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Odonata diversity (Insecta: Arthropoda) in rice and vegetable fields in a north-eastern district of Tamil Nadu, India

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ABSTRACT:

Odonata diversity in vegetable fields (brinjal and okra) and rice fields was studied from January 2005 to December 2008 in Tiruvallur district of Tamil Nadu. Totally 23 species of Anisoptera (dragonflies) and 12 species of Zygoptera (damselflies) were recorded and all these species were grouped into eight families. In vegetable fields 31 species of dragonflies and damselflies were recorded under 22 genera. In rice fields the species richness (21 species) and total genera (16) were less than vegetable fields during the entire study period. Libellulidae was the large family in both vegetable and rice fields which comprised maximum number of species. *Pantala flavescens* (Fabricius), a migratory species, was the most dominant in numbers throughout the year. Diversity indices clearly showed that odonata diversity was higher in vegetable fields than in rice fields.

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INTRODUCTION

Dragonflies and damselflies in the order Odonata are important group of insects in agroecosystems, forest ecosystems and aquatic ecosystems. They are potential biocontrol agents of agricultural, horticultural and forest pests. Many studies have shown that the larval stages of Odonata are important biological control agents of mosquito larvae (Mandal *et al*., 2008; Spencer *et al*., 1999). According to Corbet (1999), dragonflies and damselflies are excellent ecological indicators. Around 6,000 species and subspecies of Odonata have been described under 630 genera in 28 families throughout the world (Tsuda, 1991). In India, 499 species, 139 genera and 17 families of dragonflies and damselflies have been documented (Prasad and Varshney, 1995; Sharma, 2010). Odonata diversity has been extensively studied in different forest areas. Emiliyamma (2005) has recorded 31 species of dragonflies and damselflies from southern Western Ghats in the Kottayam district of Kerala. Very few investigators have studied the Odonata diversity in agricultural fields (Gunathilagaraj *et al*., 1999; Kandibane *et al*., 2005). A knowledge on Odonata diversity in different agro ecosystems is very essential to understand the influence of crop type on species richness, abundance and evenness of dragonflies and damselflies. Hence the present work was undertaken to assess the Odonata diversity in two different agricultural fields, i.e. rice and vegetable fields in Tiruvallur district of Tamil Nadu.

MATERIAL AND METHODS

Study site:

Dragonflies and damselflies were sampled from vegetable fields, viz. brinjal and okra in Kolappancheri village and rice fields in Vayalanallur village of Tiruvallur district. The geocordination of Tiruvallur district is 12° 15 and 13° 5`N Latitude and 99° 15` and 80° 20` E Longitude.

Sampling of Odonates:

In each village, dragonflies and damselflies were sampled in three different locations by quadrate method. Quadrates of 25 m x 10 m size were laid down with threads inside rice, brinjal and okra fields separately. Totally three quadrates were put in each rice and vegetable fields. Perched dragonflies and damselflies found inside the quadrates were collected by sweeping net (25 cm in diameter) during day times (between 10.00 AM to 15.00 PM). Flying Odonates inside quadrate area were also caught with sweeping net. Sampling was done twice in a month from January 2005 to December 2008. Specimens from replications were pooled together.

Identification:

The specimens were identified using identification keys provided by Fraser (1933, 1934 and 1936) and Subramanian (2009). After identification and counting the total number of specimens, few specimens from each taxa were retained and others were left behind alive in the field. Specimens which were not identified in the field were brought to the laboratory for identification. The identified specimens were deposited at the Entomology Research Institute, Loyola College, Chennai.

Meteorological Data:

Data on atmospheric temperature, relative humidity, mean total rainfall and total number of rainy days from 2005 to 2008 were obtained from Regional Meteorological Centre, Chennai.

Diversity indices:

Total number of dragonflies and damselflies collected during the study period was recorded. Total abundance, Simpson's index of diversity (1-D), Shannon -Wiener Diversity Index (H), Shannon entropy, species richness and species evenness were calculated by using the software 'Past.exe' (ver. 2.14). Jaccard's similarity index was calculated to find out the similarity in Odonata diversity between vegetable and rice fields.

The formulae for the diversity indices are as follows:

Simpson's index (D) = $\Sigma\, n_i\,(n_i\text{-}1) / N\,(N\text{-}1)$

i = 1

Where n_i = number of individual for each species

N = total number of individuals

Shannon index of general diversity ($\overline{H}$)

$$\overline{H} = -\sum \left(\frac{ni}{N}\right)_{\log} \left(\frac{ni}{N}\right)$$

Where *ni* = number of individual for each species

N = total number of individuals

Evenness (*e*)

$$e = \frac{\overline{H}}{\log S}$$

Where $\overline{H}$ = Shannon index

S = number of species

The similarity in odonata diversity between vegetable fields and rice fields was assessed by using the formula of Jaccard's similarity index as follows:

Jaccard's Index = A/ (A+B+C)

Where A= total number of species present in both communities

B= the number of species present in community 1 but not 2

C= the number of species present in community 2 but not 1

RESULTS

Totally 35 species of dragonflies and damselflies were recorded collectively from vegetable and rice fields in Tiruvallur district from January 2005 to December 2008 (Figure1). The species composition, richness, evenness and other diversity indices showed variations between vegetable and rice fields.

Species composition and diversity in vegetable fields

Three families viz., Aeshnidae, Gomphidae and Libellulidae were recorded under Anisoptera (dragonflies) and five families viz., Calopterygidae, Coenagrionidae, Euphaeidae, Lestidae and Platycnemididae were recorded under Zygoptera (damselflies) (Table 1). Totally 31 species of dragonflies and damselflies were recorded under 22 genera, of which 15 genera and 22 species were dragonflies and 7 genera and 9 species were damselflies. Libellulidae was found to be the largest family, which has the highest number of species (18 species) throughout the study period. Species richness was 31 throughout the study. Total abundance was maximum (4167) in 2008. Maximum evenness of 0.899 was recorded in vegetable fields in 2007 and this was correlated with the maximum Shannon-Wiener diversity index of 3.328 during the same study year (Table 2). The similarity index (Jaccard's similarity index) was calculated as 0.660 for each study year (Table 2).

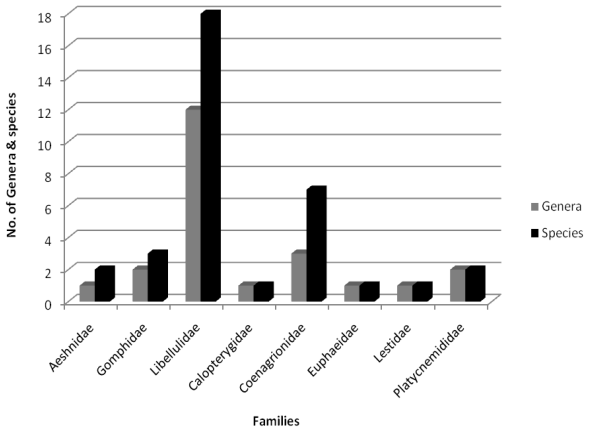

Figure 1. Total number of genera and species collected under different families of Odonata collectively from vegetable and rice fields

Species composition and diversity in rice fields

Five different families namely Aeshnidae, Gomphidae, Libellulidae, Coenagrionidae and Lestidae were recorded in rice field. All the species collected from rice fields were grouped under 16 genera (12 Anisoptera and 4 Zygoptera). Total number of species recorded in rice field was 21 (15 Anisoptera and 6 Zygoptera). Maximum total abundance (1703) was recorded in 2008. Maximum Shannon-Wiener diversity index (2.871) and

Table 1. Taxonomic composition and total number of individuals collected under different species of Odonata from North-Eastern Tamilnadu during 2005-2008

Sl.No.	Species	Number of individuals collected							
		Vegetable fields				Rice fields			
		2005	2006	2007	2008	2005	2006	2007	2008
	Anisoptera								
	Family: Aeshnidae								
1	*Anax guttatus* (Burmeister)	0	0	0	0	9	11	7	6
2	*Anax immaculifrons* (Rambur)	25	52	67	72	12	6	14	11
	Family: Gomphidae								
3	*Heliogomphus selysi* (Fraser)	179	158	124	186	38	88	76	54
4	*Ictinogomphus distinctus* (Rambur)	128	94	108	134	0	0	0	0
5	*Ictinogomphus rapax* (Rambur)	112	75	82	92	29	42	37	32
	Family: Libellulidae								
6	*Brachythemis chalybea* (Brauer)	128	142	108	129	0	0	0	0
7	*Brachythemis contaminata* (Fabricius)	106	85	122	148	78	55	86	73
8	*Bradinopyga geminata* (Rambur)	27	35	42	33	0	0	0	0
9	*Crocothemis servilia* (Drury)	220	145	189	238	36	42	46	58
10	*Diplocodes trivialis* (Rambur)	175	205	218	232	125	163	158	182
11	*Neurothemis tullia* (Drury)	98	112	147	121	58	82	117	93
12	*Orthetrum glaucum* (Brauer)	116	105	98	165	78	67	63	85
13	*Orthetrum sabina* (Drury)	125	145	102	148	51	25	48	60
14	*Orthetrum testaceum* (Burmeister)	114	108	122	148	0	0	0	0
15	*Pantala falvescens* (Fabricius)	480	306	318	372	185	211	203	197
16	*Rhyothemis variegata* (Linn.)	219	184	225	236	89	58	62	71
17	*Sympetrum vulgatum flavum* (Bartenef)	90	109	128	114	0	0	0	0
18	*Tholymis tillarga* (Fabricius)	30	18	45	55	0	0	0	0
19	*Tramea basilaris* (Palisot de Beauvois)	170	165	138	145	31	27	41	29
20	*Tramea limbata* (Desjardins)	150	120	111	165	0	0	0	0
21	*Trithemis aurora* (Burmeister)	112	78	65	92	26	34	31	40
22	*Trithemis festiva* (Rambur)	107	118	128	108	0	0	0	0
23	*Trithemis pallidinervis* (Kirby)	72	110	95	108	52	45	69	42
	Zygoptera								
	Family:Calopterygidae								
24	*Caliphaea* sp	27	35	42	33	0	0	0	0
	Family: Coenagrionidae								
25	*Agriocnemis femina femina* (Brauer)	0	0	0	0	110	74	101	122
26	*Agriocnemis pygmaea* (Rambur)	0	0	0	0	92	68	81	105
27	*Ceriagrion coromandelianum*(Fabricius)	190	78	158	212	140	61	125	156
28	*Ischnura aurora* (Brauer)	70	78	65	128	43	59	78	88
29	*Ischnura delicata* (Hagen)	0	0	0	0	121	82	88	106
30	*Ischnura inarmata* (Calvert)	71	65	108	108	0	0	0	0
31	*Ischnura senegalensis* (Rambur)	92	84	149	132	0	0	0	0
	Family: Euphaeidae								
32	*Euphaea* sp	30	45	68	73	0	0	0	0
	Family: Lestidae								
33	*Lestes viridulus* (Rambur)	69	80	118	120	61	68	91	93
	Family: Platycnemididae								
34	*Copera marginipes* (Rambur)	70	78	92	55	0	0	0	0
35	*Platycnemis* sp	54	65	88	65	0	0	0	0
	Total	3656	3277	3670	4167	1464	1368	1622	1703

evenness (0.8409) in rice fields were recorded during 2007. Odonata diversity in rice fields was lower than vegetable fields. The similarity index (Jaccard's similarity index) was calculated as 0.660 for each study year.

Table 2. Diversity indices for Odonata in vegetable and rice fields from 2005 to 2008

Sl. No.	Diversity Indices	2005		2006		2007		2008	
		Rice Fields	Vegetable Fields	Rice Fields	Vegetable Fields	Rice Fields	Vegetable Fields	Rice Fields	Vegetable Fields
1	Species richness (S)	21	31	21	31	21	31	21	31
2	Total no. of individuals	1464	3656	1368	3277	1622	3670	1703	4167
3	Shannon-Wiener Diversity Index (H)	2.84	3.221	2.828	3.3	2.871	3.328	2.847	3.308
4	Simpson 1-D	0.9326	0.9508	0.9288	0.9584	0.9358	0.9601	0.934	0.9591
5	Evenness	0.815	0.8082	0.8056	0.8749	0.8409	0.8991	0.8208	0.8817
6	Jaccard Similarity Index	0.660		0.660		0.660		0.660	

Table 3. Mateorological data for the years from 2005 to 2008

Year	Mean Maximum temperature (^{o}C)	Mean minimum temperature (^{o}C)	Mean Relative Humidity (%) @ 0830/1730 hrs IST	Mean Total Rainfall (mm)	Total number of rainy days (2.5mm and above)
2005	33.6	24.8	66.8-75.6	199.8	73
2006	33.8	24.6	64.3-75.9	123.9	67
2007	33.3	24.5	67.1-75.7	106.9	68
2008	33.7	24.8	64.3-75.3	150.2	63

Meteorological data:

The meteorological data is given in the table 3. Mean maximum and minimum yearly temperatures were low in 2007 compared to other three years. Also the relative humidity was high in the year 2007.

DISCUSSION

Present study reports the odonata diversity in vegetable and rice agroecosystems. Odonates are predaceous insects and they are important biocontrol agents of agricultural pests and vector mosquitoes. In the present study families Libellulidae in Anisoptera and Coenagrionidae in Zygoptera were found to be more diverse families in terms of the number of species. Similar findings were already reported by some investigators. Ghahari *et al*.,(2009) have reported that families Libellulidae and Coenagrionidae were dominant in terms of number of species in rice fields in Iran. Kumar and Mitra (1998) reported that family Libellulidae was represented by high number of species (18 species) among a total collection of 42 species from Sahstradhara, Dehra Dun. Similar reports were published by Prasad (2002), Kumar (2002) and Vashishth *et al*., (2002).

Several investigators have reported that dragonflies and damselflies are very common in rice agroecosystems. Kandibane *et al*., (2003) have recorded 12 species of Odonata under three families in rice fields of Madura. In the present work the number of species and families recorded in rice fields were high compared to the results of Kandibane *et al*., (2003, 2005). Among the various species, *Pantala flavescens*, a migratory species, was abundant in numbers. The damselfly *Ceriagrion coromandelianum* was abundant in both vegetable fields and rice fields. In rice field, *Agriocnemis femina femina* was also found to be abundant. Kandibane *et al*., (2003) have reported that *A. femina* was more abundant in rice ecosystems.

The diversity and distribution of insects may be influenced by type of ecosystems and climate. In the present study the species richness, total abundance and diversity of Odonata were high in vegetable ecosystems compared to rice ecosystem. Higher evenness values were recorded in vegetable fields than rice fields during 2006, 2007 and 2008. When the richness and the evenness of a community increases, the Shannon index also increases. In the present study the Shannon index was higher in vegetable fields than rice fields. This was

due to the higher species richness and evenness in vegetable fields. The dominance of species was found to be lower in vegetable crops compared to rice fields. Hence the Simpson's index of diversity (1-D) was higher in vegetable crops and it clearly explained that species distribution in vegetable crops was equal.

Besides the type of crop, the climatic factors such as rainfall, atmospheric temperature and humidity also affect the insect diversity. The average annual temperature was the lowest in the year 2007. This lowest average temperature in 2007 coincided with the maximum insect diversity in both rice and vegetable crops. Brinjal and okra plants grow taller with branches and provide suitable microclimate and resting place for perching adult Odonata. Vegetable fields also harbour variety of small insects, which are the main prey of Odonates. Latif *et al*., (2009) have reported 20 species of pest insects and 10 families of predaceous insects in brinjal field. Hence the presence of variety of prey insects might be the reason for higher odonata diversity in vegetable fields.

CONCLUSION

It is concluded that dragonfly and damselfly diversity was influenced by type of crop because vegetable ecosystem supported more taxa of Odonates than rice field.

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