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Biodiversity and population density of fruit flies (*Bactrocera* sp.) at Kanke, Ranchi (Jharkhand)

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Abstract
Fruit flies (Diptera*:* Tephritidae) are considered as one of the most severe pest, which causes huge economic damage to crops, especially fruits and vegetables. Due to the infestation of fruit flies the local market value of the fruits and vegetables affects poorly. Not only that, but it also affects the demand and export potential of the fruits to several countries. Jharkhand contains highly rich plant diversity and a number of native fruit tree species, which have been threatened by a number of frugivore fruit flies (Diptera*:* Tephritidae) will This half-yearly research studies on the biodiversity and population density of different fruit fly species (Diptera*:* Tephritidae) in Ranchi will help us to formulate management strategies.

Keywords: Fruit flies (Diptera*:* Tephritidae), fruit fly lure, local biodiversity

Introduction
Fruit flies (Diptera*:* Tephritidae) are among the most economically important pest species globally, attacking a wide range of fruits and fleshy vegetables throughout tropical and sub-tropical areas [1]. There are about 4000 species in 481 genera [11]. Among the various fruit flies, the species under the genus *Bactrocera* are a severe threat nowadays to the several parts of the world. *Bactrocera* is a large genus of tephritid fruit flies, with close to 500 species currently described and accepted [2]. In India fruit flies have been identified as one of the most serious problems in Agriculture. The mainly available species in India under the genus *Bactrocera* are *B. dorsalis* (*Hendel*), *B. correcta* (*Bezzi*), *B. caryeae* (*Kapoor*), *B. latifrons* (*Hendel*), *Bactrocera* (*Zeugodacus*) *cucurbitae* (*Coquillett*), *B. minax* (*Enderlein*), *B. oleae* (*Rossi*), *B. zonata* (*Saunders*), *Dacuslongicornis* (*Wiedemann*) & *Zeugodacus tau* (*Walker*) [3, 4]. The biological diversity of these fruit flies varies from region to region and several biodiversity related studies have been done in various parts of the country for better management purposes.
Fruit fly management is a difficult process of practice as these frugivorous insects cannot be managed by using a single management tactic. Several methods of practices like cultural control, physical control, mechanical control, behavioral control, biological control and chemical control have been adopted to control these flies. For such management tactics, we must first know about the density and diversity of different fruit fly species in a particular location where management strategies would occur. The population density of different fruit fly species in a specific region has an ever changing relationship with the region's abiotic factors (viz, temperature, relative humidity and total rainfall). As in the sub-tropical country like India, these abiotic factors change season-wise, so do the diversity and population density of different fruit fly species. Several authors have studied the season-wise changes of fruit flies (Diptera*:* Tephritidae) in other part of the country.
This study is based on the Male annihilation technique (MAT). In this method pheromones like Methyl eugenol (ME) and Cue lure (CUE), which are highly species specific and highly efficient in attracting fruit flies (male) from a long distance, have been used [9]. The parapheromone Methyl eugenol, is known to attract 69 species of fruit flies [6, 7, 8] and it is being widely used for the management of *Bactrocera* spp. [10]. This six-month study (from April, 2020 to September, 2020) help us to cumulate data from two different seasons (summer and monsoon) and help to understand the changes of other fruit fly species (Diptera*:* Tephritidae) with major abiotic factor (viz, temperature, relative humidity and total rainfall) changes in the climate in different area of Kanke, Ranchi (Jharkhand).

Materials and Methods

Materials

1. Fruit fly lures
2. Very small and dried pieces of woods with a soaking capacity
3. Transparent water bottles with caps
4. Hard threads of 30-35cm. long
5. Knife
6. Scissor
7. Needle
8. Brush.
9. Magnifying glass
10. White paper
11. Gloves
12. Small size Pebbles

Composition of Fruit Fly Lures [5]

- **Methyl Eugenol:** Mix Ethyl Alcohol- 60ml + Methyl eugenol- 40ml + Malathion (Pesticide)- 20ml (*i.e.* in the ratio of 6:4:2)
- **Cue Lure:** Mix Ethyl Alcohol- 60ml + Cue lure (p-Acetoxyphenylbutanone-2) - 40ml + Malathion (Pesticide)- 20ml (*i.e.* in the ratio of 6:4:2)

Methods

The method of the experiment involves the preparation of a mixture of both Cue lure and Methyl Eugenol lure with proper care and protection. The final mixture was soaked by very small and dried pieces of woods and kept safely in packed condition. Then transparent bottles were cut partially on three sides making three small windows. Fruit fly lure containing pieces of woods were attached tightly at one end of 30-35cm. long thin but hard cotton threads. Then passing the threads through a hole created on the top of the bottle caps as the fruit fly lures can be hanged easily inside the bottles. The other side of the threads above the caps were tightly bound to the branches of a fruit tree. One or two small pebbles were inserted as the bottles can't be swung abruptly. The trapping bottles were placed 1.60m- 1.80m above the ground and at least 500m apart from each other to maximize the trapping process [11]. After a week the bottles were collected and the trapped fruit flies were removed with a brush carefully on a white paper. Finally the identification procedure and counting the numbers of each species of the fruit flies continued following standard literatures [3].

The first set of experiment for the study of biodiversity and population density of fruit flies (Diptera*:* Tephritidae) was set up on 1st April, 2020 (Afternoon). After an week long observation the data was collected from the above set on 8th April, 2020 (Forenoon). The second sets was put in for an another week long data collection on the same day, 8th April, 2020 (Afternoon) and so on. The last experiment set was set up on 23rd September, 2020 (Afternoon) and the data was collected on 30th September, 2020 (Forenoon). The data of each sets were collected after an week long observation. All the above sets of experiments were set up on three different locations (in Patratu Road, Gandhi Nagar and Ratu Road) in Kanke, Ranchi, Jharkhand. Each of these places contained plantation of fruit trees including; Mango trees (*Mangifera indica*, family: *Anacardiaceae*), Litchi trees (*Litchi chinensis*, family: *Sapindaceae*) and Common guava trees (*Psidium guajava*, family: *Myrtaceae*) which are already very much prone to the frugivorous fruit flies (Diptera*:* Tephritidae). The overall area was contained combination of both cultivated and un-cultivated lands.

The weather related data and other necessary information are collected from www.timeanddate.com, official website of Indian Meterological Depertment (www.imd.gov.in) and Dainik Jagaran News Paper (Jharkhand edition).

Result and Discussion

From the different sets of experiments, it is observed that the biodiversity of fruit fly species *Bactrocera dorsalis* is much higher than the other fruit fly species (Diptera*:* Tephritidae) in this area. During the hot summer in April, May and June, the biodiversity of *Bactrocera dorsalis* is higher than in monsoon and gradually decline in number with the changed weather (Table:1-6 ; Figure:7). The population of fruit fly species *Bactrocera correcta* and *Bactrocera cucurbitae* are available in relatively small quantity in this area though, their population density also varies with the climate change from April to September (Table:1-6 ; Figure:8, 9). Fruit fly species *Bactrocera correcta* were available in small quantity in hot summer but, their presence is relatively unnoticeable in the months of monsoon. *Bactrocera cucurbitae* numbers drastically fall from April to June and slightly increase in the month of July but again goes downward like other two species (Table:1-6 ; Figure:8, 9). *B. correcta* and *B.cucurbitae* have relatively very little population density in this area in terms of *Bactrocera dorsalis* (Table:1-6 ; Figure:1-6). Presence of another species of fruit fly *Dacus longicornis* observed sporadically in different months, though their number is negligible in terms of others (Table: 1-6; Figure:10).

The overall climate in Kanke, Ranchi (Jharkhand) is warm and temperate. April and May are the warmest months of the year. The fruit fly population density is the highest in these two months. The numbers of fruit flies gradually decreases with the fall of temperature. Also the relative humidity and average rainfall plays a crucial role in fruit flies population density as the fly species numbers fall steadily with the increasing humidity and average rainfall in that area with some exception. So, all the fly species with some exception (*viz*. population density of *D.longicornis* in this area does not shows any particular relationship with the abiotic factors) definitely show a positive correlation with the abiotic factor like temperature and negative correlation with the relative humidity and the average rainfall in this particular area (Table: 1-6; Figure:11).

Similarly, Choudhary *et al*., 2012; Ganie *et al*., 2013; Devi and Mehta, 2015 and Das *et al*., 2017, also studied the fruit fly density and biodiversity studies in Jharkhand, Kashmir Valley, North-Western Himalayas and West Bengal according to the sessional climatic changes and on different plant families (viz. Cucurbitae). The study of Choudhary *et al*., 2012 supports the prevalence of Tephritidae fruit fly *Bactrocera dorsalis* in Jharkhand area though, the predominant species they found was *Bactrocera zonata*.

Biodiversity and numbers of different species of trapped fruit flies (*Bactrocera sp.*) observed on weekly intervals as below

Table 1: Collected data from the month of April, 2020

Duration of each batch of experiments (7 days intervals)	Species of Fruit flies (*Bactrocera sp.*)			Temperature of 7 Days Intervals		Humidity of 7 Days Intervals		Total Rain Fall of 7 Days Intervals
	B. dorsalis	*B. correcta*	*B. cucurbitae*	Maximum (Average)	Minimum (Average)	Maximum (Average)	Minimum (Average)	
08.04.2020	141	08	00	35.14	22.85	65.28	35.40	0.67
15.04.2020	150	07	12	39.71	25.43	53.14	22.71	Nil
22.04.2020	134	22	21	39.57	25.71	60.00	28.43	1.80
29.04.2020	83	08	15	39.43	26.29	60.14	25.00	Nil

Table 2: Collected data from the month of May, 2020

Duration of each batch of experiments (7 days intervals)	Species of Fruit flies (*Bactrocera sp.*)			Temperature of 7 Days Intervals		Humidity of 7 Days Intervals		Total Rain Fall of 7 Days Intervals
	B. dorsalis	*B. correcta*	*B. cucurbitae*	Maximum (Average)	Minimum (Average)	Maximum (Average)	Minimum (Average)	
06.05.2020	80	11	19	36.29	24.86	78.14	48.29	6.20
13.05.2020	123	08	11	38.00	26.14	84.14	39.00	Nil
20.05.2020	91	11	03	37.29	27.29	74.42	39.57	Nil
27.05.2020	42	06	00	33.00	24.57	92.14	57.14	42.40

Table 3: Collected data from the month of June, 2020

Duration of each batch of experiments (7 days intervals)	Species of Fruit flies (*Bactrocera sp.*)				Temperature of 7 Days Intervals		Humidity of 7 Days Intervals		Total Rain Fall of 7 Days Intervals
	B. dorsalis	*B. correcta*	*B. cucurbitae*	*D. longicornis*	Maximum (Average)	Minimum (Average)	Maximum (Average)	Minimum (Average)	
03.06.2020	93	03	01	02	29.86	24.43	92.57	73.57	10.37
10.06.2020	55	03	00	00	32.00	24.00	95.57	74.71	11.13
17.06.2020	69	04	02	00	32.85	24.86	90.71	59.57	5.69
24.06.2020	51	00	01	00	32.00	24.29	90.43	66.00	1.83

Table 4: Collected data from the month of July, 2020

Duration of each batch of experiments (7 days intervals)	Species of Fruit flies (*Bactrocera sp.*)			Temperature of 7 Days Intervals		Humidity of 7 Days Intervals		Total Rain Fall of 7 Days Intervals
	B. dorsalis	*B. correcta*	*B. cucurbitae*	Maximum (Average)	Minimum (Average)	Maximum (Average)	Minimum (Average)	
01.07.2020	43	00	03	26.86	23.43	96.71	81.71	5.21
08.07.2020	37	00	08	28.29	23.86	96.00	85.43	7.03
15.07.2020	29	01	04	28.86	23.29	94.86	84.43	89.30
22.07.2020	36	00	02	30.29	23.71	95.57	76.71	22.16
29.07.2020	31	00	00	28.14	23.71	94.86	83.00	6.09

Table 5: Collected data from the month of August, 2020

Duration of each batch of experiments (7 days intervals)	Species of Fruit flies (*Bactrocera sp.*)			Temperature of 7 Days Intervals		Humidity of 7 Days Intervals		Total Rain Fall of 7 Days Intervals
	B. dorsalis	*B. cucurbitae*	*D. longicornis*	Maximum (Average)	Minimum (Average)	Maximum (Average)	Minimum (Average)	
05.08.20	43	5	1	30.29	24.29	94.43	74.71	0.98
12.08.20	27	4	0	27.43	24.14	95.30	84.43	7.16
19.08.20	28	0	1	30.30	24.00	94.30	71.70	1.90
26.08.20	12	0	0	29.00	23.00	94.28	76.00	32.60

Table 6: Collected data from the month of September, 2020

Duration of each batch of experiments (7 days intervals)	Species of Fruit flies (*Bactrocera sp.*)			Temperature of 7 Days Intervals		Humidity of 7 Days Intervals		Average Rain Fall of 7 Days Intervals
	B. dorsalis	*B. correcta*	*B. cucurbitae*	Maximum (Average)	Minimum (Average)	Maximum (Average)	Minimum (Average)	
02.09.20	*8*	*0*	*0*	27.10	21.70	96.40	81.40	70.60
09.09.20	19	1	1	28.30	21.60	96.60	76.10	8.20
16.09.20	26	0	4	28.30	19.90	89.30	62.00	Nil
23.09.20	9	0	0	26.57	20.00	95.90	73.60	74.79
30.09.20	19	0	0	25.70	18.90	94.40	68.40	5.07

Month wise observed Biodiversity and numbers of different species of fruit flies (*Bactrocera sp.*) are as below

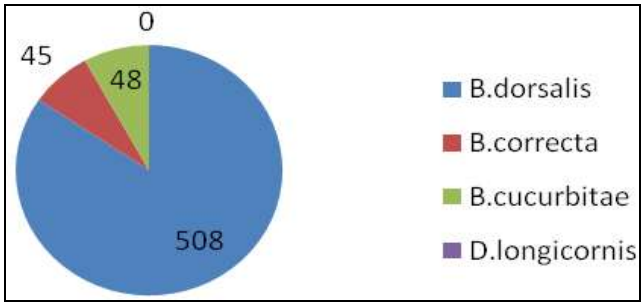

Fig 1: Biodiversity of *Bactrocera sp.* In April, 2020

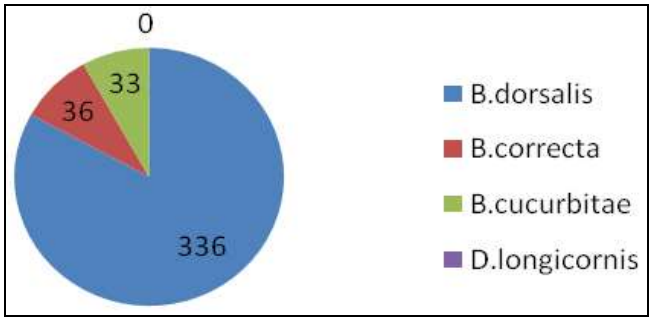

Fig 2: Biodiversity of *Bactrocera sp.* In May, 2020

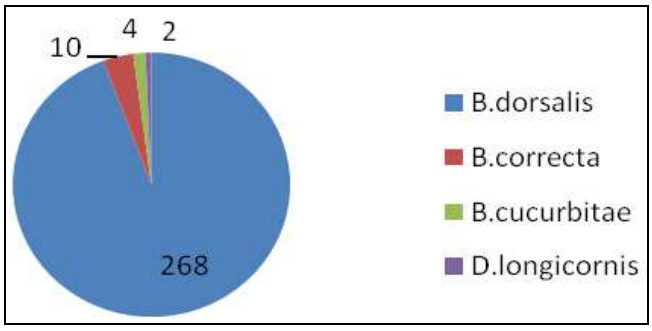

Fig 3: Biodiversity of *Bactrocera sp.* In June, 2020

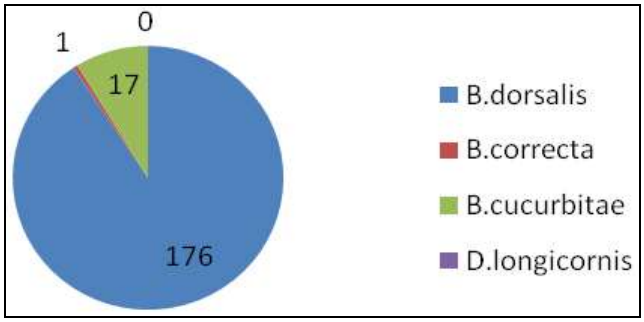

Fig 4: Biodiversity of *Bactrocera sp.* In July, 2020

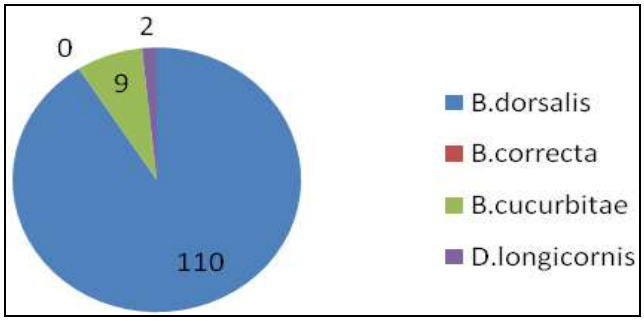

Fig 5: Biodiversity of *Bactrocera sp.* In August, 2020

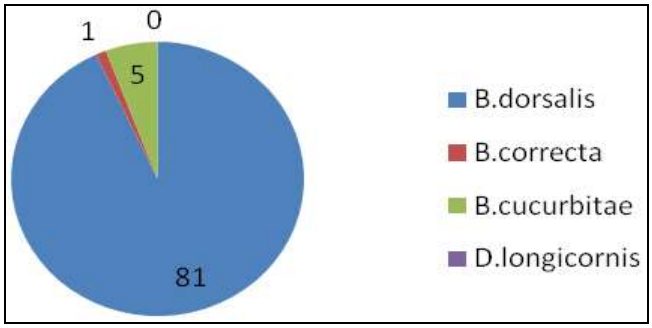

Fig 6: Biodiversity of *Bactrocera sp.* In September, 2020

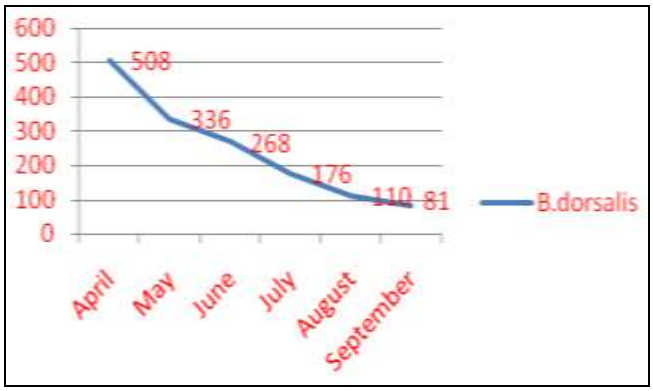

Fig 7: Gradual changes in the population of *Bactrocera dorsalis* diversity from April to September

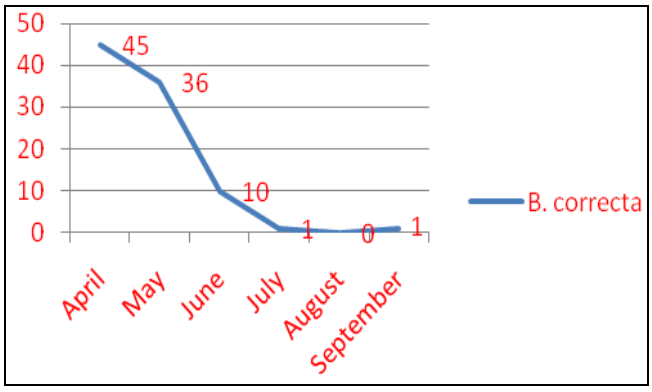

Fig 8: Gradual changes in the population of *Bactrocera correcta* diversity from April to September

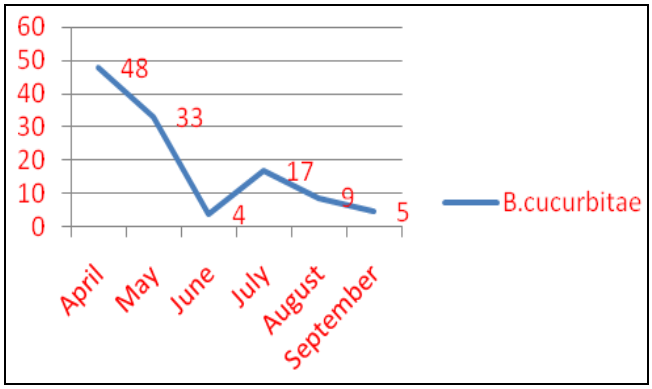

Fig 9: Gradual changes in the population of *Bactrocera cucurbitae* diversity from April to September

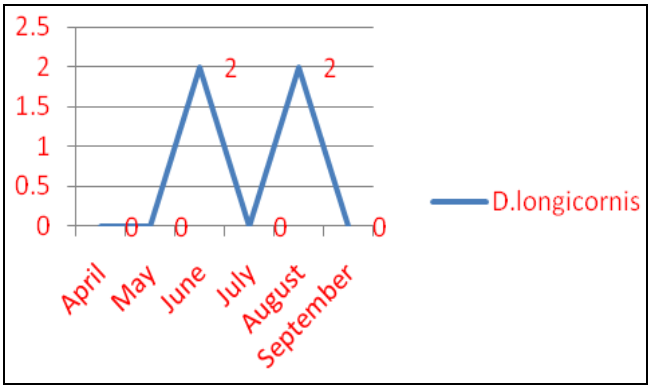

Fig 10: Gradual changes in the population of *Dacus longicornis* diversity from April to September

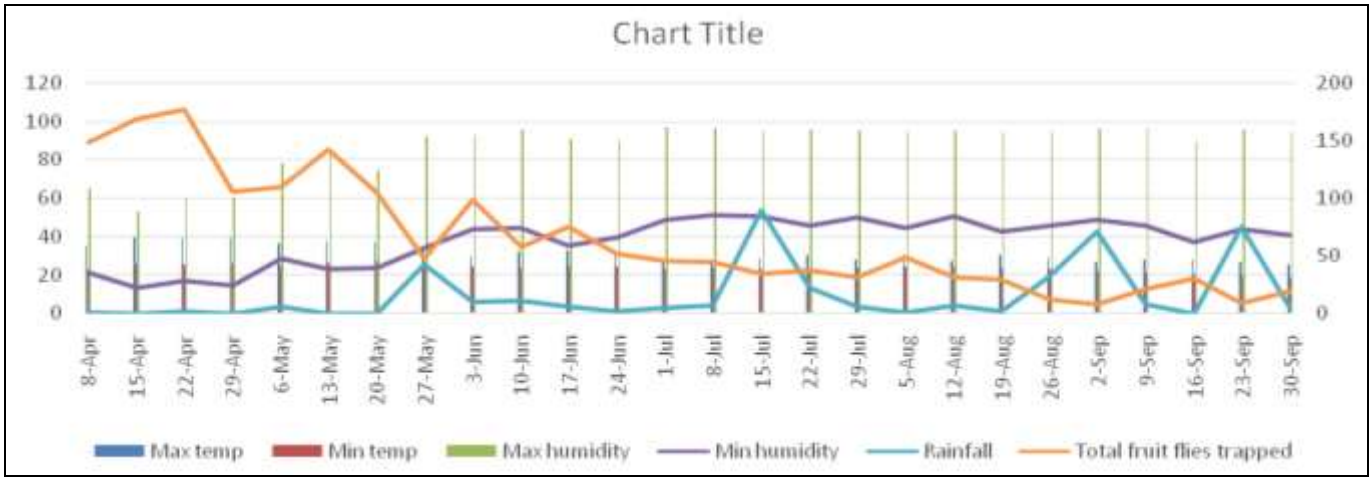

Fig 11: Gradual changes in Total Trapped Fruit Flies Number with Temperature, Humidity and Rain Fall from April to September

Conclusion

From the present study it is concluded that the population density of fruit fly species *Bactrocera dorsalis* is much higher than the population density of the other available fruit fly species (Diptera*:* Tephritidae) in this area. Apart from that, the fly density change drastically with the ever changing weather in this area. During the hot summer the biodiversity of *Bactrocera dorsalis* is higher than in monsoon and gradually decline in number with the changed weather. The fruit fly species *Bactrocera correcta* and *Bactrocera cucurbitae* are available in relatively small quantity in this area though, their population density also varies with the climate change from April to September. Presence of another species of fruit fly *Dacus longicornis* observed sporadically in different months, though their number is negligible in terms of others. The role of the abiotic factors (viz. temperature, relative humidity, rainfall) present in the climate play a crucial role in the ever changing diversity and population density of different fruit fly species in this area. Further detailed studies on the biodiversity and population density of fruit flies (Diptera*:* Tephritidae) in different seasons of the year may reveal more interesting result.

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