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# Insect Fauna associated with the Tea Ecosystem of North Bengal, India

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## Abstract

Present communication reports 167 species belonging to 139 genera of 42 families under 6 orders of insects from the tea gardens of North Bengal. Of them, Lepidoptera shares maximum number of species (77), followed by Hemiptera (29), Diptera (24), Coleoptera (19), Odonata (12) and Orthoptera (06). Among them, 20 species of Lepidoptera, 05 species of Hemiptera, 05 species of Coeloptera and 03 species of Orthoptera are found as tea pests. Besides this, 01 species of Diptera and Odonata are found as predators of tea pest. In addition to this, 14 species of Hemiptera, 11 species of Coleoptera and 09 species of Lepidoptera reported as pests/borers of other crops and timber plants. In addition to this, 03 species of Hemiptera and 03 species of Diptera as predator and 16 species of Diptera as flower visitors/pollinators in other ecosystem are also found.

**Keywords**: North Bengal, Pest, Pollinator, Predator, Tea Garden

## Introduction

Insects are among the major animal visitors of any crop fields and act as pests, pollinators or some other biologically important organism to a particular plant including tea gardens. Therefore, accurate identification of insects at genus and species level is essential for understanding their biological role in a particular ecosystem.

Tea (*Camellia sinensis* (L.) O. Kuntze) is a popular beverage all over the world. Globally, 1031 arthropod species are associated with tea; a small number of pests (about 3%) are common throughout the world (Hazarika *et al.*, 2009). All parts of the plant, leaf, stem, root, flower, and seed, are fed upon by at least one pest species, resulting in 11%-55% loss in yield if left unchecked (Hazarika *et al.*, 2009). Tea with perennial foliage is infested by about 167 insect species in the North-Eastern tea growing regions of India (Das *et al.*, 2010) including the Dooars and Terai. Besides the role of insects in tea ecosystem as pest, they are serving other functional role as predator, parasites and pollinator. Bezbaruah, (1975) stated that, insect pollinators contribute to pollination success in tea.

Majority of the works in North Bengal tea gardens are restricted with insect pest, predator, and parasites and their control. Khewa and Mukhopadhyay (2010) worked on biopesticides of *Arctonis submarginata*. Roy *et al.* (2010) evaluated the effectiveness of acaricides/insecticides in killing the eggs of *Helopeltis theivora* Waterhouse and *Oligonychus coffeae* Nietner in North Bengal. Roy *et al.* (2010) studied the bio efficacy of coccinellid predators on major tea pests. Das *et al.* (2010) studied the seasonal occurrence of the three lepidopteron species from Terai tea plantations. Das *et al.* (2010) reported 94 species of predators and 33 of parasitoids as natural enemies of arthropods in sub-Himalayan tea plantations of North Bengal, India. After that, Mitra *et al.* (2014a and 2014b) published a list of 07 species of Orthoptera and 28 species of Hemiptera from tea plantations of Dooars. Biswas *et al.* (2015) reported 14 species of moths (Lepidoptera: Erebidae) associated with the tea plantations of northern West Bengal. Shah and Mitra (2015) also published a list of 39 species as tea associated moths, of which, 15 species were recognized as serious pests of tea. Documentation of butterflies has also been done by Mitra *et al.* (2015),

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where 37 species were observed to visit in tea plantations. Apart from this, the interactions of 12 species of Odonata (Shah *et al.*, 2015) and 13 species of Coleoptera (Mitra *et al.*, 2016) have also been recorded from this ecosystem. Recently, Mitra *et al.* (2017) documented 24 species belonging to 08 families of dipteran flies and their association with the tea plants.

Apart from these, there are many more insect species unknown to us in tea gardens. They may be beneficial or harmful to the tea plants. Without regular surveys and proper identification of these species, it is not possible to undertake any action on them.

Field surveys were conducted in 74 tea gardens and its adjoining areas from 04 districts i.e., Jalpaiguri, Alipurduar, Kochbihar and Darjeeling of northern West Bengal from 2012-2016.

167 species belonging to 139 genera of 42 families under 6 orders of insects are reported from the tea gardens of North Bengal. Of them, Lepidoptera (77 species), followed by Hemiptera (29 species), Diptera (24 species), Coleoptera (19 species), Odonata (12 species) and Orthoptera (06 species) were collected and identified

## Material and Methods

### Study area

Survey was conducted in Dooars and the hilly area of Darjeeling of West Bengal from 2012 to 2016 in three districts of North Bengal and visited 74 tea gardens (Map.1-4). The serial number (1-74) has been maintained as per Table 1.

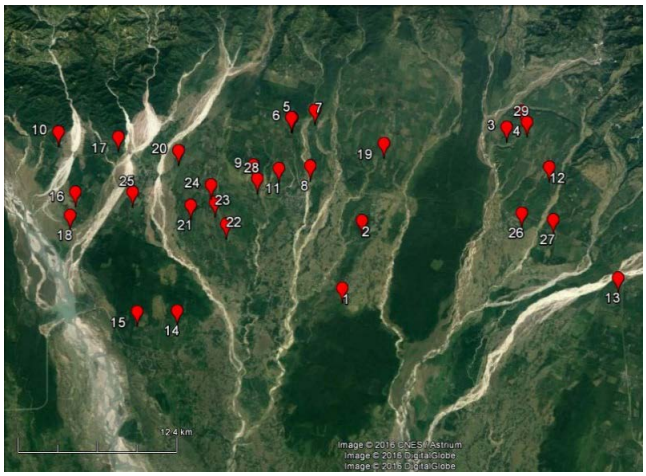


**Figure 1.** Tea gardens of Jalpaiguri district (Sr. No. 1-29).

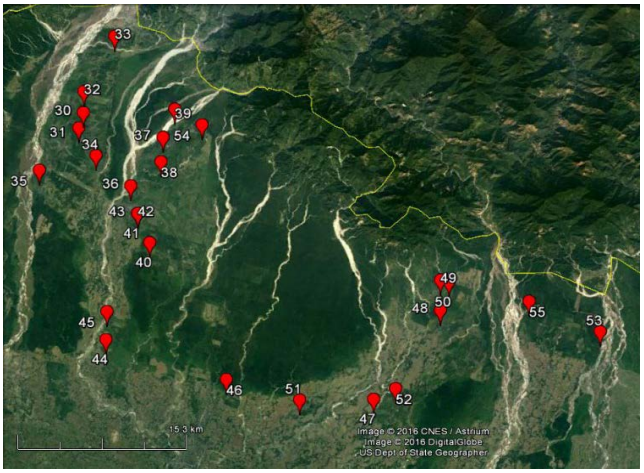


**Figure 2.** Tea gardens of Alipurduar district (Sr. No. 30-55).

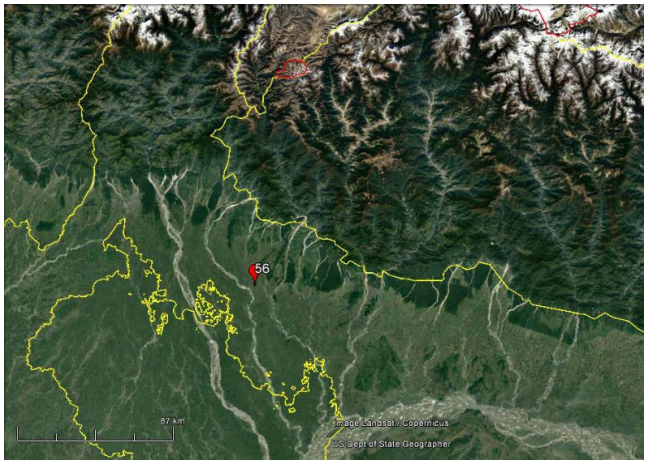


**Figure 3.** Tea garden of Kochbihar district (Sr. No. 56).

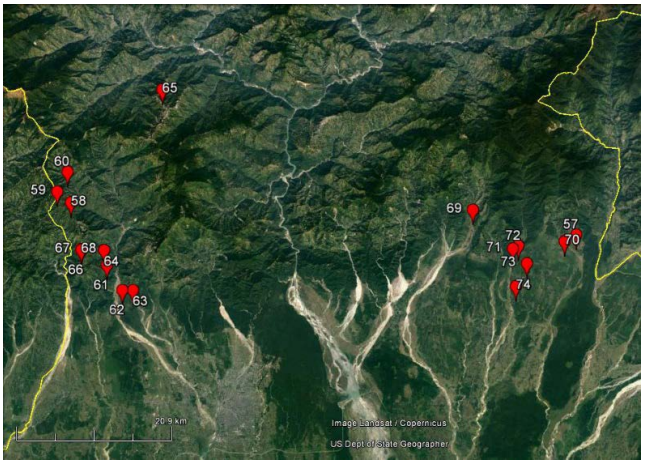


**Figure 4.** Tea gardens of Darjeeling district (Sr. No. 57-74).

## Methodology

The insects were randomly collected from various types of habitats observed in tea ecosystem. At day time, collections were operated by sweeping insect net, beating vegetation and handpicking method. The nocturnal insects were collected between 5.30 p.m. to 10.00 p.m. by using light trap (a white screen and a 27 Watt CFL lamp operated by portable rechargeable UPS machines). Collection permission was not granted after 10 PM., due to elephants and leopards movement. Butterflies and other macro insects were mostly photographed and identified in the field itself. The doubtful specimens were collected, killed by putting them in killing bottle containing ethyl acetate and brought to the laboratory in insect envelops. Soft bodied insects like Hymenopterans and some dipterans etc. were collected and preserved in glass vials containing 90 percent ethyl alcohol. The collected specimens, after bringing in Z.S.I. laboratory, were further processed using standard methods (Arora, 1986). The collected specimens were identified after setting and pinning by Scientists of Z.S.I., Kolkata.

## Brief Description of the Plant

*C. sinensis* (Linnaeus) belonging to the family Theaceae is an evergreen tree or shrub that attains a height of 10-15 m in the wild and 0.6-1.5 m when cultivated. These are characterized by the presence of light green leaves, short stalked, coriaceous, alternate, lanceolate, serrate margin, glabrous or pubescent beneath, varying in length from 5-30 cm and about 4 cm width. Mature leaves are bright green colored, smooth and leathery while young leaves are pubescent. Flowers are white fragrant, 2.5-4 cm in diameter, found in solitary or in clusters of two or four. Flowers bear numerous stamens with yellow anther and produce brownish red capsules (Ross, 2005). Fruit is a flattened, smooth, rounded trigonous three celled capsule, seed solitary in each, size of a small nut (Biswas, 2006).

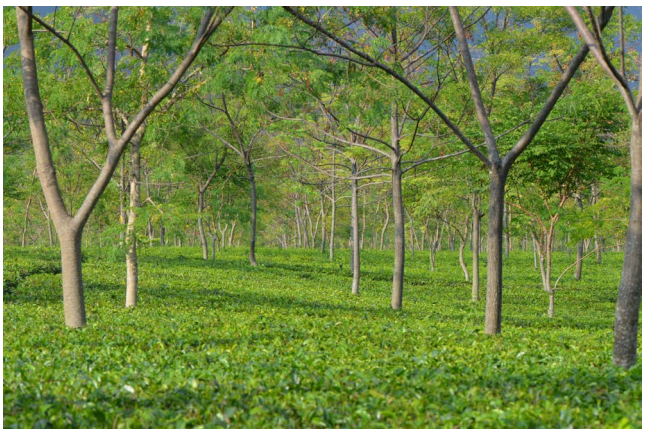

**Figure 5.** Tea garden before pruning.

**Figure 6.** Tea garden after pruning.

**Figure 7.** Tea plant.

**Figure 8.** Tea leaves.

**Figure 9.** Tea flower.

**Figure 10.** Tea fruits.

## Observations

74 tea gardens in 4 districts of North Bengal were surveyed, within the range of 26° 29.526° to 27° 03.070° North latitude to 88° 08.916° to 89° 43.517° East longitude and altitude from 127′ to 6630′ (Table 1). Of them, 29 tea gardens are in the Jalapiguri, 26 tea gardens in Alipurduar, 18 in Darjeeling and single in Kochbihar district. Most of the tea gardens were visited once in a year but few gardens visited for more than one time (Table 1). In all, 167 species belonging to 139 genera of 41 families under 6 order of insects were reported and identified from the tea gardens (74) of North Bengal.

**Table 1.** Details of visited Tea gardens of North Bengal

| Sr No. | Name of the Tea gardens | District | Geographical Position | Alt. (ft. ASL) | Visited months |
|---|---|---|---|---|---|
| 1 | BARODIGHI | Jalpaiguri | N26° 48.193", E 088° 47.790" | 470 | Jan-Feb |
| 2 | BATABARI | Jalpaiguri | N26° 51.149", E 088° 48.045" | 570 | December |
| 3 | HILLA | Jalpaiguri | N26° 56.244", E 088° 53.807"<br>N 26 56.847, E 88 53.509<br>N26° 57.039", E 088° 54.370" | 1138<br>950<br>1158 | Jan-Feb, July, December, June, August, January |
| 4 | NAGRAKATA TRA | Jalpaiguri | N26° 57.039", E 088° 54.370" | 1158 | Jan-Feb, July |
| 5 | MEENGLAS | Jalpaiguri | N26° 54.777", E 088° 43.834" | 667 | Jan-Feb, December, November |
| 6 | MAL NADY | Jalpaiguri | N26° 54.776", E 88° 43.785", N26° 54.776", E 88° 43.785" | 873 | December |
| 7 | NAKHATI | Jalpaiguri | N26° 55.289", E 088° 44.802" | 882 | December, January |
| 8 | SOONGACHI | Jalpaiguri | N26° 52.952", E 088° 45.126" | 608 | December, August, January |
| 9 | RANGAMUTTEE | Jalpaiguri | N26° 52.497", E 088° 42.489" | 575 | December, August |
| 10 | WASABARI | Jalpaiguri | N26° 52.156", E 088° 33.151" | 570 | Jan-Feb |
| 11 | NEDAM | Jalpaiguri | N26° 52.577", E 088° 43.695" | 600 | July |
| 12 | KURTI | Jalpaiguri | N26° 54.975", E 088° 56.161" | 907 | July, November |
| 13 | RED BANK | Jalpaiguri | 26 51.003', E 089 00.432', | 644 | July |
| 14 | ANANDPUR | Jalpaiguri | N26° 45.814", E 088° 40.385", N26 45.370, E 088 39.658, | 409<br>415 | December, June |

| | | | | | |
|---|---|---|---|---|---|
| 15 | KAILASHPUR | Jalpaiguri | N26° 45.432", E 088° 38.545"<br>N 26 45.370, E 088 39.658 | 442<br>415 | December, June |
| 16 | SONALI | Jalpaiguri | N26° 49.823", E 088° 34.511" | 465 | Jan-Feb, November |
| 17 | BAGRACOTE | Jalpaiguri | N26° 52.471", E 088° 35.969" | 551 | November, August, January |
| 18 | LEESH RIVER | Jalpaiguri | N 26° 48.813', E 088° 34. 495" | 495 | November |
| 19 | KILLCOTT | Jalpaiguri | N26° 54.520", E 088° 48.304" | 876 | December |
| 20 | RANICHHERA | Jalpaiguri | N26° 52.435", E 088° 38.888" | 565 | June |
| 21 | DAMDIM TG | Jalpaiguri | N 26 50.290, E O88 39.982" | 474 | June |
| 22 | BETGURI TG | Jalpaiguri | N 26 49.817, E O88 41.806" | 497 | June |
| 23 | KUMLAI TG | Jalpaiguri | N 26 50.626, E O88 41.070" | 533 | June |
| 24 | DIANA TG | Jalpaiguri | N 26 51.308, E O88 40.723" | 533 | June |
| 25 | ODLABARI | Jalpaiguri | N26° 50.323", E 088° 37.168" | 456 | December |
| 26 | BHOGOTPUR | Jalpaiguri | N26° 52.848, E 088° 55.350" | 587 | June |
| 27 | GRASS MORE | Jalpaiguri | N26° 52.846", E 088° 56.868" | 663 | June |
| 28 | NEW GLENCO | Jalpaiguri | N26° 51.963", E 088° 42.802" | 478 | August, November |
| 29 | NYA SHELLEY | Jalpaiguri | N26° 56.626", E 088° 54.693" | 1179 | November |
| 30 | BHARNOBARI | Alipurduar | N26° 44.735, E 089° 21.811" | 472 | June |
| 31 | SATALI | Alipurduar | N 26° 43.904, E 089° 21.773" | 442 | June |
| 32 | BEECH TG | Alipurduar | N 26° 45.807, E 089° 21.563" | 502 | June |
| 33 | MAHUA | Alipurduar | N 26° 48.947", E 089° 22.457" N 26° 49.044, E 089° 21.850" | 629<br>589 | Jan-Feb, December, November,July,June, |
| 34 | MADHU | Alipurduar | N 26° 42.709", E 089° 23.064" | 398 | November |
| 35 | SUBHASINI | Alipurduar | N 26° 41.316", E 089° 20.241" | 306 | November |
| 36 | KALCHINI | Alipurduar | N 26° 41.565", E 089° 25.320" | 420 | December, January |
| 37 | CHUAPARA | Alipurduar | N 26° 44.380", E 089° 26.394" | 517 | December |
| 38 | MECHPARA | Alipurduar | N 26° 43.125", E 089° 26.610" | 495 | December |
| 39 | RADHARANI | Alipurduar | N 26° 45.936", E 089° 26.646" | 625 | December |
| 40 | ATIABARI | Alipurduar | N 26° 38.904", E 089° 27.093" | 287 | December |
| 41 | TOORSA | Alipurduar | N 26° 49.557", E 089° 22.956" | 657 | December |
| 42 | BHATKAWA | Alipurduar | N 26° 40.243", E 089° 26.074" | 348 | December |
| 43 | DIMA | Alipurduar | N 26° 40.230", E 089° 26.043" | 345 | December, January |
| 44 | PATKAPARA | Alipurduar | N 26° 33.489", E 089° 26.069" | 239 | December |
| 45 | NIMTI JHORA | Alipurduar | N 26° 34.927", E 089° 25.744" | 229 | December,November |
| 46 | MAJHER DABRI | Alipurduar | N26° 32.839", E 089° 33.003" N26° 33.330", E 089° 30.638" | 151<br>127 | November |
| 47 | KOHINOOR | Alipurduar | N26° 33.498", E 089° 41.087" | 162 | November |
| 48 | KARTIKA | Alipurduar | N26° 38.747", E 089° 43.438" | 299 | November |
| 49 | RAHIMA BAD | Alipurduar | N26° 40.278", E 089° 43.036" | 351 | November |
| 50 | TURTURI | Alipurduar | N26° 40.274", E 089° 43.517" | 379 | November |
| 51 | SRINATH PUR | Alipurduar | N26° 32.626", E 089° 37.168" | 165 | November |
| 52 | DHOWLA JHORA | Alipurduar | N26° 34.283", E 089° 42.112" | 206 | November |

| | | | | | |
|---|---|---|---|---|---|
| 53 | SANKOSH TEA ESTATE | Alipurduar | N26$^0$39.463" E 089$^0$52.216" | 306 | December |
| 54 | BHATPARA | Alipurduar | N26$^0$45.455" E 089$^0$28.311" | 609 | December |
| 55 | NEW LANDS | Alipurduar | N26$^0$40.199" E 089$^0$48.028" | 316 | December |
| 56 | COOCHBEHAR TEA | Cooch Behar | N26$^0$29.526" E 089$^0$12.273" | 174 | December |
| 57 | KUMAI TEA ESTATE | Darjeeling | N26$^0$58.901" E 088$^0$50.468" | 1090 | December |
| 58 | THURBO | Darjeeling | N 26° 53.890", E 088° 10.106" | 5111 | June |
| 59 | OKAYTI | Darjeeling | N 26° 54.461", E 088° 08.916" | 5816 | June |
| 60 | SEEYOK | Darjeeling | N26° 55.995", E088° 09.321" | 4947 | June |
| 61 | GYABAREE | Darjeeling | N26° 49.975", E 088° 13.745" | 2528 | June |
| 62 | LONGVIEW | Darjeeling | N26° 48.404", E088° 15.282" | 1003 | June |
| 63 | MARIONBARI | Darjeeling | N 26° 48.562", E 088° 16.128" | 933 | June |
| 64 | SINGBULLI | Darjeeling | N 26$^0$51.009", E 088$^0$13.336" | 1100 | June |
| 65 | HAPPY VALLEY | Darjeeling | N 27° 03.070", E 088° 15.586" | 6630 | June |
| 66 | TINGLING | Darjeeling | N26° 50.726", E 088° 11.623" | 4178 | June |
| 67 | SOURENI | Darjeeling | N26° 50.726", E 088° 11.623"<br>N 26° 51.413", E 088° 11.671" | 4178<br>4434 | June |
| 68 | PHUGURI | Darjeeling | N26° 50.726", E 088° 11.623" | 4178 | June |
| 69 | AMBIOKE | Darjeeling | N26 59.164", E 088 41.840" | 1551 | June |
| 70 | YOUNTANG | Darjeeling | N 26° 58.246", E 088° 49. 651" | 1203 | November |
| 71 | ZURRANTEE | Darjeeling | N 26° 56.997", E 088° 45. 658" | 1037 | November |
| 72 | ENGO | Darjeeling | N 26° 57.283", E 088° 46. 047" | 1130 | November |
| 73 | NAGAISUREE | Darjeeling | N 26° 56.152", E 088° 47. 013" | 830 | November |
| 74 | INDONG | Darjeeling | N 26° 54.376", E 088° 46. 509" | 815 | November |

## Order LEPIDOPTERA

Butterflies, moths and skippers are one of the most important groups of insect in the animal world under the order Lepidoptera. They are beautiful in colours, diverse in their numbers, and play a pivotal role in the faunal analysis and environmental monitoring and planning of any region. The role of butterflies and some moths in any habitat is best known by even common people nowadays, as good and potential natural pollinators, ecological indicators etc., which enable to assess or monitor habitat changes. Among insects, butterflies are well studied groups in terms of their taxonomy, geographic distribution etc., and therefore, they are the suitable group for ecological studies, Butterflies show distinct pattern of habitat utilization. The presence of butterflies denotes the availability of larval food plants in great abundance. Butterfly host plants are those plants, on which specific butterfly species lay eggs, and caterpillars will then hatch and use plant as their sole food source. Butterflies are generally diurnal and visit flowers that open in the morning and also during the hours of bright sunshine.

Presently 37 species belonging to 06 families of butterflies from North Bengal tea gardens were collected and identified. Of them, Nymphalidae shares 20 species followed by Pieridae (10 species), Hesperiidae (03 species), Papilionidae (02 species), Lycaenidae (01 species) and Riodinidae (01 species) (Table 2).

**Table 2.** List of Butterflies associated with tea plants of North Bengal

| No. | Species |
|---|---|
| | **Family HESPERIIDAE** |
| 1 | *Celaenorrhinus leucocera* (Kollar, 1844) |
| *2* | *Pelopidas mathias* (Fabricius, 1798) |
| *3* | *Tagiades japeteus attieus* (Fabricius, 1793) |
| | **Family LYCAENIDAE** |
| 4 | *Poritia hewitsoni* Moore, 1865 |

| | |
|---|---|
| | **Family NYMPHALIDAE** |
| 5 | *Aglais cshmirensis* (Kollar, 1848) |
| 6 | *Athyma kanwa* Moore, 1858 |
| 7 | *Athyma perius* (Linnaeus, 1758) |
| 8 | *Danaus chrysippus* (Linnaeus, 1758) |
| 9 | *Danaus genutia* (Cramer, 1779) |
| 10 | *Euploea core core* (Cramer, 1780) |
| 11 | *Euploea mulciber mulciber* (Cramer, 1777) |
| 12 | *Junonia almana* Linnaeus, 1758 |
| 13 | *Junonia atlites* Linnaeus, 1763 |
| 14 | *Junonia hierta* (Fabricius, 1798) |
| 15 | *Junonia iphita* Cramer, 1779 |
| 16 | *Junonia lemonias* (Linnaeus, 1758) |
| 17 | *Melanitis leda* (Linnaeus, 1758) |
| 18 | *Mycalesis perseus blasius* (Fabricius, 1798) |
| 19 | *Neptis hylas astola* Linnaeus, 1872 |
| 20 | *Parantica aglea melanoides* Moore, 1883 |
| 21 | *Symbrenthia hippoclus* (Cramer, 1782) |
| 22 | *Tirumala hamata septentrionis* (Butler, 1874) |
| 23 | *Ypthima hubneri* Kirby, 1871 |
| 24 | *Ypthima similis* Elwis & Edward, 1893 |
| | **Family PAPILIONIDAE** |
| 25 | *Papilio polytes stichius* Evans, 1912 |
| 26 | *Parides dasarada* (Moore, 1857) |
| | **Family PIERIDAE** |
| 27 | *Appias libythea* (Fabricius, 1775) |
| 28 | *Catopsilia crocale* Cramer, 1775 |
| 29 | *Catopsilia pomona* (Fabricius, 1775) |
| 30 | *Catopsilia pyranthe* (Linnaeus, 1758) |
| 31 | *Cepora nadina* (Lucas, 1852) |
| 32 | *Eurema blanda silhetana* Wallace, 1867 |
| 33 | *Eurema hecabe* (Linnaeus, 1758) |
| 34 | *Hebomoia glaucippe* (Linnaeus, 1758) |
| 35 | *Leptosia nina nina* (Fabricius, 1739) |
| 36 | *Pieris brassicae* (Linnaeus, 1758) |
| | **Family RIODINIDAE** |
| 37 | *zemeros flegyas* (Guerin, 1843) |

Beside above, 40 species belonging to 06 families of moths are found associated with tea plants in North Bengal. The family Erebidae dominates with 15 species followed by the family Crambidae (09 species), Geometridae (08 species), Sphingidae (04 species), Zygaenidae (03 species) and Torticidae (01 species). Present communication reports 20 moth species (*) as tea pests from North Bengal (Table 3).

**Table 3.** List of moths associated with tea plants of North Bengal

| No. | Species |
|---|---|
| | **Family CRAMBIDAE** |
| 1 | *Omiodes surrectalis* (Walker, 1866) |
| 2 | *Arthroschista hilaralis* (Walker, 1859) |
| 3 | *Glyphodes stolalis* Guenee, 1854 |
| 4 | *Parotis marginata* (Hampson, 1893) |
| 5 | *Herpetogramma licarsisalis* (Walker, 1859) |
| 6 | *Cnaphalocrocis poeyalis* (Boisduval, 1833) |
| 7 | *Nosophora semitritalis* (Lederer, 1863) |
| 8 | *Eoophyla sejuncta* (Snellen, 1876 ) |
| 9 | *Diaphania* sp. |
| | **Family EREBIDAE** |
| 10* | *Arctornis submarginata* Walker, 1855 |
| 11* | *Somena scintillans* (Walker, 1856) |
| 12* | *Lymantria marginalis* (Walker, 1862) |
| 13* | *Miltochrista cuneonotata* (Walker, 1855) |
| 14 | *Chionaema bianca* (Walker, 1856) |
| 15* | *Nyctemera adversata* Schaller, 1788 |
| 16* | *Creatonotos transiens* (Walker, 1855) |
| 17 | *Creatonotos gangis* (Linnaeus, 1763) |
| 18* | *Argina argus* (Kollar, 1844) |
| 19 | *Argina astrea* (Drury, 1773) |
| 20 | *Asota egens* (Walker, 1854) |
| 21* | *Arna bipunctapex* Hampson, 1891 |
| 22* | *Euproctis* sp. |
| 23* | *Orgyia* sp. |
| 24 | *Callimorpha plagiata* Walker, 1855 |
| | **Family GEOMETRIDAE** |
| 25* | *Ascotis selenaria* (Denis & Schiffermiller, 1775) |
| 26* | *Biston suppressaria* (Guenee, 1858) |
| 27* | *Hyposidra talaca* Walker, 1860 |
| 28* | *Hyposidra infixaria* Walker, 1860 |
| 29 | *Semiothisa eleonora* (Villers, 1789) |
| 30* | *Ectropis* sp. |
| 31* | *Cleora* sp. |
| 32* | *Petelia* sp. |
| | **Family SPHINGIDAE** |
| 33 | *Theretra nessus* Drury, 1773 |
| 34 | *Hippotion boerhaviae* (Fabricius, 1775) |

| | |
|---|---|
| 35 | *Argius convolvuli* (Linnaeus, 1758) |
| 36 | *Acosmeryx omissa* Rothschild and Jordan, 1903 |
| | **Family TORTRICIDAE** |
| 37 | *Loboschiza koenigiana* (Fabricius, 1775) |
| | **Family ZYGAENIDAE** |
| 38* | *Eterusia aedea aedea* Linnaeus, 1763 |
| 39* | *Eterusia edcola* Doubleday, 1847 |
| 40* | *Trypanophora semihyalina* Kollar, 1844 |

## Order HEMIPTERA

Hemiptera (True Bugs), is a very large and diverse order and also important in agriculture, known to cause direct damage to plants by herbivory and indirectly by transporting diseases. Predatory Hemiptera have also been used in agricultural systems to control pests

29 species belonging to 28 genera of hemipteran bugs from the tea gardens of North Bengal were reported. Of them, the family Pentatomidae shares the highest number of species (07), followed by Coreidae (04), Lygaeidae (03), Fulgoridae (03), Reduviidae (03), Cicadidae (02), Cercopidae (01), Membracidae (01), Largidae (01), Pyrrhocoridae (01), Scutelleridae (01), Miridae (01). 05 hemipteran species (*) were reported as pest of tea from North Bengal (Table 4).

**Table 4.** List of hemipteran species associated with tea plants of North Bengal

| No. | Species |
|---|---|
| | **Family CERCOPIDAE** |
| 1 | *Leptataspis fulviceps* (Dallas, 1850) |
| | **Family CICADIDAE** |
| 2* | *Huechys sanguinea* (De Geer, 1773) |
| 3 | *Paomponia picta* (Walker, 1870) |
| | **Family FULGORIDAE** |
| 4 | *Lawana conspersa* (Walker, 1851) |
| 5 | *Ricania speculum* (Walker, 1851) |
| 6 | *Polydictya tricolor* (Westwood, 1845) |
| | **Family MEMBRACIDAE** |
| 7 | *Darthula hardwicki* (Gray, 1831) |
| | **Family COREIDAE** |
| 8 | *Cletus bipunctatus* (Herrich-Schaffer, 1840) |
| 9 | *Riptortus linearis* (Fabricius, 1775) |
| 10 | *Riptortus pedestris* (Fabricius, 1775) |
| 11* | *Elasmomia granulipes* (Westwood, 1842) |
| | **Family LYGAEIDAE** |
| 12 | *Paromius exiguous* (Distant, 1883) |
| 13 | *Metochus uniguttatus* (Thunberg, 1879) |
| 14 | *Graptostethus trisignatus* (Distant, 1879) |
| | **Family PENTATOMIDAE** |
| 15* | *Halys dentatus* (Fabricius, 1775) |
| 16 | *Nezara viridula* (Linnaeus, 1758) |
| 17* | *Andrallus spinidens* (Fabricius, 1787) |
| 18 | *Tolumnia latipes* (Dallas, 1851) |
| 19 | *Erthesina fullo* (Thunberg, 1783) |
| 20 | *Plautia crossata* (Stal, 1869) |
| 21 | *Eocanthecona furcellata* (Wolf, 1811) |
| | **Family LARGIDAE** |
| 22 | *Macroceraria grandis* (Gray, 1832) |
| | **Family PYRRHOCORIDAE** |
| 23 | *Odontopus nigricornis* (Stall, 1861) |
| 24 | *Physopelta quadrigutta* (Bergroth, 1894) |
| | **Family REDUVIIDAE** |
| 25 | *Vilius melanopterus* (Stall, 1863) |
| 26 | *Coranus spiniscutis* (Reuter, 1881) |
| 27 | *Triatoma rubrofasciatus* (De Geer, 1773) |
| | **Family SCUTELLERIDAE** |
| 28 | *Cantao ocellatus* (Thunberg, 1784) |
| | **Family MIRIDAE** |
| 29* | *Helopeltis theivora* (Waterhouse, 1886) |

## Order DIPTERA

The Diptera are commonly known as "True flies" and include many familiar insects such as mosquitoes, flies (black flies, fruit flies, blow flies, house flies etc.), midges (biting, non-biting), gnats (fungus, root), keds, bots etc. This diversity of names denotes the importance of the group and reflects the range of organisms in the order. Diptera exploit most of the available ecological niches in most of the biological roles, e.g., saprophages (many), commensals (some Scatopsidae, Chironomidae and Phoridae), predators (many), parasites (many), symbionts (some Chironomidae and algae) and scavengers.

24 species under 23 genera of (08) families of Diptera were reported from the tea gardens of North Bengal (Table 5). Of them, the family Syrphidae shares maximum number of species (09), followed by Asilidae (04), Bombyllidae (02), Calliphoridae (02), Rhiniidae (02),

Muscidae (02) and Sarcophagidae (02) and Tipulidae (01). Shah and Mitra (2015) reports *Microstyllum pseudoanantakrishnanii* Joseph and Parui as the predator of the moths from the tea gardens of North Bengal (**). Das *et al.* (2010) confirmed 54 species of predators of insect pests from tea gardens of northern West Bengal, of which a single dipteran species *Ischiodon scutellaris* (**) as a predator (maggot stage) of tea pest (Table 5).

**Table 5.** List of dipteran species associated with tea plants of North Bengal

| No. | Species |
|---|---|
| | **Family TIPULIDAE** |
| 1 | *Nephrotoma consimilis* (Brunetti, 1911) |
| | **Family ASILIDAE** |
| 2** | *Microstyllum pseudoanantakrishnanii* (Joseph & Parui, 1982) |
| 3 | *Microstyllum brunnipenne* (Macquart, 1849) |
| 4 | *Cophinopoda chinensis* (Fabricius, 1794) |
| 5 | *Promachus duvaucelii* (Macquart, 1838) |
| | **Family SYRPHIDAE** |
| 6 | *Volucella* sp. |
| 7 | *Episyrphus balteatus* (De Geer, 1776) |
| 8 | *Eristalis tenax* (Linnaeus, 1758) |
| 9 | *Mesembrias* sp. |
| 10 | *Eristalodes paria* (Bigot, 1880) |
| 11 | *Eristalinus arvorum* (Fabricius, 1787) |
| 12 | *Melanostoma orientale* (Wiedemann, 1824) |
| 13 | *Betasyrphus serarius* (Wiedemann, 1830) |
| 14** | *Ischiodon scutellaris* (Fabricius, 1805) |
| | **Family BOMBYLIIDAE** |
| 15 | *Hyperalonia suffusipennis* (Brunetti, 1909) |
| 16 | *Exoprosopa (Exoprosopa) insulata* (Walker, 1852) |
| | **Family CALLIPHORIDAE** |
| 17 | *Chrysomya megacephala* (Fabricius, 1794) |
| 18 | *Hemipyrellia ligurriens* (Wiedemann, 1830) |
| | **Family RHINIIDAE** |
| 19 | *Idiella mandarina* (Wiedemann, 1830) |
| 20 | *Stomorhina discolor* (Fabricius, 1794) |
| | **Family MUSCIDAE** |
| 21 | *Musca (Musca) domestica* (Linnaeus, 1758) |
| 22 | *Neomyia indica* (Robineau-Desvoidy, 1830) |
| | **Family SARCOPHAGIDAE** |
| 23 | *Sarcophaga (Liosarcophaga) dux* (Thomson, 1869) |
| 24 | *Sarcophaga* sp. |

## Order COLEOPTERA

Coleoptera (beetles and weevils) is the largest order in the class Insecta. They feed on a wide variety of diets, inhabit all terrestrial and fresh-water environments, and exhibit a number of different life styles. Many species are herbivores, adapted to feed on the roots, stems, leaves, or reproductive structures of their host plants. Some species live on fungi, others burrow into plant tissues and some excavate tunnels in wood or under bark. Many beetles are predators. Some beetles are scavengers, feeding primarily on carrion, decaying wood or other dead organic matter.

19 species under 16 genera belonging to 05 families of the order Coleoptera were reported from the tea gardens of North Bengal (Table 6). Of them, Scarabaeidae represent 09 Species followed by Cerambycidae (06 Species), Coccinellidae (02 Species), Lucanidae (01 species) and Curculionidae (01 species). Among the family Scarabaeidae, three species namely, *Holotrichia* sp., *Anomala dimidiata* and *Xylotrupes gideon* are reported as pests of tea (Roy *et al.*, 2014).

Only two species of the family Cocinellidae, *Micraspis discolor* and *Coccinella septempunctata* are recorded during present study (Table 6). *Micraspis discolor* is the most abundant species of coccinellid in all the ecosystems. Roy *et al.,* (2010) were observed twenty species of coccinellid predators in Sub-Himalayan tea plantation of North Bengal during 2004 to 2006. Of these, *Micraspis discolor* (**) was dominant (42.5%) in the conventionally managed tea plantations. The life cycle studies also suggested that the tea aphid was the preferred prey for *Micraspis discolor*, but the predator can survive on red spider mite also Roy *et al.*, (2010). The abundance of adult *M. discolor* in rice at flowering phase does not correspond to prey abundance in the field but rather reflects an inclination to pollen feeding more than entomophagy (Shanker *et al.* 2013). *C. septempunctata* (**) has a broad ecological range. Both the adults and the larvae are voracious predators of aphids. The diversity of lady bird beetles in tea ecosystem may be due to the complex and stable ecosystem of tea plantations.

05 species (*) as pest and 02 species as predators (**) of the order Coleoptera were reported from the tea gardens of North Bengal (Table 6).

**Table 6.** List of coleopteran species associated with tea plants of North Bengal

| No. | Species |
|---|---|
| | **Family CERAMBYCIDAE** |
| 1 | *Dorysthenes (Lophosternus) indicus* (Hope, 1831) |
| *2* | *Dorysthenes (Paraphrus) granulosus* (Thomson, 1861) |
| *3* | *Xystrocera globosa* (Olivier, 1795) |
| 4 | *Aristobia approximator* (Thomson, 1865) |
| 5 | *Batocera rufomaculata* (De Geer, 1775) |
| 6 | *Nupserha* sp. |
| | **Family SCARABAEIDAE** |
| 7* | *Xylotrupes gideon* (Fabricius, 1775) |
| 8* | *Catharsius molossus* (Linnaeus, 1758) |
| 9 | *Catharsius sagax* (Quenstedt, 1806) |
| 10 | *Onitis subopacus* (Arrow, 1931) |
| 11* | *Holotrichia* sp. |
| 12 | *Brahmina* sp. |
| 13 | *Anomala grandis* (Hope, 1840) |
| 14* | *Anomala dimidiata* (Hope, 1831) |
| 15 | *Melolontha guttigera* (Sharp, 1876) |
| | **Family COCCINELLIDAE** |
| 16** | *Micraspis discolor* (Fabricius, 1798) |
| 17** | *Coccinella septempunctata* (Linnaeus,1758) |
| | **Family LUCANIDAE** |
| 18 | *Odontolabis siva* (Hope & Westwood, 1845) |
| | **Family CURCULIONIDAE** |
| 19* | *Astycus lateralis* (Fabricius, 1792) |

## Order ODONATA

The Odonata is an important insect order which comprises of fascinating and harmless insects popularly known as dragonflies (Anisoptera) and damsel flies (Zygoptera). Odonates are amphibiotic and diverse in nature. Many of these species inhabit wide variety of natural fresh water habitats, though there are some species which have adapted themselves to man-made water bodies. Being habitat specific and sensitive to habitat change their presence or absence indicates the quality of an ecosystem. They are considered as beneficial insects because their larvae (aquatic) and adults (terrestrial) are predators. Thus, assist in control of insect pest populations.

12 species under 08 genera belonging to 02 families of the order Odonata were reported from different tea gardens of North Bengal. The family Libellulidae shared 09 species and the family Coenagrionidae shared 03 species.

Das *et al.* (2010) observed that in sub Himalayan tea plantations of North Bengal, 4% of the predatory insects comprised of odonates. Present study documented *Orthetrum sabina* (Drury) (**) predates on the *Hyposidra talaca* (Walker) in the tea gardens of North Bengal (Table 7).

**Table 7.** List of odonate species associated with tea plants of North Bengal

| | **Family LIBELLULIDAE** |
|---|---|
| 1 | *Crocothemis erythraea* (Brulle, 1832) |
| 2 | *Crocothemis servilia* (Drury, 1773) |
| 3 | *Diplacodes trivialis* (Rambur, 1842) |
| 4 | *Neurothemis fulvia* (Drury, 1773) |
| 5 | *Orthetrum glaucum* (Brauer, 1865) |
| 6 | *Orthetrum pruinosum* (Burrneister, 1839) |
| 7** | *Orthetrum sabina* (Drury, 1770) |
| 8 | *Pantala flavescens* (Fabricius, 1798) |
| 9 | *Trithemis festiva* (Rambur, 1842) |
| | **Family COENAGRIONIDAE** |
| 10 | *Ischnura aurora* (Brauer, 1865) |
| 11 | *Pseudagrion microcephalum* (Rambur, 1842) |
| 12 | *Pseudagrion rubriceps* (Selys, 1876) |

## Order ORTHOPTERA

The insects under order Orthoptera are popularly known as grasshoppers, crickets etc. These insects inhabit many variety of habitats, like open grasslands, gardens, pastures, agro-fields, swamps and rain forests etc. Present communication reports 06 species under 06 genera belonging to 03 families of Orthoptera from the tea gardens of North Bengal (Table 8). Of them, Tettigonidae shares highest number of species (04) followed by Gryllidae and Pyrgomorphidae one species each. Nath *et al.*, (2009) has been detected *Atractomorpha crenulata* (Fabricius, 1793) as possible pest of tea plant and other crops. Present communication reports only four orthopteran species (*) as pest of tea plant from North Bengal (Table 8).

**Table 8.** List of orthopteran species associated with tea plants of North Bengal

| No. | Species |
|---|---|
| | **Family TETTIGONIDAE** |
| 1* | *Holochlora indica* (Kirby, 1906) |

| | |
|---|---|
| 2 | *Ducetia japonica* (Thunberg, 1815) |
| 3 | *Euconocephalus pallidus* (Redtenbacher, 1891) |
| 4* | *Mecopoda elongata* (Linnaeus, 1758) |
| | **Family GRYLLIDAE** |
| 5* | *Tarbinskiellus orientalis* (Fabricius, 1775) |
| | **Family PYRGOMORPHIDAE** |
| 6* | *Atractomorpha crenulata* (Fabricius, 1793) |

## Discussion

Tea is grown as a perennial monoculture crop over large contiguous areas in different parts of India. These tea gardens itself occupy a wide variety of functional niches and microhabitats. Insects, the most diverse component of tea gardens play a major role in the sustainable and healthy functioning of tea ecosystem. The tea estates of Assam and North Bengal are well known for the pest infestation since time immemorial. The tea garden owners/ researcher/ managers are only interested to high yields and control of the major pests. Therefore, there conventional tea cultivation has often accomplished high yields and stable crop production which need more use of chemical pesticides. These ultimately lead resistance, resurgence of pests and destruction of natural enemies.

In addition to this, there is very limited taxonomic knowledge on other group of insects who are also part and parcel of this tea ecosystem. In fact, there number is more and playing vital role in maintaining ecosystem healthy and sustainable. Keeping this in view, the present study was conducted in 74 tea gardens to identify the tea plant associated insects and their functional role in tea garden ecosystem.

**Table 9.** List of pest, predator and pollinators species of other plants reported from the tea ecosystem of North Bengal

| **Order LEPIDOPTERA** | | |
|---|---|---|
| **No** | **Species** | **Biological Role** |
| Family SPHINGIDAE | | |
| 1 | *Theretra nessus* (Drury, 1773) | *Dioscorea* (family Dioscoreaceae), *Amarantahceae*, *Cucurbitaceae* |
| 2 | *Hippotion boerhaviae* (Fabricius, 1775) | Amarantahceae, Cucurbitaceae, Rubiaceae |
| 3 | *Argius convolvuli* (Linnaeus, 1758) | *Arachis hypogaea* (groundnut), *Chrysanthemum* (daisy), *Colocasia esculenta* (taro), Helianthus annuus (sunflower), *Ipomoea batatas* (sweet potato), *Vigna mungo* (black gram), *Vignara diata* (mung bean), *Vigna unguiculata* (cowpea), *Vigna vexillata* (wild sweet pea) |
| Family GEOMETRIDAE | | |
| 4 | *Semiothisa eleonora* (Villers, 1789) | Pest of *Mimosa rubicaulis* and *Acacia concinna* |
| Family PIERIDAE | | |
| 5 | *Catopsilia pyranthe* (Linnaeus, 1758) | Pests of crops |
| 6 | *Eurema blanda silhetana* (Wallace, 1867) | Pest of shade trees of tea plantations |
| 7 | *Eurema hecabe* (Linnaeus, 1758) | Pests of timber plants |
| 8 | *Pieris brassicae* (Linnaeus, 1758) | Pest of Cruciferous plants |
| Family LYCAENIDAE | | |
| 9 | *Poritia hewitsoni* (Moore, 1865) | Pest of Sal forests |
| **Order HEMIPTERA** | | |
| Family CERCOPIDAE | | |
| 10 | *Leptataspis fulviceps* (Dallas, 1850) | Phytopgagus |
| Family CICADIDAE | | |
| 11 | *Paomponia fusca* (Olivier, 1790) | Phytophagus |
| Family FULGORIDAE | | |
| 12 | *Lawana conspersa* (Walker, 1851) | Phytophagus |
| 13 | *Ricania speculum* (Walker, 1851) | Oil Palm |

| | | |
|---|---|---|
| Family COREIDAE | | |
| 14 | *Cletus bipunctatus* (Herrich-Schaffer, 1840) | *Amaranthus viridis* L. *Portula caoleracea* L. |
| | *Riptortus linearis* (Fabricius, 1775) | Maize, Millets, Pulses, Sorghum,<br><br>Soyabean, Sweet Potato and Murraya koenigii. |
| 15 | *Riptortus pedestris* (Fabricius, 1775) | Mung Bean, legume crops |
| Family LYGAEIDAE | | |
| 16 | *Paromius exiguous* (Distant, 1883) | Rice |
| 17 | *Graptostethus trisignatus* (Distant, 1879) | Phytophagus |
| Family PENTATOMIDAE | | |
| 18 | *Tolumnia latipes* (Dallas, 1851) | *Vigna unguiculatas esquipedalis* , *Sanatalum album*, *Solanum nigrum* and *Lantana* sp. |
| 19 | *Eocanthecona furcellata* (Wolff, 1811) | Predator |
| Family LARGIDAE | | |
| 20 | *Macrocheraia grandis* (Gray, 1832) | Cotton, okra, hibiscus, *Trewia nudiflora, Bombax ceiba*, etc. |
| Family PYRRHOCORIDAE | | |
| 21 | *Odontopus nigricornis* (Stal, 1861) | *Sterculia foetida, Acacia mangium, , Acacia auriculiformis* |
| 22 | *Physopelta quadrigutta* (Bergroth, 1894) | Phytophagous |
| Family REDUVIIDAE | | |
| 23 | *Vilius melanopterus* (Stal, 1863) | Mainly ants, bes, termites |
| 24 | *Coranus spiniscutis* (Reuter, 1881) | Soft bodied insects, catterpiller, termites |
| 25 | *Triatoma rubrofasciatus* (De Geer, 1773) | Haematophagous |
| **Order DIPTERA** | | |
| Family ASILIDAE | | |
| 26 | *Microstyllum brunnipenne* (Macquart, 1849) | Predator |
| 27 | *Cophinopoda chinensis* (Fabricius, 1794) | Predator |
| 28 | *Promachus duvaucelii* (Macquart, 1838) | Predator |
| Family SYRPHIDAE | | |
| 29 | *Volucella* sp. | Flower visitors of tea plants |
| 30 | *Eristalis tenax* (Linnaeus, 1758) | Effective pollinators of different plant species. |
| 31 | *Mesembrias* sp. | Flower visitor of different plants. |
| 32 | *Eristalodes paria* (Bigot, 1880) | Flower visitor of *Helianthus* sp. |
| 33 | *Eristalinus arvorum* (Fabricius, 1787) | Flower visitor of several flowers. |
| 34 | *Melanostoma orientale* (Wiedemann, 1824) | Effective pollinator of *Brassica juncea*. |
| Family BOMBYLIIDAE | | |
| 35 | *Hyperalonia suffusipennis* (Brunetti, 1909) | Predator |
| 36 | *Exoprosopa (Exoprosopa) insulate* (Walker, 1852) | Effective pollinator of some medicinal plants in India. |
| Family CALLIPHORIDAE | | |
| 37 | *Chrysomya megacephala* (Fabricius, 1794) | Flower visitor |
| 38 | *Hemipyrellia ligurriens* (Wiedemann, 1830) | Pollinator of *Periscaria chinensis*. |

| | | |
|---|---|---|
| Family RHINIIDAE | | |
| 39 | *Idiella mandarina* (Wiedemann, 1830) | Flower visitor |
| 40 | *Stomorhina discolour* (Fabricius, 1794) | Flower visitor of *Brassica juncea*. |
| Family MUSCIDAE | | |
| 41 | *Musca (Musca) domestica* (Linnaeus, 1758) | Most common flower visitor |
| 42 | *Neomyia indica* (Robineau-Desvoidy, 1830) | Flower visitors of *Alstonia scholaris* and *Helianthus annuus.* |
| **Order COLEOPTERA** | | |
| Family CERAMBYCIDAE | | |
| 43 | *Dorysthenes (Lophosternus) indicus* (Hope, 1831) | Root borer |
| 44 | *Dorysthenes (Paraphrus) granulosus* (Thomson, 1861) | Root borer |
| 45 | *Xystrocera globosa* (Olivier, 1795) | Pest of shade tree of tea garden |
| 46 | *Aristobia approximator* (Thomson, 1865) | Borers of dead log |
| 47 | *Batocera rufomaculata* (De Geer, 1775) | Borers of dead log |
| 48 | *Nupserha* sp. | Borers of dead log |
| Family SCARABAEIDAE | | |
| 49 | *Onitis subopacus* Arrow. 1931 | Coprophagous |
| 50 | *Holotrichia* sp. | Coprophagous |
| 51 | *Brahmina* sp. | Root of Young Tea and Seedling Plants |
| 52 | *Anomala grandis* (Hope, 1840) | Phytophagous |
| Family LUCANIDAE | | |
| 53 | *Odontolabis siva* (Hope & Westwood, 1845) | Root borer |

In this research work, 167 species belonging to 139 genera of 42 families under 06 order of insects from the tea gardens of North Bengal. Of them, Lepidoptera contained the highest number of species (77), followed by Hemiptera (29), Diptera (24), Coleoptera (19), Odonata (12) and Orthoptera (06).

Among the order Lepidoptera, 37 species are butterflies reported from these tea gardens. According to Krenn (2010), the majority of butterflies feed on floral nectar, though their role as effective pollinators remains doubtful in many examples (Courtney *et al.*, 1982; Wiklund, 1981; Wiklund *et al.*, 1979). In fact, some authors regard butterflies as opportunistic flower visitors that use resources as they become available during the season (Shreeve, 1992; Stefanescu and Traveset, 2009; Tudor *et al.*, 2004). Besides this, some butterflies reported from Tea ecosystems are considered as pest of other plants. Chaudhary and Saravanan (2013) reported *Catopsilia pyranthe* (Linnaeus, 1758) as one of the major pests of lndian senna (*Cassia angustifolia* Yehl). Jha and Sen Sharma (2008) reported *Eurema hecabe* (Linnaeus, 1758) as pest of *Tectona grandis*. The other butterflies recorded as pest of *Tectona grandis* by Jha and Sen Sharma (2008) is *Poritia hewitsoni* (Table 9). In their study, David *et al.*, (2004) recorded *Eurema blanda silhetana* as pest of shade trees of tea plantations. Similarly, *Pieris brassicae* reported in this communication is well known pest of Cruciferous plants (Sharma, 2011) (Table 9). Among the 40 species of moths reported during this study period, *Arctornis submarginata*, *Somena scintillans*, *Lymantria marginalis*, *Miltochrista cuneonotata*, *Nyctemera adversata*, *Creatonotos transiens*, *Argina argus*, *Arna bipunctapex*, *Euproctis* sp., *Orgyia* sp., of the family Erebidae and *Ascotis selenaria*, *Biston suppressaria*, *Hyposidra talaca*, *Hyposidra infixaria*, *Ectropis* sp., *Cleora* sp., *Petelia* sp. of the family Geometridae are the recognised pests of Tea. Besides this, *Eterusia aedea aedea*, *Eterusia edcola*, *Trypanophra semihyalina* of the family Zygaenidae are also the major threats of Tea gardens in North Bengal (Table 9). Present communication reports 29 species of hemipteran bugs

from the tea gardens of North Bengal. Of them, 14 species of hemipteran bugs are found as pests and 3 species as carnivore/predators of other crops (Table 9). Ariyarathna *et al.*, (2007) stated that, insufficient knowledge on breeding systems and floral biology is a major barrier in strategic planning of practical tea crop breeding programmes as well as in research on tea crop improvement. As observed, tea flowers being bisexual, bowl shaped, actinormorphic, with large number of stamens, are unspecialised and arranged solitarily or loosely clustered. Faegri and Pijl (1979) reported that such characteristics are typical floral syndromes among insect pollinated plant species. In their study, Bezbaruah (1975), Wickramaratne and Vitarana (1985) showed that, general pollinators, mainly dipterans contribute to pollination success in tea. A study on *Camelia sinensis* from Sri Lanka by Wickramaratne and Vitarana (1985) reveals that dipteran flies were numerous (60-90 % of total insects) and the efficient pollinators of tea whereas bees only visit seasonally and in very few numbers. Mitra *et al.*, (2017) are also discussed about their pollination ability on tea plants in North Bengal. Present study recorded 24 species of 8 families from the tea gardens of North Bengal (Table 5). Of them, the syrphids, bombyllids, calliphorids and muscids are potetial pollinators of many crop plants (Table 9). Beside their role as pollination, dipterans are also act as biological control agents. Robber flies (Diptera: Asilidae) are the natural predators to several insect pest for different agricultural crops or plants. Various work reveals robber fly as the predators of spider (Dennis *et al.*, 2012) and insects like Hymenoptera (Dennis and Lavigne, 2007), Lepidoptera, (Dennis *et al.*, 2012), Coleoptera, (Shelly and Pearson, 1978), Orthoptera, (Joern and Rudd, 1982) and Hemiptera (Dennis *et al.*, 2010). In this communication, 3 species of robber flies, viz. *Microstyllum brunnipenne* Macquart, 1849, *Cophinopoda chinensis* (Fabricius, 1794) and *Promachus duvaucelii* (Macquart, 1838) are reported which are carnivores and predators (Table 9). Among five families of the order Coleoptera from the tea gardens of North Bengal scarabs are the dominant group found during this study. Adults of this beetle generally feed on dung, carrion, fungi, vegetation, pollen, fruits, compost or roots. Unfortunately knowledge on the Indian scarab beetles is still poor. Only need of the hour is to utilize this potential boioresource in the interest of human society. The scarabs reported during this study are mainly phytophagous species (*Brahmina* sp., *Holotrichia* sp., *Xylotrupes gideon, Anomala dimidiata, Anomala grandis).* Apart from this, few coprophagous species (*Catharsius molossus, Catharsius sagax* and *Onitis subopacus)* are also recorded during this survey (Table 9). These beetles are dung feeders which feed on the dungs and excreta of the animals. Thus it helps in breaking down of plant and animal remains that contribute to the recycling of nutrients and the cleaning of the environment. The next dominant group of beetles in the tea ecosystems of North Bengal are Longhorn beetles or round-headed borers (Family Cerambycidae). Wood boring is carried out by various groups of insects either to obtain food or as means of protection of their eggs, larvae and pupae. Among the wood boring insects, the members of the family Cerambycidae are the most notorious pests of the freshly felled logs or dying standing trees. They mostly damage the shade trees of tea gardens and may also attack the tea plants. Majority of the cerambycid species are the borers of shade trees of tea gardens or other timber plants (Table 9). The members of the family Coccinellidae are mostly phytophagous but few species are also flower visitors and some are key predators that are conserved and augmented in agricultural ecosystems, to achieve biological control of pests. The other two families, Lucanidae are mostly rotten wood feeder and Curculionidae phytophagous (Table 9). Odonata are key organisms of the food web as predators both as larvae and as imagoes. They are among the dominant invertebrates predators in an ecosystem (Manwar NA *et al.*, 2012). Present communication reports 12 species under 08 genera belonging to 02 families of the order Odonata from different tea gardens of North Bengal (Table 1). Worldwide orthopterans are considered of immense economic and ecological importance, because many species are accepted as pests of crops. Both nymphs and adults devour different kinds of vegetation, particularly succulent types. In ecology these insects provide food for the predators at all stages of life and some prey upon smaller invertebrates (Table 9).

Eventually it can be concluded that long term monitoring of insects and their taxonomic study in tea ecosystem is very much essential to understand their biological role (Pest, predator, pollinator and parasite) in the tea gardens of North Bengal. During this study, it has been observed that, apart from regular pests of tea

plants there are many insects visited tea gardens those are recognised pests of other plants/crops. In future they may play a major role on the economy of tea gardens. Therefore, this study will definitely help to the tea gardens owner for making a full proof plan to control the pest and parasite attack in one side and in the other side conservation of the beneficial insects (Predator and pollinator) of the tea gardens.

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