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Species composition and taxonomic similarity of Hymenoptera in an irrigated rice ecosystem of Tamil Nadu, India

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ABSTRACT
A total of 22 taxa of hymenopteran arthropods were recorded in 7 families on rice ecosystem. All the 22 taxa were present in partially weeded plot, where as in weeded plot, 16 taxa were recorded. Among the hymenopteran arthropods, *Xanthopimpla punctata* (Fab.), *X. flavolineata* Cameron and *Temelucha biguttata* (Munakata) were the dominant species of parasitoids in weeded and partially weeded rice ecosystems. Two taxa of ants were recorded in both the ecosystems. Four taxa of parasitoids *viz., Cotesia boaris* Wilkinson, *Goniozus* nr. *triangulifer*, *Brachymeria lasus* (Walker) and *Telenomus rowani* (Gahan) showed greater abundance in partially weeded rice ecosystem. However, the abundance of all the taxa of parasitoids was comparatively more in partially weeded rice ecosystem than in weeded rice ecosystem. The diversity of Hymenoptera exhibited 0.80 – 1.00 similarity in the first and last week and some families of parasitoids were absent in the last week. The similarity of parasitoids was found to be less during tillering and flowering stages of the crop (third, fourth, fifth, and sixth week). Formicids registered perfect similarity (1.00) through out the season. There were 18 species of weed plants recorded in partially weeded rice ecosystem. Among them, *Echinochloa colonum*, *Cyperus rotundus*, *C. iria*, *C. diformis*, *Panicum repens* and *Bracharia mutica* were dominant. The weed plants present in partially weeded rice plot provided pollen and nectar, which was more useful to conserve parasitoids when the population of herbivores was low.

Key words: Taxonomic similarity, Abundance, Diversity, Hymenoptera, Rice crop, Weed plants.

INTRODUCTION

An inventory of the biodiversity of hymenopterous parasitoids associated with rice agroecosystems of the world has shown that there are 524 species, which are intensively and extensively exercising natural control. The observation on the biosystematics of these species have shown that these fall under 181 genera belonging to six super families and 19 families. An analysis of their parasitism on the different stages of the life cycle of the various rice pests indicates that a greater majority of them are egg and larval parasitoids (148 and 289 species respectively); while seven are egg – larval, 17 larval – pupal and 63 pupal indicating their immense potential for both biodiversity exploration and biological control for IPM and sustainable agriculture. The inventory has been reinforced with all associated details namely zoogeographical distribution, parasitism potential attributes and other such relevant details from primary sources so that it will serve as a startup for planning an IPM strategy involving biocontrol in rice agroecosystem. The inventory has indicated that Ichneumonoidea and Chalcidoidea are the potential groups, which have to be exploited, monitored and watched for a better IPM approach in rice agro ecosystem (Dey *et al*., 1999). In Tamil Nadu, the abundance, inventory and diversity of Hymenoptera between weeded and partially weeded rice ecosystem had not been studied earlier. Hence, the present investigation was taken up in an irrigated rice ecosystem to study the diversity of various families of Hymenoptera.

MATERIALS AND METHODS

The field trial to study the diversity and relative abundance of Hymenotpera in irrigated rice ecosystem was conducted at the wetlands of Agricultural College and Research Institute, Madurai, Tamil Nadu during *Kharif* 2000. Four ruling rice varieties viz., MDU 5, ADT 36, ADT 39 and ADT 43 were used and each variety replicated into two treatments namely weeded plot (all the weeds removed) and partially weeded plot (10 weeds allowed /m^2). The study area receives water from the vaigai dam. Monthly minimum and maximum temperatures varied between 28° and 38°, May being the warmest (40° C maximum temperature) and January the coolest (28° C minimum temperature) months during 2000. The average rainfall of Madurai was 893 mm during 2000. The collection of arthropods was done with sweep net and the collected insects sorted out into respective taxa based on taxonomic characters. The collection of arthropods was done at weekly intervals from 30 days after transplanting and a total of seven samples taken during the season. Twenty sweeps were made diagonally across each plot. The numbers of taxa in weeded and partially weeded rice ecosystems were recorded in each week. The weed plants allowed in partially weeded plot were collected and identified. In the present investigation, Morisita coefficient index of similarity (Magurran, 1988; Wolda, 1981) was used to study the similarity of insects (= diversity) between weeded and partially weeded rice ecosystems in a location; data will be expressed as percentage of similarity (100 times Cmhw).

$$\text{Morisita index } (C_{mhw}) = \frac{2\,\Sigma(\text{ani} \times \text{bni})}{(\text{da} + \text{db})\,\text{aN} \times \text{bN}}$$

Where,
aN = Number of individuals in sample A.
bN = Number of individuals in sample B
ani = Number of individuals in the i th taxon in sample A and
bni = Number of individuals in the i th taxon in sample B.

$$\text{Da} = \frac{\Sigma \text{ani}^2}{\text{aN}^2} \text{ and } \text{db} = \frac{\Sigma\, \text{bni}^2}{\text{bN}^2}$$

RESULTS AND DISCUSSION

The inventory of Hymenoptera diversity revealed the record of 22 species in 7 families (Fig. 1). Among the hymenopteran parasitoid groups, Ichneumonids recorded 9 species followed by braconds, chalcids, bethylids, scelionids and encyrtids containing 4, 3, 2, 1 and 1 species, respectively. Two species of ants were only the hymenopteran predators recorded in rice ecosystem. Among the inchneumone parasitoids, *Xanthopimpla punctata* (Fab.) was the dominant species followed by *X. falvolineata* Cameron and *Temelucha biguttata* (Munakata) in weeded and partially weeded rice ecosystems. The common species with more individuals had behaviour of surviving in existing maximum and minimum environmental conditions. This finding is in accordance with the statement of Risch (1981), who stated that abundance of a common species (dominant taxa) was relatively more

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Table 1 : Taxonomic similarity of Hymenoptera in irrigated rice ecosystem during *kharif* 2000

Fauna	I week				II week			
	MDU5	ADT 36	ADT39	ADT 43	MDU5	ADT 36	ADT39	ADT 43
Formicids	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ichneumonids	0.96	0.92	0.95	0.90	0.85	0.82	0.85	0.80
Braconids	0.95	0.95	0.90	0.93	0.86	0.85	0.85	0.87
Chalcids	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bethylids	1.00	1.00	1.00	1.00	0.90	0.95	0.90	0.94
Scelionids	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Encyrtids	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Fauna	IIIweek				IV week			
	MDU5	ADT 36	ADT39	ADT 43	MDU5	ADT 36	ADT39	ADT 43
Formicids	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ichneumonids	0.60	0.64	0.66	0.69	0.66	0.60	0.64	0.62
Braconids	0.70	0.74	0.72	0.68	0.66	0.64	0.61	0.71
Chalcids	1.00	1.00	1.00	1.00	0.65	0.60	0.70	0.68
Bethylids	0.75	0.70	0.72	0.75	0.70	0.74	0.72	0.73
Scelionids	0.70	0.66	0.65	0.64	0.65	0.60	0.58	0.64
Encyrtids	0.73	0.72	0.75	0.68	0.60	0.55	0.62	0.54

Fauna	Vweek				VI week			
	MDU5	ADT 36	ADT39	ADT 43	MDU5	ADT 36	ADT39	ADT 43
Formicids	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ichneumonids	0.55	0.58	0.50	0.58	0.40	0.45	0.42	0.48
Braconids	0.50	0.56	0.48	0.49	0.55	0.50	0.48	0.56
Chalcids	0.55	0.55	0.55	0.55	0.50	0.55	0.52	0.53
Bethylids	0.45	0.48	0.52	0.50	0.55	0.58	0.50	0.59
Scelionids	0.70	0.68	0.60	0.62	0.60	0.52	0.48	0.55
Encyrtids	0.60	0.58	0.65	0.64	0.50	0.55	0.58	0.40

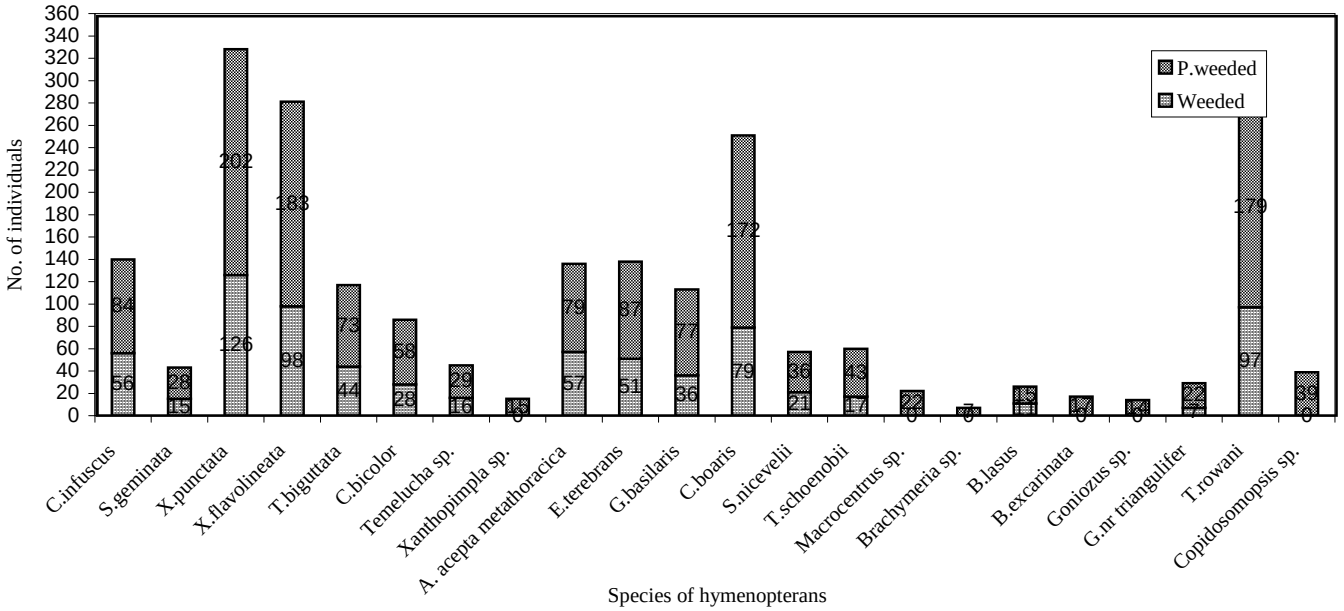
Fauna	VII week			
	MDU5	ADT 36	ADT39	ADT 43
Formicids	1.00	1.00	1.00	1.00
Ichneumonids	0.90	0.91	0.90	0.90
Braconids	0.80	0.75	0.80	0.82
Chalcids	0.00	0.00	0.00	0.00
Bethylids	1.00	1.00	1.00	1.00
Scelionids	0.00	0.00	0.00	0.00
Encyrtids	0.00	0.00	0.00	0.00

* Values in the columns are indices

in weed free soybean than in weedy soybean habitat. In the remaining group of parasitoids, *Cotesia boaris* Wilkinson, *Goniozus nr. triangulifer, Brachymeria lasus* (Walker) and *Telenomus rowani* (Gahan) were mostly dominant in partially weeded rice ecosystem possibly due to abundance of more herbivores as stated by Andow (1981). In weeded plots there were 16 taxa of hymenopterans recorded while in partially weeded plots a total of 22 species were registered. Earlier, Pimentel (1961) predicted that dominant species of parasitoids had more individuals in unprotected ecosystem, however species abundance of parasitoids was more in unprotected ecosystem than in protected ecosystem and rare species of parasitoids with fewer individuals occurred under favourable stage of the crop in partially weeded rice ecosystem. Of these parasitoids, two species *viz., X. punctata* and *C. boaris* were dominant and they were found to occur in rice ecosystem through out the season. The inventory of hymenopteran arthropods is furnished in appendix 1.

The diversity of hymenopteran families showed 0.90 – 1.00 similarity values in the first week (Table 1). This was due to the presence of same number of species and individuals in both the ecosystems as suggested by Whittaker (1965). Bethylids, chalcids, scelionids and encyrtids showed perfect similarity (1.00) in the first and second week, since all the species were present in both the ecosystems. Hence, these species correctly fit the morisita index (Wolda, 1981). The parasitoids exhibited less similarity values (0.60, 0.64; 0.60, 0.62; 0.50, 0.55; 0.40, 0.42) in third, fourth, fifth and sixth week samplings. The diversity of parasitoids was more during tillering and flowering stages of the crop. This is in accordance with the view of Root (1973) who stated that the crop during tillering and flowering stages provided favourable mincroclimates for the abundance of hymenopteran arthropod fauna. In the seventh week, the diversity of incheunomids, braconids and bethylids exhibited 0.90, 0.80 and 1.00 similarity values. This is the fact that at the time of crop maturity the abundance of herbivores and alternate resources like pollen and nectar were low. Hence, the diversity of hymenopterans showed perfect similarity (Lawton, 1983; Hunter and Wilmer, 1989). The diversity of chalcids, scelionds and encyrtids was absent in the last week. These groups of hymenopterans were found to occur when the herbivore hosts became more. This finding is inconsonance with Islam and Karim (1995) who stated that the most of hymenotperan parasitoids needed original hosts for their reproduction and multiplication. The species diversity of hymenopterans was more in partially weeded plot compared to weeded plot. It is proposed with the fact that the weed plants present in partially weeded rice ecosystem during flowering stage provided pollen and nectar, which were utilized by natural enemies for their survival when the density of herbivores was low, so the diversity of natural enemies was more in partially

Fig 1 : Relative abundance of hymenopterans in irrigated rice ecosystem during kharif 2000



Appendix 1 : Inventory of Hymenoptera arthropod fauna in irrigated rice ecosystem during *kharif* 2000

Fauna Formicidae	Weeded Relative abundance	Partially weeded Relative abundance
Camponotus infuscus	56	84
Selonopsis geminata Fab.	15	28
Ichneumonidae		
Xanthopimpla punctata (Fab.)	129	202
X. flavolineata Cameron	98	183
Temelucha biguttata (Munakata)	44	73
Charops bicolor (Szepligeti)	28	58
Temelucha sp.	16	29
Xanthopimpla sp.	0	15
Amaramorpha accepta metathoracica Ashmead	57	79
Eriborus terebrans (Gravenhorst)	51	87
Goryphus basilaris	36	77
Braconidae		
Cotesia boaris Wilkinson	79	172
Stenobracon nicevelii Bingham	21	36
Tropbracon schoenobii Viereck	17	43
Macrocentrus sp.	-	22
Chalcidae		
Brachymeria sp.	-	7
Brachymeria lasus (Walker)	11	15
B. excarinata Gahan	-	17
Bethylidae		
Goniozus sp.	-	14
Goniozus nr. triangulifer	7	22
Scelionidae		
Telenomus rowani (Gahan)	97	179
Encyrtidae		
Copidosomopsis sp.	-	39
Total number of taxa	16	22

* Values in the columns are numbers of individuals collected during the season

weeded rice ecosystem (Ohgushi, 1992). There were no greater variations in diversity of hymenopteran arthropod fauna observed among the rice varieties used in this study.

The present study is concluded that two taxa of ants were present through out the season and showed perfect similarity since they were a common predator in rice ecosystem. The diversity of parasitic hymenopterans became more during tillering and flowering stages in partially weeded rice ecosystem. The abundance of parasitic hymenopterans seemed to be comparatively more in partially weeded plot than in weeded plot. The weed plants allowed in partially weeded plot provided alternate resources like honey dew and pollen and nectar for the conservation of natural enemies. Hence, there was a biotic balance between natural enemies and herbivores observed in partially weeded rice ecosystem.

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