VOLUME 9 ISSUE 2 2023

ISSN 2454 – 3055

INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Zoological Investigations Vol. 9, No. 2, 661-670 (2023)

International Journal of Zoological Investigations
Contents available at Journals Home Page: www.ijzi.net
Editor-in-Chief: Prof. Ajai Kumar Srivastav
Published by: Saran Publications, Gorakhpur, India

ISSN: 2454-3055

Study on the Diversity, Foraging Behaviour of the Insect Visitors of Marigold (*Tagetes erecta* L.) and Their Role in Pollination in Tentulia Village in Swarupnagar Block of North 24 Parganas District, West Bengal

Gunin Sourav and Mondal Sagata*

Post Graduate Department of Zoology, Vidyasagar College, Salt Lake Campus, C L Block, Kolkata 700091, India

**Corresponding Author*

Received: 16th July, 2023; **Accepted:** 31st August, 2023; **Published online:** 24th September, 2023

https://doi.org/10.33745/ijzi.2023.v09i02.076

Abstract: The study on the diversity and foraging behavior of insect visitors of Marigold (*Tagetes erecta* L.) and their role in pollination was evaluated during October 2022- February 2023 at Tentulia village in Swarupnagar Block, North 24 Parganas, West Bengal, India. Data were collected at 2 day in a week for 3 months continuously in two shift in a day as morning shift (7:00 a.m. to 9.00 a.m.) and afternoon shift (3:00 p.m. to 5:00 p.m.) during the present study. 22 insect species belonging to 18 families of 8 orders were recorded from marigold flowers. Among the insect pollinators/visitors the most average abundance showed in order Hymenoptera and Lepidoptera. The present study also observed that the highest average foraging speed is shown by Hymenoptera order followed by Lepidoptera and Diptera. It was also considered in this study that insects having different foraging behavior as in Hymeoptera, Hemiptera, Orthoptera and Diptera order the insects forage polen from the Top of flower to other flower into patches, and in Lepidoptera, Odonata, Coleoptera, Neuroptera order the insects forage from both top and side from one flower to another. The aim of the present study was to explore and document insect visitors related to Marigold field, which will be a useful platform for conservation and studies about their role in pollination.

Keywords: Diversity, Abundance, Pollinators, Foraging behaviour, Marigold flower, Hymeoptera, Hemiptera, Orthoptera, Diptera

Citation: Gunin Sourav and Mondal Sagata: Study on the diversity, foraging behaviour of the insect visitors of marigold (*Tagetes erecta* L.) and their role in pollination in Tentulia Village in Swarupnagar Block of North 24 Parganas District, West Bengal. Intern. J. Zool. Invest. 9(2): 661-670, 2023.

https://doi.org/10.33745/ijzi.2023.v09i02.076

Introduction

In cultivation of flower and ornamental plants many people helped through income source, employment and empowerment called Floriculture. In these, Genda (*Tagetes erecta* L., Family Asteraceae) is a popular cultivated flower mostly in West Bengal, India. This flowers are largely used in many festivals and the flowers and leaves are also used in Ayurvedic treatment and perfumery. Genda are mainly found in a single solid lemon yellow, light sulphur yellow and

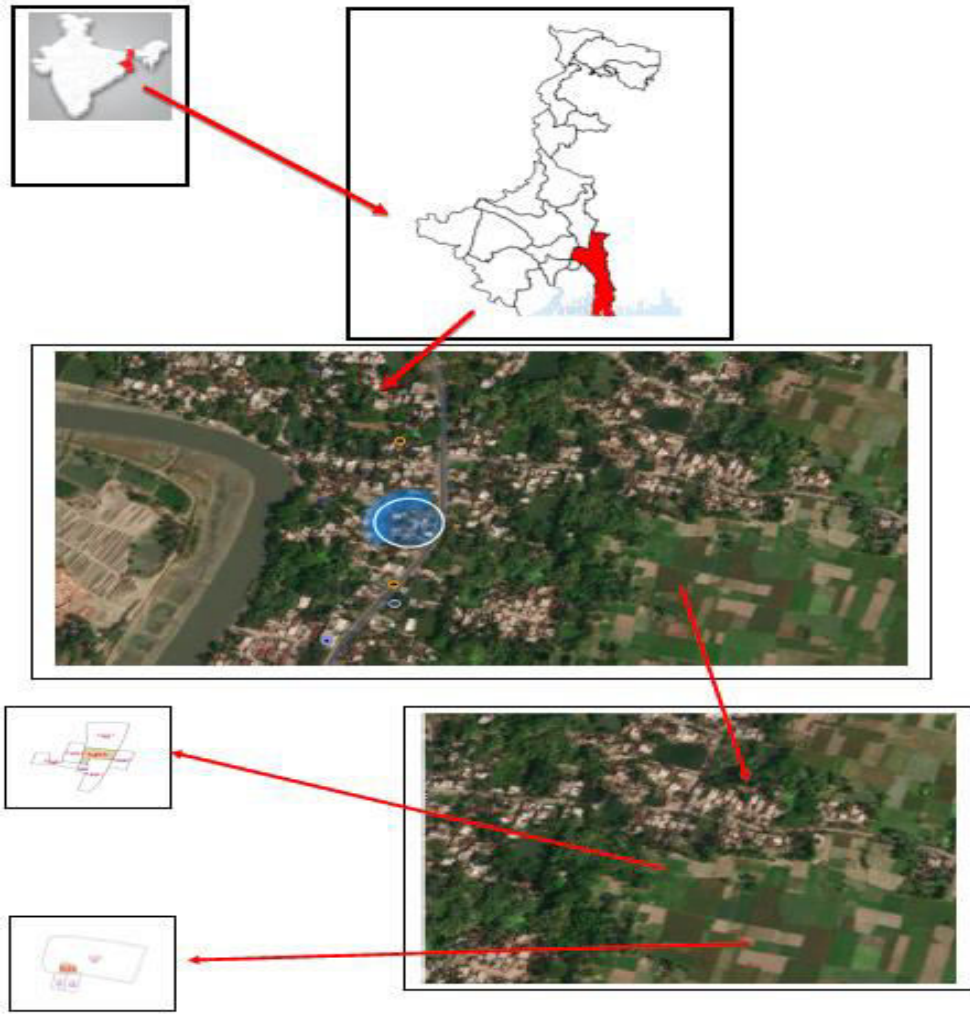

Fig. 1: Location of study area.

orange color. Various types of insects visits the flowering plants called Insect Visitors. Insects visits flower mostly for food source, some of them when visits the flower the pollen grains attached to their wings or legs from anther and detached to stigma by the vibration of wing muscles. Through this behaviour insect pollination (Entomophilous) occur. Only 5 per cent of plants are able to self pollinate and 95 per cent plants are cross polinated by animals (Hawksworth, 2011). *Tagetes erecta* L. is also a entomophilous plant so insects make huge impact to this floriculture. Therefore this study was performed on the diversity and foraging behavior of insect visitors of Marigold (*Tagetes erecta* L.) and their role in pollination was evaluated during October 2022-February 2023 at Tentulia village in Swarupnagar Block, North 24 Parganas (PGS), West Bengal, India.

Materials and Methods

Study area:

The study was carried in Tentulia village, Swarupnagar (Fig. 1), which lies in Dist. North 24 PGS. Tentulia village is one of the most populated urban regions of Swarupnagar Block of these Dists. According to the Ministry of Urban Development (MoUD 2015), Tentulia village

accounts for 12% of the total urban population; meanwhile, Tentulia village alone contributes 9.7 % of the total population in Swarupnagar block, North 24 PGS. Tentulia is an urban village located in the center of North 24 PGS. These villages crop field lies at 22°47'32.0"N &88°51'24.6"E. The Ichhamati river and Sonaikhal runs beside the crop land area that take important role in water supply in agriculture.

Experimental design:

The experiment was designed in four large plots measuring 12x6 m each. Then five small plots measuring 1 m^2 (1x1 m) were selected randomly from each of the large plots, *Tagetes erecta* L. (local) variety of Indian marigold was sown on November, 2022 on each field.

Data collection:

The experiments were carried out in the agricultural field at village Tentulia in Swarupnagar Block of North 24 Parganas district, WB during October 2022 – February 2023. 3 different plot of marigold floricultural land was selected during the present study as Patch/Quadrate as follows- Q-1, Q-2, and Q-3 with dimension of 12 m x 6m. Field study data was taken at 2 day in a week for 3 months continuously in two shift in a day as morning shift (7:00 a.m. to 9.00.a.m.) and afternoon shift (3:00 p.m. to 5:00 p.m.). From each Quadrate/Patch taken the number of mature flower and number of buds in both shift. Observed the pollinators and visiting insects and try to capture them during the study period and also observed the foraging rate of each species.

Determination of the foraging rate of insect pollinators:

Foraging rate of insect was recorded in terms of the number of flowers visited per minute (Free, 1993). Ten bees of each species were observed for recording the number of flowers visited per minute at peak activity time of particular species at peak flowering period in each patch/quadrate of the Field. The number of flowers visited per minute was recorded including the flying time from one flower to another flower. Ten observations were recorded for each bee species in different hours in two shift of the day from 7:00 a.m. to 9.00 a.m. and 3:00 p.m. to 5:00 p.m. at the initiation of 10 per cent flowering in the each patch/quadrate, at peak flowering and before the cessation of flowering in the field. The abundance of insect pollinators was estimated in term of number of pollinators/m^2/5 min.

Calculation of biodiversity:

Biodiversity is a mathematical measure of species/family diversity in a given community that was calculated as Shannon Index (H) and Simpson index (D).

Shannon Index:

$$H' = -\sum_{i=1}^{R} p_i \ln p_i$$

where p= is the proportion (n/N) of individual, S= Total number of species, N= Total number of individuals, ln = is the natural log n= total number of individuals in a species/family.

Simpson Index:

Simpson Index (D) $= \sum_{i=1}^{s} pi^2$

Simpson Index of biodiversity (1-D) $= 1 - \sum_{i=1}^{s} pi^2$

Simpson Reciprocal Index (1/D) $= 1 / \sum_{i=1}^{s} pi^2$

where p= is the proportion (n/N) of individual, S= Total number of species, N= Total number of individuals, ln = is the natural log, n= total number of individuals in a species/family.

Diversity of insect pollinators visiting mustard flowers:

Insect visitors of flowers were collected by using hand net. Sweeping was done at two hours' interval from 7.00 am to 5.00 pm, once in a week throughout the blooming period of the crop starting from 10% flowering. Collected insects were killed and were subsequently identified following the literature available. Photograph of different insect visitors on mustard flowers were also taken.

Table 1: Insect visitor/pollinator observed on marigold flower

S. No.	Scientific Name	Family	Order
1.	*Vespula germanica*	Formicidae	Hymenoptera
2.	*Austroscolia soror*	Scoliidae	
3.	*Apis mallifera*	Apidae	
4.	*Ceratina sp.*		
5.	*Polistes dorsalis*	Vespidae	
6.	*Catopsilia pyranthe*	Pieridae	Lepidoptera
7.	*Graphium agamemnon*	Papilionidae	
8.	*Papilio polytes*		
9.	*Danaus chrysippus*	Nymphalidae	
10.	*Euploea core*		
11.	*Junonia almana*		
12.	*Prlopidas sp.*	Hesperidae	
13.	*Musca domestica*	Muscidae	Diptera
14.	*Eristalinus arvorum*	Syrphidae	
15.	*Chrysomya albiceps*	Calliphoridae	
16.	*Ceriagrion coromandelianum*	Coenagrionidae	Odonata
17.	*Diplacodes trivialis*	Libellulidae	
18.	*Spilostethus pandurus*	Lygaeidae	Hemiptera
19.	*Nephotettix cincticeps*	Cicadellidae	
20.	*Coccinellaseptem punctata*	Coccinellidae	Coleoptera
21.	*Omocestus viridulus*	Acrididae	Orthoptera
22.	*Chrysopa perla*	Chrysopidae	Neuroptera

Relative Abundance:

The number of insect visitors per square meter area of crop was recorded for 2 min from five randomly selected areas at around 11 am, the time of maximum insect activity. The relative abundance of these insect visitors was calculated by using the formula: Relative abundance (%) = (Population of a particular species visiting flowers/Total population of all species visiting flowers) x 100. These observations taken once a week starting from 10 % of the plants which came into bloom and continued throughout blooming period of the crop.

Foraging Speed:

Insect visitor/pollinators are observed at species level and calculated the number of flower visited by each insect every minute during the time of study.

Foraging speed = (no. of flower visited by insect species/min)

The average percentage of Foraging speed in each order was also calculated during the present study.

Identification of Insects:

The species were identified and sorted out by tallying its photograph with various booklets, guidelines, and research papers. The butterflies were identified by using the booklet provided by Rasul *et al.* (2014). Similarly, honeybees

Table 2: Relative abundance of insect pollination on Marrigold during different periods

Name of Species	On set bloom	Full bloom	End of bloom	Average	Mean per cent population
Austroscolia soror	1.5	2.3	1.3	1.7	3.17
Apis mallifera	2.8	3.6	2.3	2.9	5.42
Catopsilia pyranthe	4.9	6.32	4.62	5.28	9.86
Graphium agamemnon	2.9	3.1	2.2	2.73	5.10
Polistes dorsalis	2	2.6	1.6	2.06	3.85
Danaus chrysippus	1.5	2.3	1.1	1.63	3.04
Junonia almana	2.7	3.3	1.9	2.63	4.91
Papilio polytes	3	2.2	1.6	2.26	4.22
Musca domestica	2.1	2.3	2	2.13	3.98
Prlopidas sp.	4.15	4.86	4.6	4.536	8.47
Spilostethus pandurus	5	6.3	4.2	5.16	9.64
Ceratina sp.	1.5	2.2	1.3	1.66	3.10
Eristalinus arvorum	1.3	1.8	1.1	1.4	2.61
Ceriagrion coromandelianum	4.2	5.3	4.9	4.8	8.97
Coccinella septempunctata	0.25	0.5	0	0.25	0.46
Diplacodes trivialis	1.5	2	1.2	1.57	2.93
Omocestus viridulus	1.3	2.1	1.8	1.73	3.23
Nephotettix cincticeps	3	4.3	2.3	3.2	5.98
Chrysopa perla	2.6	3.2	2.5	2.77	5.17
Chrysomya albiceps	0.22	0.6	0.19	0.33	0.61
Vespula germanica	2.9	3.1	2.3	2.76	5.15

were identified by tallying its photographs with the guideline (Panthi, 2013). The identification of the Lepidopterans and Odonates was primarily made directly in the field. In critical condition specimens were collected only with handheld aerial sweep nets and subsequently released without harm. Photographs of the specimens were taken in the field from various angles and identified with the help of field identification guide (Andrew and Patrick, 2008; Kehimkar, 2008; Ekesi *et al.*, 2009; Somchoudhury *et al.*, 2011; Mallik *et al.*, 2016; Smetacek, 2017).

Results

Survey and documentation of different insects:

In the present study twenty two different types of insect species belonging to eighteen families of eight orders were recorded from *Tagetes erecta* L. flowers, in which, seven belongs to order Lepidoptera (*Catopsilia pyranthe*, Graphium agamemnon, *Papilio polytes*, *Danaus chrysippus*, *Euploea core*, *Junonia almana*, *Prlopidas* sp.), five to Hymenoptera (*Vespula germanica*, *Austroscolia soror*, *Apis mellifera*, *Ceratina* sp., *Polistes dorsalis*), three to Diptera (*Musca domestica*, *Eristalinus arvorum*, *Chrysomya albiceps*), one to Coleoptera (*Coccinella septempunctata*) and two to Odonata (*Ceriagrion coromandelianum*, *Diplacodes trivialis*), two to hemiptera (*Spilostethus pandurus*, *Nephotettix cincticeps*), one to Orthoptera (*Omocestus viridulus*) and one to Neuroptera (*Chrysopa perla*) (Table 1; Fig. 5).

Table 3 shows the abundance of every insect order at the different time period of day time at 8 a.m., 10 a.m., 2 p.m. and 4 p.m. As the most average abundance showed in order Hymenoptera (7.62) followed by Lepidoptera (4.59), Diptera (3.4) and Coleopra (1.78).

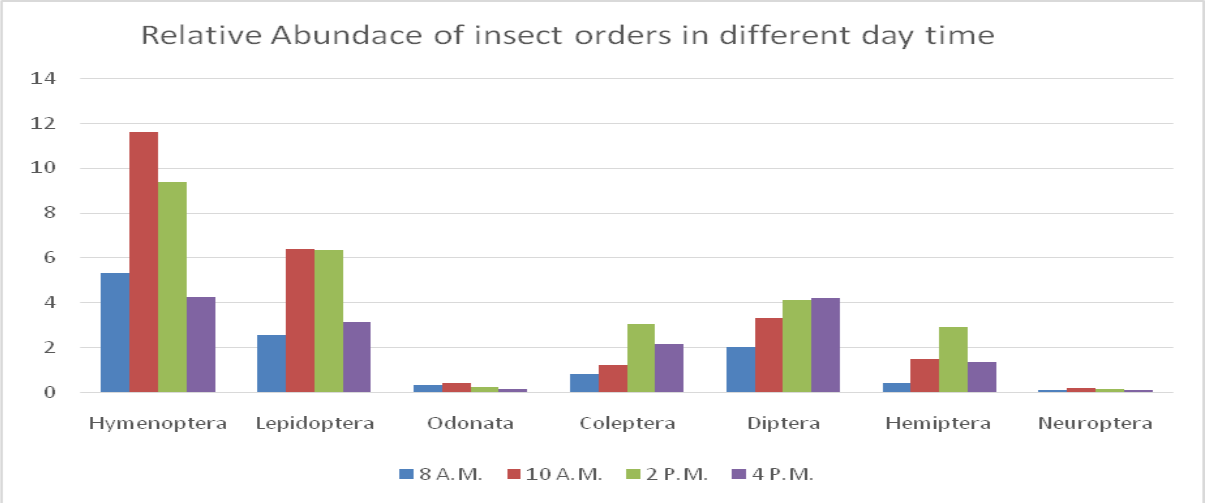

Fig. 2: Relative abundance of insect visitor/pollinators in different time period of day.

Table 3: The relative abundance of insect visitors/pollinators indifferent time period of day

Number per 25 square feet per 10 min at day time

Order	8 a.m.	10 a.m.	2 p.m.	4 p.m.	Average	Percentage
Hymenoptera	5.32	11.59	9.36	4.22	7.62	40
Lepidoptera	2.56	6.36	6.32	3.11	4.59	25
Odonata	0.3	0.39	0.23	0.15	0.27	1
Coleptera	0.8	1.21	3.02	2.12	1.78	9
Diptera	2	3.29	4.11	4.19	3.4	17
Hemiptera	0.4	1.46	2.9	1.32	1.52	7.5
Neuroptera	0.1	0.19	0.15	0.08	0.13	0.5

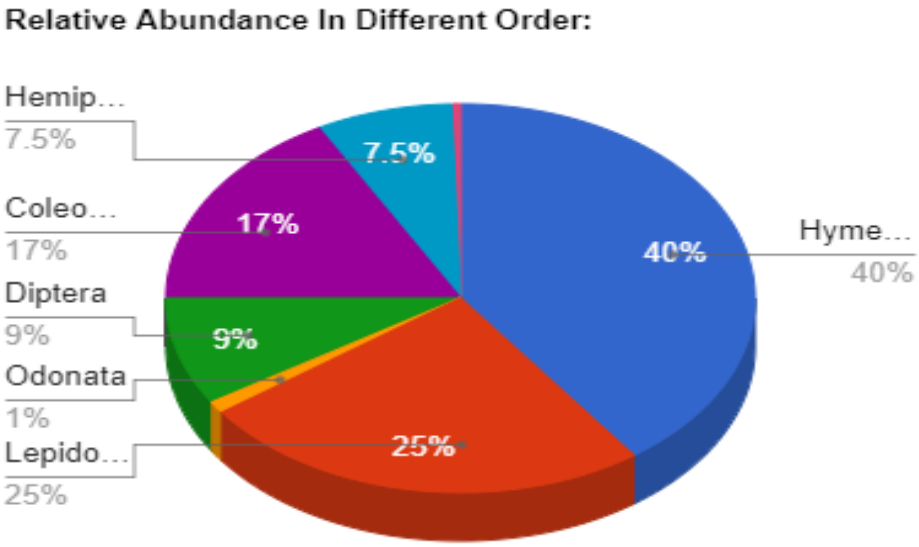

Fig. 3: Relative Abundance (%) in Different Orders.

Table 4: Insect visitors/pollinators in each Quadrate

S. No.	Species	Family	Order	Q-1	Q-2	Q-3	Total No.
1.	*Vespula germanica*	Formicidae	Hymenoptera	6	6	4	16
2.	*Austroscolia soror*	Scoliidae	Hymenoptera	3	5	0	8
3.	*Apis mallifera*	Apidae	Hymenoptera	16	15	18	49
4.	*Polistes dorsalis*	Vespidae	Hymenoptera	3	2	2	7
5.	*Ceratina sp.*	Apidae	Hymenoptera	3	1	0	4
6.	*Catopsilia pyranthe*	Pieridae	Lepidoptera	8	11	9	28
7.	*Graphiumagamemnon*	Papilionidae	Lepidoptera	4	2	2	8
8.	*Danaus chrysippus*	Nymphalidae	Lepidoptera	8	9	7	24
9.	*Junonia almana*	Nymphalidae	Lepidoptera	9	7	5	21
10.	*Euploea core*	Nymphalidae	Lepidoptera	5	3	3	11
11.	*Papilio polytes*	Papilionidae	Lepidoptera	4	2	1	7
12.	*Prlopidas sp.*	Hesperidae	Lepidoptera	26	22	19	67
13.	*Musca domestica*	Muscidae	Diptera	8	7	3	18
14.	*Eristalinus arvorum*	Syrphidae	Diptera	18	16	16	50
15.	*Chrysomya albiceps*	Calliphoridae	Diptera	7	4	5	16
16.	*Ceriagrion coromandelianum*	Coenagrionidae	Odonata	1	0	0	1
17.	*Diplacodes trivialis*	Libellulidae	Odonata	4	1	2	7
18.	*Coccinellaseptem punctata*	Coccinellidae	Coleoptera	4	2	1	7
19.	*Omocestus viridulus*	Acrididae	Orthoptera	9	8	11	28
20.	*Nephotettix cincticeps*	Cicadellidae	Hemiptera	9	8	11	28
21.	*Spilostethus pandurus*	Lygaeidae	Hemiptera	3	1	2	5
22.	*Chrysopa perla*	Chrysopidae	Neuroptera	2	0	0	2

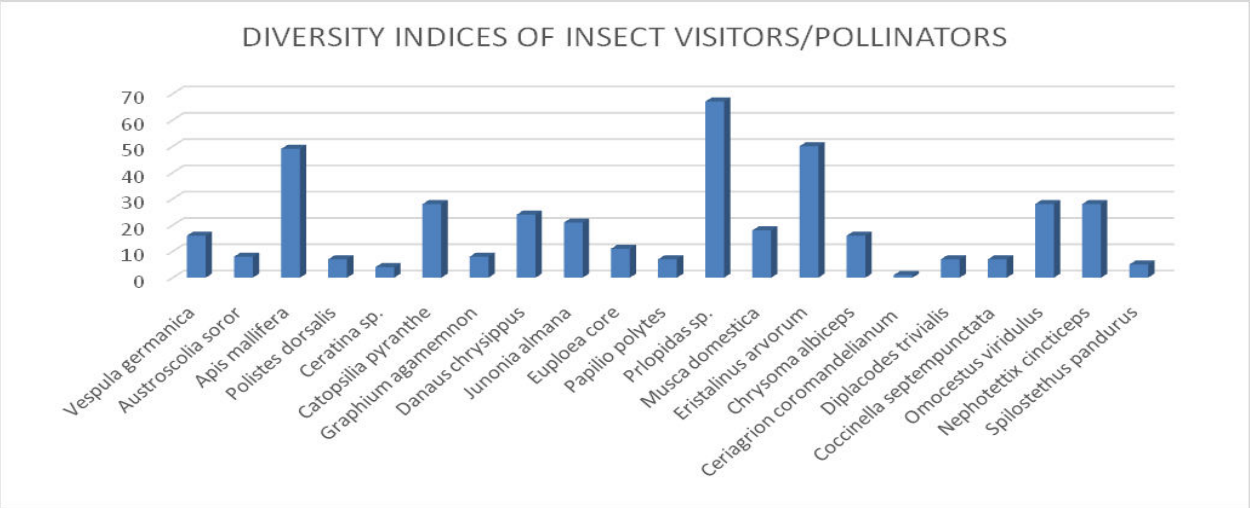

Fig. 4: Insect diversity.

Biodiversity of insect pollinators was calculated in term of Shannon index (H) and Simpson index (D). Shannon index (H) was estimated: 2.725, Simpson index (D): 0.083, Simpson index of biodiversity (1-D): 0.917 and Simpson reciprocal index (1/D): 12.048 and average poplation size is 22 as given in Table 2. Some most common insect visitors/pollinators are shown in Figure 2 (Guo *et al.*, 2017)

Foraging Speed:

Foraging Speed of each insect species calculated (visited flower/min) as the most foraging speed is observed in *Apis mellifera* (visited 25

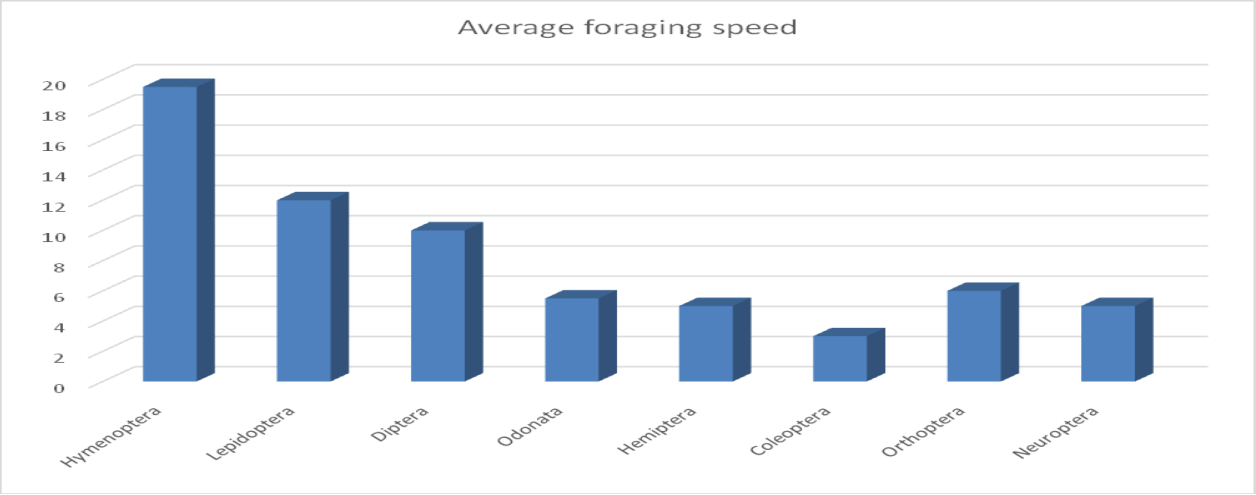

Fig. 5: Average Foraging Speed Of Different Orders of insect visitors/pollinators.

Table 5: Foraging Speed Of Different Species And Average Foraging Speed Of Different Orders

S. No.	Scientific Name	Foraging Speed (visit flower/ min)	Family	Average Foraging Speed (%)	Order
1.	*Vespula germanica*	20	Formicidae	19.5	Hymenoptera
2.	*Austroscolia soror*	15	Scoliidae		
3.	*Apis mellifera*	25	Apidae		
4.	*Ceratina sp.*	22			
5.	*Polistes dorsalis*	14	Vespidae		
6.	*Catopsilia pyranthe*	12	Pieridae	12	Lepidoptera
7.	*Graphium agamemnon*	15	Papilionidae		
8.	*Papilio polytes*	15			
9.	*Danaus chrysippus*	12	Nymphalidae		
10.	*Euploea core*	11			
11.	*Junonia almana*	13			
12.	*Prlopidas sp.*	06	Hesperidae		
13.	*Musca domestica*	10	Muscidae	10	Diptera
14.	*Eristalinus arvorum*	8	Syrphidae		
15.	*Chrysomya albiceps*	11	Calliphoridae		
16.	*Ceriagrion coromandelianum*	06	Coenagrionidae	5.5	Odonata
17.	*Diplacodes trivialis*	05	Libellulidae		
18.	*Spilostethus pandurus*	06	Lygaeidae	5	Hemiptera
19.	*Nephotettix cincticeps*	04	Cicadellidae		
20.	*Coccinellaseptem punctata*	03	Coccinellidae	3	Coleoptera
21.	*Omocestus viridulus*	06	Acrididae	6	Orthoptera
22.	*Chrysopa perla*	05	Chrysopidae	5	Neuroptera

flowers/min) followed by *Ceratina* sp. (visited 22 flowers/min), *Vespula germanica* (visited 20 flowers/min), and *Austroscolia soror*, *Graphium agamemnon*, Papiliopolytes (visited15 flowers/ min). The highest average foraging speed is shown by Hymenoptera order (19.5%), followed by Lepidoptera (12%), and Diptera (10%).

Discussion

In the present study twenty two insect species

belonging to eighteen families of eight orders were recorded from *Tagetes erecta* L. flowers, in which, six belong to order Lepidoptera, five to Hymenoptera, three to Diptera, one to Coleoptera and two to Odonata. Chaudhary and Singh (2006) reported that the floral visitors on fennel included 39 species belonging to 20 families and 7 orders. Earlier studies indicated that *A. florea* (Sagar, 1981; Baswana, 1984) and *A. mellifera* were the chief floral visitors of fennel (Youngken, 1950). Hanh *et al*. (2014) reported twenty-four insect species on cucumber at agro-climatic region of Hisar. Among different bee species, the maximum mean population observed in case of *Austroscolia soror* (1.7 bees/m^2/5 min) followed by *A. mellifera* (2.9 bees/m^2/5 min) and *Vespula germanica* (2.76 bees/m^2/5 min), whereas, the least abundance was observed in case of *Ceratina* sp.(1.66 bees/m^2/5 min. Besides in Lepidoptera the maximum mean population observed in case of *Catopsilia pyranthe* (5.28 /m^2/5 min), followed by *Prlopidas* sp. (4.536 /m^2 /5 min), *Graphium agamemnon* (2.73 /m_2 /5 min), *Papilio polytes* (2.06 /m^2/5 min), *Junonia almana* (2.63 /m^2/5 min), and the least abundance was observed in case of *Danaus chrysippus* (1.63 /m^2/5 min). During the study time the most foraging speed of insect observed in *Apis mellifera* (visit 25 flower/min) as the average foraging speed is observed in Hymenoptera order followed by Lepidoptera and diptera. Mishra *et al.* (1988) reported the peak foraging activity of *A. mellifera*, *Eristalis* sp. and other dipterans at Solan (Himachal Pardesh), India. Sunshine influences the atmospheric temperature as well as the intensity of light, both of which play an important role in flying/foraging activities of honey and other bees.

Acknowledgements

The authors express thanks to the In-charge of Entomology Laboratory, Dept. of Zoology and the Head of the Department, Post-graduate Department of Zoology, Vidyasagar College, Kolkata, for providing the laboratory facilities.

References

Andrew ML and Patrick CT (2008) Population ecology of insect invasions and their management. Annual Rev Entomol. 53: 387-408.

Baswana KS. (1984) Role of insect pollination on seed production in coriander and fennel. South Indian Horticulture 32: 117-118.

Chaudhary OP and Singh J. (2007) Diversity, temporal abundance, foraging behaviour of floral visitors and effect of different modes of pollination on coriander (Coriandrum sativum L.). J Spices Aromatic Crops 16(1): 8-14.

Ekesi S, Chabi-Olaye A, Subramanian S and Borgemeister C. (2009) Horticultural pest management and the African economy: Successes, challenges and opportunities in a changing global environment. Acta Horticulturae 911(911): 165-183.

Free JB. (1993) Insect Pollination of Crops, 2nd edn., Academic Press, London, UK, pp. 544.

Guo Y, Zhang X, Shao Y and Li J. (2017) Evaluation of diversity and abundance of pollinating insects on oilseed rape in major planting area of China. Int J Agricult Policy Res. 5(6): 117-124.

Hanh T, Thi M, Sharma SK and Rana MK. (2014) Pollination efficiency of native bee pollinators of cucumber (*Cucumis sativus* L.) in India. J Apicult. 29(3): 199-205.

Hawksworth DL. (2011) Biodiversity and conservation of insects and other invertebrates. Biodivers Conserv. 20: 2863-2866.

Kehimkar I. (2008) The Book of Indian Butterflies, Bombay Natural History Society, Oxford University Press.

Mallik S, Sagata M and Nirmal D. (2016) Study on the butterfly diversity in Chittaranjan town, Bardhaman district, West Bengal. The Pharma Innovation J. 11(6S): 2892-2899.

Mishra RC, Kumar J and Gupta JK. (1998) The effect of mode of pollination on yield and oil potential of *Brassica campestris* var. sarson with observations on insect pollinators. J Apic Res. 27: 186-189.

Sagar, P. (1981) Role of insects in crop pollination of fennel crop at Ludhiana. Agric Res J. 18: 388-392.

Smetacek P. (2017) A naturalist's guide to the Butterflies of India, Pakistan, Nepal, Bhutan, Bangladesh and Sri Lanka. John Beauf Publishers, Oxford, England, pp. 176.

Somchoudhury AK, Nair N, Tudu B, Debnath MR and Dhar PP. (2011) Effects of some common natural

enemies and neem formulations on *Hyposidra infixaria* Walk. (Lepidoptera: Geometridae), a resurgent looper pest of tea. J Entomol Res. 35(1): 9-13.

Rasul G, Hussain A, Khan MA, Ahmad F and Jasra AW. (2014) Towards a framework for achieving food security in the mountains of Pakistan; ICIMOD Working Paper. Doi: 10.53055/ICIMOD.596.

Youngkin HW. (1950) A Text Book of Pharmacognosy, 6th edn., Blakiston Co., Philadelphia.