

ORIGINAL ARTICLE

Diversity of Insect Fauna of Tea Garden Ecosystem of North Bengal, West Bengal, India

S Rehan Ahmad\*<sup>1</sup> & Md. Nurul Hasan<sup>2</sup>

1. Dept. of Zoology, H M M College for Women, Kolkata, W.B, India

2. Zoological Survey of India, Kolkata, India

\*Principal & Corresponding author's Email : [zoologist.rehan@gmail.com](mailto:zoologist.rehan@gmail.com)

ABSTRACT

Tea being a favourite and economically important beverage and the pest harm tea production led us to work on Tea Garden fauna. To explore the Tea Garden Fauna emphasis being on harmful pest. Methodology: Surveyed a total of 130 Tea Gardens in North Bengal, covering three district namely Alipurduar, Darjeeling and Jalpaiguri of West Bengal. The researchers collected the samples and preserved them in formalin and got Identified by Entomologist. Current survey reports 170 species belonging to 46 families under 07 Orders of class Insecta of Phylum Arthropoda in the ecosystem of Tea Garden of North Bengal, West Bengal, India, it is found that Order Lepidoptera shares maximum number of species (77), followed by Hemiptera (32), Diptera (23), Coleoptera (18), Odonata (12) and Orthoptera (06) and Thysanoptera (2). Among them, 18 species of Lepidoptera, 11 species of Hemiptera, 06 species of Coleoptera, 04 species of Orthoptera and 02 species of Thysanoptera are found as tea pests. Besides this, 02 species of Diptera, 02 species of Coleoptera and 01 species of Odonata are found as predators of tea pest. Two species of Insect, *Scirtothrips dorsalis* (Hood, 1919) and *Taeniothrips setiventris* (Bagnall, 1918) belongs to family Thripidae of Order Thysanoptera found in the Tea Gardens of North Bengal which were not found in any earlier survey work.

Keywords: Insect, Pest, Predator, Tea Garden Ecosystem, North Bengal, West Bengal.

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INTRODUCTION

One of the most oldest and admirable beverage that is known to be native to China is tea. It is even believed that the tea plantations in the world are the most valuable crops. There has been an exponential expansion in the global market of trading, processing and cultivating of the tea [1]. Among other beverages in the world, tea is considered as the most inexpensive and popular. *Camellia sinensis* is the scientific name of tea, this crop is only grown within tropical regions, and the agro ecological conditions required are quite diverse. The humidity required for growing tea is required to be from 30 to 90% with the annual required rainfall needed is 938 to 6000 mm and the temperature ranges should be within -12°C to 40°C [2]. In India, the land that is involved in the tea plantation is around 621,610 hectares and India being the second largest tea producer produces around 1,325,050 tons of tea every year. India consists of the single largest tea producing area in the whole world where the regions that are invested in the production of the crop includes areas Dooars, Nilgiri, Darjeeling and Assam. Assam, West Bengal, Tamil Nadu, Kerala and Karnataka are the five top most ranked in tea producer's states in India.

China, Sri Lanka and India are the primary main tea producer countries of the world whereas other countries such as Kenya, Iran, Argentina, Uganda, Georgia, Indonesia, Japan, Malawi and Turkey are those countries that form the secondary tea producing countries of the world. Also in countries such as Zaire, Mozambique, Vietnam and Tanzania has also tea production has recently been booming. The pest ecology of the tea crop has unique characteristics and is significantly influential to in exceptional manner. The plantations of the tea crops are generally perennial (lasts over 100 years) and are evergreen [3], and in southeast Asia the cultivators are quite diverse and plant shade trees along with the tree plantations [4].

It is thought that both the mite and insects coexist by the means of intra tree plantation, which forms as a precise niche formation for ecological co-existence [3] this is the reason why it is hardly thought of the tea plantations as a forest of single species [5].

#### **Brief Description of the Plant**

Tea crop is best suited to grow in the well-drained and porous tropic and sub-tropic [6] areas where the acidic value of the soil is from pH 3.3 to 6.0 and there is a need of a wide range of conditions of climates and experience of diverse agrological conditions where the temperature can vary from  $-12^{\circ}\text{C}$  to  $40^{\circ}\text{C}$  with the humidity levels ranging from 30% to 90% and the intensity of the radiation ranges from 0.3 to  $0.8 \text{ cal cm}^{-2} \text{ min}^{-1}$  and the required rainfall annually is from 938 to 6000 mm. The tea plantations are mostly evergreen and lives for around 100 years [3] and in Southeast Asia the plantations are interplant with trees that provide shade to these plantations [4] which in turns aids in providing a climatic feature that is steady and relative for the communities of insects and mites. Hence, "single species forest" is a resemblance, which is similar to the tea plantations [5]. It is thought that both the mite and insects coexist by the means of intra tree plantation, which forms as a precise niche formation for ecological co-existence [3,7]. [8] explained that the natural enemies of the tea plantations consider staying below the plucking table. For the refuge of these natural enemies, and to act as an alternative hosts for the pests, the tea ecosystem majorly need the weeds [9]. In some countries, there is also a practice of intercropping of cover crops and putting green manure in the vacant areas of the tea fields [10] with citrus crops [11]. Planned biodiversity as such [12] helps in performing significant purification of the ecosystem by not just aiding in the tea plantations but also by regulating nutrient and its cycle, regulation of microclimate and pests and noxious chemical detoxifications.

The tea plantation biota [13] involves in particular the plant's interaction with the ecosystem with the natural enemies and the pests which is linked both above and below the ground and the biodiversity that has its association [12] that also includes the control and impact of human [14] is not researched quite well.

The core aim of this work is find out the different types of insects found in Tea Garden Ecosystem of North Bengal, India and an especial attention will be given on different types of pest and predator of Tea Garden Ecosystem by which Tea Crop are damaging regularly. Above all, a final effort will be there to find the new species of Insects in Tea Garden or newly migrated insects found in the same locality.

## **MATERIAL AND METHODS**

### **Study area**

The researcher chosen the **three** district of north Bengal named as Alipurduar, Darjeeling and Jalpaiguri for his survey. These tea gardens are located near agricultural land, roadside, riverside, forest area etc. (Table -1).

### **Data Collection :**

Insect fauna were collected from 130 tea gardens of North Bengal during regular field survey conducted from January, 2018 to July, 2019 under the project "Diversity of Insect Fauna in Tea Garden Ecosystem of North Bengal, West Bengal, India funded by Padma Estate Private Limited, Kolkata, West Bengal, India.

### **METHODOLOGY**

Insect fauna specimens were collected by various type of technique like by catching net, beating vegetation and hand picking method from different habitats of tea garden ecosystem. The specimen are collected in two shift one (8 am to 5 pm) for adult and diurnal insects and second shift (5.30 pm to 9.30 pm) for nocturnal insects. The researcher used light trap (a white screen and a 27 Watt CFL lamp operated by portable rechargeable UPS machines). Most of insect easily were identified and those who were not identified, were collected and killed and put them in bottle containing ethyl acetate and brought to the laboratory for identification. Certain insects whose body are soft belonging to Oler Hymenoptera, Dipterans etc were collected and preserved in glass vials containing 90 percent ethyl alcohol. Identification have been done by following standard and available literatures with the help of stereo zoom microscope Leica EZ4 and Leica M205A. The researcher used Nikon D3400 24.2 MP Digital SLR Camera Double VR Kit (Black) for photography of Insects in tea Gardens.

**Figure No. 1 :** Tea garden before Pruning



**Figure No. 2 :** Tea garden after Pruning



**Figure No. 3 :** Tea Fruits



**Figure No. 4 :** Tea Flower (Withered)



**Table 1. Details of visited Tea gardens of North Bengal**  
**Details of Tea Gardens in North Bengal district Wise**

<b>Details of Tea Gardens in Jalpaiguri district , North Bengal</b>						
<b>Sl. No.</b>	<b>Name of Tea Gardens</b>	<b>Dist./Sadar/Place</b>	<b>Area of Tea Garden (Acre)</b>	<b>Alt. (meter ASI)</b>	<b>Geographical Identification</b>	<b>Duration / Visiting Time</b>
1	Ambari	Dhupguri	1550.34	251	26°52'27.4"N 89°03'11.3"E	<b>Survey Started*</b>
2*	Banarhat	Dhupguri	1407.5	169	26°48'02.4"N 89°02'31.1"E	
3	Binnaguri	Dhupguri	308.48	143	26°45'28.3"N 89°03'11.1"E	
4	Chamurchi	Dhupguri	287.49	294	26°52'46.9"N 89°05'05.5"E	
5	Chunabhathi	Dhupguri	879.54	266	26°52'04.6"N 89°04'49.7"E	
6	Debpara	Dhupguri	2628.72	181	26°50'02.1"N 89°00'51.5"E	

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7	Diana	Dhupguri	1113.67	200	26°50'59.6"N 89°01'30.2"E
8	Gairkata	Dhupguri	754.44	101	26°42'00.4"N 89°02'46.2"E
9	Gendrapara	Dhupguri	1310.45	157	26°46'18.0"N 89°01'22.7"E
10	Haldibari	Dhupguri	391.1	132	26°45'08.4"N 89°01'16.3"E
11	Jaldacca Altadanga	Dhupguri	986.04	116	26°43'42.3"N 89°02'28.0"E
12	Karbala	Dhupguri	766.45	180	26°46'45.0"N 89°04'24.4"E
13	Lakhipara	Dhupguri	946.26	173	26°49'14.1"N 89°00'48.6"E
14	Mogalkata	Dhupguri	768.9	125	26°46'35.0"N 88°57'25.8"E
15	Moraghat	Dhupguri	805.43	143	26°46'35.4"N 89°01'18.9"E
16	Palashbari	Dhupguri	977.07	190	26°48'53.6"N 89°02'59.6"E
17	Reabari	Dhupguri	592.99	201	26°48'57.7"N 89°04'38.9"E
18	Redbank	Dhupguri	1195.69	235	26°52'28.4"N 89°02'20.3"E
19	Telepara -II	Dhupguri	1308.44	119	26°43'46.7"N 89°03'04.6"E
20	Totapara	Dhupguri	1308.44	136	26°46'27.9"N 88°58'52.7"E
21	Shikarpur	Rajganj	1358.99	102	26°37'31.7"N 88°34'30.4"E
22	Karlavally	Sadar	3526.59	84	26°33'08.6"N 88°39'45.6"E
23	Carron	Nagrakata	1435.6	301	26°54'51.0"N 88°59'31.6"E
24	Chengmari	Nagrakata	4577.53	261	26°53'54.2"N 89°00'54.2"E
25	Ghatia	Nagrakata	1868.35	268	26°54'36.1"N 88°57'18.3"E
26	Grassmore	Nagrakata	1893.45	175	26°52'14.4"N 88°57'17.5"E
27	Hilla	Nagrakata	1640.29	228	26°56'57.4"N 88°53'37.6"E
28	Jiti	Nagrakata	2308.12	362	26°58'35.0"N 88°55'31.5"E
29	Looksan	Nagrakata	1846.48	243	26°53'59.4"N 88°57'54.2"E
30	Naya Sylee	Nagrakata	1915.28	352	26°56'25.5"N 88°55'04.6"E
31	Tondoo	Nagrakata	584.85	129	26°48'33.9"N 88°53'53.6"E
32	Kalabari / I	Nagrakata	767.9	127	26°46'05.1"N 88°56'46.3"E
33	Anandapur	Malbazar	1550.34	113	26°45'29.5"N 88°40'06.8"E
34	Bagrakot III & IV	Malbazar	1407.5	185	26°52'45.0"N 88°34'51.7"E
35	Baintbari	Malbazar	879.54	140	26°50'36.9"N 88°46'43.9"E
36	Baroon II & III	Malbazar	1310.45	139	26°50'31.9"N 88°46'42.3"E
37	Chel (Ranichera )	Malbazar	391.1	190	26°52'46.5"N 88°39'29.7"E

January, 2018  
to  
June, 2018

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38	Dalimkot	Malbazar	986.04	173	26°53'04.3"N 88°45'59.1"E
39	Ellenbarie	Malbazar	946.26	148	26°51'44.0"N 88°44'25.8"E
40	Gendavil	Malbazar	768.9	190	26°52'48.6"N 88°39'30.6"E
41	Kumlai	Malbazar	1195.69	141	26°50'40.7"N 88°41'12.0"E
42	Manabari	Malbazar	1329.07	174	26°52'56.5"N 88°37'33.9"E
43	Needam	Malbazar	881.95	337	26.949278, 88.893778
44	Nepuchapur	Malbazar	914.46	149	26°52'08.1"N 88°44'10.6"E
45	Oodlabari	Malbazar	1539.83	140	26°49'44.0"N 88°37'02.3"E
46	Sylee	Malbazar	1674.58	218	26°54'06.1"N 88°40'30.3"E
46	Washabarie	Malbazar	1131.15	174	26°52'06.5"N 88°33'11.4"E
48	Aibheel	Mateli	1596.4	237	26°54'28.1"N 88°46'11.7"E
49	Baradighi	Mateli	2128.73	126	26°46'35.3"N 88°46'34.7"E
50	Chalsa I	Mateli	1456.14	263	26°56'39.4"N 88°50'18.3"E
51	Engo	Mateli	397.91	289	26°57'21.6"N 88°45'30.5"E
52	Indong	Mateli	1829.52	254	26°55'41.7"N 88°49'16.7"E
53	Nagaisuree	Mateli	2324.64	272	26°56'10.7"N 88°48'35.1"E
54	Matelli	Mateli	2436.07	313	26°56'44.3"N 88°48'46.5"E
55	Samsing	Mateli	1860.09	466	26°58'45.6"N 88°48'21.4"E
56	Soongachi	Mateli	1535.82	169	26°52'59.0"N 88°45'39.5"E
57	Zurantee	Mateli	1928.86	327	26°56'23.9"N 88°46'13.3"E

**Details of Tea Gardens in Alipurduar district, North Bengal**

1	Birpara	Birpara	3377.01	115	26°42'19.6"N 89°08'55.2"E
2	Dalmore	Birpara	2948	185	26°45'34.8"N 89°09'43.2"E
3	Gopalpur	Birpara	1941.59	125	26°43'06.2"N 89°11'04.5"E
4	Hossainabad	Birpara	837.35	143	26°44'00.9"N 89°09'29.8"E
5	Joybirpara	Birpara	969.18	155	26°45'25.9"N 89°06'20.4"E
6	Makrapara	Birpara	1487.23	272	26°48'06.3"N 89°11'03.7"E
7	Nangdala	Birpara	2149.98	142	26°44'32.3"N 89°06'57.8"E
8	Ramjhora	Birpara	1493.42	200	26°45'30.5"N 89°12'25.6"E
9	Rahimpur	Birpara	779.61	125	26°43'36.7"N 89°05'13.3"E
10	Dalgaon	Falakata	1639.15	92	26°40'15.2"N 89°08'48.8"E

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11	Dalmoni	Falakata	1002.43	91	26°40'06.3"N 89°06'29.1"E
12	Ethelbari	Falakata	900.75	84	26°38'46.1"N 89°05'14.4"E
13	Kadambini	Falakata	2248.89	63	26°31'51.1"N 89°14'34.6"E
14	Dhumchipara	Madarihat	2591.8	188	26°45'13.6"N 89°14'22.3"E
15	Gargenda	Madarihat	1887.37	255	26°46'49.8"N 89°13'44.9"E
16	Hantapara	Madarihat	2578.9	170	26°45'15.5"N 89°15'46.1"E
17	Mujnai	Madarihat	1854.21	136	26°43'43.2"N 89°14'45.0"E
18	Bharnobari	Jaigaon	2135.93	140	26°44'39.2"N 89°22'14.2"E
19	Beech	Jaigaon	2303.3	145	26°45'48.3"N 89°21'09.2"E
20	Chinchula	Jaigaon	2138.42	129	26°41'51.4"N 89°28'37.0"E
21	Dalsingpara	Jaigaon	3715.28	162	26°46'04.0"N 89°22'13.7"E
22	Mahua	Jaigaon	242.99	160	26°48'59.6"N 89°20'57.3"E
23	Atiabari	Kalchini	1812.6	91	26°38'59.7"N 89°29'11.7"E
24	Bhatkhawa	Kalchini	1935.96	100	26°39'34.3"N 89°27'54.0"E
25	Bhatpara	Kalchini	3091.08	149	26°43'08.8"N 89°28'06.4"E
26	Central dooars	Kalchini	3028.45	246	26°48'36.9"N 89°26'25.8"E
27	Chuapara	Kalchini	2259.56	165	26°44'37.0"N 89°27'00.2"E
28	Kalchini	Kalchini	4291.3	132	26°42'35.7"N 89°26'28.3"E
29	Dima	Kalchini	2365.93	115	26°41'07.6"N 89°26'59.3"E
30	Mechpara	Kalchini	1854.63	134	26°43'22.3"N 89°25'59.1"E
31	Nimtijhora	Kalchini	1235.17	70	26°35'04.9"N 89°26'30.3"E
32	Radharani	Kalchini	938.21	192	26°46'10.2"N 89°26'41.1"E
33	Rajabhat	Kalchini	1039.15	100	26°39'40.3"N 89°29'51.4"E
34	Chuniajhora-i	Kumargram	567.89	108	26°39'43.1"N 89°40'32.8"E
35	Chuniajhora-iii	Kumargram	662.98	107	26°39'43.1"N 89°40'32.8"E
36	Goodluck	Kumargram	405.82	118	26°43'15.4"N 89°20'49.3"E
37	Jayanti-hatipota-i	Kumargram	2044.81	121	26°40'49.9"N 89°42'39.3"E
38	Martick	Kumargram	1544.3	95	26°38'39.6"N 89°43'56.3"E
39	Kumargram	Kumargram	1952.7	97	26°39'44.3"N 89°49'44.3"E
40	Newlands	Kumargram	2014.98	101	26°39'45.5"N 89°48'51.5"E
41	Rahimabad	Kumargram	1355.42	110	26°40'26.2"N 89°41'41.2"E

July, 2018 to  
December,  
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42	Rydak	Kumargram	3489.26	85	26°37'00.5"N 89°45'41.9"E	
43	Sankosh	Kumargram	2293.3	97	26°39'42.2"N 89°51'30.1"E	
44	Kohinoor	Samuktala	1659.91	62	26°33'26.7"N 89°41'07.1"E	
45	Mathura	Samuktala	2432.92	60	26°31'22.2"N 89°24'02.7"E	
<b>Details of Tea Gardens in Darjeeling district , North Bengal</b>						
<b>Darjeeling East</b>						
1**	Arya Tea Estate	Darjeeling	310	900- 1800	27°02'29.8"N 88°14'17.5"E	<b>(Survey Ended)</b>  July , 2019
2	Lingia Tea Estate	Darjeeling	220	915- 1829	27°02'28.6"N 88°11'04.4"E	
3	Risheehat T.E	Darjeeling	256	762- 1463	27°02'29.2"N 88°13'11.4"E	
4	Tumsong T. E	Darjeeling	200	823 - 1675	27°02'09.2"N 88°10'42.4"E	
<b>Darjeeling West</b>						
5	Happy Valley T .E	Darjeeling	440	2000- 2100	27°03'05.1"N 88°15'30.4"E	June , 2019
6	Ging Tea Estate	Darjeeling	618	650- 1550	27°04'13.4"N 88°17'50.7"E	
7	Soom Tea Estate	Darjeeling	590	1550- 1600	27°04'29.1"N 88°13'51.1"E	
8	North Tukvar T.E	Darjeeling	480	460-850	27°05'43.3"N 88°15'29.7"E	
<b>Kurseong North</b>						
9	Balasan T.E	Kurseong North	448	365- 1375	26°51'40.5"N 88°14'04.8"E	May , 2019
10	Dilram T.E	Kurseong North	485	670- 1800	26°56'09.8"N 88°17'37.7"E	
11	Oaks Tea Estate	Kurseong North	345	760- 1980	26°56'54.8"N 88°15'16.0"E	
12	Margaret's Hope T.E	Kurseong North	892	107- 1828	26°55'28.1"N 88°17'03.0"E	
<b>Kurseong South</b>						
13	Castleton T.E	Kurseong South	420	980- 2300	26°51'56.1"N 88°16'42.2"E	April , 2019
14	Giddhapahar T.E	Kurseong South	115	1372- 1585	26°52'34.6"N 88°18'18.9"E	
15	Makaibari T.E	Kurseong South	120	1300- 1500	26°52'18.2"N 88°16'05.9"E	
16	Rohini Tea Estate	Kurseong South	138	1500 - 2300	26°48'54.9"N 88°18'09.2"E	
<b>Mirik</b>						
17	Gopaldhara T.E	Mirik	790	1675- 2135	26°55'40.0"N 88°09'09.9"E	March , 2019
18	Phuguri Tea Estate	Mirik	1067	1066- 1830	26°51'11.0"N 88°14'26.3"E	
19	Seeyok Tea Estate	Mirik	1003	1100- 1800	26°56'01.5"N 88°10'14.0"E	
20	Singbulli T E	Mirik	1171	366- 1250	26°50'50.2"N 88°12'52.7"E	
<b>Uppar Fagu / Rungbong</b>						
21	Dhajea Tea Estate	Uppar Fagu	440	790- 1070	26°55'27.6"N 88°13'11.1"E	February , 2019
22	Nagri Tea Estate	Uppar Fagu	571	800 - 2000	26°54'55.3"N 88°12'54.9"E	
23	Sungma Tea Estate	Uppar Fagu	670	1155 - 1700	27°27'05.2"N 88°18'05.6"E	

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24	Tukdah Tea Estate	Uppar Fagu	1376	762-1981	27°03'56.2"N 88°15'30.4"E	January , 2019	
<b>Teesta</b>							
25	Ambiok Tea Estate	Teesta	255	350-400	27°00'43.3"N 88°42'18.4"E		
26	Glenburn T.E	Teesta	400	305-915	27°05'00.7"N 88°20'12.8"E		
27	Kumai Tea Estate	Teesta	380	300-3000	26°59'44.0"N 88°49'44.6"E		
28	Lopchu Peshok T.E	Teesta	226	1450-1500	27°02'37.9"N 88°20'27.7"E		
<b>Total Tea Gardens Visited are ( 57 + 45 + 28 ) = 130</b>							

**Table 2. List of Insect Fauna associated with tea plants of North Bengal , W.B , India**

Diversity of Extant Insects Fauna in Tea Ecosystem in Dooars , West Bengal , India		
Sl. No.	Species	Comments
<b>ORDER : LEPIDOPTERA</b>		
<b>Family : Hesperidae</b>		
1	<i>Celaenorrhinus leucocera</i> (Kollar, 1844)	Commonly called as Spotted Flat
2	<i>Pelopidas mathias</i> (Fabricius, 1798)	Commonly called as black branded swift
3	<i>Tagiades japeteus attieus</i> (Fabricius, 1793)	Commonly called as snow flat
<b>Family : Lycaenidae</b>		
4	<i>Poritia hewitsoni</i> Moore, 1865	Commonly called as the common gem
<b>Family : Nymphalidae</b>		
5	<i>Aglais cshmirensis</i> (Kollar, 1848)	Commonly called as the Indian tortoiseshell
6	<i>Athyma kanwa</i> (Moore, 1858)	Commonly called as Dot-dash Sergeant
7	<i>Athyma perius</i> (Linnaeus, 1758)	Commonly called as Oriental Common Sergeant
8	<i>Danaus chrysippus</i> (Linnaeus, 1758)	Commonly called as Plain tiger
9	<i>Danaus genutia</i> (Cramer, 1779)	Commonly called as the Common Tiger
10	<i>Euploea core core</i> (Cramer, 1780)	Commonly called as Common Crow
11	<i>Euploea mulciber mulciber</i> (Cramer, 1777)	Commonly called as Striped Blue Crow
12	<i>Junonia almana</i> Linnaeus, 1758	Commonly called as the peacock pansy
13	<i>Junonia atlites</i> Linnaeus, 1763	Commonly called as Grey pansy
14	<i>Junonia hierta</i> (Fabricius, 1798)	Commonly called as Yellow Pansy
15	<i>Junonia iphita</i> Cramer, 1779	Commonly called as Chocolate pansy
16	<i>Junonia lemonias</i> (Linnaeus, 1758)	Commonly called as Lemon pansy
17	<i>Melanitis leda</i> (Linnaeus, 1758)	Commonly called as Common evening brown
18	<i>Mycalasis perseus blasius</i> (Fabricius, 1798)	Commonly called as Common Bushbrown
19	<i>Neptis hylas astola</i> Linnaeus, 1872	Commonly called as he common sailor
20	<i>Parantica aglea melanooides</i> Moore, 1883	Commonly called as Himalayan Glassy Tiger
21	<i>Symbrenthia hippoclus</i> (Cramer, 1782)	Commonly called as common jester
22	<i>Tirumala hamata septentrionis</i> (Butler, 1874)	Commonly called as Dark blue tige
23	<i>Ypthima hubneri</i> Kirby, 1871	Commonly called as Common fourring
24	<i>Ypthima similis</i> Elwis & Edward, 1893	No Common name
<b>Family : Papilionidae</b>		
25	<i>Papilio polytes stichius</i> Evans, 1912	Commonly known as Common Mormon
26	<i>Parides dasarada</i> (Moore, 1857)	Commonly known as Great Windmill
<b>Family : Pieridae</b>		
27	<i>Appias libythea</i> (Fabricius, 1775)	Commonly called as Striped albatross
28	<i>Catopsilia crocale</i> Cramer, 1775	
29	<i>Catopsilia pomona</i> (Fabricius, 1775)	Commonly called as common emigrant
30	<i>Catopsilia pyranthe</i> (Linnaeus, 1758)	Commonly called as the mottled emigrant
31	<i>Cepora nadina</i> (Lucas, 1852)	Commonly called as Lesser Gull
32	<i>Eurema blanda silhetana</i> Wallace, 1867	Commonly called as three-spot grass yellow
33	<i>Eurema hecabe</i> (Linnaeus, 1758)	Commonly called as Eurema hecabe



34	<i>Hebomoia glaucippe</i> (Linnaeus, 1758)	Commonly called as Great orange-tip
35	<i>Leptosia nina nina</i> (Fabricius, 1739)	Commonly called as Oriental Psyche
36	<i>Pieris brassicae</i> (Linnaeus, 1758)	Commonly known as Large white
<b>Family : Riodinidae</b>		
37	<i>Zemerus flegyas</i> (Guerin, 1843)	Commonly known as the PUNCHINELLO
<b>Family : Crambidae</b>		
38	<i>Arthroschista hilaralis</i> (Walker, 1859)	Commonly called as kadam defoliator
39	<i>Cnaphalocrocis poeyalis</i> (Boisduval, 1833)	Commonly called as the lesser rice-leafroller
40	<i>Diaphania indica</i>	Commonly called as cotton caterpillar
41	<i>Eoophyla sejuncta</i> (Snellen, 1876)	Commonly called as
42	<i>Glyphodes stotalis</i> Guenee, 1854	Commonly called as
43	<i>Herpetogramma licarsisalis</i> (Walker, 1859)	Commonly called as the grass webworm
44	<i>Omiodes surrectalis</i> (Walker, 1866)	Commonly called as
45	<i>Parotis marginata</i> (Hampson, 1893)	Commonly called as
<b>Family : Erebidae</b>		
46	<i>Arctornis submarginata</i> (Walker, 1855)	Commonly called as
46	<i>Argina astrea</i> (Drury, 1773)	Commonly called as the crotalaria podborer
48	<i>Arna bipunctapex</i> (Hampson, 1891)	
49	<i>Asota egens</i> (Walker, 1854)	Commonly called as Hypsa nebulosa Butler
50	<i>Argina argus</i> (Kollar, 1844)	Commonly called as Red spot moth
51	<i>Cretonotos transiens</i> (Walker, 1855)	Commonly called as Phissama transiens
52	<i>Cretonotos gangis</i> (Linnaeus, 1763)	Commonly called as minor pest
53	<i>Chionaema bianca</i> (Walker, 1856)	Commonly called as
54	<i>Euproctis chrysorrhoea</i> L.	Commonly called as The brown-tail moth
55	<i>Lymantria marginalis</i> (Walker, 1862)	Commonly called as
56	<i>Mitochrista cuneonotata</i> (Walker, 1855)	Commonly known as the "Cup. Moths"
57	<i>Nyctemera adversata</i> Schaller, 1788	
58	<i>Orgyia</i> sp.	Commonly known as tussock moths
59	<i>Somena scintillans</i> (Walker, 1856)	Commonly known as
<b>Family : Geometridae</b>		
60	<i>Ascotis selenaria</i> (Denis & Schiffermiller, 1775)	Commonly known as Giant looper
61	<i>Biston suppressaria</i> (Guenee, 1858)	Commonly known as the tea looper
62	<i>Cleora scriptaria</i>	Commonly known as the kawakawa looper moth
63	<i>Ectropis</i> sp.	Commonly known as Norfolk Moths
64	<i>Hyposidra talaca</i> Walker, 1860	Commonly known as the black looper or black inch worm
65	<i>Hyposidra infixaria</i> Walker, 1860	Commonly known as
66	<i>Petelia</i> sp.	Commonly known as common gray
67	<i>Semiothisa eleonora</i> (Villers, 1789)	Commonly known as
<b>Family : Spingidae</b>		
68	<i>Argius convolvuli</i> (Linnaeus, 1758)	also known as the convolvulus hawk-moth
69	<i>Acosmeryx omissa</i> Rothschild and Jordan, 1903	also known as the
70	<i>Hippotion boerhaviae</i> (Fabricius, 1775)	also known as the
71	<i>Theretra nessus</i> Drury, 1773	also known as the
<b>Family : Tortricidae</b>		
72	<i>Loboschiza koenigiana</i> (Fabricius, 1775)	also known as leaf webber
73	<i>Cydia leucostoma</i> (Mayrick, 1911)	
<b>Family : Zygaenidae</b>		
74	<i>Eterusia aedea aedea</i> Linnaeus, 1763	
75	<i>Eterusia edcola</i> Doubleday, 1846	also known as the red slug caterpillar
76	<i>Trypanophora semihyalina</i> Kollar, 1844	
<b>Family : Cossidae</b>		
77	<i>Zeuzera coffeae</i>	
<b>Order : HEMIPTERA</b>		

<b>Family : Aphididae</b>		
1	<i>Toxoptera aurantii</i> ( Boyer de Fonscolombe ,1841 )	
<b>Family : Coccidae</b>		
2	<i>Coccus viridis</i> ( Green , 1889 )	
3	<i>Saissetia coffaea</i> ( Walker,1852 )	
4	<i>Eriochitin theae</i> ( Green )	
<b>Family : Cicadellidae</b>		
5	<i>Empoasca flavescens</i> ( Walsh ,1952 )	
<b>Family : Cercopidae</b>		
6	<i>Leptataspis fulviceps</i> (Dallas, 1850)	
<b>Family : Cicadidae</b>		
7	<i>Huechys sanguinea</i> (De Geer, 1773)	also known as black and scarlet cicada
8	<i>Paomponia picta</i> (Walker, 1870)	
<b>Family : Fulgoridae</b>		
9	<i>Lawana conspersa</i> (Walker, 1851)	also known as White moth plant hopper
10	<i>Polydictya tricolor</i> (Westwood, 1845)	also known as
11	<i>Ricania speculum</i> (Walker, 1851)	also known as Black plant hopper or Ricaniid Plant hopper
<b>Family : Membracidae</b>		
12	<i>Darthula hardwicki</i> (Gray, 1831)	also known as common tree-hopper
<b>Family : Coreidae</b>		
13	<i>Cletus bipunctatus</i> (Herrich-Schaffer, 1840)	also known as Stipa sp.
14	<i>Elasmomia granulipes</i> (Westwood, 1842)	also known as
15	<i>Riptortus linearis</i> (Fabricius, 1775)	also known as
16	<i>Riptortus pedestris</i> (Fabricius, 1775)	also known as
<b>Family : Lygaeidae</b>		
17	<i>Graptostethus trisignatus</i> (Distant, 1879)	also known as
18	<i>Metochus uniguttatus</i> (Thunberg, 1879)	also known as
19	<i>Paromius exiguous</i> (Distant, 1883)	also known as the clown stink bug
<b>Family : Pentatomide</b>		
20	<i>Andrallus spinidens</i> (Fabricius, 1787)	also known as asturiano
21	<i>Bagrada cruciferarum</i> ( Kirkaldy ,1909)	
22	<i>Eocanthecona furcellata</i> (Wolf, 1811)	also known as
23	<i>Erthesina fullo</i> (Thunberg, 1783)	also known as Yellow spotted stink bug
24	<i>Halys dentatus</i> (Fabricius, 1775)	also known as
25	<i>Nezara viridula</i> (Linnaeus, 1758)	also known as green stink bug
26	<i>Plautia crossata</i> (Stal, 1869)	also known as
27	<i>Tolumnia latipes</i> (Dallas, 1851)	also known as
<b>Family : Largidae</b>		
28	<i>Macroceraria grandis</i> (Gray, 1832)	also known as
<b>Family : Reduviidae</b>		
29	<i>Triatoma rubrofasciatus</i> (De Geer, 1773)	also known as kissing bugs
30	<i>Vilius melanopterus</i> (Stall, 1863)	also known as
<b>Family : Scutelleridae</b>		
31	<i>Cantao ocellatus</i> (Thunberg, 1784)	also known as Westwood
<b>Family : Miridae</b>		
32	<i>Helopeltis theivora</i> (Waterhouse, 1886)	also known as tea mosquito bug
<b>Order : DIPTERA</b>		
<b>Family : Tipulidae</b>		
1	<i>Nephrotoma consimilis</i> (Brunetti, 1911)	also known as
<b>Family : Asilidae</b>		
2	<i>Cophinopoda chinensis</i> (Fabricius, 1794)	also known as
3	<i>Microstylum brunnipenne</i> (Macquart, 1849)	also known as

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4	<i>Microstylum pseudoanantakrishnani</i> (Joseph & Parui,	also known as
5	<i>Promachus duvaucelii</i> (Macquart, 1838)	also known as the false bee-killer
<b>Family : Syrphidae</b>		
6	<i>Betasyrphus serarius</i> (Wiedemann, 1830)	also known as
7	<i>Eristalinus arvorum</i> (Fabricius, 1787)	also known as
8	<i>Episyrphus balteatus</i> (De Geer, 1776)	also known as marmalade hoverfly
9	<i>Eristalodes paria</i> (Bigot, 1880)	also known as Barry aphids
10	<i>Ischiodon scutellaris</i> (Fabricius, 1805)	also known as Aphis brevis
11	<i>Mesembrias</i> sp.	also known as
12	<i>Melanostoma orientale</i> (Wiedemann, 1824)	also known as
13	<i>Volucella</i> sp.	also known as
<b>Family : Bombylidae</b>		
14	<i>Exoprosopa (Exoprosopa) insulata</i> (Walker, 1852)	also known as
15	<i>Hyperalonia suffusipennis</i> (Brunetti, 1909)	also known as
<b>Family : Calliphoridae</b>		
16	<i>Chrysomya megacephala</i> (Fabricius, 1794)	also known as oriental latrine fly
17	<i>Hemipyrellia ligurriens</i> (Wiedemann, 1830)	also known as The blow fly
<b>Family : Rhinidae</b>		
18	<i>Idiella mandarina</i> (Wiedemann, 1830)	also known as
19	<i>Stomorhina discolor</i> (Fabricius, 1794)	also known as
<b>Family : Muscidae</b>		
20	<i>Musca (Musca) domestica</i> (Linnaeus, 1758)	also known as the House fly
21	<i>Neomyia indica</i> (Robineau-Desvoidy, 1830)	also known as
<b>Family : Sarcophagidae</b>		
22	<i>Sarcophaga (Liosarcophaga) dux</i> (Thomson, 1869)	also known as synanthropic flesh fly
23	<i>Sarcophaga</i> sp.	also known as the grey flesh-fly
<b>Order : COLEOPTERA</b>		
<b>Family : Cerambycidae</b>		
1	<i>Aristobia approximator</i> (Thomson, 1865)	also known as Tuft-bearing Longhorn Beetle
2	<i>Batocera rufomaculata</i> (De Geer, 1775)	also known as Mango stem Borer, Fig Borer, Tropical Fig Borer.
3	<i>Dorysthenes (Lophosternus) indicus</i> (Hope, 1831)	also known as
4	<i>Dorysthenes (Paraphrus) granulosus</i> (Thomson, 1861)	also known as
5	<i>Nupserha</i> sp.	also known as
6	<i>Xystrocera globosa</i> (Olivier, 1795)	also known as Monkey pod round headed borer
<b>Family : Scarabaeidae</b>		
7	<i>Anomala dimidiata</i> (Hope, 1831)	also known as
8	<i>Anomala grandis</i> (Hope, 1840)	also known as
9	<i>Catharsius molossus</i> (Linnaeus, 1758)	also known as
10	<i>Catharsius sagax</i> (Quenstedt, 1806)	also known as
11	<i>Holotrichia</i> sp.	also known as white-grubs
12	<i>Melolontha guttigera</i> (Sharp, 1876)	also known as
13	<i>Xylotrupes gideon</i> (Fabricius, 1775)	also known as
<b>Family : Coccinellidae</b>		
14	<i>Coccinella septempunctata</i> (Linnaeus, 1758)	also known as the seven-spot ladybird
15	<i>Micraspis discolor</i> (Fabricius, 1798)	also known as Ladybird beetle
<b>Family Lucanidae</b>		
16	<i>Odontolabis siva</i> (Hope & Westwood, 1845)	also known as shining black
<b>Family : Curculionidae</b>		
17	<i>Astycus lateralis</i> (Fabricius, 1792)	also known as
18	<i>Xyleborus fornicates</i> (Eichhoff, 1877)	

Order : Odonata		
Family : Libellulidae		
1	<i>Crocothemis servilia</i> (Drury, 1773)	also known as The scarlet skimmer or ruddy marsh
2	<i>Crocothemis erythraea</i> (Brulle, 1832)	also known as Scarlet Darter and Scarlet Dragonfly
3	<i>Diplacodes trivialis</i> (Rambur, 1842)	also known as Blue Ground Skimmer
4	<i>Neurothemis fulvia</i> (Drury, 1773)	also known as the Fulvous Forest Skimmer,
5	<i>Orthetrum glaucum</i> (Brauer, 1865)	also known as Common Blue Skimmer
6	<i>Orthetrum pruinosum</i> (Burrmeister, 1839)	also known as the crimson-tailed marsh hawk
7	<i>Orthetrum sabina</i> (Drury, 1770)	also known as Green Marsh Hawk
8	<i>Pantala flavescens</i> (Fabricius, 1798)	also known as the globe skimmer, globe wanderer or wandering glider,
9	<i>Trithemis festiva</i> (Rambur, 1842)	also known as The black stream glider
10	<i>Ischnura aurora</i> (Brauer, 1865)	also known as golden dartlet
11	<i>Pseudagrion microcephalum</i> (Rambur, 1842)	also known as The blue riverdamsel
12	<i>Pseudagrion rubriceps</i> (Selys, 1876)	also known as saffron-faced blue dart
Order : Orthoptera		
Family : Tettigonidae		
1	<i>Ducetia japonica</i> (Thunberg, 1815)	also known as White Median-striped Katydid
2	<i>Euconocephalus pallidus</i> (Redtenbacher, 1891)	also known as
3	<i>Holochlora indica</i> (Kirby, 1906)	also known as
4	<i>Mecopoda elongata</i> (Linnaeus, 1758)	also known as Katydid
Family : Gryllidae		
5	<i>Tarbinskiellus orientallis</i> (Fabricius, 1975)	also known as oriental mole cricket
Family : Pyrgomorphidae		
6	<i>Atractomorpha crenulata</i> (Fabricius, 1793)	also known as Locust or Tobacco grasshopper.
ORDER : THYSANOPTERA		
Family : Thripidae		
1	<i>Scirtothrips dorsalis</i> (Hood, 1919)	
2	<i>Taeniothrips setiventris</i> (Bagnall, 1918)	
Total No. of Insects found in Tea Garden Ecosystem = 170		

## RESULTS

The researcher surveyed the 3 district of North Bengal and were visited a total of 130 tea gardens . Among 130 tea gardens , 45 tea garden are in the Alipurduar , 28 tea gardens in Darjeeling and 57 tea gardens are in Jalpiguri district . ( Table-1 ) .

In all, 170 species belonging to 46 families under 7 order of insects were reported and identified from the Tea Gardens (130) of North Bengal , West Bengal , India .

### Taxonomic Account

Kingdom Animalia

Phylum Arthropoda

Subphylum Hexapoda

### Subphylum Hexapoda

All the insects were formerly included in the order Insecta, which is currently classified as Hexapoda, but recently scientists have excluded the orders Collembola, Protura and Diplura from the class Insecta, and these have been upgraded to the class level .

### Class Insecta (true insects)

#### Subclass Apterygota

Zygentoma and Archaeognatha (Thysanura): Some of the most primitive insects that are wingless are included in the order of Thysanura. Silvery scales generally cover the body of these insects. Due to the presence of this silvery scale, these insects have a trivial name, which is "silverfish". Thysanura is a cosmopolitan order. The many segmented antennae which is quite long, a single median telson at the abdomen's terminal part and 2 anal cerci and their larger body makes these insects distinguishable and from the sub class Apterygota's other close related members. Mouthparts of these insects are adapted for biting, as they are ectognathous. Worldwide, around more than 1200 Thysanura species has yet been reported [15]. In India, 10 species that belongs to six genera and two families represent the suborder Archaeognatha and 28 species that belongs to 15 genera and 3 families represent the other suborder Zygentoma [16]. 23 species that are known among the taxa, in India are endemic [17].

#### **SUBCLASS PTERYGOTA**

These ancient groups of aquatic insects have evolved more than 290 million years ago and are commonly known as mayflies. These flies are generally found in the streams and lakes, which are mostly unpolluted wetlands. Depending upon the species, the adults can have a life span that ranges from few hours to few weeks. These insect play a major role in the organic matter degradation and are significant as benthic macro-invertebrates. These insects are also commonly used as biological indicators to find the quality of water and habitat. Globally, there are 3000 species that belong to 400 genera of 42 families are present of the mayflies insects. In India alone it is reported that we can find 124 species that are belonging to 46 genera which are from 12 families are already listed (ZSI, 2012), [17]

#### **ORDER: ODONATA**

The most common name given to these files are damselflies (Zygoptera) and dragonflies (Anisoptera). These insects spends the most part of their life in the ecosystem of freshwater and and amphibiotic. On the other hand, when they become adult or start flying their life span becomes shorter. While the adults are predaceous in their nature, the larvae are voracious feeders and are carnivorous. Under the suborder, which is known as Anisoptera, Anisozygoptera and Zygoptera there are 6000 species that belongs to 37 families approximately present. Fraser (1933, 1934, and 1936) in his series Fauna of British India published his three volumes of work, which was the first consolidated work in the Odonata of India. Later in the year, 1995 Varshney and Prasad published 449 species and subspecies as another checklist of the Odonata that were present in the regions of India. 463 species that belongs to 139 genera of 19 families of Odonata are presently listed in India (ZSI, 2012). Out of them, the number of species that are endemic is 115 [17].

**Our Finding in Tea Gardens of North Bengal:** In the Odonata order, 12 species that belongs to two families have been collected and reported by us. Three species out of them belongs to the family Coenagrionidae and nine species belongs to the family Libellulidae (Table -02). From the tea gardens of the North Bengal, India, we were also able to report a species that is a predator and belong to the family Libellulidae of the Odonata order namely *Orthetrum sabina* (Drury, 1770). It was one of our findings apart for the other nine (Table -04).

#### **ORDER: ORTHOPTERA**

Katydid, crickets and grasshoppers makes up this order and the presence of hind legs characterized them that are used for jumping at great distances. A lot number of katydids resemble like infection of fungal, leaf veins and insect-feeding damages. Hence, thought to be masters of camouflage as they have green leaf like wings with markings.

The calls of the crickets and katydids, in the tropical regions of the world, are an integral part of the evening chorus and major Orthoptera males, to attract mates produce distinct sounds. While some are predators, the majority of them are herbivorous. In the global, there are around 24,276 Orthoptera species are known altogether. In India alone a sum of 1033 species that are from 398 genera which falls in 21 families are known [18] from which the number of species that are endemic are 563 [17].

**Our Finding in Tea Gardens of North Bengal:** In the Orthoptera order, we were able to collect and report 06 species that were from three families. Four out of the six were from the family Tettigonida; one was from the family Gryllidae and one from Pyrgomorphidae family (Table- 2). Two species out of the six that we found in the tea gardens of North Bengal were includes as Pest, which are as; *Mecopda elongate* (Linnaeus, 1958) and *Holochlora indica* (Kirby, 1906) and belong to the family Tettigonidae of Orthoptera Order.

#### **ORDER: HEMIPTERA**

The order of Hemiptera includes insects that is leafhoppers and is made up of the cicadas, plant hoppers, aphids, whiteflies, scales and other that fall in the Homoptera class and Heteroptera which are the true bugs. The insects in this order, to obtain their food have their mouth parts distinctively modified that looks like piercing – sucking beaks. Those insect that are predator in this order usually pierce their most common prey; other insects; and inject them with digestive fluids in order for starting the digestion. Only in the heteropterans, predators are found along with those few who also feed on the blood of vertebrates. While some of the insect in this order are aquatic, most of them re terrestrial. In total, 103,590 species of Hemiptera presently comes from 152 families and divided into 4 suborders that is globally known. From India alone, there are 6469 species are reported that comes from 92 families . The 2421 species among the known taxa in India are supposedly endemic [17].

**Our Finding in Tea Gardens of North Bengal:** of the Order Hemiptera the number of species, that we were able to collect, report species was 32, and they belonged to 14 families. Out of the 32 species, around eight of those species belonged from Pentatomide family. The other four species belonged from coreidae family. Three species of them belonged to the coccidae family. Another three species of them belonged to

the Fulgoridae family. Another three of the species belonged to the Lygaeidae family. Other two species of them belonged from cicadidae family. Another two species belonged from the Reduviidae family. Another one species belonged from the Amphididae family. Another one species belonged to the cicadellidae family. Another one species belonged to the ceracopidae family, another one belonged to the membracidae family, another one species belonged to the Largidae family, another one species belonged to the scutelleridae family and the last one species belonged to the meridae family (Table-02). Out of the 32 species that we were able to report and are above mentioned, 11 of these species belongs to 7 families and are included as pests. Additionally out o, the seven families there are present three species that belongs to the Coccidae family. Other three specie that belongs from the Pentatomidae family. Another one species that belongs to the Aphididae family. Another one species that belongs to the cicadidae family. Another one species that belongs to the cicadellidae family. Another one species that belongs to the coreidae family and lastly one species that belongs to the miridae family (Table -3).

#### **ORDER: THYSANOPTERA**

The insects that come from the order Thysanoptera are quite unusual. The insect's body in this order is slender and small and is generally having fringed wings. For improved grip on the substrata, these insects have inflatable bladder in the tarsal segment of their bodies. The insect from this order, feeds on the plants, fungi and debris through their asymmetrical and piercing-sucking mouthparts.

In total there are 6019 species which are globally known out which in India 686 species has been reported which belongs to 258 genera and come from 7 families and the total number of species that are endemic in India are 520 [17].

**Our Finding in Tea Gardens of North Bengal :** A total number of 2 species ; namely *Taeniothrips setiventris* (Bagnall ,1918 ) and *Scirtothrips dorsalis* ( Hood ,1919 ) that came from the Thripidae families of the Thysanoptera order were collected and reported by us and both of them are known as pest of the tea plants (Table-2 & Table -3).

#### **ENDOPTERYGOTA**

##### **ORDER: COLEOPTERA**

One of the biggest proportions of the species of insects that are described is belonged to those of the beetles. There are around 8,00,000 species that are known globally of Insects and among them the number of beetle species itself is around 3,59,000 and it is considered that out of every 4 living organism there is one beetle [19.20]. By the end of the year, the number even was updated to 3,87,100 species of beetles [21]. In the terms of all insects the Coleoptera are supposedly coined as the most successful. The beetles of the order Coleoptera are the largest organism group globally. These insect have hardened and greatly strengthened mesothoracic (first) pair of wings, which acts superbly as shields for abdomen but is not use for flying. The elytra which is the name given to the hardened forewings are held usually to flush over the beetle's back. This hardened elytra is very difficult to crush and it slippery surface even makes it difficult to grasp. Some groups of beetles even have solid form of overall body that is compact and flattened. This enables them to make extensive burrows in soil, penetrate cryptic habitats and even hide with ease. Undoubtedly, due to these modifications that the beetles have been able to evolve makes them in the planet a prominent insect form. There is even as estimate that says that there are species that exceeds the number 3,87,000 has been globally considered valid and has been described to be dividing among 169 families. A wide majority of these beetles fall under six families that are significantly diverse (the names are Cerambycidae, Carabidae, Curculionidae, Chrysomelidae, Scarabaeidae and Staphylinidae) and each of these families has around 20,000 different kinds of species. In India, there is a diversity of these beetles' fauna due to the presence of wide topography, favoring conditions of ecology and feature full climatic characteristics. In India , the works have already been made and accounted which says that about 4.86% of the species which are the part of the fauna which means that 17,455 of the species that belongs to 114 families which falls under 2 suborder namely the Polyphaga and the Adephaga is vividly present. It is also accounted that 3100 species out of the total that is present in India [17] are endemic nature.

**Our Finding in Tea Gardens of North Bengal:** Of the order Coleoptera, the number that we were able to gather and collect was 18 species that belonged to five families. Maximum (7) of these collected specie belonged to the Scarabaeidae family. The other six species that we were able to collect and gather belonged to the Cerambycidae family, next other two species that we collected were from Coccinellidae family , the other two species that we collected were from curculionidae family and one of the collected samples were belonging to the Lucanidae family (Table-2). Out of the 18 species that were collected two species were those that were listed as predators and six species were those, which were listed as pests. Out of the six species of pest that we were able to collect, there four species that were belonging form

Scarabaeidae family and the remaining two species were listed in the curculionidae family (Table -3). The two species of predator that we were able to collect, both of them were from the Coccinellidae family.

#### **Order: DIPTERA**

They are found almost everywhere and are called true flies. The most distinctive features that these flies have is that their metathoracic wings are reduced and are formed as knob-like halteres which works like gyroscope for these insects. The immense modification has enabled the Diptera to become the master of movement in the air and have enhanced level of maneuverability. The larvae of these insects are scavengers, herbivores, predators or in some cases even parasites while most of the adults of this order needs protein rich meals in order to fly in an enhanced way and for the production of eggs that are mature. It is quite common to find the larvae of Diptera as they live freely and is generally found on rotting vegetables, inside of the soil, exposed on the vegetation and even feeding on the plants sometimes. Those insect in the order Diptera that are aquatic are generally found in water columns, on the surface of rocks, sand underlying a body of water, or even in logs in the vegetation. Mammals are attacked by only the endo-parasites of this order and mostly the arthropods are attacked by the parasitoids. Globally there are listed 1,59,294 species that come from 159 families of Diptera. The number of species that are present listed in India is currently 6337 of these true flies, they come from 1180 genera that belong to the 87 families, and only 2183 of these species are endemic that come from 110 genera [17].

**Our Finding in Tea Gardens of North Bengal:** Of the order Diptera we were able to collect and report species of 23 kinds that belonged to eight families. Maximum (8) out of the 23 species were from the Syrphidae family. Another four of the species belonged to the family known as Asilidae. Two of the other species belonged to the family known as Bombyliidae. Another two of the species belonged to the family known as Calliphoridae. Another 2 of the species belonged to the family known as Muscidae, another 2 of the species belonged to the family known as Rhinidae, another 2 of the species belonged to the family known as Sarcophagidae and 1 of them belonged to the Tipulidae family (Table -2). Among all the species that were mentioned, one of those species namely *Microstylum pseudoanantakrishnanii* [22] was listed as a predator and belongs to the family Asilidae (Table -3)

#### **ORDER: LEPIDOPTERA**

Butterflies and moths make up this order. Due to the diurnal and the colorful group called butterflies present in this order, it makes them the best known among the insects. However, around 80% of the group is made up of often drably colored, nocturnal moths and the moths have the most diversity in the order Lepidoptera. The larvae of this group are voracious plant feeders and commonly known as caterpillars. The larvae feed on almost all the parts of the plants such as seeds, stem, leaf, root and flower and this might affect the plants. Where most of the species in this order are phytophagous, some species are predatory while there are some species that feed on wool and other animal materials. Since most of the species are dependant of the nectar of flower, their mouthparts of the adults are modified and formed as coiled tubes that are long and it makes them easy for taking up liquids. In India alone the number of species of moths that are known are 15,000 species which share 84 families, along with the moths there are 1641 butterfly species known as well which are further divided into sub species [23]. Around 1500 species of the known taxa in India are listed as endemic; most of them are the butterflies [17].

**Our Finding in Tea Gardens of North Bengal:** Of the Order Lepidoptera we were able to report and collect around 77 species that shared 13 families. Maximum (20) of the species that were able to collect belonged to Nymphalidae family. Another 14 species of what we collected belonged to the Erebidae family. Another 10 species of what we collected belonged to the Pieridae family. Another eight species of what we collected belonged to the Crambidae family.

Another eight species of what we collected belonged to the Geometridae family. Another four species of what we collected belonged to the Sphingidae family. Another three species of what we collected belonged to the Hesperidae family. Another three species of what we collected belonged to the Zygaenidae family. Another two species of what we collected belonged to the Papilionidae family. Another two species of what we collected belonged to the Tortricidae family, 1 species from Cossidae family, 1 species from the Lycaenidae family and lastly one from the Riodinidae family (Table -1). Out of the 77 species that we were able to collect, the numbers of species that belong to pests were 18 that shared five families. Out of these 5 families 8 of the species belonged to the Erebidae family, from the Geometridae family there were 6 species, from the Zygaenidae family there were 2 species and one species each from the Cossidae and Tortricidae family (Table -3).

In the strenuous field work in the tea gardens of North Bengal from January, 2018 to July, 2019, the researchers found the following Insects are as follows

**Total Insects during whole research Work :**

A total of 170 species belonging to 46 families under 07 Orders of class Insecta of Phylum Arthropoda in the ecosystem of Tea Garden of Doars, West Bengal, India are found. It is found that Order Lepidoptera shares maximum number of (77) species ( 45.30 % of total species ), followed by Hemiptera (32) species (18.83 % of total species ), Diptera (23) species (13.52 % of total species ), Coleoptera (18) species ( 10.60 % of total species), Odonata (12) species ( 7.05 % of total species ) and Orthoptera (06) species (3.50 % of total species ) and Thysanoptera (2) (species 1.20 % of total species ) ( Table -02 & Table -03 ). Out of seven Orders, the top three families sharing Insects Flies are Nymphalidae ( 11.76 % of total species ), Erebidae ( 8.23 % of total species ) & Pieridae ( 5.88 % of total species ) of order Lepidoptera, Pentatomidae ( 4.70 % of total species ), Coreidae ( 2.35 % of total species ), Coccidae & Fulgoridae ( 1.76 % of total species ) of Order Hemiptera, Syrphidae ( 4.70 % of total species ), Asilidae ( 2.35 % of total species ) and Bombylidae, Calliphoridae, Rhinidae, Muscidae & Sarcophagidae ( 1.17 % of total species ) of Diptera Order, Scarabaeidae ( 4.11 % of total species ), Cerambycidae ( 3.5 % of total species ) and Coccinellidae & Curculionidae ( 1.17 % of total species ) of Coleoptera Order, Libellulidae ( 5.29 % of total species ) and Coenagrionidae ( 1.76 % of total species ) of Odonata Order, Tettigonidae ( 2.35 % of total species ) and Pyrgomorphidae & Gryllidae ( 0.58 % of total species ) of order Orthoptera, Thripidae Tettigonidae ( 1.17 % of total species ) of Thysanoptera order.

**Insect as Pest :**

Among them, 18 species ( 10.58 % of total species ) of Lepidoptera, 11 species ( 6.47 % of total species ) of Hemiptera, 06 species ( 3.52 % of total species ) of Coleoptera, 04 species ( 2.35 % of total species ) of Orthoptera and 02 species ( 1.17 % of total species ) of Thysanoptera are found as tea pests ( Table -04 ).

**Insect as Predator :**

Besides this, 02 species ( 1.17 % of total species ) of Diptera, 02 species ( 1.17 % of total species ) of Coleoptera and 01 species ( 0.58 % of total species ) of Odonata are found as predators of tea pest ( Table -05 ).

**DISCUSSION**

On the planet Earth, insect are one of the most adaptable animal. Broadly, insects can be classified into four categories based on the utilization and exploitation. The most important group of them is the Industrial Insects. These insects are used for the extraction and production of number of products for the humans to use such as Lac Insect, Aesthetic Insects, Dye Insects, Honeybee and Silkworm. The next group of insect that are significantly important are the Edible and Therapeutic Insect, which are generally used for the purposes of therapeutic and edible purposes as some insects are source of rich proteins and there are many minerals and vitamins are present in them. The next important group of insects is Forensic Investigator Insects, which are helpful in processes such as post mortem and so. The last groups of insects that are of importance are Economic Importance Insects. These insects have their job to work as pollinators, predators and potential pests. These insects are even used in the process of assessing the effects on the stressors of the effect on the environment like those of pollutants and act as a bio indicator [24]. It is globally estimated that there are 2.6-7.8 million species of insects that are present and make up the diversity and around 900,000 species of them are already been listed. Out of the known lists, beetles are among 40% of the entire group. However, it is in the belief of some entomologist that there are chances that insects from the order Hymenoptera and Diptera might be more diverse. The orders Hemiptera, Diptera, Lepidoptera, Coleoptera and Hymenoptera are among the most rich and diverse orders of insects. There has been developed a complex relationship between humans and insects that co-exist the Earth together.

It is estimated that there is only less than 1% of those insects, which acts as pests and compete for food or enables transmission of diseases into the lives of humans and their much helpful livestock [25]. For the survival and the reproduction of the diverse kinds of pests and insects, the tea plant acts as a monoculture as they have long lives and provide the much needed supply of food and sites along with the environmental conditions that are quite favorable [26]. Over the globe there are around more than 1000 species that are linked with tea plantations, of arthropods [27,28]. The weather conditions also play an important factor that influences the abundance of pests on the tea plantations. While some insects are perennial and attack the tea during the whole year, some insects are seasonal and attack the tea either during the dry season or during the wet season. Based on the feeding habit that such as either by chewing or by sucking, the pests of tea are also classified. Insects such as the red slug caterpillar, loppers, flush worm, etc are some of the major tea-chewing pests. On the other hand, jassids, aphids, jassids and tea mosquito bugs of tea are some of the major tea-sucking pests [29].



These bugs sometimes can cause up to 55% of loss in the yield [28]. of the crops. The insect group Lepidoptera in the current research was of the maximum finding, which was followed by Hemiptera, Coleoptera, Orthoptera and Thysonoptera (Table -03). The count of the predator that was higher was in the order Diptera that was followed by Coleoptera and Odonata (Table -04).

**Table – 03 :** Details of Pest found in tea gardens , North Bengal , India

Sl. No.	Details of Pests of Tea Plant , North Bengal West Bengal , India
	<b>Order Lepidoptera</b>
	<b>Family Cossidae</b>
01	<i>Zeuzera coffaea</i> ( Nietner ,1861 )
	<b>Family Erebidae</b>
02	<i>Arctornis submarginata</i> (Walker, 1855)
03	<i>Argina argus</i> (Kollar, 1844)
04	<i>Arna bipunctapex</i> Hampson, 1891
05	<i>Cretonotos gangis</i> (Linnaeus, 1763)
06	<i>Euproctis</i> sp.
07	<i>Lymantria marginalis</i> (Walker, 1862)
08	<i>Nyctemera adversata</i> ( Schaller, 1788)
09	<i>Somena scintillans</i> (Walker, 1856)
	<b>Family Geometridae</b>
10	<i>Ascotis selenaria</i> (Denis & Schiffermiller, 1775)
11	<i>Biston suppressaria</i> (Guenee, 1858)
12	<i>Cleora</i> sp
13	<i>Ectropis</i> sp.
14	<i>Hyposidra talaca</i> ( Walker, 1860)
15	<i>Petelia</i> sp.
	<b>Family Zygaenidae</b>
16	<i>Eterusia aedea aedea</i> (Linnaeus, 1763)
17	<i>Eterusia edcola</i> (Doubleday, 1846)
	<b>Family Tortricidae</b>
18	<i>Cydia leucostoma</i> ( Mayrick ,1911 )
	<b>Order Hemiptera</b>
	<b>Family Aphididae</b>
1	<i>Toxoptera aurantii</i> ( Boyer de Fonscolombe , 1841 )
	<b>Family Coccidae</b>
2	<i>Coccus viridis</i> ( Green ,1889 )
3	<i>Saissentia coffeae</i> ( Walker, 1852)
4	<i>Eriochiton these</i> ( Green )
	<b>Family Cicadidae</b>
5	<i>Huechys sanguinea</i> (De Geer, 1773)
	<b>Family Cicadellidae</b>
6	<i>Empoasca flavescens</i> (Walsh ,1962 )
	<b>Family Coreidae</b>
7	<i>Elasmomia granulipes</i> (Westwood, 1842)
	<b>Family Pentatomidae</b>
8	<i>Andrallus spinidens</i> (Fabricius, 1787)
9	<i>Bagrada cruciferarum</i> ( Kirkaldy ,1909 )
10	<i>Halys dentatus</i> (Fabricius, 1775)
	<b>Family Miridae</b>
11	<i>Helopeltis theivora</i> (Waterhouse, 1886)
	<b>Order Coleoptera</b>
	<b>Family Scarabaeidae</b>
1	<i>Xylotrupes gideon</i> (Fabricius, 1775)
2	<i>Catharsius molossus</i> (Linnaeus, 1758)

3	<i>Holotrichia</i> sp.
4	<i>Anomala dimidiata</i> (Hope, 1831)
<b>Family Curculionidae</b>	
5	<i>Astycus lateralis</i> (Fabricius, 1792)
6	<i>Xyleborus fornicates</i> (Eichhoff, 1877)
<b>Order Orthoptera</b>	
<b>Family Tettigonidae</b>	
1	<i>Holochlora indica</i> (Kirby, 1906)
2	<i>Mecopoda elongata</i> (Linnaeus, 1758)
<b>Family Gryllidae</b>	
3	<i>Tarbinskiellus orientalis</i> (Fabricius, 1775)
<b>Family Pyrgomorphidae</b>	
4	<i>Atractomorpha crenulata</i> (Fabricius, 1793)
<b>Order Thysanoptera</b>	
<b>Family Thripidae</b>	
1	<i>Scirtothrips dorsalis</i> (Hood, 1919)
2	<i>Taeniothrips setiventris</i> (Bagnall, 1918)
<b>Total Number of Pest 41</b>	

**Table - 04 :** Details of Pest found in tea garden , North Bengal , India

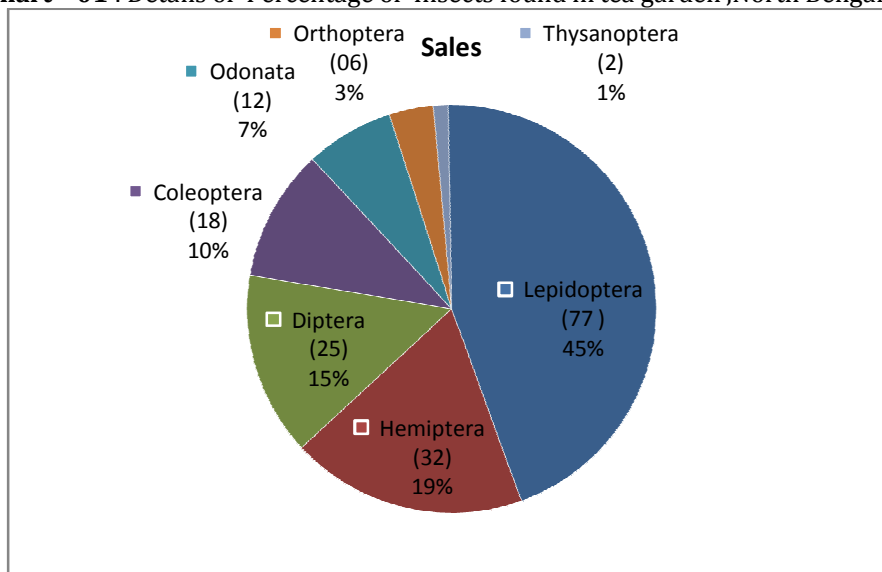
<b>Details of Predators of Tea Plant , Dooars West Bengal , India</b>	
<b>Order Diptera</b>	
<b>Family Asilidae</b>	
<i>Microstylum pseudoanantakrishnanii</i> (Joseph & Parui, 1982)	
<b>Family Syrphidae</b>	
<i>Ischiodon scutellaris</i> (Fabricius, 1805)	
<b>Order Coleoptera</b>	
<b>Family Coccinellidae</b>	
<i>Micraspis discolor</i> (Fabricius, 1798)	
<i>Coccinella septempunctata</i> (Linnaeus, 1758)	
<b>Order Odonata</b>	
<b>Family Libellulidae</b>	
<i>Orthetrum sabina</i> (Drury, 1770)	
<b>Total Number of Pest 05</b>	

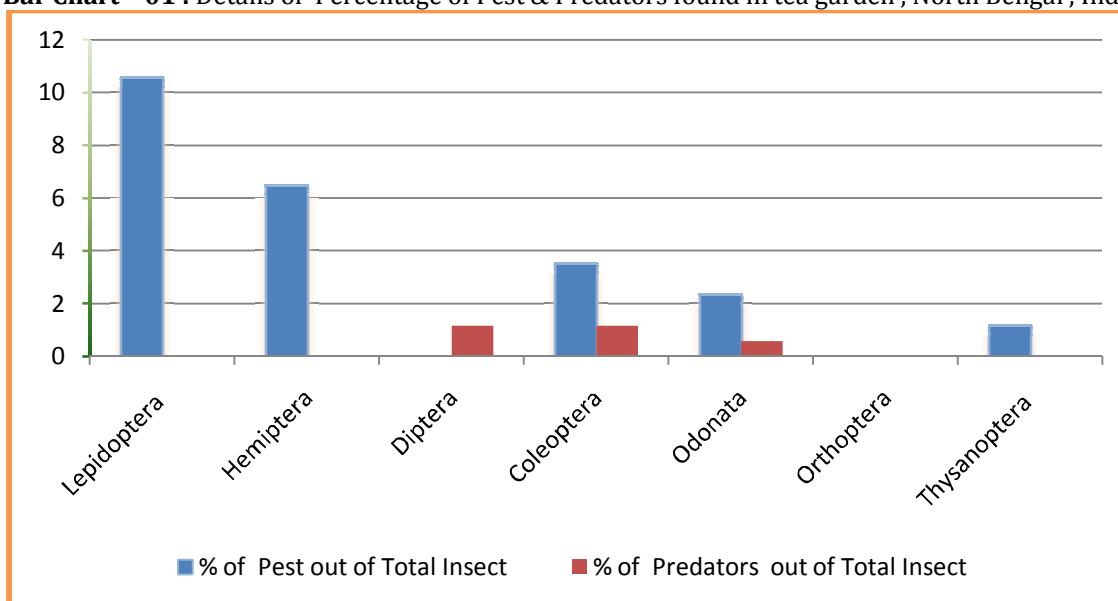
**Table - 05 :** Orders & Families of Insects associated with Tea Garden in , North Bengal , India

Name of Order	No. of Families	Name of Families	Number of Species	Total No. of Species	Total No. of Families
<b>LEPIDOPTERA</b>	1	family : Hesperidae	3	<b>77</b>	<b>13</b>
	2	family : Lycaenidae	1		
	3	family : Nymphalidae	20		
	4	family : Papilionidae	2		
	5	family : Pieridae	10		
	6	family : Riodinidae	1		
	7	family : Crambidae	8		
	8	family : Erebididae	14		
	9	family : Geometridae	8		
	10	family : Sphingidae	4		
	11	family : Tortricidae	2		
	12	family : Zygaenidae	3		
	13	family : Cossidae	1		
<b>HEMIPTERA</b>	1	family : Aphididae	1	<b>32</b>	<b>14</b>
	2	family : Coccidae	3		
	3	family : Cicadellidae	1		
	4	family : Cercopidae	1		

	5	family : Cicadidae	2		
	6	family : Fulgoridae	3		
	7	family : Membracidae	1		
	8	family : Coreidae	4		
	9	family : Lygaeidae	3		
	10	family : Pentatomide	8		
	11	family : Largidae	1		
	12	family : Reduviidae	2		
	13	family : Scutelleridae	1		
	14	family : Miridae	1		
<b>DIPTERA</b>	1	family : Tipulidae	1	<b>23</b>	<b>8</b>
	2	family : Asilidae	4		
	3	family : Syrphidae	8		
	4	family : Bombylidae	2		
	5	family : Calliphoridae	2		
	6	family : Rhinidae	2		
	7	family : Muscidae	2		
	8	family : Sarcophagidae	2		
<b>COLEOPTERA</b>	1	family : Cerambycidae	6	<b>18</b>	<b>5</b>
	2	family : Scarabaeidae	7		
	3	family : Coccinellidae	2		
	4	family : Lucanidae	1		
	5	family : Curculionidae	2		
<b>ODONATA</b>	1	family : Libellulidae	9	<b>12</b>	<b>2</b>
	2	family : Coenagrionidae	3		
<b>ORTHOPTERA</b>	1	family : Tettigonidae	4	<b>6</b>	<b>3</b>
	2	family : Gryllidae	1		
	3	family : Pyrgomorphidae	1		
<b>THYSANOPTERA</b>	1	family : Thripidae	2	<b>2</b>	<b>1</b>
Total Number of Species & Families				<b>170</b>	<b>46</b>

**Pie Chart - 01** : Details of Percentage of Insects found in tea garden ,North Bengal , India



**Bar Chart – 01** : Details of Percentage of Pest & Predators found in tea garden , North Bengal , India**ACKNOWLEDGEMENT**

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**CONFLICT OF INTEREST**

The author declare that there exist no commercial or financial relationship that could , in any way , lead to potential conflict of interest .

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**ETHICAL APPROVAL**

This study has nothing to do with human and animal testing.

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