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Biodiversity of natural enemies in rice under Siang belt of Arunachal Pradesh

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Abstract

Rice is the staple food crop and is grown extensively in North East Hill region of India. Insect-pests take a heavy toll of rice crop in Siang belt of Arunachal Pradesh resulting in losses in grain yields ranging from 10-51%. Insect specific predators and parasites used in biological control acts as natural biological control agents for these insect pests in the region. Keeping in view the above facts, roving field surveys were conducted in *Kharif* season of years 2015-2019 to identify natural enemy diversity (Predators and parasitoids) prevalent in rice in rainfed rice cropping system of five districts (East Siang, West Siang, Upper Siang, Lower Siang and Siang) of Arunachal Pradesh, falling under Siang belt of Arunachal Pradesh. The results revealed that as many as Twenty nine species of predators belonging to 20 genera under 15 families of 6 orders were recorded in traditional and improved rice growing belt under rainfed rice cropping system of Siang belt of Arunachal Pradesh. Damsel flies, Dragon flies, long horned grasshopper, Lynx spiders, Plant and leaf bugs and Wolf spiders were recorded in high numbers, whereas Ground beetles, Lady bird beetles, Long jawed spiders, Orb spiders, Ripple bugs and Sword bearing crickets were recorded in moderate numbers. Earwigs, Rove beetles and Sac spiders were recorded low in numbers. Among parasites, twenty six species (identified) and 4 unidentified species belonging to 18 genera under 10 families of Hymenoptera order were recorded. Genus *Apanteles*, *Telenomus*, *Trichogramma* and *Xanthopimpla* were recorded in high numbers, whereas *Amuromorpha*, *Anagrus*, *Anastatus*, *Bracon*, *Cotesia*, *Stenobracon*, *Temelucha* and *Tetrastichus* were recorded in moderate numbers. Genus *Aphanogmus*, *Brachymeria*, *Elasmus*, *Gonatocerus*, *Isotima* and *Oligosita* were recorded low in number.

Keywords: Rice, rainfed rice system, survey, insect pests, natural enemy diversity

1. Introduction

Rice (*Oryza sativa* L.) is the staple food of over half the world's population and is grown over about 167.13 million hectares. It is one of the most important cereal crops of the world and forms the staple food for more than 65 per cent of the world population and known as king of cereals. India is the largest rice growing country, while China is the largest producer of rice. In India, rice accounts for more than 40% of foodgrain production, providing direct employment to 70% people in rural areas (ICAR, 2011) ^[1]. In Arunachal Pradesh rice is grown in valleys, terraces, uplands, hills and Jhum. The total area under rice cultivation is 130.505 thousand hectares with a total production of 328.845 thousand tones grain and a productivity of 25.20 q/ha (Anonymous, 2019) ^[2]. One of the major reasons for the low production of rice is the pest problems associated with the crop. About 300 species of insects have been reported to attack rice crop in India, out of which 20 have been found to be the major pests (Arora and Dhaliwal, 1996) ^[3]. These pests infest the crop at all stages of plant growth and cause a variety of damage such as tissue boring, sap sucking, defoliation and leaf scrapping (Sharma *et al.*, 2004) ^[19]. In North East Hill (NEH) region the rice crop is host to many species of insect pests, few of them cause severe economic damage and records 20% yield losses to complete failure of the crop during epidemics. Yellow stem borer, leaf folder, case worm, hispa, gundhi bug, swarming caterpillar, thrips, gall midge and army worm are the important pests prevalent in the region (Shylesha *et al.*, 2006) ^[20]. During the last two decades, the wide adoption of high-yielding varieties, increased use of agro chemicals and improved package of cultural practices in rice has considerably increased the pest problems (Atwal and Dhaliwal, 2018) ^[4]. Some of the pests considered as minor pests have gained status of major pests in recent years and the severe outbreak of some pests in certain localities causes heavy yield losses (Garg *et al.*, 2004) ^[8].

The rainfed rice in the region is severely damaged by subterranean insects like root aphids and white grubs which are otherwise not a major problem of this crop in any other parts of India (Azad Thakur *et al.*, 2012) ^[5]. Insect pests and diseases are the major production constraints in increasing productivity of rice in rainfed rice cropping system in Siang belt of Arunachal Pradesh (Pathak *et al.*, 2013) ^[14] and Riba *et al.*, 2014) ^[17]. However, the rice fields of Arunachal Pradesh have seemingly rich community of natural enemies (Predators and parasitoids). These natural biological control agents are the friends of farmers and are responsible in managing the population build-up of rice insect pests. These natural enemies play a dominant role in suppressing pest population in the crop ecosystem, whenever favourable conditions prevail for their survival, development, conservation and multiplication. Furthermore, it is of paramount importance to have correct identification of natural enemies and understanding of their role in order to optimize the strategies for the management of insect pests (Way and Heong, 1994) ^[21]. Naturally occurring biological control has a potential role to play in the management of rice insect pests in Arunachal Pradesh and there is a need to emphasize the impact of indigenous natural enemies as an essential part of Integrated Pest Management (IPM) programmes (Ooi and Shephard, 2004) ^[12]. Conservation of the natural enemy fauna in situ for suppressing the pest population seems to be a very good alternative, also information available on natural enemies of paddy insect pests from this area is meager.

Hence, in view of the importance of above facts, roving field surveys were conducted in *Kharif* seasons of year 2015-2019 to identify natural enemy (Predator and Parasitoid) diversity in rice crop in five districts of Arunachal Pradesh falling under Siang belt.

2. Materials and Methods

Collection of insect pests, natural enemies (predators and parasitoids) was done from paddy fields of five districts of Arunachal Pradesh *viz.* East Siang, West Siang, Upper Siang, Lower Siang and Siang falling under Siang belt of Arunachal Pradesh. Mostly the sampling was done by sweep net taking a 50 successive double stroke sweep during day time at 15 days interval starting from last week of July to 1st week of November at all the locations. Immature stages and damaged hills were also collected from different fields and reared in Biocontrol laboratory of Department of Plant Protection, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh for emergence of adults. Collected predators and parasites were killed immediately after capture with the help of potassium cyanide, ethyl acetate, carbon tetrachloride and chloroform. Collected specimens were kept temporarily in 70% alcohol and preserved in Outman's fluid. Specimens were also preserved using paper envelopes, setting board (Spreading/Stretching board), relaxing container and pins for dragon and damsel flies. Pinning of dead flies was done through thorax into groove of setting board. Labeling was done according to date, collector and location. Specimens were kept in wooden boxes of dimension 45 x 30 x 15 cm. Repellants and preservatives like Naphthalene balls, para-dichloro-benze (PDB) crystals were used to repel other live insects from specimens. The collected specimens were identified up to species level from Zoological Survey of India, Kolkata, Department of Zoology, Aligarh Muslim University, Aligarh Department of Entomology, Indian Agricultural Research Institute (IARI),

New Delhi and National Centre for Integrated Pest Management, IARI, New Delhi. Based on the relative abundance of predators and parasites recorded in paddy fields they were classified into three main categories i.e. high, moderate and low (Garg *et al.*, 2002 ^[10]; Bhattacharyya *et al.*, 2006 ^[6] and Garg *et al.*, 2008) ^[9].

3. Results and Discussion

During this study, the insect pests recorded attacking the rice crop at different developmental stages were leaf folder (*Cnaphalocrosis medinalis*), stem borer (*Scirpophaga incertulas*), white backed plant hopper [WBPH] (*Sogatella furcifera*), Leaf hoppers (*Recilia dorsalis* and *Nephotettix virescens*) and rice hispa (*Di cladispa armigera*). Incidence of leaf folder, stem borer and rice hispa were recorded at tillering stage and remained till the maturity of the crop, whereas, leaf hopper and WBPH were seen at flowering/milky stage (Table 1 and 2). Results of survey showed that 29 species of predators belonging to 20 genera under 15 families of 06 orders were recorded in traditional and improved rice growing region under Siang belt of Arunachal Pradesh. Damsel flies (*Agriocnemis pygmaea* and *Ischnura senegalensis*), Dragon flies (*Crocothemis servilia* and *Orthetrum sabina*), Long horned grasshopper (*Conocephalus longipennis*), Lynx spiders (*Oxyopes javanus*, *O. lineatipes* and *O. assamensis*), Plant and leaf bugs (*Cyrtorhinus lividipennis*) and Wolf spiders (*Lycosa pseudoannulata*) were recorded in high numbers, whereas Ground beetles (*Ophionea nigrofasciata*, *Casnoidea ishii ishii* and *Casnoidea indica*), Lady bird beetles (*Harmonia octomaculata*, *Micraspis discolor* and *Micraspis inops*), Long jawed spiders (*Tetragnatha mandibulata*, *T. japonica*, *T. javana*, *T. virescens* and *T. maxillosa*), Orb spiders (*Argiope catenulate*), Ripple bugs (*Microvelia douglasi* and *Mesovelia vittigera*) and Sword bearing crickets (*Anaxipha longipennis* and *Metioche vittaticollis*) were recorded in moderate numbers. Earwigs (*Euborellia stali*), Rove beetles (*Paederus fuscipes*) and Sac spiders (*Clubiona japonicola* and *C. lena*) were recorded low in numbers (Table 1).

Among parasites, 26 species (identified) and 4 unidentified species belonging to 18 genera under 10 families of Hymenoptera order were recorded. *Apanteles angustibasis*, *Telenomus dignus*, *T. remus*, *T. rowani* and *T. triptus*, *Trichogramma chilonis*, *T. japonicum*, *X. flavolineata* and *Xanthopimpla punctata* were recorded in high numbers, whereas *Amuromorpha accepta*, *Anagrus optabilis*, *Anastatus* sp., *Bracon chinensis*, *Cotesia flavipes*, *Cotesia ruficornis*, *Stenobracon oculatus*, *philippinensis*, *Temelucha stangli*, *Tetrastichus formosanus* and *T. schoenobii* were recorded in moderate numbers. *Aphanogmus* sp., *Brachimeria* sp., *Brachymeria excarinata*, *B. lasus*, *B. marmontii*, *Elasmus philippinensis*, *Gonatocerus* sp., *Isotima dammermani*, *Isotima javensis* and *Oligosita yasumatsuii* were recorded low in number (Table 2).

Garg *et al.* (2002) recorded 14 species of predators belonging to 13 genera under 13 families in rice fields in Baghpat district of Uttar Pradesh. It was evident that relative abundance of Ground beetle, Crickets, Grasshoppers, Plant bugs, Damsel flies and Wolf spiders was high, whereas Lady beetles and Long jawed spiders were recorded moderate in number. Water bugs, Earwigs, Lynx spiders, Dwarf spiders and Orb spiders were recorded low in number. Similarly, 08 species of Hymenopteran parasites belonging to 08 genera under 08 families were also recorded from rice fields. It was

evident from the results that relative abundance of *Xanthopimpla flavolineatta*, *Stenobracon nicevillei*, *Apanteles angustibasis* and *Apanteles flavipes* were medium in number and *Tetrastichus schonobii*, *Telenomus rowani*, *Capidosomopsis nacoieiae*, and *Trichogramma* sp. were recorded low in number. The abundance and diversity of predator and parasites showed a gradual increase with the growth of rice plants and gradually decreased towards ripening of the crop. Bhattacharyya *et al.*, 2006 [6] from Jorhat, Assam recorded 26 species of Predators with their target prey species, predatory stage, period of activity and relative abundance. They also reported 29 species of parasitoids belonging to 10 families of Hymenoptera *viz.*, Braconidae, Ichneumonidae, Scelionidae, Trichogrammatidae, Bethyidae, Eulophidae, Chalcididae, Pteromalidae, Ceraphronidae and Vespidae. The present findings on predators and parasitoids of rice insect pests of Arunachal Pradesh corroborate the findings of Rahman (1983) [16], Anonymous (1992) [1] and Bhuyan and Basit (1995) [7] from Assam. Similar report was also made by

Pathak *et al.* 2002 [13], Riba *et al.* 2013 [18] and Pathak *et al.* 2014 [15].

The study has revealed the presence of a wide array of natural enemies (predators and parasitoids) of rice insect pests, which may be of greater value in the biological control. Some natural enemies were found throughout the growing period, some were more during vegetative stage of the crop and reproductive stage of the crop. All the recorded predator and parasitoids are known to be directly related to their prey population. Therefore, greater emphasis is required for the conservation and augmentation of the rich natural enemy fauna in rice ecosystem of Arunachal Pradesh. However, the seasonal incidence, relative abundance of the pests/natural enemies and predators/parasitoids-prey relationship has to be worked out under different agro climatic zones to know the real impact of these naturally occurring biocontrol agents. It further suggests that important biological control agents can be exploited in the management of the major insect pests of rice.

Table 1: Predators recorded/ collected in rice ecosystem during Survey of Siang belt of Arunachal Pradesh (Kharif 2015 to 2019).

Common Name	Scientific Name	Order	Family	Host	Period of activity	Relative abundance
Damsel flies	<i>Agriocnemis pygmaea</i>	Odonata	Agriionidae	Stem borer, Leaf folders and Planthoppers	Aug-Sept.	High
Damsel flies	<i>Ischnura senegalensis</i>	Odonata	Agriionidae	Stem borer, Leaf folders and Planthoppers	Aug-Sept.	High
Dragon flies	<i>Crocothemis servilia</i>	Odonata	Libullulidae	Stem borer, Leaf folders and Planthoppers	Aug-Sept.	High
Dragon flies	<i>Orthetrum sabina</i>	Odonata	Libullulidae	Stem borer, Leaf folders and Planthoppers	Aug-Sept.	High
Earwig	<i>Euborellia stali</i>	Dermaptera	Carcinophoridae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	Low
Ground beetles	<i>Ophionea nigrofasciata</i>	Coleoptera	Carabidae	Leaf and Planthoppers, Leaf folders	Aug-Sept.	Moderate
Ground beetles	<i>Casnoidea ishii ishii</i>	Coleoptera	Carabidae	Leaf and Planthoppers, Leaf folders	July end-Sept	Moderate
Ground beetles	<i>Casnoidea indica</i>	Coleoptera	Carabidae	Leaf and Planthoppers, Leaf folders	July end- mid Oct	Moderate
Lady bird beetles	<i>Harmonia octomaculata</i>	Coleoptera	Coccinellidae	Leaf and Planthoppers, Leaf folders	Aug-Sept.	Moderate
Lady bird beetles	<i>Micraspis discolor</i>	Coleoptera	Coccinellidae	Leaf and Planthoppers, Leaf folders	Aug-Sept.	Moderate
Lady bird beetles	<i>Micraspis inops</i>	Coleoptera	Coccinellidae	Leaf and Planthoppers, Leaf folders	Aug-Sept.	Moderate
Long horned grasshopper	<i>Conocephalus longipennis</i>	Orthoptera	Tettigonidae	Leaf and Planthoppers, Leaf folders	July end- mid Oct	High
Long jawed spider	<i>Tetragnatha mandibulata</i>	Araneae	Tetragnathidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	Moderate
Long jawed spider	<i>T. japonica</i>	Araneae	Tetragnathidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	Moderate
Long jawed spider	<i>T. javana</i>	Araneae	Tetragnathidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	Moderate
Long jawed spider	<i>T. virescens</i>	Araneae	Tetragnathidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	Moderate
Long jawed spider	<i>T. maxillosa</i>	Araneae	Tetragnathidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	Moderate
Lynx spider	<i>Oxyopes javanus</i>	Araneae	Oxyopidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	High
Lynx spider	<i>O. lineatipes</i>	Araneae	Oxyopidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	High
Lynx spider	<i>O. assamensis</i>	Araneae	Oxyopidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	High
Orb spider	<i>Argiope catenulata</i>	Araneae	Araneidae (Agriopidae)	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	Moderate
Plant and leaf bugs	<i>Cyrtorhinus lividipennis</i>	Hemiptera	Miridae	Leaf and Planthoppers, Leaf folders	Aug-Sept.	High
Ripple bug	<i>Microvelia douglasi</i>	Hemiptera	Veliidae	Leaf and Planthoppers, Leaf folders	Aug-Sept.	Moderate
Ripple bug	<i>Mesovelia vittigera</i>	Hemiptera	Veliidae	Leaf and Planthoppers, Leaf folders	Aug-Sept.	Moderate
Rove beetles	<i>Paederus fuscipes</i>	Coleoptera	Staphylinidae	Stem borer, Leaf folder, Leaf and	July end- mid	Low

				Planthoppers	Oct	
Sac spider	<i>Clubiona japonicola</i>	Araneae	Clubionidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	Low
Sac spider	<i>C. lena</i>	Araneae	Clubionidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	Low
Sword bearing crickets	<i>Anaxipha longipennis</i>	Orthoptera	Trigoniidae	Leaf and Planthoppers, Leaf folders	July end- mid Oct	Moderate
Sword bearing crickets	<i>Metioche vittaticollis</i>	Orthoptera	Trigoniidae	Leaf and Planthoppers, Stem borer, Leaf folders	July end- mid Oct	Moderate
Wolf spider	<i>Lycosa pseudoannulata</i>	Araneae	Lycosidae	Stem borer, Leaf folder, Leaf and Planthoppers	July end- mid Oct	High

Table 2: Parasites recorded /collected in rice ecosystem during Survey of Siang belt of Arunachal Pradesh (Kharif 2015 to 2019)

Parasitoid	Order	Family	Host species	Host Stage Parasitized	Period of activity	Relative abundance
<i>Amuromorpha accepta</i>	Hymenoptera	Ichneumonidae	<i>S. incertulas</i>	Eggs, Larvae	July end-mid Oct.	Moderate
<i>Anagrus optabilis</i>	Hymenoptera	Mymaridae	<i>S. furcifera</i>	Nymph and adults	Aug.-mid Oct.	Moderate
<i>Anastatus</i> sp.	Hymenoptera	Eupelmidae	Bugs and Grasshoppers	Eggs	Aug.-mid Oct.	Moderate
<i>Apanteles angustibasis</i>	Hymenoptera	Braconidae	<i>C. medinalis</i>	Larvae	July end-mid Oct.	High
<i>Aphanogmus</i> sp.	Hymenoptera	Ceraphronidae	<i>C. medinalis</i>	Larvae, Pupae	Aug.-mid Oct.	Low
<i>Brachimeria</i> sp.	Hymenoptera	Chalcididae	<i>C. medinalis</i>	Egg, Larvae	Aug.-mid Oct.	Low
<i>Brachymeria excarinata</i>	Hymenoptera	Chalcididae	<i>C. medinalis</i>	Eggs, Larvae	Aug.-mid Oct.	Low
<i>Brachymeria lasus</i>	Hymenoptera	Chalcididae	<i>C. medinalis</i>	Egg, Larvae	Aug.-mid Oct.	Low
<i>Brachymeria marmonti</i>	Hymenoptera	Chalcididae	<i>Charops bicolor</i>	Egg, Larvae	Aug.-mid Oct.	Low
<i>Bracon chinensis</i>	Hymenoptera	Braconidae	<i>S. incertulas</i>	Larvae	Sept.-Oct.	Moderate
<i>Cotesia flavipes</i>	Hymenoptera	Braconidae	<i>S. incertulas</i>	Larvae	Sept.-Oct.	Moderate
<i>Cotesia ruficrus</i>	Hymenoptera	Braconidae	<i>S. incertulas</i>	Larvae	Sept.-Oct.	Moderate
<i>Elasmus philippinensis</i>	Hymenoptera	Elasmidae	<i>C. medinalis</i>	Larvae	Aug.-Oct.	Low
<i>Gonatocerus</i> sp.	Hymenoptera	Mymaridae	<i>S. incertulas</i>	Larvae	Aug.-mid Oct.	Low
<i>Isotima dammermani</i>	Hymenoptera	Ichneumonidae	<i>S. incertulas</i>	Eggs, Larvae	Aug.-Oct.	Low
<i>Isotima javensis</i>	Hymenoptera	Ichneumonidae	<i>S. incertulas</i>	Eggs, Larvae	Aug.-Oct.	Low
<i>Oligosita yasumatsui</i>	Hymenoptera	Trichogrammatidae	<i>S. furcifera</i>	Nymph and adults	Aug.-mid Oct.	Low
<i>Stenobracon oculatus</i>	Hymenoptera	Braconidae	<i>S. incertulas</i>	Eggs, Larvae	Aug.-mid Oct.	Moderate
<i>Telenomus dingus</i>	Hymenoptera	Scelionidae	<i>S. incertulas</i>	Eggs	Aug.-mid Oct.	High
<i>Telenomus remus</i>	Hymenoptera	Scelionidae	<i>S. incertulas</i>	Eggs	Aug.-mid Oct.	High
<i>Telenomus rowani</i>	Hymenoptera	Scelionidae	<i>S. incertulas</i>	Eggs	Aug.-mid Oct.	High
<i>Telenomus triptus</i>	Hymenoptera	Scelionidae	<i>S. incertulas</i>	Eggs	Aug.-mid Oct.	High
<i>Temelucha philippinensis</i>	Hymenoptera	Ichneumonidae	<i>C. medinalis</i>	Eggs, Larvae	Aug.-mid Oct.	Moderate
<i>Temelucha stangli</i>	Hymenoptera	Ichneumonidae	<i>C. medinalis</i>	Eggs, Larvae	Aug.-mid Oct.	Moderate
<i>Tetrastichus formosanus</i>	Hymenoptera	Eulophidae	<i>S. incertulas</i>	Eggs	Aug.-mid Oct.	Moderate
<i>Tetrastichus schoenobii</i>	Hymenoptera	Eulophidae	<i>S. incertulas</i>	Eggs	Aug.-mid Oct.	Moderate
<i>Trichogramma chilonis</i>	Hymenoptera	Trichogrammatidae	<i>S. incertulas, C. medinalis</i>	Eggs	Aug.-mid Oct.	High
<i>Trichogramma japonicum</i>	Hymenoptera	Trichogrammatidae	<i>S. incertulas, C. medinalis</i>	Eggs	Aug.-mid Oct.	High
<i>Xanthopimpla flavolineata</i>	Hymenoptera	Ichneumonidae	<i>S. incertulas, C. medinalis</i>	Eggs, Larvae	July end-mid Oct.	High
<i>Xanthopimpla punctata</i>	Hymenoptera	Ichneumonidae	<i>C. medinalis</i>	Eggs, Larvae	July end-mid Oct.	High

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