Research article

Diversity and Community Structure of Terrestrial Invertebrates in an Irrigated Rice Ecosystem

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Abstract Diversity and community structure of terrestrial invertebrates in rice ecosystems were studied in rice fields under irrigated condition from January to April 2011. The research revealed that terrestrial invertebrate fauna comprised 84 species of insects in 72 families and 10 orders. Arachnids are the most abundant with 18 species in 10 families, amounting to a total of 102 terrestrial invertebrate species from irrigated rice ecosystem in Khon Kaen. The majority of insects belonged to Order Hymenoptera (29 species) followed by Homoptera (15 species), Coleoptera (11 species) and Diptera (9 species). The community structure of terrestrial invertebrates consisted of natural enemies (70 species) followed by insect pest (26 species), insect visitor (5 species) and scavenger (2 species).

Keywords terrestrial invertebrate, irrigated rice ecosystem, community structure

INTRODUCTION

Irrigated rice fields are managed as wetland ecosystems that operate on a short temporal scale and provide a rich diversity of organisms (Heckman, 1979). The system is dominated by micro, meso and macro invertebrates (especially arthropods) inhabiting the soil, water and vegetation sub-habitats of the rice fields. The terrestrial arthropod community in rice fields mainly consists of insects and spiders. The occurrence of terrestrial arthropods in a rice ecosystem is mainly influenced by the rice plants. The different communities of terrestrial arthropods in the rice field include rice pests, their natural enemies (predators and parasitoids) and other non-rice pest insects that inhabit or visit the vegetation. The composition of the arthropod communities is known to change with the growth of the rice crop (Heong et al., 1991). Dale (1994) stated on over 800 species of insects damaging the rice plant. There are only a few studies that examine the overall terrestrial arthropod community in rice fields. Heong et al., (1991) and Schoenly et al., (1995) studies carried out in the Philippines provide an insight into the arthropod communities and their guild structure in irrigated rice fields. In Thailand, studies on terrestrial arthropods in rice fields are confined to surveys documenting the distribution of major rice insect pests and their natural enemies (Ruay-aree, 1994) while no attempts have been made to document the structure and diversity of terrestrial arthropod communities in rice fields. Such a study carried out over successive rice cultivation cycles would provide useful information for the development of effective and safe integrated rice pest management strategies.

The objective of this study was to determine the contribution of the terrestrial arthropod community to the irrigated rice field ecosystem.

METHODOLOGY

The study was conducted at conventional irrigated rice fields in Khon Kaen province, Muang district, located in the northeastern region of Thailand. Photoperiod-insensitive variety Pitsanulok2 was used**.** Sampling of the terrestrial arthropod community was conducted to determine species composition using standard sweeping net. This was done at fortnightly intervals after planting, from January to April of 2011. Specimens were collected from 20 sweeps per replication and were sorted and counted later in the laboratory. They were divided into different insect and spider taxa and counted.

The insects and spiders collected from the rice fields were identified and classified into the smallest possible taxa using available keys and guides for the different taxa. Barrion and Litsinger (1994) study was used as a reference for rice pests, their predators and parasitoids. The Araneae were identified using Barrion and Litsinger (1995). Following the identification of the terrestrial arthropods collected from the rice habitats, they were assigned to guilds according to Moran and Southwood (1982) and Heong et al., (1991). These guilds were based on feeding habits and included phytophages (rice pests and non-rice pest visitors), predators, parasitoids and scavengers decomposers.

RESULTS AND DISCUSSION

A total of 102 arthropod species were recorded from the irrigated rice field during the study. A terrestrial arthropod fauna comprising 84 species of insects that belongs to 72 families and 10 orders, and 18 species of arachnids in 10 families. The majority of the insect species documented from the studied rice field belonged to the order Hymenoptera (29 species in 18 families), dominated by the family Braconidae and Ichneumonidae (Fig.1). The second largest insect order recorded was Homoptera, consisted of 19 species, in 5 families, dominated by the family Cicadellidae (14 spp.). Coleoptera was the third largest insect order, with 13 species in 11 families. Coccinellidae and Bruchidae were dominant among the Coleoptera. In order Diptera, 9 species were identified in 20 families. Order Hemiptera included 9 species in 7 families. The hemipterans were dominated by family Reduviidae (2 species) and Miridae (2 species). The Odonata included 2 species in 2 families. The Orthoptera included 3 species identified in 4 families. The Lepidoptera included 3 species in 3 families. The remaining 2 insect orders (Neuroptera and Thysanura) included one specy each. The Arachnids consisted of 18 species of Araneae (spiders) in 10 families. Amongst the spiders, family Araneidae had the highest number of species (4 spp.) followed by the family Theridiidae (3 spp.).

Terrestrial arthropods recorded from the rice ecosystem were assigned to guilds based on food habits of the species. Accordingly, five arthropod guilds were identified. The majority of these arthropods were predators (36 spp.) (Table 1), where spiders were the dominant predatory group with 18 species followed by Hemiptera with 5 species, Coleoptera and Diptera with 4 species each. From the 5 species identified, all of them were visitors and non rice pest insects that were associated with weeds in the rice field. The visitor guild was dominated by Coleoptera (3 spp.) followed by Diptera and Lepidoptera with 2 species each. The phytophagous insects comprised 26 species of rice pests represented by sap feeders, leaf feeders, stem feeders and root feeders (Table 1). Homopterans (15 spp.) were the dominant phytophagous pest group, closely followed by hemipterans pests (2 spp.). The parasitoid guild comprised 32 species of insects being dominated by hymenopterans (30 spp.). The scavenger/decomposer guild contained the fewest number of species, dominated by the order Diptera and Coleoptera with one species each. The overall species composition reflects a high richness of arthropod natural enemies (predators and parasitoids) in relation to the rice insect pests, where the natural enemy to pest ratio is 2.8:1. A majority of the parasitoids recorded attack rice insect pests.

This study highlights the richness of the terrestrial arthropod fauna associated with an irrigated rice field ecosystem in Khon Kaen province. The terrestrial arthropod fauna comprising 102 species was recorded during the present study. The study also reflects the importance and the role

of one single group of insects; the Order Hymenoptera with the largest number of species represented almost entirely by beneficial insects including natural enemies of paddy pest insects and pollinators. The richness of the predatory spider fauna inhabiting the rice fields is evident from their species composition, abundance and distribution within the rice ecosystem.

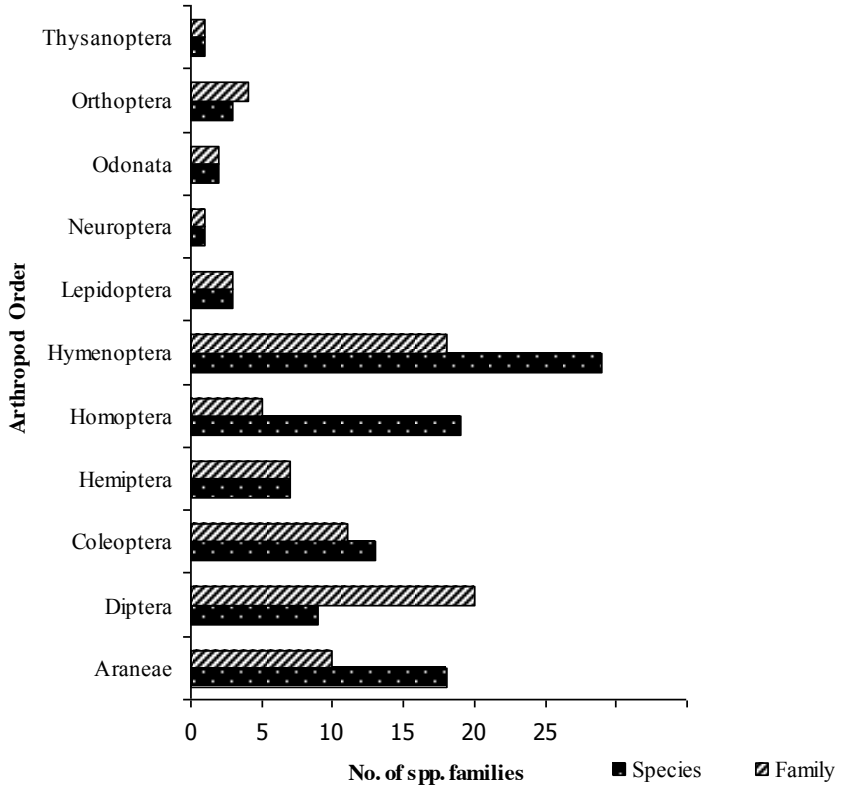

Fig. 1 Species composition and taxonomy of arthropods in irrigated rice ecosystem, at Khon Kaen province documented from January to April of 2011.

Table 1 Number of terrestrial arthropod in difference guilds in the rice habitat based on sweep net collection

Guild	Phytophagous					Predators	Parasitoids	Scavengers/ decomposers
	Rice Pests				Visitors (non-rice pests)			
Order	SF	DFM	SB	RF				
Araneae	-	-	-	-	-	18	-	-
Coleoptera	-	1	-	2	3	4		1
Diptera	-	1	1	-	2	3	1	2
Hemiptera	2	-	-	-	-	5	-	-
Homoptera	15	-	-	-	-	-	-	-
Hymenoptera	-	-	-	-	5	-	29	-
Lepidoptera	-	2	-	-	2	-	-	-
Neuroptera	-	-	-	-	-	1	-	-
Odonata	-	-	-	-	-	2	-	-
Orthoptera	-	2	-	-	1	2	-	-
Thysanoptera	1	-	-	-	-	-	-	-
Total	18	5	1	2	5	45	30	3

Note: Pests: SF – Sap feeders; DFM – Defoliators/miners; SB – Stem borers; RF – Root feeders

The guild structure of the arthropod fauna further emphasizes the importance of the predators (36 spp.) and parasitoids (32 spp.) that outnumbered the phytophagous rice pests (26 spp.). Thus,

the natural enemies accounted for 70.8 % of all the terrestrial arthropod taxa collected. The composition of the rice field arthropod fauna, while highlighting the high biodiversity in a monoculture crop, confirms the long term stability of the rice agroecosystem in respect to pests and natural enemies. As is evident from the present study, the significant positive relationships between the pest insects and their natural enemies (predators and parasitoids) exhibit the natural balance that exists among arthropod guilds in the rice field ecosystem. A high species richness among arthropod natural enemies in rice ecosystems has been observed by previous researchers as well (Heong et al., 1991).

CONCLUSION

In conclusion, the composition and structure of the arthropod communities in an irrigated rice ecosystem in Khon Kaen was classified, which order Hymenoptera (29 species) was dominant followed by Homoptera (15 spp), Coleoptera (11 spp), and Diptera (9 spp). The community structure of terrestrial invertebrates consisted of natural enemies (70 spp) followed by insect pests (26 spp), insect visitors (5 spp) and scavengers (2 spp). The findings highlight the existence of stable relationships between the rice insect pests and their arthropod natural enemies, under minimal biocide application. The population of arthropod natural enemies in rice fields could be conserved and enhanced through the maintenance of a rich weed flora during the fallow period, management of weed communities on the bunds through partial slashing and by minimal use of biocides when needed, to avoid economic damage by specific insect pests.

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