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Insect diversity and species distribution in rice field of Tharangambadi Taluk, Nagapattinam district, Tamil Nadu, India

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Abstract
The study was carried out in paddy field during the navarai and samba seasons. The data obtained by net sweeping and hand picking from September 2016 to October 2017 showed the diversity of phytophagous and entomophagous, their diversity richness and evenness. Totally 45 species of phytophagous, entomophagous 70 species and six neutral insects were collected. Order Lepidoptera maximum number of phytophagous insects. Coleoptera beetle *Ophionea indica* and *Dytiscus* sp was the most abundant phytophagous. A maximum number of entomophagous insects and seven neutral insects recorded in paddy crop their richness; dominance and evenness were statistically analyzed.

Keywords: rice, tharangambadi, diversity, Shannon's index, Simpson index, phytophagus

Introduction
Rice is grown mostly in the warm and humid environment under diverse cultural conditions and over a wide geographical range (Dale, 1994) [2]. A tropical rice field offers a biologically diverse and dynamic environment for microbial, floral and invertebrate population to flourish shortly after fields are flooded and continuing well after canopy closure (Schoenly *et al*., 1998; Settle *et al*., 1996) [9]. Arthropods diversity in rice ecosystems has received lot of attention during the past one decade (Way and Heong, 1994; Settle *et al*., 1996; Bambaradeniya, 2003) [14]. Arthropods inhabiting tropical agro ecosystems are highly affected by seasonal variations due to marked variation in weather conditions in such areas. Several instances of pest outbreaks in rice crop were either solely due to environmental conditions as in the case of *Cnaphalocrocis medinalis* (Pathak, 1975), Manisekaran *et al*., 1995) [10] studied the *Ophionea* sp, *Micraspis crocea*, *Paederus fuscipes* were active during samba season. Kalaisekar and Ramamurthy (2004) observed three abundant insects *Altica cyanea*, *Coccinella septempunctata* kharif season. Diraviyam *et al*., (2003) reported that *Micraspis discolor* most dominant during the samba season. Arthropod inventories can be good indicators of habitat biodiversity because arthropods respond quickly to environmental changes, since they are highly diverse in nature (Longino, 1994).Insects pests have been recognized as major biotic stress responsible for significant reduction in yield of rice in different system zone of India (Chelliah *et al*., 1989). The study was deal with the documentation of the major and important arthropod insects, quantification of various ecological indices viz., species richness, population diversity and evenness indices in irrigated paddy field during the study period.

Materials and Methods
Study Area: Nagapattinam District Background
The Nagapattinam District was carved out of the earlier composite Thanjavur District in 1991. The marine or coastal land has plain lands except for a few sand dunes and tilts from coastline to the inland area. The Vedaranyam salt swamp, south of Nagapattinam town is the largest swamp in Tamil Nadu, running 7-8 kms. It is one of the richest regions of biodiversity in the country. This District lies on the shores of the Bay of Bengal between Northern Latitude 10.7906 degrees and 79.8428 Degrees Eastern Longitude. The general geological formation of the district is plain and coastal. The Cauvery and its offshoots are the principal rivers.
The most important feature of the taluk is the Cauvery River spread over with its numerous branches. In this study areas was conducted in six different villages in Tharangambadi taluk, namely as Sembanarkovil, Akkur, Karuvi, Kiliyanur, Perambur and Sankaranpanthal, Nagapattinam district.

Insect collection
Insects were collected from September 2016 to October 2017. Sweeping net, were used to collect the insects from the paddy crops every week. Some insects were collected by hand picking method. Insect collection was done every week from random sites in each village. Net sweeping was done while walking through the fields at random sites.

Identification of insects
The collected insects were killed by ethyl acetate vapor, sorted out into different orders and families and mounted in insects boxes. Small and soft bodied insects were preserved in 70% ethanol. Most insects were identified up to genus and species level with the help of experts and by using identification keys provided in different volumes of Fauna of British India and other books (Srinivasan, 2009) [12]. Few insects were identified up to family level only. The number of individuals collected under each species, genera, family and orders during the study period were recorded.
The collection included phytophagous insects, predatory insects, parasitoids and neutral insects. (Neutral insects are those which are not harmful to the paddy crops and phytophagous insects in the study areas). In this study insects from 11 different orders were recorded. The insect

orders recorded were: Orthoptera, Lepidoptera, Hemiptera, Homoptera, Coleoptera, Thysanoptera, Odonata, Hymenoptera, Diptera, Neuroptera, and Dermaptera Totally 45 species of phytophagous, entomophagous 70 species and neutral insects were collected.

Ecological indices／Data Analysis

Collected insects were sorted out into families, genera and species. Total number of individuals collected under each family was used for diversity analysis. Species richness, evenness and diversity indices such as Shannon's index and Simpson index were calculated by using diversity analysis software (PAST)

Results

The study has brought out interesting results pertaining to the biodiversity of the agriculturally important arthropods in paddy crop ecosystem in Tharangambadi taluk, Nagapattinam District of Tamil Nadu covering six villages. The collection included phytophagous insects, predatory insects, parasitoids and neutral insects. (Neutral insects are those which are not harmful to the crops and phytophagous insects in the study areas). In this study insects from 11 different orders were recorded. The insect orders recorded were Orthoptera, Lepidoptera, Hemiptera, Homoptera, Coleoptera, Thysanoptera, Odonata, Hymenoptera, Diptera, Neuroptera, and Dermaptera Totally 45 species of phytophagous, entomophagous 70 species and six neutral insects were collected. Order Lepidoptera contained maximum number of phytophagous insects. The results revealed that maximum diversity Shannon Index (2.57), Species richness (3.49), Evenness (0.85) was recorded in samba season followed by the Shannon index (1.91), Species richness (2.66), Eveness (0.73) respected in during the January to April Navarai season Table:1. The distribution of different phytopahgous, entomophagous and neutral insects in different orders is detailed below:

Phytophagous insects

Order Lepidoptera was the dominant one in the collections. Around 15 species of moths and butterflies were collected and recorded. The lepidopteran insects recorded were: *Sesamia inferens*, *Cnaphalocrocis medinalis* (Guenee), *Hymenia recurvalis* (Fab), *Danius* sp, *Creatonotus gangis*, *Telicota augias*, *Pericallia ricini* (Fab), *Mythimna separate* (Walker), *Heliothis* sp, *Spodoptera litura* (Fab), *Earias vittella* (Fab), *Melanitis leda*, *Melanitis smene*,*Chilo partellus* (Swinhoe), and *Spodoptera litura*, The predominant grasshopper species in all the locations studied were *Atractomorpha crenulata* (Fab), *Oxya nitidula* (Walker), *Acrida* sp. and *Anacridium flavascens* (Fab). The other species recorded were: *Acrida exaltata* (Walker), *Oxya fuscovittata* (Marsch), *Cantantops* sp., *Truxalis* sp., and *Poecilocerus pictus* (Fab).The hemipterans such as *Pyrrhocoris apterus*, *Recelia dorsalis*, *Aradus* sp., *Nezara viridula* (Linn.), *Riptarsus linearis*, *Tricentrus* sp., were collected from all the locations. Homopteran insects included plant hoppers and leaf hoppers as major groups. The commonly recorded leaf hoppers were: *Cofana spectra*, the leaf hoppers were: *Balclutha incise*, *Amrasca biguttula biguttula* Ishida, *Amrasca devastans* was recorded in all locations.

The other homopterans included one species each in the following families: Aleyrodidae (*Bemisia tabaci* Genn, Cercopidae *Clovia* sp. Cixiidae *Oliarius* sp and Tropiduchidae species

Thysanoptera order the following species of thrips were recorded from Sembanarkovil, Karuvi, Kiliyanur and Sanakaranpanthal. *Aeolothrips indicus* (Bhatti), *Thrips apiculatus, Thrips tabaci* (Thripidae) and one unidentified species was collected from Aakkur, Karuvi, Sembanarkovil and perambur paddy fields. The leaf beetle *Ophionea indica* and *Dytiscus* sp was the most abundant phytophagous insect in paddy crop, *Hispa stygia* (Chapuis), *Myllocerus discolor*, *Cantharis* sp, *Paederus fuscipes* were recorded from Sembanarkovil village during rainy season. The common dipteran pests were *Drosophila melanogaster* (Drosophilidae).

Entomophagous insects

Predatory insects

The predatory insects comprised of dragonflies and damselflies Odonata assassin bugs, mirid bugs, anthocorid bugs Hemiptera, ground beetle, rove beetle and lady bird beetle Coleoptera ant and wasp Hymenoptera, Some common predatory insects of paddy field recorded during the study period are given in the damselflies recorded were *Ceriagrion coromandelianum* Fabricius, *Ischnura aurora* (Brauer). The common dragon flies were *Pantala falvescens* (Fab), *Trithemis aurora*, *Diplocodes trivialis* (Rambur), *Brachythemis contaminate*, *Orthetrum Sabina* (Drury), *Orthetrum testaceum* (Burmeister), *Lestes viridis*, *Lestes viridulus* (Rambur), *Copera marginipes* (Rambur) and *Epallage fatime* recorded in all locations in Nagapattinam District,Tamil Nadu.

The predatory hemipteran insects recorded were *Diplinychus rusticus* (Fab), *Geocoris tricolor* (Fab) (Lygaeidae), *Zelus* sp, *Oncocephalus impudicus*, *Polytoxus fuscovittatus*, *Nephotettix virescens*, *Cofana spectra*, *Pygomenida* sp, *Andrallus spinidens* and *Rhynocoris fuscipes* (Fab). The most common coleopteran predatory beetles were *Carabus granulates Chlaenius bioculatus*, *Dicladispa armigera*, *Leptispa pygmoea*, *Chlaenius bioculatus*, *Cheilomenos sexmaculata*, *Coccinella tranversalis*, *Micraspis discolor* and *Paederus fuscipes*.

The most common dominant hymenopteran predatory insects were *Amegilla* sp., *Isotima* sp, Cynipidae, Evaniidae (Undetermined), *Camponotus sericeus sericeus*, *Camponotus varians*, *Vespa cincta*, *Camponotus vicinus*, *Camponotus socrayes*, *Myrmecia pavida*, *Megascolia* sp, *Mymicaria* sp, *Campsomeriella collaris* (Scoliidae),

Parasitoids

The hymenoptera parasitoid wasps from the family Aphelinidae were collected from Sembanar kovil, Akkur village. *Goniozus* sp., *Goniozus nephantidis* (Bethylidae), *Coelinideaelegans* (Curtis), *Aulasaphes* sp, *Cardiochile* sp (Braconidae), *Trichopria* sp (Diapriidae).The dipteran predator from the family Asilidae (Undetermined) was the most common one. *Muscina levida*, *Hydrotaea dentipes*, *Muscina levida*, *Musca domestica* (Muscidae).*Voria ruralis* (Fallen), *Dexia extendens* and Undetermined Stratiomyid fly were collected from all locations. The ant-lion predator *Plparus carinatus* (Ghosh), (Myrmeleontidae) was recorded from Sempanarkovil, Aakkur, Karuvi, Kiliyanur and Kiliyanur villages. *Myrmeleon formicarius* was collected from Kakilipettai and *Chrysoperla carnea* were collected from all locations. The hymenoptera parasitoid wasps from

the family Aphelinidae were collected from Sempanarkovil, Kiliyanur village. *Goniozus nephantidis* (Bethylidae), *Cardiochile* sp (Braconidae), *Trichopria* sp (Diapriidae), *Anagyrus chrysos* and *Telenomous beneficiens* (Zehntner) were collected from all locations. The dipteran parasitoids collected were: *Helophilus* sp, *Hemipenthes sinuosa*, *Platycheirus* sp and *Helophilus fasciatus* (Syrphidae).

Neutral insects

Dipteran flies such as *Sylvicola* sp. (Anisopodidae), *Chrysomya rufifacies*, *Chrysomya megacephala* (Calliphoridae) were the neutral flies. Hemipteran bugs like *Geocoris tricolor* (Fab), (Lygaeidae), *Delias eucharis* (Drury) and *Pareronia valeria* (Pieridae), *Renia discoloralis* (Erebidae) recorded from Sembanar kovil, Akkur, and Perambur village

Discussion

Existence of a variety of plants, animals and microorganisms (Biodiversity) is essential for the well-being of humans because they provide the basic needs such as food, cloth, medicine, clean water and air, places for recreation and other such ecosystem services (Solbrig *et al*. 1994; Daily 1997; Grifo and Rosenthal 1997; Kim 2001; Field 2001; Giampetro 2004; Kremen 2005) [11, 1, 5, 6, 3, 7] of humans. In practice the term ‘ biodiversity’ is mainly associated with species conservation in natural or semi-natural habitats. Agro ecosystems are man-made artificial ecosystems where much importance is not given for diversity of plants and invertibrates, because agroecosystems are managed with production goals. In agroecosystems more productive species, varieties and races are conserved and unproductive species are reduced. Pests and weeds are unwanted species in agroecosystems and are eliminated by some techniques. Application of pesticides is the most common and widely practiced method of pest control. Pesticide application has one important deleterious effect that it not only eliminates pests alone but also eliminates beneficial insects from agroecosystems. Hence the entire insect diversity is lost due to pesticide application.

Before the advent of chemical pesticides, our ancestors followed natural methods of pest control, which were eco-friendly and had less impact on entire insect diversity. In this context studies on insect biodiversity in agroecosystmes get their importance. Before the diversity analysis it is very important to document the insect fauna in agro ecosystems. Hence the present study was undertaken. Many investigators have studied the insect diversity, distribution and relative abundance in agro ecosystems in different parts of the country. But very few diversity studies have been conducted in paddy fields in North eastern Tamil Nadu.

In the present study the entire insect fauna was divided into three categories namely, phytophagous, entomophagous and neutral. Phytophagous insects were dominant in both number of individuals and number of taxa. Natural enemies were also abundant in paddy fields. Among the natural enemies ladybird beetles (coleopteran) and hymenopteran insects were dominant. Stary and Pike (1999) [13] reported that carabids, coccinellids, syrphids, ants and parasitic wasps were common representatives in agroecosystems. Their significance becomes apparent in their absence or when they are reduced in numbers allowing the pests to reach crop-injuring levels (Ridgway and Vinson, 1977) [8]

Conclusion

From the present investigation, it was clear that varieties of phytophgous and entomophagous insects existed in Paddy crops. Among the phytophagous insects very few insects were reported as serious pests and Lepidoptera, Coleoptera insects and Orthoptera insects occupy the place of serious phytophgous pests. Hymenoptera and Odonata were found to be the most important predatory insects in paddy crops. Maximum numbers of insects found to be samba season between that the favourable climatic factors to influence. More studies are needed to understand the population dynamics and seasonal patterns of insects in this particular geographical area.

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Conflict of Interest

Author confirmed no any conflict of interest.

Fig 1: No of Individual insects recorded from September 2016 to October 2017

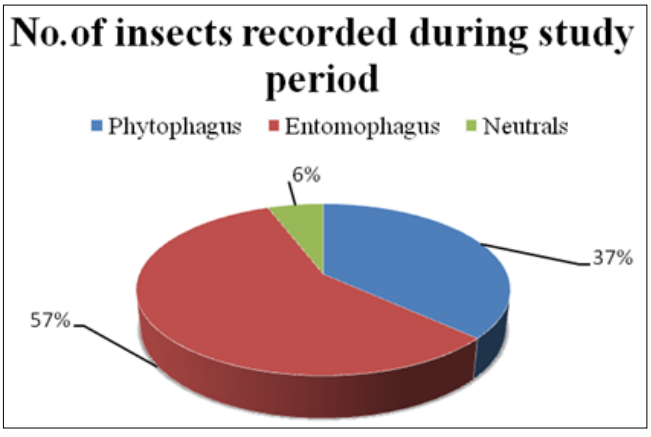

Fig 2: No of species recorded during the study period

Table 1: Species richness, diversity and eveness indices for samba and navarai seasons during study period

Biodiversity indices	During the period Sep- 2016 to Oct- 2017	
	Cultivated period	
	Samba	Navarai
Margalef`s (R1)	3.49	2.66

Menhinick (R2)	1.24	1.12
Diversity		
Shannon`s index (H`)	2.57	1.91
Hill`s Div.No.1 (N1)	13.33	8.65
Hill`s Div.No.2 (N2)	10.39	6.33
Evenness		
E1	0.85	0.73
E2	0.64	0.55
E3	0.62	0.49
E4	0.77	0.74
E5	0.76	0.67

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