rev Int. 1985;1(1):1-25.
4. Bahaar SWN, Bhat GA. Community Organisation and Distribution of Lepidoptera in the Rice Fields of Kashmir

(J and K) India. Asian J Biol Sci. 2011;4(7):563-569.
5. Beigh MA. Impact analysis of front-line demonstration of rice (*Oryza sativa*) on the yield, economics and farmer's knowledge in temperate region of India. SRE. 2015;10(14):449-455.
6. Chandra K. Insect fauna of states and Union Territories in India. Arthropods and their Conservation in India (Insects & Spiders); ENVIS Bulletin. 2011;14(1):189-218.
7. David KJ. Insects of South India-Hemiptera: Heteroptera (Pentatomidae to Aradidae). Universities Press; 2005.
8. Dhaliwal GS, Arora R, Dhawan AK. Crop losses due to insect pests in Indian agricultural: An update. Indian J Ecol. 2004;31(1):1-7.
9. Drechsler M. Predator-prey interactions in rice ecosystems: effects of guild composition, trophic relationships, and land use changes-a model study exemplified for Philippine rice terraces. Ecol Modell. 2001;137:135–159.
10. Gahan CJ. The Fauna of British India including Ceylon and Burma-Coleoptera: Cerambycidae. Taylor & Francis, 1906, 1.
11. Hampson GF. The Fauna of British India. Moths. Taylor & Francis. 1892-1896, 1(4).
12. Kunte K. India A Lifescape. Butterflies of Peninsular India. Indian Academy of Science, Bangalore, University Press; c2000.
13. Loevinsohn MA. Rice pests and agricultural environments. In: Biology and Management of Rice Insects. Wiley; c1994. p. 485–511.
14. Loevinsohn MA, Litsinger JA, Heinrichs EA. Rice insect pests and agricultural change. In: Harris MK, Rogers CE, Eds. The entomology of indigenous and naturalized systems in agriculture. Westview Press; c1988. p. 161–182.
15. Meeran M. Assessment of insect diversity in paddy fields of Uthamapalayam, Theni district, Tamil Nadu, India. J Wildl Biodivers. 2021;5(2):88-98.
16. Oka IN. Role of cultural techniques in rice IPM systems. In: Teng S, Heong KL, Eds. Pesticide management and integrated Pest management in Southeast Asia. Consortium for International Crop Protection; c1988. p. 83–93.
17. Patil VN. Ecological and economical assessment of paddy (*Oryza sativa*) cultivation in some villages of shahuwadi tahsil of Kolhapur District of Maharashtra, India. Int J Agric Sci Res (IJASR). 2013;3(1):225-234.
18. Pawar GN, Bhoite SH, Bendre NN, Deshpande VY, Pawar PA. Faunal diversity of Moths of Mahadare, Satara District, Maharashtra (Western Ghats). Our Heritage. 2020;68(34):149-155.
19. Pawar G, Pawar SM. Preliminary study on Parasitoids Infesting Lepidopteran Species; c2023. DOI: 10.13140/RG.2.2.30852.71046.
20. Schoenly KG, Justo HD, Barrion AT, Harris MK, Bottrell GD. Analysis of invertebrate biodiversity in Philippines farmers irrigated rice field. Environ Entomol. 1998;27:1125-1136.
21. Subramanian KA. Dragonflies and Damselflies of Peninsular India. Universities Press; c2009.
22. Dhaliwal G, Mukherjee D. Peripheral arterial disease: Epidemiology, natural history, diagnosis and treatment. International Journal of Angiology. 2007 Jun;16(02):36-.