International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 754-758

Received: 11-05-2019
Accepted: 15-06-2019

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Biodiversity of natural enemies of cole crops insect pests in mid hills of Meghalaya

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Abstract
The North eastern region of India is one of the mega biodiversity hotspots in the World. The climatic conditions of the region are highly conducive for reproduction and multiplication of insects. The efforts were undertaken to study the biodiversity of natural enemies of major insect pests of cole crops in mid hills of Meghalaya. Limited information is available on natural enemies in cole crops ecosystem in mid – hills of Meghalaya. A total of 17 natural enemies belonging to three insect orders *viz*., Coleoptera (4 Predators), Hymenoptera (5) (1 nymphal/pupal; 3 Larval papasitoid; 1 Pupal parasitoid) and Diptera (8) (5 Predator, 3 pupal parasitoid) were documented during the year 2014-2015. Natural enemies especially Predators of aphids Viz., *Coccinellid beetles*, Syrphid flies were recorded, Parasitoids observed were; nymphal/adult Parasitoid of aphids, *Diaeretiella rapae*, larval parasitoid of cabbage butterfly, Hyposoter sp and *Cotesia glomerata* and Pupal parasitoid including *Brachymeria femorata* and *Tachinidae* sp. The collected species were identified by established taxonomic keys and by taxonomists. The comprehensive data generated from present study would be useful in further understanding of the biodiversity of arthropod fauna associated with cole crops in other regions of the country and this study would certainly have implications for pest management, taxonomy, quarantine and trade and for development of diagnostic guide.

Keywords: Natural enemies, biodiversity, parasitoid and predator

Introduction
Cole crops, the most abundantly consumed vegetables in the world belonging to the family Brassicaceae comprises about 380 genera and over 3000 species of cultivated and wild plants that have almost similar insect pest complex (Heywood, 1993) [13]. Throughout the world, a total of 51 insect pests species (Maison, 1965) [17] and a total of 37 insect pest species from India have been reported to feed on cruciferous crops (Lal, 1975) [14]. The enormous yield and economic losses in *Brassica* crop production every year caused by insects is a threat to global agriculture. Sometimes the yield loss by insects reaches as high as 60-70% and a report has been made that Indian agriculture is currently suffering an annual loss of about ₹ 86.39 million due to insect pests (Dhaliwal *et al*., 2007) [4]. On an average 25-30% yield loss in vegetables worldwide is caused by insect pests (Reddy and Zehr, 2004) [21].

Besides, insect pest several natural enemies also harbored in cole crop ecosystems. Natural enemies of insect pest play a key role in reducing the level of pest populations below those causing economic injury level. Most of the natural enemies (predators, parasitoids and pathogen) available in the agricultural and urban environments are naturally occurring, which provide excellent regulation of many pests with little or no assistance from humans. The additive effects of multiple species of natural enemies, attacking different host stages, is more likely to make an important contribution to reducing pest populations than an individual natural enemy species operating alone. Although parasitoids are currently believed to constitute 8-25% of all insect species (Godfray, 1994) [11], there might be many more species of having specificity to hosts-might have been underestimated. Firake *et al.* (2012) [6] reported about 21 natural enemies in cruciferous ecosystems of Meghalaya and *Hyposoter ebeninus* (Grav.) (Hymenoptera: Ichneumonidae) and *Cotesia glomereta* (L.) (Hymenoptera: Braconidae) are two most important larval parasitoids of *P. brassicae* naturally controlling more than 70% larvae of *P. brassicae* during peak season. Additionally, *Trichogramma brassicae* (Bez) (Hymenoptera: Trichogrammatidae) is widely used egg parasitoid of several lepidopteran pests throughout the World. India occupying about 2% of global space is among

the top ten mega diversity nations of the world in terms of insect diversity with about 7.10% of the world insect fauna (Ojha and Jalali, 2014) [19]. It is estimated that over 900,000 species of insects are known across the globe with over 60,000 species described from India with nearly as many species remaining to be named (Ojha and Jalali, 2014) [19]. Owing to their ubiquitous nature, species identification of insects is an important and difficult task due to the existence of huge diversity and morphological similarities. Morphological differences and similarities have been used to group and classify organisms, such as insect into taxonomic groups. However discerning finer differences among strains, races and biotype is usually difficult due to the influence of the environment (Fakrudin *et al*., 2006) [5]. Therefore, identification based on morphological characters have always been a challenge.

Although some studies have been done, till date no comprehensive information is available, especially of natural enemies of cole crop ecosystem of India or Meghalaya. Many more unidentified insect species might have been harboring under cole crop ecosystem in this region. Accurate identification of already identified species is also is an issue as evidenced in different species of cabbage white butterfly (*Pieris brassicae*, *P. napae*, *P. rapae* and *P. canidia*) (Pachuau *et al.,* 2012) [20]. Therefore, major aim of this study is to develop study and develop data of natural enemies of cole crops ecosystem in mid hills of Meghalaya. The details of natural enemies of cole crop ecosystem would be very useful and could be shared with other research community and quarantine agencies across the globe.

Materials and Methods

Location and Site

Studies on "Biodiversity of Natural enemies of cole crops insect pests in mid hills of Meghalaya" was carried out during 2014-15 in the IPM laboratories of Entomology section of Crop Protection Division, ICAR Research Complex for North Eastern Hill (NEH) Region, Umiam, Meghalaya. The institute is situated at Umiam (Barapani), 25º41'-21" North latitude and 91º55'-25" East longitude having an elevation of 1010 m above the msl. The climatic condition in this area is of mid tropical zone, with an average annual rainfall of 2810 mm with maximum temperature range of 20.9^0C to 27.4^0C and minimum temperature from 6.7^0C to 18.1^0C. The biodiversity of natural enemies of cole crops in this area was observed during the experimental period.

Sample collection

Specimens (Maximum 10 each) were collected from two multiple experimental plots of cole crops at two different locations *viz.,* Entomology experimental farms of Entomology Section and Horticulture Division of ICAR Research Complex for North East Hill Region, Umiam (Barapani), Meghalaya during October 2014 to March 2015 (Table 1). The pupae and parasitized caterpillars of their respective host were collected in mass and were reared under laboratory condition and natural enemies emerged from these parasitized larva or pupa were collected. A maximum ten specimens were collected for each species. Information on host plant, location, collection date and stage collected were recorded for all the individual species.

Species identification

Preliminary identification was done based on established taxonomic key or by matching the characters with identified species in Insect Museum of Entomology section of Crop Protection Division, ICAR research complex for NEH Region, umiam, Meghalaya. Some samples which were not identified by established taxonomic keys were also sent to IARI and NBAIR (National Bureau of Agricultural Insect Resources), Bengaluru. All the Syrphid species reported in this study were identified personally by Dr. Kumar Ghorpade, an eminent taxonomist (Diptera) during his visit to entomology section.

Preservation

The multiple specimens of species which were identified using established taxonomic keys and later by taxonomist were preserved in 100% ethanol. All the tubes were labelled with name of species and other collections details. The voucher specimens of all the identified species were maintained at Insect Museum, Division of Crop Protection of ICAR Research Complex for NEH Region, Umiam, Meghalaya. The dry specimen of insects were spread and pinned and kept in insect box for display with proper information about each species. A clear and close up photo of various specimens was also maintained separately.

Results & Discussion

Biodiversity of natural enemies in cole crops ecosystem of Meghalaya

The North-Eastern Himalayan region of India is exceptionally rich in terms of flora and fauna and is also considered to be one of the mega biodiversity hotspot in the World (Mayer *et al*., 2000) [18]. In present investigation, a total of 17 insect pest species were collected, identified and documented from cole crops ecosystem during the year 2014-2015 in mid altitude of Meghalaya. (Table 2).Out of the 17 species collected, nine species were predators consisting of four coccinellids and five hover/syrphid fly. Coccinellids were *Coccinella septempunctata*, *C. transversalis*, *Micraspis* sp and *Oenopia* sp (Table 2: Plate 1-4). Predatory hover fly/Syrphid fly were; *Episyrphus viridaureus*, *Melanostoma orientale*, *Sphaerophoria macrogaster*, *Eristalis cerealis* and *Macrosyrphus confrator* (Table 2; Plate 5-9). Among 17 natural enemies, eight were parasitoids and out of eight parasitoids, three were larval parasitoid (*Hyposoter* sp., *C. glomerata* and *Cotesia* sp) (Table 2; Plate 10-12) and five were pupal parasitoids, (*D. rapae*, *B. femorata*, *Tachinidae* sp1, *Tachinidae* sp2 and *Tachina* sp) (Table 2; Plate 13-17). The population of natural enemies was very high in cole crops ecosystem in this region. Lal and Chandra (1976) [15] recorded five larval and three pupal parasites attacking *P. brassicae* in cole crops ecosystem in India. Bhat and Bhagat (2009) [1] studied the biodiversity of natural enemies in cole crops and reported three potential hymenopteran parasitoids viz., *H. ebeninus*, *C. glomerata* and *B. femorata* of cabbage butterflies from Kashmir valley of India. The natural enemies reported and identified in present investigation on cole crops were further supported by findings of Firake *et al.* (2012) [7] where authors observed similar kind of natural enemies in Brassica crops of Meghalaya. Firake *et al*. (2012) [6] reported several natural enemies especially, Predators of aphids, *Diaeretiella rapae*, larval parasitoids of cabbage butterfly, *Hyposoter ebeninus* and *Cotesia glomerata*, *Exorista larvarum*, *Exorista bombysis*, *Pteromalus puparum*, etc in cole crops ecosystems of Meghalaya. Among the parasitoids attacking this pests, *Cotesia glomerata* (L.) (Hymenoptera; Braconidae) and *Hyposoter ebeninus* (Gravenhorst) (Hymenoptera: Ichneumonidae) are the two most important endo-larval

parasitoids, with both being widely distributed across the world (Lozan *et al.*, 2008; Harvey *et al*., 2010) [16, 12]. As observed in present investigation, predators like Coccinellids beetle and syrphid fly preying upon aphids and other soft bodies insects were abundant throughtout the season. Sathe and Bhosale (2001) [22] reported 21 species of coccinelids beetles feeding on aphids and several soft bodies homopterous pests of agricultural and forest plants from Maharashtra States. Brunetti (1907, 1917) [2, 3] recorded a total of about 76 species (in 36 genera) of syrphidae from Himachal Pradesh, Ghorpade (1973, 1974) [9, 10] studied the fauna of Bangalore and reported 20 species in 25 genera. Ghorpade *et al.* (2011) [8] also confirmed 16 species of 10 genera which were sampled from the Coromandel coast of Andhra Pradesh, India. All the above mentioned studies, strongly supports findings reported in present investigation that coccinellids beetle and syrphid fly are most common predators of aphids which is indeed a major insect pests of cole crops.

The preliminary identification of the collected insect pests were established based on known taxonomic keys. The species/specimens which were difficult to identify based on known taxonomic keys were sent to ICAR-NBAIR, Bengaluru or IARI, New Delhi, India. Based on their taxonomic classification, the collected 17 specimens were classified under three major insect orders, Diptera(8), Coleoptera (4) and Hymenoptera (5). The images of the insect whenever possible were also documented and all these information are presented in Table 2.

Conclusions

In this study, we have analysed and documented only 17 natural enemies of major insect pests of cole crops, but there may be more species harboured in this region of India. Therefore, additional studies have to be undertaken to get a clear picture of insect pests diversity and the pest status in the region. The comprehensive data generated from present study would be useful in further understanding of the biodiversity of arthropod fauna associated with cole crops in other regions of the country and this study would certainly have implications for pest management, taxonomy, quarantine and trade and for development of diagnostic guide.

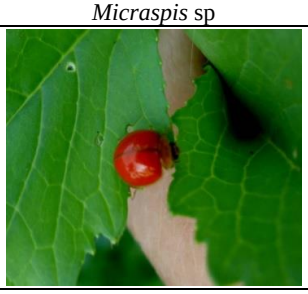
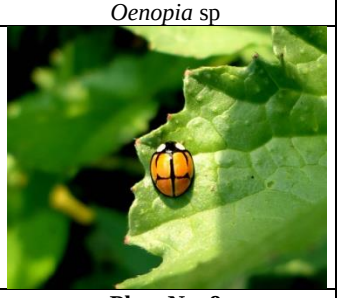
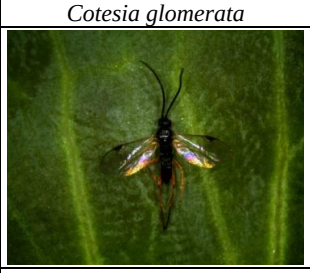
Disclosure statement- No potential conflict of interest was reported by the authors.

Table 1: Collection details of identified natural enemies during experimental season (2014-15)

Sl. No	Name of insect species	Order	Family	Date collection	Host	Location	No of specimens
1	*Brachymeria femorata*	Hymenoptera	Chalcididae	Nov. 2014	Pieris pupa	Ento. Field	10
2	*Hyposoter* sp	Hymenoptera	Ichneumonidae	Nov. 2014	*Pieris* sp	Ento. Field	10
3	*Oenopia* sp	Coleoptera	Coccinellidae	Nov. 2014	Aphids	Ento. Field	10
4	*Micraspis* sp	Coleoptera	Coccinellidae	Nov. 2014	Aphids	Ento. Field	10
5	*Coccinella transversalis*	Coleoptera	Coccinellidae	Dec. 2014	Aphids	Ento. Field	10
6	*Cocinella septempunctata*	Coleoptera	Coccinellidae	Dec. 2014	Aphids	Ento. Field	10
7	*Tachinidae* sp1	Diptera	Tachinidae	Jan. 2015	*Spodoptera* pupa	Ento. Field	10
8	*Tachinidae* sp2	Diptera	Tachinidae	Jan. 2015	*Spodoptera* pupa	Ento. Field	10
9	*Tachina* sp	Diptera	Tachinidae	Jan. 2015	Pupa	Ento. Field	10
10	*Sphaerophoria macrogaster*	Diptera	Syrphidae	Jan. 2015	Aphids	Ento. Field	10
11	*Melanostoma orientale*	Diptera	Syrphidae	Jan. 2015	Aphids	Ento Field	10
12	*Diaeretiella rapae*	Hymenoptera	Braconidae	Jan. 2015	Aphids	Ento. Field	10
13	*Episyrphus viridaureus*	Diptera	Syrphidae	Jan. 2015	Aphids	Ento. Field	10
14	*Macrosyrphus confrator*	Diptera	Syrphidae	Jan. 2015	Aphids	Ento. Field	10
15	*Cotesia glomerata*	Hymenoptera	Braconidae	Jan. 2015	*Pieris* sp	Ento. Field	10
16	*Cotesia* sp	Hymenoptera	Braconidae	Jan. 2015	*Pieris* sp	Ento. Field	10
17	*Eristalis cerealis*	Diptera	Syrphidae	Jan. 2015	Aphids	Ento. Field	10

Table 2: Image and Biodiversity of Natural enemies of cole crops insect pests in mid hills of Meghalaya

Sl. No	Scientific name	Status	Plate no.
1	*Cocinella.septempunctata*	Predator	1
2	*Coccinella.transversalis*	Predator	2
3	*Micraspis* sp	Predator	3
4	*Oenopia* sp	Predator	4
5	*Episyrphus viridaureus*	Predator	5
6	*Melanostoma orientale*	Predator	6
7	*Sphaerophoria macrogaster*	Predator	7
8	*Eristalis cerealis*	Predator	8
9	*Macrosyrphus confrator*	Predator	9
10	*Hyposoter* sp	Larval parasitoid	10
11	*Cotesia glomerata*	Larval parasitoid	11
12	*Cotesia* sp	Larval parasitoid	12
13	*Diaeretiella rapae*	Pupal parasitoid	13
14	*Brachymeria femorata*	Pupal parasitoid	14
15	*Tachinidae* sp1	Pupal parasitoid	15
16	*Tachinidae* sp2	Pupal parasitoid	16
17	*Tachina* sp	Pupal parasitoid	17

Plate No. 1 *Cocinella.septempunctata*	**Plate No. 2** *Coccinella.transversalis*	**Plate No. 3** *Micraspis* sp	**Plate No. 4** *Oenopia* sp
			
Plate No. 5 *Episyrphus viridaureus*	**Plate No. 6** *Melanostoma orientale*	**Plate No. 7** *Sphaerophoria macrogaster*	**Plate No. 8** *Eristalis cerealis*
			
Plate No. 9 *Macrosyrphus confrator*	**Plate No. 10** *Hyposoter* sp	**Plate No. 11** *Cotesia glomerata*	**Plate No. 12** *Cotesia* sp
			
Plate No. 13 *Diaeretiella rapae*	**Plate No. 14** *Brachymeria femorata*	**Plate No. 15** *Tachinidae* sp1	**Plate No. 16** *Tachinidae* sp2
			
Plate No. 17 *Tachina* sp			

Acknowledgement
The authors are thankful to Division of crop protection, Entomology, ICAR, Research Complex for NEH Region and School of Crop Protection, College of Post Graduate Studies, Umiam Barapani for providing the field and necessary lab facilities for conducting this research.

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