Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(5): 2115-2118

Received: 10-07-2020
Accepted: 16-08-2020

Pavithran S
M.Sc. Research Scholar, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Chitra N
Associate Professor, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Arulprakash R
Assistant Professor, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Sugumaran MP
Assistant Professor, Department of Environmental Sciences, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Corresponding Author:
Pavithran S
M.Sc. Research Scholar, Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Diversity of Odonata in the rice fields of Tamil Nadu

Pavithran S, Chitra N, Arulprakash R and Sugumaran MP

DOI: https://doi.org/10.22271/j.ento.2020.v8.i5ac.7792

Abstract
Odonata is one of the most predominant natural enemy of the rice ecosystems and their diversity in rice fields from different parts of Tamil Nadu *viz.*, Coimbatore, Aduthurai, Pudukkottai, Ramanathapuram, Bhavanisagar and Gudalur was studied. The Odonata assemblage comprised 21 species under 19 genera under 4 families. Anisoptera (dragonflies) were dominant with 15 species and 14 genera over Zygoptera (damselflies) (6 species, 5 genera). Libellulidae (Anisoptera) was the most speciose family with 14 species followed by Coenagrionidae (Zygoptera) with 5 species. Diversity analysis of Odonata from rice fields of Tamil Nadu revealed that the order of Simpson Diversity index (SID) of diversity was Coimbatore (0.89) > Bhavanisagar (0.88) > Aduthurai (0.87) > Ramanathapuram (0.87) > Gudalur (0.84) > Pudukottai (0.82). Margalef index (α) of species richness were high in Coimbatore (2.33) and least in Gudalur (1.55). Eveness of species within the region (Pielou`s evenness index, *E1*) was the highest for Bhavanisagar (0.94) and the lowest for Aduthurai (0.84). Among the different regions, Odonata in rice fields of the Coimbatore and Aduthurai were found to have a maximum similarity.

Keywords: Odonata, Anisoptera, Zygoptera, rice, Tamil Nadu

Introduction
Rice (*Oryza sativa* L.) is the world`s principal staple food and feeds more than half the world population [1]. India ranks second in rice production followed by china producing 17.258 million tonnes covering an area which is around 44.5 m ha [2]. Whereas overall rice cultivation in Tamil Nadu amounts to 1.93 m ha which produces 2.37 m tonnes of rice [3]. Rice fields not only serve as staple food to us but also provides diverse assemblage of insects to make it as lively ecosystem [4]. Rice is the world's largest irrigated crop covering 29 percent of the total irrigated crop area and nearly 50 percent of the cereal area being irrigated [2]. Rice fields were well suited for aquatic insects where the deep water layer provides an appropriate habitat for odonates to complete their lifecycle [5]. Insect pest was reported as the major threat to rice production. More than 800 species of insect pests have been reported in rice, whereas in tropical areas only 20 insects cause a major damage in rice up to yield losses of 21 to 51 percent [6,7]. Order Odonata is completely predatory insects and also one of the most primitive insects which called as living fossil. In India, 493 extant species were described in that Zygoptera accounts for 213 species, Anisoptera 279 species and Anisozygoptera one species [8] whereas in rice ecosystem alone accounts for 127 species under 71 genera of 13 families [9]. So far in Tamil Nadu, odonatan studies from rice fields are done in Coimbatore [10], Chidambaram [11], Madurai [12], Thiruvallur [13] and Pattukkottai [14]. The diversity of Odonata in rice ecosystem of Tamil Nadu was poorly studied. Therefore, in this context the present study was undertaken to assess the diversity of odonatan fauna in rice ecosystem.

Materials and Method
This study was carried out in the rice fields during 2019-2020 in six rice growing districts of Tamil Nadu, Coimbatore at, Paddy Breeding Station, Coimbatore (427 m msl, 10°59'43.24''N, 76°54'59.22''E), Aduthurai at, (19.5 m MSL, 11^0 N, 79° E), Pudukkottai at (93 m MSL, 10°36 N, 78°90E), Ramanthapuram at (5 m MSL, 9°50' N, 79°27' E), Bhavanisagar at, (256 m MSL, 11° 29' N, 77° 80' E) and Gudalur at (1300 m MSL, 11°5' N, 76°5' E). The time of sampling from each district was decided by rice growing season, June to August, (Kuruvai season), October to January (Samba season) in Coimbatore, Aduthurai, Bhavanisagar whereas October to January (Samba season) in Pudukkottai and Ramanathapuram. Samples were collected from all stages of the crop. Adult odonates were

collected by using sweep net between 7.00 A.M. and 11.00 A.M. Collected odonates were killed using ethyl acetate fumes and then dry preserved. Identification of collected Odonata was carried out as per the *Fauna of British India including Ceylon and Burma* [15,16] with additional literatures [17,18]. These identified specimens were deposited in the Insect Biosystematics Laboratory, Tamil Nadu Agricultural University, Coimbatore.

Alpha diversity indices include Simpson's diversity Index (SDI) Shannon-Wiener index (H'), Margalef Index (α) and Pielou's Evenness Index (E1). Simpson's diversity index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. It is calculated using the formula, $D = \Sigma n (n-1)/ N(N-1)$ where n = total number of organisms of a particular species and N = total number of organisms of all species [19]. The value of the index ranges from 0 to 1, the greater the value the greater the sample diversity. Shannon-Wiener index (H') is another diversity index and is given as follows: $H' = -\Sigma Pi \ln(Pi)$, where $Pi = S / N$; S = number of individuals of one species, N = total number of all individuals in the sample, ln = logarithm to base [20]. The higher the value of H', the higher the diversity. Species richness was calculated for the six regions using the Margalef index which is given as Margalef Index, $\alpha = (S - 1) / \ln (N)$; S = total number of species, N = total number of individuals in the sample [21]. Species evenness was calculated using the Pielou's Evenness Index (E1). Pielou's Evenness Index, $E1=H'/ \ln(S)$; H' = Shannon-Wiener diversity index, S = total number of species in the sample [22]. As species richness and evenness increase, diversity also increases [23]. Beta diversity comprises calculating similarity or dissimilarity between regions using Bray Curtis Method. Here, it was done by Non Metric Multidimensional Scaling Analysis (NMDS). NMDS represents the original position of data in multidimensional space as accurately as possible using a reduced number of dimensions that can be easily plotted and visualized. In this, abundance is plotted against species and regions by using bray Curtis distance method. Samples that plot nearby have similar species composition where plot further apart has less similar to each other. Diversity analysis and NMDS are performed by R Software using Vegan package [24].

Results and Discussion

In the present study, a total of 1754 odonata specimens were collected from different rice ecosystems that represents 21 species under two sub orders. Under the sub order Anisoptera, family Aeshnidae, species include *Gynacantha dravida* Lieftinck, 1960; under family Libellulidae, species includes *Acisoma panorpoides* Rambur, 1842, *Brachythemis contaminata* (Fabricius, 1793), *Bradinopyga geminata* (Rambur, 1842), *Crocothemis servilia* (Drury, 1770), *Diplacodes trivialis* (Rambur, 1842), *Neurothemis tullia* (Drury, 1773), *Orthetrum pruniosum* (Burmeister, 1839), *Orthetrum sabina* (Drury, 1770), *Pantala flavescens* (Fabricius, 1798), *Potamarcha congener* (Rambur, 1842), *Rhyothemis variegata* (Linneaus, 1763), *Tholymis tillarga* (Fabricius, 1798), *Tramea basilaris* (Palisot de Beauvois, 1805) and *Trithemis aurora* (Burmeister, 1839). Under the sub order Zygoptera, family Lestidae, species include *Lestes elatus* Hagen in Selys, 1862; under family Coenagrionidae, species includes *Aciagrion occidentale* Laidlaw, 1919, *Agriocnemis pygmaea* (Rambur, 1842), *Ceriagrion coromandelianum* (Fabricius, 1798), *Ischnura rubilio* Selys, 1876 and *Ischnura senegalensis* (Rambur, 1842). From Coimbatore, Aduthurai, Pudukkottai, Ramanathapuram, Bhavanisagar and Gudalur regions, the number of species collected were 16,15,9,12,12 and 8 respectively (Table1.). *Brachythemis contaminata* (Fabricius, 1793), *Diplacodes trivialis* (Rambur, 1842), *Orthetrum sabina* (Drury, 1770), *Pantala flavescens* (Fabricius, 1798) and *Ischnura rubilio* Selys, 1876 were ubiquitously found all the rice growing regions. Species like *Acisoma panorpoides* Rambur, 1842 and *Rhyothemis variegata* (Linneaus, 1763) found only in Bhavanisagar and *Gynacantha dravida* Lieftinck, 1960 present only in Coimbatore. Similar trends in abundance are also recorded from their studies [14, 25, 26].

Simpson Index of Diversity is highest for Coimbatore (0.89) followed by Bhavanisagar (0.88), Aduthurai (0.87) and lowest in Pudukkottai (0.82). The highest Simpson value in Coimbatore denotes high number of species diversity in that region. A similar trend was observed when analyzing Shannon-Wiener index (H') in which follows Coimbatore (2.45) > Aduthurai (2.27) > Bhavanisagar (2.25) > Ramanathapuram (2.22) > Gudalur (1.94) > Pudukkottai (1.90). Margalef Index (α) was maximum for Coimbatore (2.33) and minimum in Gudalur (1.55). Pielou's Evenness Index (E1) shows the highest value for Bhavanisagar (0.94) followed by Gudalur (0.93) (Table 2.). Even though Coimbatore, Aduthurai, Pudukkottai and Ramanathapuram shows more number of species diversity compared to Bhavanisagar and Gudalur distribution of number of individuals within the species were not even. Non Metric Multidimensional Scaling Analysis (NMDS) plot reveals regions Coimbatore and Aduthurai were more similar between them (Fig. 1.). Gudalur has less similar among other regions. Overall in similarity, almost all regions where similar between each other.

Family Libellulidae was dominant odonatan family among all the rice growing regions. This study was significant with the findings [11, 25, 27]. Their dominance may be due to adaptation of modern agricultural practices. Libellulidae diversification may also due to their high preference for lentic habitats [17]. Coimbatore region shows maximum species diversity because of continuous paddy cultivation and water availability in nearby irrigation channels even in fallow period. Gudalur consists minimum number of species records because less water abundance and seasonal cultivation. The construction of water retention structure within the paddy fields store water and serve breeding place for odonates during dry seasons [5]. Odonata can be used as biocontrol agent for controlling major rice insect pests [28] and also it efficiently predates the mosquitoes [29,30]. Negative effects of pesticides on Odonata in rice fields have been previously documented by various authors [31-33]. The application of chemicals such as fertilizer, herbicides and insecticides often lead to deteriorate water quality which become vain to aquatic organisms [34, 35]. The cases for significant reduction in odonatan population maybe result of applying huge volume of insecticides in the rice field. Studies by [36, 37] reveals application of agrochemicals (insecticides and herbicides) suppresses up to 70 percent of odonates in rice ecosystem. Nevertheless, due to our study will pave way for future direction of research on correlation between agrochemicals and odonata population relies more ways to conserve them in agricultural fields.

Table 1: Inventory of Odonata in rice fields of Tamil Nadu

Genus	Coimbatore	Aduthurai	Pudukottai	Ramanthapuram	Bhavanisagar	Gudalur
Acisoma panorpoides	0	0	0	0	21	0
Brachythemis contaminata	29	11	7	2	13	4
Bradinopyga geminata	12	5	0	0	0	0
Crocothemis servillia	13	17	2	6	12	9
Diplacodes trivialis	56	79	23	17	26	19
Orthetrum pruinosum	0	2	0	0	0	17
Orthetrum sabina	53	42	14	8	19	3
Neurothemis tullia	0	0	0	0	37	11
Pantala flavescens	78	110	33	30	37	17
Potamarcha congener	3	0	0	0	0	0
Gynacantha dravida	11	0	0	0	0	0
Tramea basilaris	7	3	0	4	0	0
Thollymis tillarga	17	9	3	0	7	0
Trithemis aurora	35	16	4	2	0	0
Rhyothemis variegata	0	0	0	0	12	0
Aciagrion ocidentale	0	17	0	6	0	0
Agriocnemis pygmaea	129	84	17	11	13	0
Ceriagrion coramandelium	47	23	0	12	17	0
Ischnura rubilio	76	62	27	21	42	11
Ischnura senegalensis	27	38	0	0	0	0
Lestes elatus	28	0	0	19	0	0
Total	621	518	130	138	256	91

Table 2: Diversity indices of rice growing regions of Tamil Nadu

Sites	Simpson`s Index of Diversity (SID)	Shannon Diversity Index(*H'*)	Margalef Index (α)	Pielou's Evenness Index (E1)
Coimbatore	0.89	2.45	2.33	0.88
Aduthurai	0.87	2.27	2.24	0.84
Pudukottai	0.82	1.90	1.64	0.86
Ramanathapuram	0.87	2.22	2.23	0.89
Bhavanisagar	0.88	2.25	1.83	0.94
Gudalur	0.84	1.94	1.55	0.93

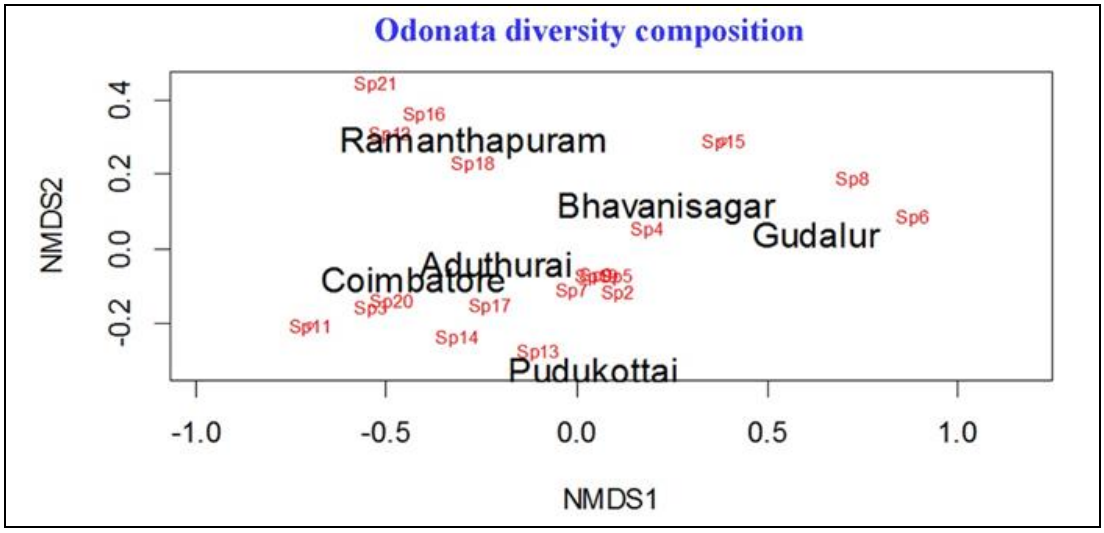

Fig 1: NMDS plot for rice growing regions of Tamil Nadu

Conclusion

Inventory of Odonata diversity in rice ecosystem forms the basis for formulating integrated pest management practices for any given geographical region. The reduction in chemical pesticide use associated with biological control method is increasing the abundance of some beneficial insects and improving the natural control of specific pests. Our study concludes that richness of odonatan in rice ecosystem will take care of rice pests by some extent. This study has certainly improved our knowledge absent Odonata diversity in paddy crop agroecosystem.

Acknowledgement

Authors thank the Professor and Head, Dept. of Agrl. Entomology, Director, TRRI and Head, Pulse Research Centre, TNAU for providing necessary facilities. Thanks are also due to Dr. V. Sheela, Assistant Professor of Entomology, TNAU for facilitating requirements during survey.

References

1. IRRI. Rice facts. International Rice Research Institute. https://www.irri.org/our-work/impact-challenges/nutrition-food-security. 3 October, 2020.

2. Faostat. Food and Agriculture Organization of the United Nations, Statistics Division. Area Harvested (hectares), Rice, World Total, 2018. Retrieved from the FAOSTAT database. http://www.fao.org/statistics/en/ 29 september, 2020.
3. Statista. Total area of cultivation for rice across india from financial year 2014 to 2018. https://www.statista.com/statistics/765691/india-area-of-cultivation-for-rice/ 3 October, 2020.
4. Edirisinghe PJ, Bambaradeniya CNB. Rice field: an ecosystem rich in biodiversity. Journal of National Science Foundation of Sri Lanka. 2006;34:57-59.
5. Giuliano D, Bogliani G. Odonata in rice agroecosystems: Testing good practices for their conservation. Agriculture, Ecosystems & Environment. 2019;275:65-72.
6. Barrion AT, Listinger J. Biology and Management of Rice Insects. Wiley Eastern Ltd., New York. 1994;14:359
7. Singh J, Dhaliwal GS. Trends in Agricultural Pest Management. Common wealth publishers, New Delhi. 1994,56-122.
8. Subramanian KA, Babu R. Checklist of Odonata (Insecta) of India, Version 3.0 www.zsi.gov.in. 2017;51p.
9. Pavithran S, Chitra N, Arulprakash R. Checklist of odonata in the rice fields of India. Indian Journal of Entomology. 2020;82(1):99-109.
10. Gunathilagaraj K, Soundarajan RP, Chitra N, Swamiappan M. Odonata of rice fields of Coimbatore. Zoos' Print Journal. 1999;14:43-44.
11. Asaithambi M, Manickavasagam S. Odonata of Annamalai University, Annamalai Nagar, Tamil Nadu. Zoos' Print Journal. 2002;17:704 706.
12. Kandibane M, Raguraman S, Ganapathy N. Relative abundance and diversity of Odonata in an irrigated rice field of Madurai, Tamil Nadu. Zoos' Print Journal. 2005;20:2051-2052.
13. Anbalagan V, Paulraj MG, Ignacimuthu S. Odonata diversity (Insecta: Arthropoda) in rice and vegetable fields in a north-eastern district of Tamil Nadu, India. Journal of Research in Biology. 2013;3(4):977-983.
14. Arulprakash R, Chitra N, Gunathilagaraj K. Biodiversity of Odonata in Rice at Pattukkottai in Tamil Nadu. Indian Journal of Entomology. 2017;79(4):498-502.
15. Fraser FC. The Fauna of British India, including Ceylon and Burma**.** Odonata, Taylor and Francis Ltd., London, 1933;1:426.
16. Fraser FC. The Fauna of British India, including Ceylon and Burma. Odonata, Taylor and Francis Ltd., London, 1936;3:461.
17. Subramanian KA. Dragonflies and damselflies of peninsular India: A field guide, Project Lifescape, Indian Academy of Science, Bangalore, 2005,118.
18. Subramaniam KA, Emiliyamma KG, Babu R, Radhakrishnan C, Talmale SS. Atlas of Odonata (Insecta) of the Western Ghats, India. Director, Zoological Survey of India, Kolkata, 2018,417.
19. Simpson EH. Measurement of species diversity. Nature. 1949; 63:688.
20. Shannon CE, Wiener W. The mathematical theory of communication. Urbana, University of Illinois Press, 1949,177.
21. Margalef R. Temporal succession and spatial heterogeneity in phytoplankton, Perspectives in Marine Biology. University of California Press, Berkeley, 1958,323-347.
22. Pielou EC. The measurement of diversity in different types of biological collections. Journal of Theoretical Biology. 1966;13:131-144.
23. Magurran E. Ecological Diversity and its Measurement. Croom Helm, Australia, 1988,215.
24. Oksanen J, Blanchet FG, Friendly M, Kindt R, Legendre P, McGlinn D *et al*. Vegan: Community Ecology Package; R package version 2.5-6. Available online: https://CRAN.R-project.org/package=vegan, 2019.
25. Palot MS, Radhakrishnan C, Soniya VP. Odonata (Insecta) diversity of rice field habitat in Palakkad district, Kerala. Records of Zoological Survey of India. 2005;104:71-77.
26. Saikia R, Mishra H, Devi A, Saikia DK. Biodiversity of odonates in rice eco-system, Titibar, Assam. Journal of Entomology and Zoology Studies. 2016;4(4):1376-1381.
27. Rohmare VB, Darshana M, Rathod M, Parasharya BM. Diversity and population dynamics of Odonata (Insecta: Odonata) in rice growing area of central Gujarat. Journal of Biological Control. 2016;30(3):149-157.
28. Ghahari H, Tabari M, Sakenin H, Ostovan H, Imani S. Odonata (Insecta) from Northern Iran, with comments on their presence in rice fields. Munis Entomology & Zoology. 2009;4(1):148-54.
29. Saha N, Aditya G, Banerjee S, Saha GK. Predation potential of odonates on mosquito larvae: Implications for biological control. Biological Control. 2012;63(1):1-8.
30. Kundu M, Sharma D, Brahma S, Pramanik S, Saha GK, Aditya G. Insect predators of mosquitoes of rice fields: portrayal of indirect interactions with alternative prey. Journal of Entomology and Zoology Studies. 2014;2(5):97-103.
31. Schoenly KG, Justo HD, Barrion AT, Harris MK, Bottrell DG. Analysis of invertebrate biodiversity in a Philippine farmer's irrigated rice field. Environmental Entomology. 1998;27(5):1125-36.
32. Suhling F, Befeld S, Häusler M, Katzur K, Lepkojus S, Mesléard F. Effects of insecticide applications on macroinvertebrate density and biomass in rice-fields in the Rhône-delta, France. Hydrobiologia. 2000;431(1):69-79.
33. Wilson AL, Watts RJ, Stevens MM. Effects of different management regimes on aquatic macroinvertebrate diversity in Australian rice fields. Ecological Research. 2008;23(3):565-72.
34. Dudgeon D. Riverine biodiversity in Asia: a challenge for conservation biology. Hydrobiologia. 2000;418(1):1-3.
35. Jergentz S, Pessacq P, Mugni H, Bonetto C, Schulz R. Linking in situ bioassays and population dynamics of macroinvertebrates to assess agricultural contamination in streams of the Argentine pampa. Ecotoxicology and Environmental Safety. 2004;59(2):133-41.
36. Arulprakash R, Gunathilagaraj K. Impact of agrochemicals on the abundance and diversity of Odonata in rice fields. Indian Journal of Plant Protection. 2011;39(3):191- 195.
37. Soniyagandhi M, Kumar K. Impact of agrochemicals on odonata in rice ecosystem. Journal of Biopesticides. 2014;7(1):52-56.