

Inventorisation of true flies (Insecta: Diptera) and their association with tea plants in Dooars, West Bengal, India

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Abstract

Insect-plant association are of crucial importance from an applied point of view. The objective of this study is to identify the true flies and their type of association with tea plants (*Camelia sinensis* Linnaeus) in Dooars. Altogether 24 species under 8 families of dipteran flies were collected from the tea gardens of Dooars, West Bengal. Among these, the family Syrphidae shares 09 species followed by Asilidae (04 species) and Bombyliidae, Muscidae, Calliphoridae, Rhiniidae and Sarcophagidae (each share 02 species) and Tipulidae (1 species).

Keywords: *Camelia sinensis*, diptera, dooars, ecosystem services, West Bengal

Introduction

Tea (*Camelia sinensis* Linnaeus) is the most common aromatic beverage consumed throughout the World. Tea leaves are used for the preparation of this popular drink, so the culture of tea plant is very important economically to any country. It is one of the most important cash crops of India which is grown in Dooars region and on the hill slopes of Darjeeling district of West Bengal, India. ^[3] Tea plantations are sometimes combined with shaded trees, natural forest, grasslands, agricultural lands and several human habitations as well.

Tea plantations intermixed with other natural ecosystems and anthropogenic habitats support diverse variety of faunal elements which also includes the insects. Several attempts have been taken in recent days to inventories of insect fauna associated with tea plants and their roles in such ecosystem. Das *et al.* (2010) have studied on the arthropod natural enemies of moth pests of tea from northern part of West Bengal ^[4]. After that, Mitra *et al.* (2014a and 2014b) is documented 7 species of Orthoptera ^[5] and 28 species of Hemiptera ^[6] from tea gardens of Dooars. Alongside, Biswas *et al.* (2015) reported 14 species of moths (Lepidoptera:

Erebidae) associated with the tea plantations of northern West Bengal, of which two species have been reported as the pests of tea ^[7]. Shah and Mitra (2015) also published a list of 39 species of moths from the tea gardens of Dooars, of which, 15 species recognized as serious pests of tea ^[3]. Documentation of butterflies have also been done by Mitra *et al.* (2015), where 37 species were observed to visit in tea plantations ^[8]. Apart from these, the association of 12 species of Odonata ^[9] and 13 species of Coleoptera ^[10] have also been recorded from these tea gardens.

The true flies visit plants and plant parts usually for getting food and shelters and in getting so, they play some biological role in that particular ecosystem. But very little have been known so far about the association of true flies (Diptera) and their role in tea garden ecosystem of West Bengal. With this view, several surveys have been made in eight different tea gardens of the Dooars area from 2011 to 2015 under the approved programme “Insect pest and pollinator of some major crops in North Bengal” of Zoological Survey of India. Altogether, 24 species under 8 families of dipteran flies have been collected during this survey.

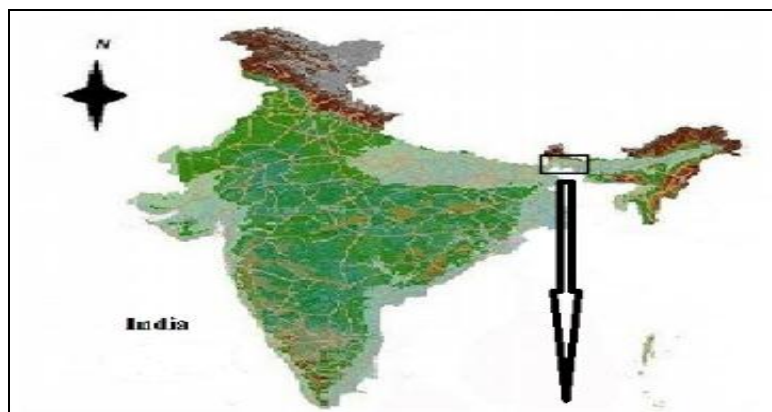




Fig 1: Study areas In Dooars, West Bengal

Table 1: Name of Tea gardens surveyed

S. No.	Name of the tea gardens
1	Soongachi
2	Toorsa
3	Nagrakata
4	Betguri
5	Kailashpur
6	Anandapur
7	Malnadi
8	Srinathpur

Dooars area in the district of Jalpaiguri. These tea gardens are situated near roadside, riverside, agricultural land, forest area etc. (Table – 1). Dipteran specimens were collected by simple insect catching net and hand picking method. The adult specimen usually observed and collected during the day time in three intervals (8 a.m. – 11 a.m., 11 a.m. – 2 p.m. and 2 p.m. – 5 p.m.). The flies were photographed in field by using Nikon D7000 camera. The collected materials were dry pinned and mounted in the laboratory of Zoological Survey of India, Kolkata. Identification have been done by following standard and available literatures with the help of stereo zoom microscope Leica EZ4 and Leica M205A. For studying their functional activity in this particular ecosystem, direct field observations have been made.

Materials and Methods

Study area

The study have been done in eight different tea gardens of the

Table 2: List of true flies (Insecta: Diptera) associated with Tea plantations

S. No.	Name of the species	Family	Remarks
01	<i>Nephrotoma consimilis</i> (Brunetti, 1911)	Tipulidae	
02	<i>Microstylum pseudoanantakrishmanii</i> Joseph & Parui	Asilidae	Shah & Mitra (2015) found this species as important predator of moth pests from tea garden. [3]
03	<i>Microstylum brunnipenne</i> Macquart, 1849	Asilidae	
04	<i>Cophinopoda chinensis</i> (Fabricius, 1794)	Asilidae	
05	<i>Promachus duvaucelii</i> (Macquart, 1838)	Asilidae	
06	<i>Volucella</i> sp.	Syrphidae	
07	<i>Episyrphus balteatus</i> (De Geer, 1776)	Syrphidae	Kunjwal <i>et al.</i> (2014), [24] Mitra <i>et al.</i> (2005a, 2008), [25, 26] Sharma & Mitra (2012), [27] Chaudhary & Singh (2007) [28] mentioned this species as potential pollinator of several plants.
08	<i>Eristalis tenax</i> (Linnaeus, 1758)	Syrphidae	Chaudhary & Singh (2007), [28] Mitra <i>et al.</i> (2005a), [25] Sharma & Mitra (2012) [27] found this species as effective pollinators of different plant species.
09	<i>Mesembrias</i> sp.	Syrphidae	Mitra <i>et al.</i> (2005a & b, 2008) [25, 29, 26] revealed species of this genus as flower visitor of different plants.
10	<i>Eristalodes paria</i> (Bigot, 1880)	Syrphidae	Mitra <i>et al.</i> (2005a) reported this species as the flower visitor of <i>Helianthus</i> sp. [25]
11	<i>Eristalinus arvorum</i> (Fabricius, 1787)	Syrphidae	Mitra <i>et al.</i> (2005a & b, 2008), [25, 29, 26] Sharma & Mitra (2012), [27] Chaudhary & Singh (2007) [28] recorded this from several flowers.
12	<i>Melanostoma orientale</i>	Syrphidae	Mitra <i>et al.</i> (2005b) recorded this species from different medicinal plants as effective

	(Wiedemann, 1824)		pollinator ^[29] and Kunjwal <i>et al.</i> (2014) also found this as effective pollinator of <i>Brassica juncea</i> . ^[24]
13	<i>Betasyrphus serarius</i> (Wiedemann, 1830)	Syrphidae	Sharma & Thakur (1997) reported this flower fly as flower visitor of the plant <i>Ammi majus</i> . ^[30]
14	<i>Ischiodon scutellaris</i> (Fabricius, 1805)	Syrphidae	Mitra <i>et al.</i> (2008, 2010) ^[26, 31] reported this as pollinators of different plants of medicinal and agricultural importance.
15	<i>Hyperalonia suffusipennis</i> Brunetti, 1909	Bombyliidae	
16	<i>Exoprosopa (Exoprosopa) insulata</i> (Walker, 1852)	Bombyliidae	Study on dipteran pollinators from Jessore Sloth Bear and Balaram- Ambaji wildlife sanctuaries, Mitra <i>et al.</i> (2006) reveals this species as flower visitors of different plants ^[32] as well as Mitra <i>et al.</i> (2005b) ^[29] found this as effective pollinator of some medicinal plants in India.
17	<i>Chrysomya megacephala</i> (Fabricius, 1794)	Calliphoridae	This species found widely to visit several kinds of flowers. Several reports have been made by Mitra <i>et al.</i> (2005a & b, 2008), ^[25, 29, 26] Roy <i>et al.</i> (2014) ^[33] etc.
18	<i>Hemipyrellia ligurriensis</i> (Wiedemann, 1830)	Calliphoridae	Mitra <i>et al.</i> (2008) reported this species as the pollinator of <i>Periscaria chinensis</i> . ^[26]
19	<i>Stomorhina discolor</i> (Fabricius, 1794)	Rhiniidae	This species was reported earlier by Roy <i>et al.</i> (2014) as flower visitor of <i>Brassica juncea</i> . ^[33]
20	<i>Idiella mandarina</i> (Wiedemann, 1830)	Rhiniidae	
21	<i>Musca (Musca) domestica</i> Linnaeus, 1758	Muscidae	This is one of the most common flower visitor and is reported by Priti & Sihag (1997), ^[34] Mitra <i>et al.</i> (2005 a & b, 2008), ^[25, 29, 26] Mitra (2010), ^[31] Devi <i>et al.</i> (2010), ^[35] Kumar <i>et al.</i> (2012), ^[36] Sharma & Mitra (2012), ^[27] Kunjwan <i>et al.</i> (2014), ^[24] Kumar <i>et al.</i> (2016) ^[37] etc.
22	<i>Neomyia indica</i> (Robineau-Desvoidy, 1830)	Muscidae	Bhowmik & Bhadra (2015) reported this as flower visitors of <i>Helianthus annuus</i> . ^[38]
23	<i>Sarcophaga (Liosarcophaga) dux</i> Thomson, 1869	Sarcophagidae	
24	Unidentified species of <i>Sarcophaga</i>	Sarcophagidae	

Results

Altogether, 24 species of true flies belonging to 08 families have been found in association with the tea plants (Table - 2). Among these species, family Syrphidae is predominant which share 09 species (37.5% of total species) followed by family

Asilidae (04 species, 16.67%) and Bombyliidae, Calliphoridae, Rhiniidae, Muscidae, Sarcophagidae (each of which share 02 species, 8.33%) and a single representative of family Tipulidae(4.17%) (Fig. 2).

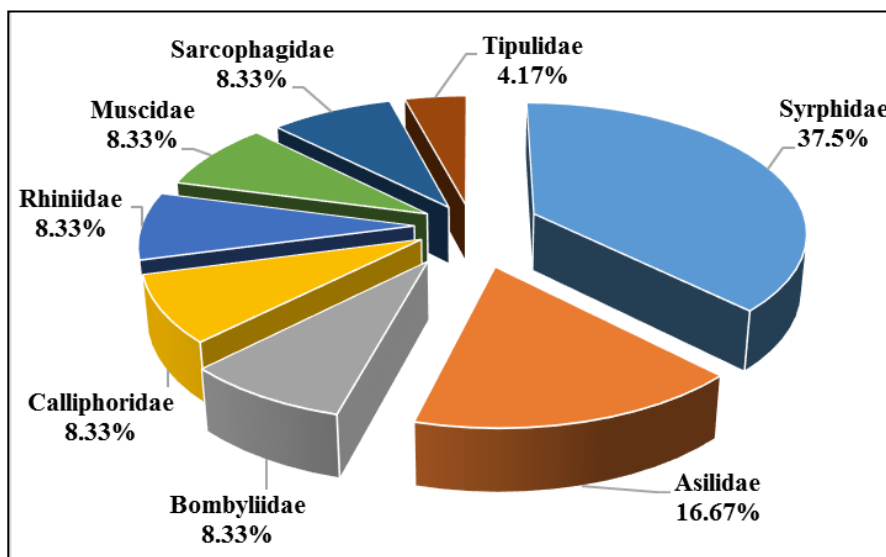


Fig 2: Diversity of true flies associated with Tea plantations

True flies serves several ecosystem services such as pollination, decomposition, predation, carrion feeders, bio indicators that lead to various functional contribution to an environment. Among the 24 species reported from the tea gardens, 9 species of syrphids, 2 species of calliphorids, 2

species of Rhiniidae, 2 species of muscids and 2 species of sarcophagids are primarily flower visitors. 4 species of asilids are the true predators, 2 species of bombyllids are predator but also flower visitors. Single species of Tipulidae is having no 23biological role in this ecosystem (Table-2)



Fig 3: *Sarcophaga dux* (Sarcophagidae) visiting tea flowers (*Camelia sinensis*)

Discussion

Pollination is one of the most important ecosystem services led by the insects and *Camelia sinensis* is self-incompatible and cross pollinating tree, thus requires insect pollinators. Several dipteran flies act as the potential pollinators of the tea plants apart from the bees, butterflies and other insects. Several works from abroad and India reported the flower flies Diptera: Syrphidae as an effective pollinator of various plants. Mitra (2010) has compiled an inventory of the total dipteran pollinators and their role in pollination from India [16]. Insect pollinators, mainly dipteran insects contribute to pollination success in tea [13]. 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 [14].

During present study, nine species of Syrphidae were found in association with tea plants (*Camelia sinensis* Linnaeus) as flower visitors. All of these are already recorded as pollinators or flower visitors of several agricultural crops, medicinal plants, ornamental plants in India (Table - 2).

Recently, Orford *et al.* (2015) established the non-syrphid Diptera along with the syrphid Diptera as the effective pollinators and studied the interaction of 520 dipteran species and 261 plant species from the temperate ecosystem within the UK [12]. From the non-syrphid group of Diptera, *Exoprosopa (Exoprosopa) insulata* (Walker, 1852) and *Hyperalonia suffusipennis* Brunetti, 1909 of family Bombyliidae and *Stomorhina discolor* (Fabricius, 1794) of family Rhiniidae have been observed to visit the flowers occasionally. The pollen grains attached to their bodies indicate they have some role in the pollination of *Camelia sinensis*.

Chrysomya megacephala (Fabricius, 1794) of family Calliphoridae, *Sarcophaga (Liosarcophaga) dux* Thomson, 1869 and an unidentified species of *Sarcophaga* (family Sarcophagidae) have also been found as the effective flower visitors and remain active in the early and late hours of the

day. *Musca (Musca) domestica* Linnaeus, 1758 and *Neomyia indica* (Robineau-Desvoidy, 1830) of family Muscidae have been found visiting the flowers throughout the day. Though the number of individuals of the species *Musca (Musca) domestica* were found relatively less in early hours but increases during late hours.

Pests are always disturbing to an ecosystem, whatever it is a rodent, a weed or an insect. Many moths have been reported as the pests of tea (*Camelia sinensis* Linnaeus) by Sinu *et al.*, [17] Biswas *et al.* [7] and Shah & Mitra. [3] Apart from this, there are several hemipteran species (plant hoppers) [6] that also may act as the pests of tea plant as they complete their life-cycle feeding on them.

Robber flies (Diptera: Asilidae) are the natural predators to several insect pest of different agricultural crops or plants. Various work reveals robber fly as the predators of spider [18] and insects as well, like Hymenoptera [19], Lepidoptera, [20] Coleoptera, [21] Orthoptera [22], and Hemiptera [23]. Alongside reporting the pest status of moths associated to tea plants, Shah & Mitra (2015) also reports *Microstylum pseudoanantakrishnanii* Joseph & Parui as the predator of the moths in the tea gardens [3]. Present communication deals with another 03 species of robber flies, viz. *Microstylum brunnipenne* Macquart, 1849, *Cophinopoda chinensis* (Fabricius, 1794) and *Promachus duvaucelii* (Macquart, 1838), those have been recorded in close association with tea plants. 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 [4]. The adults of this species was found as visitors of tea flowers during this study. Mitra *et al.* (2008, 2010) [26, 31] was also reported the pollinating ability and efficiency of this species on different medicinal and agricultural plants. (Table - 2)

Apart from above dipteran species, other recorded flies, *Nephrotoma consimilis* (Brunetti, 1911) of family Tipulidae and *Idiella mandarina* (Wiedemann, 1830) of family Rhiniidae were observed resting in the leaves and stem of the tea plants.

Since the civilization started, humans have always modified natural ecosystems to favour those species that yield direct benefits (e.g. agricultural commodities), generally overlooking the unseen but essential ecosystem services (e.g. pollination, soil fertility and biological control) that, if lost, are expensive and sometimes impossible to replace. In the tea gardens, more attention has been given on the pests of tea, and their control. This communication provides a preliminary concept of true flies association with tea plants, their ecosystem services and also how they are valued of that particular ecosystem. Though, many more studies will still require to understand and value the ecosystem services of these tiny insects and to integrate them into economic frameworks.

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