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Diversty of insect pests and their natural enemies associated with rabi crops in south 24 Parganas district, West Bengal, India

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Abstract
Insect pests and their natural enemies in vegetable crops (brinjal, cabbage, cauliflower, kholrabi, bean, cucumber, chilli, radish and tomato), paddy, mustard were recorded and their diversity was studied in six localities of Raipur, Makrampur, Kustia, Prasadpur, Narayanpur and Chakberia of South 24 Parganas Districts, West Bengal. These insects were collected from September 2021- February 2022 twice in a week. Total number of 847 individuals and 48 species of insects belongs to 30 families of 8 different orders recorded to act as insect pest, predators and parasitoids. The present study recorded pests insects to be the mostly abundant group followed by predators and Parasitoids respectively. This study also recorded that in this 6 different study areas Pests, Predators and Parasitoids Simpson's index and Shannon's index of Narayanpur (0.84 and 1.94), Chakberia (0.83 and 1.91), Raipur (0.82 and 1.86), Makrampur (0.80 and 1.765), Prasadpur (0.78 and 1.77) and Kustia (0.76 and 1.64) respectively.

Keywords: pest**,** predators and parasitoids, rabi crops, diversity, south 24-parganas, West Bengal, India

Introduction
Various insects damage Rabi crops at all stages of growth. A number of pests and their natural enemies such as red pumpkin beetle, dragonfly, ladybugs were found to be promising biological control agents. Keeping in view the importance of vegetable and paddy such as cabbage, cauliflower, etc., and economic significance of different insect pests of these crops, the present study was carried out to evaluate the population of these insect pests and their natural enemies.

Several insect pest surveys on different fruits and vegetable crops have been conducted in different parts of South 24 Parganas (Kundu and Mandal,2020; Khatun and Mondal, 2022) [9, 8], except from these different six sites - Raipur, Makrampur, Kustia, Prasadpur, Narayanpur and Chakberia of South 24 Parganas, West Bengal. The survey is therefore, designed to record the different insect pests species along with their natural enemies from some vegetables cultivated in the said six sites of South 24 Parganas.

Materials and methods
Study area and sites of collection
The present study was carried out at Raipur, Makrampur, Kustia, Prasadpur, Narayanpur and Chakberia located in South 24 Parganas district of West Bengal, India. It is enriched with enormous agricultural fields where different types of crops are cultivation throughout the year. The major Rabi crops that are cultivated here include Paddy, Mustard, Sesame seeds, and vegetables likeCabbage,cauliflower, kholrabi, radish, bean, tomato, brinjal, chilli, kholrabi, cucumber etc.

Survey method
The study conducted during the September, 2021-February, 2022 to observe the diversity and abundance of different insect species were recorded on winter crops and their natural enemies. The data were recorded at least1-2 hours of survey was done, 2 days in a week for a period of 5 months of almost 30.33 square meters of area.

Collection and Identification
Insect pests, predators and parasitoids were searched intensively in the winter crop fields. Insects were collected with a handpicked method and aerial net using method for flying insects. Collected species were preserved in 70% alcohol and brought to the laboratory and were identified upto species level following standard literatures.

Data Analysis
The biodiversity indices (Simpson Index of Diversity, Shannon Wiener Index, Relative abundance) during the present study were analyzed by using Simpson index of diversity formula adopted by Ashok, [2] and Sunil *et al* [18].

Results and discussion
The insects observed in the study area is presented in table 1. A total of 847 insects were recorded and 48 species of pests, predators and parasitoids belong to 30 families of 8 orders recorded to act as insect pests, predators and natural enemies.

Table 1: List of collected insect pest and predator and parasitoid species along with their Common name, Family & Order, associated with various Winter crops in agricultural fields of South 24 Parganas, West Bengal

Order/ Family	No	*Scientific name*	Common name	Habit
I.COLEOPTERA Chrysomelidae	1.	*Raphidopalpa foveicollis*	Red pumpkin beetle	Pest
	2.	*Charidotella sexpunctata*	Golden tortoise beetle	Predator
	3.	*Alticini sp*	Flea beetle	Pest
	4.	*Monolepta signata*	White spotted leaf beetle	Pest
	5.	*Discladispa armigera*	Rice hispa	Pest
Coccinellidae	6.	*Coccinella Californica*	Ladybird beetle	Predator
	7.	*Coccinella transversalis*	Transverse ladybug	Predator
	8.	*Henosepilachna vigintioctopunctata*	Hadda spotted beetle	Pest
Curculionidae	9.	*Myllocerussubfasciatus*	Ash weevils	Predator
II. DIPTERA Chironomidae	10.	*Chironomus pulmosus*	Lake flies	Beneficial
	11.	*Cricotopus sylvestris*	Midges	Pest
Agromyzidae	12.	*Chromatomylahorticola*	Pea leaf miner	Major pest
Ephydridae	13.	*Hydrellia sasakii*	Whorl maggot	Pest
Lonchaeidae	14.	*Silba capsicarum*	Lonchaeid fly	Pest
III.HEMIPTERA Pentatomidae	15.	*Euschistus sp*	Stink bug	Beneficial
	16.	*Halyomorpha halys*	Brown marmorated stink bug	Serious pest
	17.	*Bagrada hilaris*	Painted bug	Predator
Plataspidae	18.	*Megacopta cribraria*	Bean plataspid	Agricultural pest
Aphididae	19.	*Myzus persicae*	Green peach aphid	Pest
Aleyrodidae	20.	*Bemisia tabaci*	White fly	Pest
Alydidae	21.	*Leptocorisa acuta*	Rice carhead bug	Pest
Cicadellidae	22.	*Cofana spectra*	Hopper	Pest
IV. HYMENOPTERA Vespidae	23.	*Ancistrocerus antilope*	Wasps	Parasitoids
Braconidae	24.	*Doryctinae sp*	Braconid wasp	Parasitoids
Formicidae	25.	*Camponotus sp*	Carpenter ant	Pest
V.ORTHOPTERA Pyrgomorphidae	26.	*Atractomorpha crenulata*	Tobacco grasshopper	Pest
Acrididae	27.	*Hieroglyphus banian*	Paddy grasshopper	Major pest
VI.LEPIDOPTERA Crambidae	28.	*Parapoynx stagnalis*	Rice case worm	Pest
	29.	*Spoladea recurvalis*	Leaf folder	Pest
	30.	*Scirpophaga incertulas*	Yellow stem borer	Pest
Noctuidae	31.	*Spodoptera litura*	Cut worm	Pest
	32.	*Helicoverpa armigers*	Fruit borer	Pest
	33.	*Spodoptera frugiperda*	Fall armyworm	Pest
Nymphalidae	34.	*Melanitis ismene*	Rice horned caterpillar	Pest
Hesperiidae	35.	*Pelopidas Mathias*	Rice skipper	Pest
Phycitidae	36.	*Euzophera perticella*	Stem borer	Pest
Pieridae	37.	*Pieris brassicae*	Cabbage butterfly	Pest
Cucullidea	38.	*Cucullia intermedia*	Smooth black hairless caterpillar	Pest
Plutellidae	39.	*Plutella xylostella*	Diamond back moth	Pest
Pyraustidae	40.	*Leucinodes orbonalis*	Shoot and fruit borer	Pest
VII.THYSANOPTERA Thripidae	41.	*Scirtothrips dorsalis*	Chilli thrips	Pest
VIII.ODONATA Libellulidae	42.	*Sympetrum vulgatum*	Vagrant darter	Predator
	43.	*S. Danae*	Black meadowhawk	Predator
	44.	*S.pedemontanum*	Banded darter	Predator
	45.	*S.striolatum*	Common darter	Predator
	46.	*S. sanguineum*	Ruddy darter	Predator
	47.	*S. fonscolombii*	Red-veineddarter	Predator
Coenagrionidae	48.	*Pseudagrion sp*	Blue-sprite	Predator

A total number of individuals 33 species of Pest belong to 26 families of 7 orders recorded to act as insect pests, 13 species of Predators belong to 6 families of 3 orders recorded to act as insect Predators and 2 species of Parasitoids belong to 2 families of one order recorded to act as insect Parasitoids.

The most diverse order of insects pests found to be Lepidoptera (13species), Hemiptera (6 species), Diptera (5 species), Coleoptera (5 species), Orthoptera (2 species), Thysanoptera (1 species), Hymenoptera (1 species). And most diverse order of insects predators found to be Odonata (7 species), Coleoptera (4 species), Hemiptera (2 species), and the parasitoids showed that only one order of Hymenoptera.

According to total number of individuals pests are the most abundant and predators are second abundant andParasitoids are leastabundant number of distributed in the study areas [Fig 2].

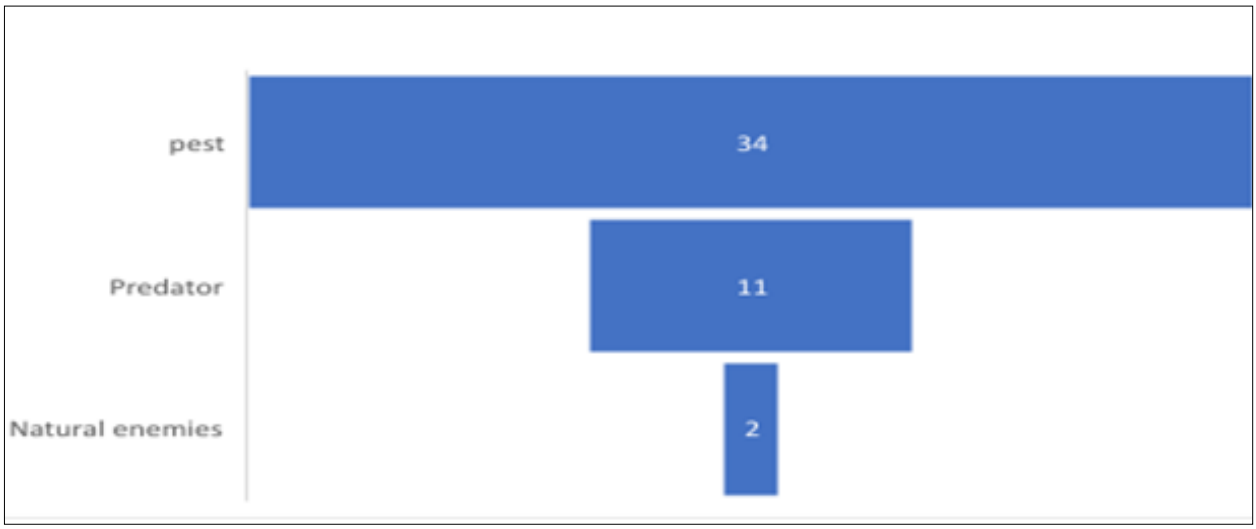

Fig 2: Distribution of total number of pest, predators and natural enemies

Diversity of the species of pests and predatory and Parasitoids in the study areas. Relative abundance insects in various vegetables and paddy. The perusal of data [Table 2] indicated the 11 identified species from 6 orders:Hemiptera,Diptera, Coleoptera, Lepidoptera, Hymenoptera and Thysanopteraincluding respectively 4, 3, 1, 1 and 1 species has been recorded on various Winter crops *Myzuspersicae*(8.26%)was the most abundant pest in winter crops respectively*Bemisiatabaci*(7.91%), *Camponotus*sp. (7.67%), *Silbacapsicarum*(7.43%), *Chironomuspulmosus*(7.08%), *Scirtothrips dorsalis* (6.84%), *Hydrelliasasakii*(6.61%), *Cofana spectra* (6.48%) was the second most abundant pest in winter crops, *Plutellaxylostella*(6.13%), *Raphidopalpafoveicollis*(5.91%), *Cricotopussylvestris*(5.31%), *Euschistus*sp.(4.13%), *Ancistrocerusantilope*(3.65%), *Coccinellacalifornica*(2.95%), *Pseudagrion*sp. (2.59%), *Coccinellatransversalis*(2.36%)was the moderate abundant and *Antactomorphacrenulata*(1.65%), *Pierisbrassicae*(1.77%), *Hieroglyphusbanian*(1.53%), *Cuculliaintermidia*(1.29%), *S. sanguineum*(1.18%) and *S. fonscolombii*(1.18%)was least abundant species in winter crops.

Table 2: List of Major insect pests and natural enemies order, family along with calculation of Relative Abundance based on number of individuals and percentage of total species that were observed during the present study period

Order	Family	Name of Species	No. of individuals specimens observed	Percent abundance of individuals species
Coleoptera	Chrysomelidae	*Raphidopalpa foveicollis*	50	5.90
	Coccinellidae	*Coccinella californica*	25	2.95
		Coccinella transversalis	20	2.36
Diptera	Chironomidae	*Chironomus pulmosus*	60	7.08
		Cricotopus sylvestris	45	5.31
	Lonchaeidae	*Silba capsicarum*	63	7.43
	Ephydridae	*Hydrellia sasakii*	56	6.61
Hemiptera	Pentatomidae	*Euschistus sp*	35	4.13
	Aphididae	*Myzus persicae*	70	8.26
	Aleyrodidae	*Bemisia tabaci*	67	7.91
	Cicadellidae	*Cofana spectra*	55	6.49
Hymenoptera	Vespidae	*Ancistrocerus antilope*	31	3.65
	Formicidae	*Camponotus sp*	65	7.67
Orthoptera	Pyrgomorphidae	*Atractomorpha crenulata*	14	1.65
	Acrididae	*Hieroglyphus banian*	13	1.53
Lepidoptera	Plutellidae	*Plutella xylostella*	52	6.13
	Cucullidea	*Cucullia intermedia*	11	1.29
	Pieridae	*Pieris brassicae*	15	1.77
Thysanoptera	Thripidae	*Scirtothrips dorsalis*	58	6.84
Odonata	Libellulidae	*S. sanguineum*	10	1.18
		S. fonscolombii	10	1.18
	Coenagrionidae	*Pseudagrion sp*	22	2.59
Total			847	

In order Hemiptera *Myzuspersicae was* the mostabundant of pestspecies in the study areas followed by Predator species respectively. In order Hymenoptera wasps was the moderate abundant of Parasitoids insects.The data clearly showed that pest and predators diversity in winter crops were very high of six Raipur, Makrampur, Kustia, Prasadpur, Narayanpur and Chakberia. Both Simpson's and Shannon's indices were high in six localities are frequently same of South 24 Parganas [Table 3].

Table 3: Ecological data analysis

Sl. No.	Site	Number of pests & predators	Simpson Index of Diversity	Shannon Wiener Index
1	Raipur	326	0.82	1.865
2	Makrampur	219	0.80	1.765
3	Kustia	113	0.76	1.644
4	Prasadpur	83	0.78	1.772
5	Narayanpur	126	0.84	1.945
6	Chakberia	158	0.83	1.914

In this study areas Pests, Predators and Parasitoids Simpson's index and Shannon's index of Narayanpur(0.84 and 1.94), Chakberia (0.83 and 1.91), Raipur (0.82 and 1.86), Makrampur (0.80 and 1.765), Prasadpur (0.78 and 1.77) and Kustia (0.76 and 1.64) respectively [Table 3].

During the presence study of winter crops 40 number of insect pests as well as 12 numbers of predator were observed on Cabbage, Cauliflower, Kholrabi, Radish, Tomato right from transplanting to till the harvest of crops. Out of these insect pests some were present in considerable and thus were classified major pests of those vegetables. Similarly Sarma *et al.* [5] also found that eleven number of insect pests as well as nine numbers of predator were observed on Cabbage right from transplanting to till the harvest of crops. Out of these some were major pests of cabbage.

According to Baker *et al.* [3] in case of insect pests, the untreated control treatment showed the highest diversity index (1.67) at maximum tillering stage and incase of natural enemies showed the highest diversity index (1.88) at reproductive stage, Similarly the presence study showed highly diversity index (Simpson's index 0.84 and Shannon's index 1.94) of Pest, Predators and Parasitoids of Narayanpur area frequently same as other five localities Raipur, Makrampur, Kustia, Prasadpur and Chakberia [Table 3& Fig 1].

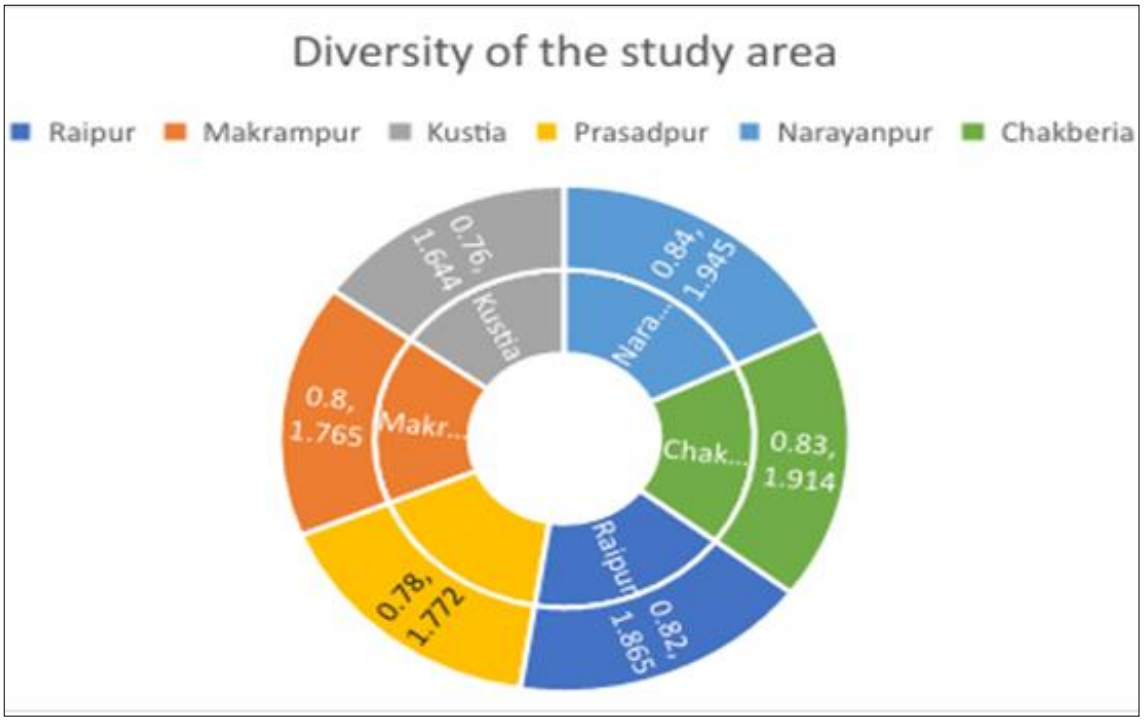

Fig 1: Comparative study of insect diversity associated with Raypur, Makrampur, Kustia, Prasadpur, Narayanpur, and Chakberia in six localities of South 24 Parganas, during the present study period (September, 2021-February, 2022)

Anbalagan *et al.* [1] studied the natural enemies of insect pests in vegetables crops along with their diversity in Tamil Nadu. A total of 129 species of insects both predatory and parasitic were observed. Here, the presence study also found 500 individual number of pests species were observed while the individual number of their number of natural were 347, that were recorded in agricultural fields associated with six localities of South 24 Parganas during the present study [Table 2].

In this present study showed that the abundance of insect pest and natural enemies was high of order Hemiptera and moderate abundant of order Coleoptera and Lepidoptera and least abundant of order Hymenoptera and Odonata were influenced by different growth stages winter crops. Rahaman *et al.*,[13] also reported that the abundance of insect pest and natural enemies was influenced by different growth stages of rice plant.

Overall results showed that enemy fauna was abundant during the second half of each year from September to February. Elancheyan *et al.*,[9] reported thirteen crops as intercrops in brinjal crops maximum number of natural enemies populations found like Coccinellidae predator, syrphids highly abundant in intercropped with cluster bean in compared to brinjal crop. The presence study also showed that maximum number of natural enemies populations found mustard, paddy, brinjal, chillietc like Coccinellidae predator highly abundant and Aphididae pests also highly abundant in intercropped with cluster bean in compared to brinjal and

tomato crop. Maximum number of Hymenoptera parasites and Parasitoids insects found in the winter crops like vegetables, oil seeds, paddy etc.

The natural enemy in the present study report comprises of 30 families, which were recorded throughout the study period. Among the natural enemies Coccinellidae, Formicidae, Chrysomelidae, Cucullidea, Lonchaeidae, Pentatomidae, Vespidae, Braconidae, Aphididae, Ephydridae, Aleyrodidae, Cicadellidae, Libellulidae and Coenagrionidae were found to be the most abundant families since maximum number of individuals were collected from these families. Coccinellid predators areentirely depending upon aphids and mealy bugs [11].

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