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Diversity, foraging activities of the insect visitors of Mustard (*Brassica juncea* Linnaeus) and their role in pollination in West Bengal

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Abstract

The study was carried out at agricultural land of Phaldi, near Duttapukur (North 24 parganas, West Bengal, India) during 2012-2013 to document the diurnal insect diversity, their activities, roles and abundance in mustard (*Brassica juncea* L.) flower. 24 insect species belonging to 14 families under six orders were found at the day time in mustard blooms among which four species (*Apis dorsata*, *Apis cerena*, *Apis florea*, *Vespa sp.*) are pollen and nectar collectors (Pollinators), 13 insects were only nectar collector and rest species were only visitors. Number of species of order Lepidoptera and Hymenoptera were high at day time. But the abundance of Hymenoptera was observed maximum followed by Coleoptera and Lepidoptera during this study. Peak activity of the insect visitors was mainly observed at the middle of the day i.e. from 12 noon to 2 P.M. Among the three honey bee species the abundance of *A. dorsata* was maximum (18%) followed by *A. cerena* (15%) and *A. florea* (4%). It was observed that the different weather conditions effect the abundance of honeybees.

Keywords: Diversity, Mustard flower, Pollinators, Honeybees

1. Introduction

Harvesting from the wild, the main source of raw material, is causing great loss of genetic diversity and habitat destruction. In this situation cultivation or propagation of the various cash crop plants are essentially important and pollination is therefore an important process in maintaining healthy and bio diverse ecosystems.

Brassica juncea L. (Indian black mustard) is an oil producing plant species under the family Brassicaceae belonging to the order Brassicales. Apart from this, it is also used in the production of the condiment mustard, dry mustard powder etc. The flowers have four bright yellow petals attached to a central core and thin green stem. The central core contains one yellow pistil and four to six shorter yellow stamens. *Brassica juncea* is a self incompatible crop due to which flowers cannot utilize their own pollen which needs biological agents like different insect groups for transfer of the pollen from male flowers to female flowers.

So far, no data was available regarding the insect visitors, their role as pollinators and also the effective pollinator species of *Brassica juncea*, except the work of Hari *et al.*^[1], an important herbal as well as cash crop plants from West Bengal region.

Therefore, to document the diversity of insect visitors, their foraging activities and their role in pollination of *Brassica juncea* in West Bengal region, a study was conducted at Phaldi, near Duttapukur (North 24 parganas, West Bengal, India) during 2012-2013.

The present report accounts of 24 insect species belonging to 14 families under six orders of insect

visitors/pollinators from the *Brassica juncea*. Among them, four species were found as pollen forager and nectar forager, 13 species were found only nectar forager and the rest seven species were found to visit flowers for other purposes (Table. 1). *Apis dorsata* was found to be the best and effective pollinators of mustard.

Table 1: Diurnal insect visitors of Mustard flower

S. No.	Name of the species	Order	Family	Pollen foragers (PF)**	Nectar foragers (NF)**	Casual visitor (CV)**
1	<i>Apis dorsata</i>	Hymenoptera	Apidae	PF	NF	
2	<i>Apis cerana indica</i>	Hymenoptera	Apidae	PF	NF	
3	<i>Apis florea</i>	Hymenoptera	Apidae	PF	NF	
4	<i>Solenopsis geminata</i>	Hymenoptera	Formicidae		NF	
5	<i>Diacamma rugosum</i>	Hymenoptera	Formicidae		NF	
6	<i>Vespa sp.</i>	Hymenoptera	Vespidae	PF	NF	
7	<i>Amata cyssea</i>	Lepidoptera	Erebidae		NF	
8	<i>Junonia almana</i>	Lepidoptera	Nymphalidae		NF	
9	<i>Euploea core</i>	Lepidoptera	Nymphalidae		NF	
10	<i>Junonia atlites</i>	Lepidoptera	Nymphalidae		NF	
11	<i>Danaus chrysippus</i>	Lepidoptera	Nymphalidae		NF	
12	<i>Catopsilia Pomona</i>	Lepidoptera	Pieridae		NF	
13	<i>Pieris brassicae</i>	Lepidoptera	Pieridae		NF	
14	<i>Delias eucharis</i>	Lepidoptera	Pieridae		NF	
15	<i>Coelophora unicolor</i>	Coleoptera	Coccinellidae			CV
16	<i>Coccinella septempunctata</i>	Coleoptera	Coccinellidae			CV
17	Unidentified species	Coleoptera	Curculionidae			CV
18	<i>Stomorhina discolor</i>	Diptera	Calliphoridae		NF	
19	<i>Chrysomya megacephala</i>	Diptera	Calliphoridae		NF	
20	<i>Hermetia illucens</i>	Diptera	Stratiomyidae		NF	
21	<i>Brachythemis contaminata</i>	Odonata	Libellulidae			CV
22	<i>Crocothemis servilia</i>	Odonata	Libellulidae			CV
23	<i>Capsus stramineus</i>	Hemiptera	Miridae			CV
24	Leafhopper	Hemiptera	Cicadellidae			CV

** Note - PF: Pollen foragers, NF: Nectar foragers, CV: Casual visitors.

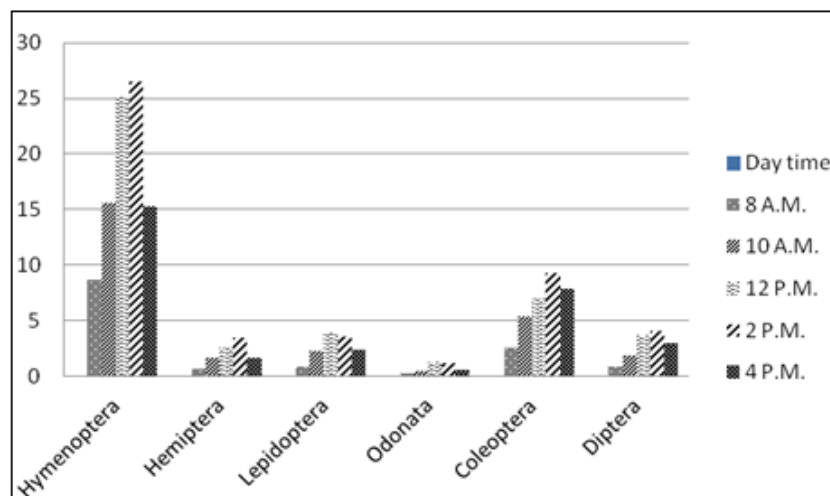


Fig 1: Foraging time of different insect orders at different day time on the mustard blossoms at Phaldi, near Duttapukur, North- 24 Parganas.

2. Materials and Methods

The field study was carried out at agricultural land of Phaldi (near Duttapukur), North 24 parganas, West Bengal during 2012-2013. Insect visitors of mustard flowers were collected by handpicking/sweeping with insect net throughout the day at two-hourly intervals and once in a week for five continuous weeks of mustard flowering period. Diurnal abundance of insect visitors in mustard flowers was recorded from five selected plots of each 25sq.ft. area. There was approximately 350-400 seedlings in every 25 sq.ft. area.

Insect visitors were got identified from the Zoological Survey of India, Kolkata (ZSIK) and all the collected examples of insect visitors were submitted to the Department of Zoology (Entomology Section), Bidhannagar College, Kolkata.

3. Results

The mustard plant was found to visit by 24 insect species under six orders (table.1). Among the six orders, Lepidoptera shared maximum number of species (eight species), followed by Hymenoptera (six species), Diptera and Coleoptera three species each and Odonata and Hemiptera two species each. (Table-1)

Among the 24 species, 17 species were found as active and frequent visitors of mustard flowers. Of them, hymenopteran species were most common with significantly high active throughout the day, followed

by Coleoptera, Diptera, Lepidoptera, Hemiptera and Odonata (Fig. 1).

Among the six species of frequent hymenopteran visitors of mustard flowers, four species were found as pollen foragers and nectar foragers and two species as only nectar foragers. All the lepidopterans (eight species) and dipterans (three species) were found as only nectar forager (Table-1). The rest seven species of the orders Coleoptera (three species), Odonata (two species) and Hemiptera (two species) were found as casual visitors of the Mustard flowers (Table-1).

It has been evident from the fig.1 that, throughout the day all the insect groups were found active and present on the Mustard flowers, but their peak foraging activity times were different. It has been found that, the peak foraging activity of the members of Hymenoptera, Coleoptera, Diptera and Hemiptera at 2 p.m. But the peak foraging activity time of the lepidopterans were found during 12 p.m (Fig. 1). The peak foraging activity of odonata were found in between 12 to 2 p.m. (Fig. 1).

Throughout the study, it has been observed that the order-wise abundance of hymenopterans were maximum (56%) followed by the Coleoptera (20%), Diptera (8%), Lepidoptera (8%), Hemiptera (6%) and Odonata (2%) on the flowers of mustard (Table 2).

Table 2: The percentages of the insect orders visited the mustard flower.

Number per 25 square feet per 10 minutes* at day time

Order	8 A.M.	10 A.M.	12 P.M.	2 P.M.	4 P.M.	Average	Percentage
Hymenoptera	8.64	15.56	25.24	26.51	15.32	18.25	56
Hemiptera	0.64	1.64	2.6	3.48	1.64	2.0	6
Lepidoptera	0.88	2.24	4	3.56	2.32	2.6	8
Odonata	0.2	0.48	1.2	1.12	0.56	0.71	2
Coleoptera	2.52	5.36	6.96	9.24	7.88	6.39	20
Diptera	0.8	1.88	3.68	4.04	3	2.68	8

*average of 25 observations

Considering the abundance of hymenopteran species, *Apis dorsata* was highest in number (18%) among the visitors of mustard flower, followed by *Coelophora unicolor* (16%), *Apis cerana indica* (15%), *Solenopsis geminata* (15%), *Vespa* sp (5%). Among the dipterans, *Chrysomya megacephala* (4%) and *Stomorphina*

discolor (4%); *Coccinella septempunctata* (4%) of Coleoptera and leafhoppers (3%) of Hemiptera were found in mustard flowers. Others insect species like *Danaus chrysippus*, *Euploea core*, *Junonia atlites*, *Junonia almana*, *Catopsilia pomona*, *Delias eucharis*, *Pieris brassicae*, *Amata cyssea* of Lepidoptera,

Brachythemis contaminata and *Crocothemis servilia* of Odonata, *Diacamma rugosum* of Hymenoptera, *Capsus stramineus* of Hemiptera and *Hermetia illucens* of

Diptera were present in very insignificant in numbers (Fig. 2).

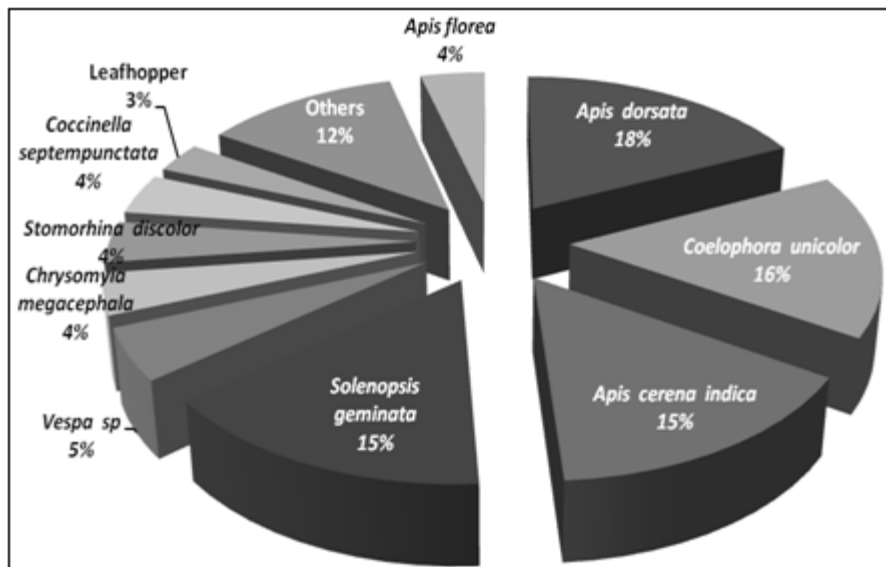


Fig 2: Relative abundance of species in mustard flower

**others :- Butterflies and moths (*Danaus chrysippus*, *Euploea core*, *Junonia atlites*, *Junonia almana*, *Catopsilia pomona*, *Delias eucharis*, *Pieris brassicae*, *Amata cyssea*), Dragonflies (*Brachythemis contaminata*, *Crocothemis servilia*), *Diacamma rugosum*, *Capsus stramineus*, *Hermetia illucens* etc.

Among the five working days, three days were sunny but two days were with fog. A huge difference of

number of honeybees was observed between the sunny and foggy days. (Fig. 3)

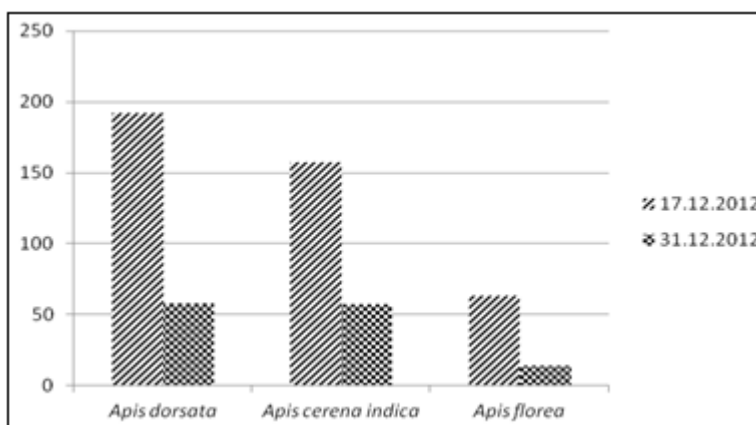


Fig 3: Difference in number of honeybees in different weather condition

Note: Date - 17.12.2012 (Maximum temperature - 26 °c, minimum temperature - 16 °c, average humidity - 75%, event – Sunny weather).

Date - 31.12.2012 (Maximum temperature - 25 °c, minimum temperature – 9 °c, average humidity - 64%, event - Fog).

4. Discussion

Cross pollination causes early seed set and higher yields [2, 3]. There are many insect species which visit mustard blossoms for nectar and pollen reward, and are the primary vectors of pollen.

During this study 24 insect species belonging to 14 families under six orders were observed as visitors of mustard flowers (Table.1). Hymenopterans were found as frequent visitors and constituted a major proportion (56%) of the total insect visitors, followed by Coleoptera (20%), Diptera (8%), Lepidoptera (8%),

Hemiptera (6%) and Odonata (2%). Previous works of Priti on onion blooms^[4], Priti and Sihag on cauliflower^[5], Priti and Sihag on carrot flower^[6] also supports that the abundance of hymenopterans are maximum than other insects.

Among the 24 species of insect visitors, four species of Hymenoptera (*Apis dorsata*, *Apis cerana indica*, *Apis florea* and *Vespa sp.*) were found as pollen foragers and nectar foragers and other two species (*Solenopsis geminata* and *Diacamma rugosum*) as only nectar foragers. All the lepidopterans (eight species) and dipterans (three species) were found as only nectar forager (Table. 1). The rest of the species from the orders Coleoptera (three species), Odonata (two species) and Hemiptera (two species) were found as neither pollen foragers nor nectar foragers. Therefore, it can be safe to say that they have no role in the pollination process of the mustard (Table. 1).

Utilization of pollinators especially honey bees is considered as one of the cheapest eco friendly approach in maximizing, the yield of cross pollinated crops (Free ^[7], Pateel and Sattagi ^[8]). Many investigations have consistently confirmed that yields level can be increased to an extend of 50-60% in fruits and plantation crops, 45-50% in sunflower, sesamum and niger, 100-150% in cucurbitaceous crops through good management of pollinators ^[9].

Out of three honey bee species the abundance of *A. dorsata* was maximum (18%) followed by *A. cerana* (15%) and *A. florea* (4%). They play an important role in the pollination of the flowers. The average abundance of all visitor insects was maximum at the middle of the day i.e. 12 noon and 2 P.M. (Fig. 1). The average forging activity of *A. dorsata* was observed from 8 A.M. – 4 P.M., and the highest foraging activity was 8.48 bees/25 ft²/10 min followed by 6.96 and 5.32 bees/25 ft²/10 min at 12 noon and 10 A.M. respectively. However, lowest activity was observed at 8 A.M. and 4 P.M. with 3.4 bees/25 ft²/10 min and 4.64 bees/25 ft²/10 min respectively. *A. cerana* foraging activity was maximum at 2 P.M. with 7.4 bees/25 ft²/10 min followed by 6.48 bees/25 ft²/10 min at 12 noon. The lowest foraging activity was observed at 8 A.M. with 1.96 bees/25 ft²/10 min followed by 3.8 and 3.92 bees/25 ft²/10 min at 10 A.M. and 4 P.M. respectively. The foraging activity of *A. florea* was maximum at 2 P.M. with 2.2 bees/25 ft²/10 min followed by 2.12 bees/25 ft²/10 min at 12 noon. The lowest foraging activity was observed at 8 A.M. with 0.28 bees/25 ft²/10 min followed by 0.84 and 1.28 bees/25 ft²/10 min at 10 A.M. and 4 P.M. respectively (Table. 3).

Table 3: Relative abundance of three different species of honeybees. Number per 25 square feet per 10 minutes* at day time

Insect Species	8 A.M.	10 A.M.	12 P.M.	2 P.M.	4 P.M.
<i>Apis dorsata</i>	3.4	5.32	6.96	8.48	4.64
<i>Apis cerana indica</i>	1.96	3.8	6.48	7.4	3.92
<i>Apis florea</i>	0.28	0.84	2.12	2.2	1.28

*average of 25 observations

It was assumed from the observation of different weather condition that the number of honeybees decreases on 31.12.2012 due to the partial absence of sunlight (foggy weather) or might be of the cold weather than 17.12.2012 (Fig. 3). Bees communicate by their dance language with their hive mates that depends upon position of the Sun,^[10, 11] it may be interrupted on that day (31.12.2012) due to partial absence of sunlight.

The lepidopterans and dipterans were found in this study only as nectar foragers and their frequency of visit were also very less in comparison to pollen

foragers. They visit flowers only to satisfy their own requirements and sometimes the nectar foragers also transfer pollen accidentally. Therefore, it can also be said that, they may help in the pollination process of mustard but they are not the primary pollinators of mustard.

According to Priti ^[4], forager abundance, foraging rate and number of loose pollen grains sticking to the body will be more in pollen foragers (PF) than nectar foragers (NF). Considering all these parameters for establishing the effective pollinators of the crops, *Apis*

dorsata was found to be the most effective pollinator of mustard crops in this study.

5. Conclusion

From the present findings we can conclude that the mustard flowers are highly attractive to the multitude of insect species especially those belonging from Hymenoptera and Lepidoptera. Some of the insects are nectar collector, some are both nectar and pollen collector and some are only visitor. Honeybees are the efficient pollen collectors for its specific structures like pollen baskets. On the basis of abundance, foraging rate and pollen gathering, *Apis dorsata*, *Apis cerena indica* and *Apis florea* are found to be the primary pollinators and *Stomorhina discolor*, *Chrysomya megacephala*, *Vespa sp.* are found to be the secondary pollinators of the mustard flower. But to control the insect pest farmers are supposed to use insecticides which also affects the beneficial insects. So, farmers should use the insecticides rationally or could use biological control methods. In that case, this work may be extended further in some other way.

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