



Rec. zool. Surv. India : **110**(Part-2) : 95-107, 2010

DIVERSITY OF FLOWER-VISITING FLIES (INSECTA : DIPTERA) IN INDIA AND THEIR ROLE IN POLLINATION

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INTRODUCTION

Nectar is one of the most important foods for majority of dipterans with respect to adult energetic requirements for flight in dispersing, finding mates, mating, and searching sites for oviposition (Larson *et al.*, 2001). The flies therefore spend much of their time on flowers. The true flies of late Jurassic period with long mouth parts also support their nectar feeding ability. Many species of Diptera visit flowers, and their abundance on plants could indicate their importance as pollinators as well as the importance of flowers in their diet. So knowledge on dipteran flower visitors is required as they perform vital role in pollination.

Very little work has been done on the flower-visiting dipteran species in India. Important contributors to this subject are Priti (1998), Priti and Sihag (1997, 1998), Mishra & Kumar (1993), Mitra & Parui (2002), Mitra *et al.* (2003, 2004, 2005, 2006), Dhara Jothi & Tandon (1993), Datta & Chakraborty (1983), and Bhatnagar (1986). Apart from this, Sharma *et al.* (1998) studied and developed an easy and quick method of breeding of flies for pollination of mango blossoms. In a recent study in Madhya Pradesh, Mishra *et al.* (2004) reported 30 species of flies from the flowers of *Zizyphus mauritiana*. But most of the studies in India on fly pollination have been made with other insect pollinator groups and research activity on flower visiting flies remained in a state of neglect. Therefore, it is imperative to prepare an inventory of flower visiting flies involved in the process of pollination of different plant species.

Keeping in view, the Diptera section of Zoological Survey of India has initiated a study to generate the

basic data on the flower-visiting flies of India. This communication has culminated in documenting 116 dipteran species belonging to 16 families as flower visitors and pollinators of 92 plant species (Table-1).

DIVERSITY OF FLOWER-VISITING FLIES

Flies are one of the major successors of the insect world, and classified into about 10,000 genera, 150 families, 22-32 superfamilies, 8-10 infraorders and 2 suborders: Nematocera and Brachycera (Yeates & Wiegmann, 1999). A preliminary estimate (Buchmann & Nabhan, 1998) indicates that 14,126 species of Diptera are involved in the process of pollination in the tropical world. Inouye (2001) stated that the diversity of Diptera can rival or exceed of Hymenoptera in tropical areas. A total of 42 families (Nematocera 12 and Brachycera 30) of Diptera are reported as pollinators in the tropical world (Roubik, 1995), of which 37 families (Nematocera 12 and Brachycera 25) are found in India.

Flies that are confirmed as pollinators differ widely in their effectiveness. About one third of Nematoceran families obtain food from flowers, as well as other sources (Gilbert & Jervis, 1998; Larson *et al.* 2001). Obligate nectar-feeders occur apparently in tropical Culicidae (Snodgrass, 1959; Schremmar, 1961) and Simuliidae (Gilbert & Jervis, 1998). These primitive flies mainly visit flowers with readily accessible nectar in tubes that are short or somewhat hidden. The Brachycera contains wider variety of flower visitors and nectar-feeders which are mostly widespread in lower Brachycera. Obligate nectarivorous flies are recorded in Bombyliidae (Gilbert & Jervis, 1998). Moreover, there are some species of long-tongued families that visit

deeper tubed flowers. It has also been observed that most of the cyclorrhaphan families are nectarivorous.

The following dipteran families are reported as flower visitors and pollinators in India

Family BOMBYLIIDAE

Bee flies have generally been considered to be primarily nectarivorous although it has been known for some time that at least some bombyliids consume pollen. They are one of the important pollinator families of Diptera, which have long, sucking mouthparts especially suitable for visiting tubular flowers.

Some of the recent works on bee flies in India are contributed by Mitra & Parui (2002), Mitra *et al.* (2005, 2006) and Banerjee & Mitra (2002). Their studies revealed that the bee flies are mostly attracted to the plants of Solanaceae family (Table-1). Little is known about diurnal activities of bee flies. Mitra *et al.* (2006) stated that the bee flies are active throughout the day which supports their effective role in pollination. Banerjee & Mitra (2002) have collected 7 species of bee flies as flower visitors of agricultural crops from Arunachal Pradesh. Altogether 18 species of flower visiting bee-flies are reported from India. Recently, Mitra (unpublished) collected one bombyliid species from the flowers of *Foeniculum* and *Anthemum spp.* (Family Umbelliferae) in Uttar Pradesh.

Family CALLIPHORIDAE

Flies of the family Calliphoridae are stout, medium to large sized, with shiny metallic coloration, and commonly known as green bottles or bluebottles and blowflies. Adult blowfly feeds on nectar, honey dew and other sweet liquid or liquid products of organic decomposition. They are mostly active during day time. Their pollination ability is not well studied thoroughly. 12 species of calliphorid flies are reported as flower visitors and pollinators in India. Priti (1998), Priti & Sihag (1997, 1998) observed that blowflies are the major pollinators of onion, carrot and cauliflower after bees and wasps. According to Mitra & Parui (2002) blowflies are the common flower visitors of cultivated and non-cultivated plants. Moreover, Mitra *et al.* (2005) identified 3 species of calliphorid flies as pollinators of medicinal plants in West Bengal. Mitra *et al.* (2006) observed a large number of *Stomorhina discolor* hovering on the

flowers of *Zizyphus* and *Anogeissus spp.* in Gujarat. Sharma & Thakur (1997) also recorded *Lucilia sp.* as a pollinator of a medicinal herb (*Ammi majus* Linn.). Bhatnagar (1986) recorded 4 species of blow flies as pollinator of Asclepiadaceae from Central India.

Family CERATOPOGONIDAE

The Ceratopogonidae, commonly known as biting midges, no-see-ums or punkies have a bad reputation as being nasty biters that pester humans and domestic animals and in some instances, transmit harmful diseases. However, few people realise that this group of flies provide some important services in ecological systems. Some species are important pollinators of plants such as cacao and rubber trees. But little is known about their foraging activities in India. Bhatnagar (1986) reported only 2 species of the genus *Forcipomya* as pollinators of Asclepiadaceae from India.

Family CULICIDAE

Mosquitoes are small and delicate. The adult females are pests to humans and many other animals as they feed on blood. Adult mosquitoes occasionally obtain nectar from flowers, but they are not significant pollinators in temperate climate. Usually male mosquitoes frequent flowers more than females. Nothing is known on the pollination ability of mosquitoes in India. Recently Mitra *et al.* (2005) recorded one species of *Culex* as flower visitor of *Polygonum chinensis* in West Bengal.

Family DIOPSIDAE

Diopsids, commonly known as stalk-eyed flies, are generally distributed throughout the World. Adults are easily identified by their characteristic eye stalks, found in all taxa, although the stalk lengths vary considerably. Barring a single species of diopsid fly as flower visitors of family Asclepiadaceae (Bhatnagar, 1986) nothing is known about other species.

Family DROSOPHILIDAE

These small, delicate-looking tan or brown flies occasionally suck nectar from flowers, but they are more likely to visit rotting fruit or fermenting sap. They are not referred as a significant pollinator group of Diptera. Bhatnagar (1986) reported only one species as pollinator of *Cosmostigma racemosum* (Family Asclepiadaceae) from Dehradun. (Table-1)

Family MUSCIDAE

The members of this family are stout, robustly-built, medium-sized, grey or black, with darker stripes and other patterns. The adults occasionally visit flowers with exposed nectaries, particularly in the Carrot family. Altogether 19 species of house flies reported as flower visitors and pollinators from India. Priti (1998), Priti & Sihag (1997, 1998), Mishra & Kumar (1993) stated that the members of this family are the important pollinators of cauliflower, carrot, onion, rape seed, almond etc. Bhatnagar (1986) identified 10 species of house flies as pollinators of Asclepiadaceae. Mitra *et al.* (2002, 2004) also collected muscid flies from the flowers of garden, orchard, and agricultural plants. Mitra *et al.* (2006) reported two species of muscids as a pollinators of medicinal plants.

Family OESTRIDAE

Species of Gasterophilinae of the Family Oestridae are commonly known as horse bot flies. They are medium-sized to large, rather thickset flies, the body covered with dense short or long hair, without thick bristles. Oestrid flower visitors got 7th rank as per their efficiency in pollination of cauliflower and carrot. (Priti & Sihag, 1997, 1998).

Family SARCOPHAGIDAE

The Sarcophagidae, commonly called as “flesh flies” comprises a group of medium-sized to fairly large and generally grayish to black flies. The adults occasionally feed on flowers with exposed nectaries. Priti (1998), Priti & Sihag (1997, 1998) reported sarcophagid species as pollinators of onion, cauliflower, and carrot. In all the studies *Sarcophaga sp* was ranked 6th as per pollinating efficiency.

Family SEPSIDAE

The Black Scavenger Flies are small, shiny black, with round heads and base of abdomen strongly constricted. The most common genus, *Sepsis*, has a pigmented spot on the tip of the wing. This family is not recognised pollinator group and only 4 species have been reported as pollinators of the family Asclepiadaceae from India (Bhatnagar, 1986).

Family STRATIOMYIDAE

Soldier flies are true flies which often superficially resemble wasps in their appearance and behaviour.

However, these flies do not bite or sting. Adults are pollen or nectar feeders. The members of the family are well known flower visitors and pollinators. But only 3 species of soldier flies are so far reported as flower visitors and pollinators from India. Mitra *et al.* (2006) observed that the foraging activity of *Adoxomyia heminopla* is mostly restricted in early morning and they are the common visitors of the flowers of upper canopy. They are also found to visit the flowers of *Tagetes patula* (Mitra *et al.* 2005).

Family SYRPHIDAE

These are small to medium-sized flies that can hover motionless in the air. They visit flowers as bees and wasps. These flies feed on nectar and are major pollinators of some flowering plants in world over & in India.

So far 46 species of hover flies have been reported as flower visitors and pollinators from India. Datta & Chakraborty (1983) reported 25 species from Jammu & Kashmir. Dhara Jothi & Tandon (1993) observed that there is no significant difference in pollinating activities of *Eristalinus arvorum* in between forenoon and afternoon on *Zizyphus mauritiana*. Mishra & Kumar (1993) reported hoverflies as one of the major pollinator groups of rapeseed and almond. Priti & Sihag (1997, 1998) also observed the pollinating efficiency of hover flies on cauliflower, carrot and onion. Several workers like, Kumar & Kumar (1997), Mishra *et al.* (2004), Sharma & Thakur (1997), Mitra *et al.* (2003, 2004, 2005) have also studied the syrphid pollination. Recently, Mitra (unpublished) collected 3 syrphid species as flower visitors of *Foeniculum and Anthemum spp.* of the family Umbelliferae from Uttar Pradesh.

Family TABANIDAE

The tabanids or horse flies are stout, bristle less, medium to large-sized flies (5-25 mm long) belonging to the suborder Brachycera. The eyes are large, covering most of the head. The adults may obtain nectar from flowers, but are not important pollinators. The adult Horseflies are more likely to use flowers as a place to perch. Only two species are reported from India as pollinators. Priti (1998) and Priti & Sihag (1998) reported *Chrysops dispar* as a pollinator of carrot and onion. Mitra *et al.* (2004) also reported

Hybomitra hirta as flower visitors from Himachal Pradesh (Table-1).

Family TACHINIDAE

These are stout, medium to large sized flies, very bristly, particularly around the posterior of the abdomen. They are often grey with checkered patterns, but sometimes appear solid black or brown. The adults are nectar feeder and are the common visitors of many wildflowers. In India, only 3 species are reported as flower visitors. Bhatnagar (1986) reported their role in pollination of the family Asclepiadaceae.

Family TEPHRITIDAE

The members of the family Tephritidae are commonly called as “fruit flies”, although the majority of the world’s species are not frugivorous. The adult tephritids typically rest on flowers, fruit or vegetation with flex wings and oviposit on the flower heads of the family Asteraceae. They are not well known pollinating group in India, only 3 species are reported as flower visitors. Bhatnagar(1986) and Mitra *et al.* (2004) studied their

pollinating activities in India.

REMARKS

The present communication reports 116 species belonging to 16 families of Diptera along with their 92 visited plant species belonging to 39 families (Table-1). It is revealed that the family Syrphidae is the dominant group among the flower visiting flies of India (46 plant species) and the family Asteraceae (17 species) is the most favoured plant family by dipterans.

It is hoped that more and more works will take up the studies on the important aspect of pollination and pollinators especially dipterans and this work can serve as ground work for future research work

ACKNOWLEDGEMENTS

I am thankful to Dr. Ramakrishna, Director, Zoological Survey of India, for the necessary facilities and encouragement. The author is also grateful to Dr. A.K. Sanyal, Addl. Director and Dr. A. Bal, Joint Director, Zoological Survey of India, Kolkata, for helping in the preparation of the paper.

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Table-1 : List of Flower visiting-flies along with their visited plant species

	POLLINATOR	PLANT	FAMILY
1. Family BOMBYLIIDAE			
1	<i>Anthrax distigma</i> (Wiedemann)	<i>Cucurbita maxima</i>	Cucurbitaceae
2	<i>Argyromoeba duvaucelli</i> (Macquart)	<i>Cassia tora</i>	Leguminosae
3	<i>Bombomyia maculata</i> Fabricius	<i>Sorghum vulgare</i>	Graminae
4	<i>Ligyra oenomous</i> (Ronadani)	<i>Tephrosia purpurea</i>	Papilionaceae
5	<i>Ligyra aurantiaca</i> (Guerin-Meneville)	<i>Tephrosia purpurea</i>	Papilionaceae
6	<i>Ligyra tantalus</i> (Fabricius)	<i>Wild orchid</i>	
7	<i>Petrorossia albofulva</i> (Walker)	<i>Solanum melongena</i>	Solanaceae
		<i>Capsicum sp.</i>	Solanaceae
		<i>Lycopersicon esculentum</i>	Solanaceae
8	<i>Petrorossia ceylonica</i> (Brunetti)	<i>Mimosa pudica</i>	Leguminosae
9	<i>Petrorossia nigrofemorata</i> (Brunetti)	<i>Coriandrum sativum</i>	Apiaceae
10	<i>Heterolania (Isotamia) insulate</i> (Walker)	<i>Capsicum frutescens</i>	Solanaceae
		<i>Ipomea sp</i>	Convolvulaceae
		<i>Cassia tora</i>	Fabaceae
		<i>Lycopersicon esculentum</i>	Solanaceae
		<i>Solanum melongena</i>	Solanaceae
11	<i>Exoprosopa flammea</i> Brunetti	<i>Foeniculum vulgare</i> Mill	Umbelliferae
		<i>Anethum graveolens</i> Linnaeus	Umbelliferae
12	<i>Toxophora javana</i> Wiedemann	<i>Cassia auriculata</i>	Leguminosae
13	<i>Thyridanthrax (Exhylanthrax) absolon</i> (Wied.)	<i>Solanum melongena</i>	Solanaceae
		<i>Cassia tora</i>	Leguminosae
		<i>Capsicum frutescens</i>	Solanaceae
		<i>Lycopersicon esculentum</i>	Solanaceae
14	<i>Villa aperta</i> (Walker)	<i>Lycopersicon esculentum</i>	Solanaceae
15	<i>Villa aureohirta</i> (Brunetti)	<i>Scaevola sericea</i>	Goodeniaceae
16	<i>Villa panisca</i> (Rossi)	<i>Scaevola sericea</i>	Goodeniaceae
		<i>Dahlia sp.</i>	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
17	<i>Litorhynchus lar</i> (Fabricius)	<i>Capsicum frutescens</i>	Solanaceae
		<i>Solanum melongena</i>	Solanaceae
18	<i>Ligyra oenomaus</i> (Rondani)	<i>Wild orchid</i>	
2. Family CALLIPHORIDAE			
19	<i>Isomyia viridaurea</i> (Wiedemann)	<i>Catharanthus roseus</i>	Apocyanaceae
20	<i>Phaenicia cuprina</i> (Wiedemann)	<i>Tabernaemontana. coronaria</i>	Apocyanaceae
21	<i>Phaenicia sericata</i> (Meigen)	<i>Tabernaemontana. coronaria</i>	Apocyanaceae
		<i>Begonia sp.</i>	Begoniaceae
22	<i>Chrysomya bezziana</i> (Villeneuve)	<i>Allium cepa</i>	Liliaceae
		<i>Daucus carota</i>	Umbelliferae
		<i>Brassica oleraceae v. botrytis</i>	Cruciferae
23	<i>Chrysomya megacephala</i> (Fabricius)	<i>Holarrhena antidysenterica</i>	Apocyanaceae
		<i>Mikania cordata</i>	Asteraceae
		<i>Lantana camara</i>	Verbenaceae

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
		<i>Tectona grandis</i>	Verbanaceae
		<i>Althaea rosea</i>	Malvaceae
		<i>Zizyphus mauritiana</i>	Rhamnaceae
24	<i>Chrysomya rufifacies</i> (Macquart)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
25	<i>Hemipyrellia liguirriens</i> (Wiedemann)	<i>Polygonum chinensis</i>	Polygoniaceae
26	<i>Hemipyrellia pulchra</i> (Wiedemann)	<i>Santalum album</i>	Santalaceae
		<i>Psidium guajava</i>	Myrtaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
27	<i>Lucilia</i> sp.	<i>Ammi majus</i>	Apiaceae
28	<i>Lucilia porphyrina</i> (Walker)	<i>Scaevola sericea</i>	Goodeniaceae
29	<i>Pyrellia scintillans</i> Bigot	<i>Cosmostigma racemosum</i>	Asclepiadaceae
30	<i>Stomorhina discolor</i> (Fabricius)	<i>Tagetes patula</i>	Asteraceae
		<i>Anogeissus pendula</i>	Combretaceae
		<i>Zizyphus</i> sp	Rhamnaceae
		<i>Tagetes patula</i>	Asteraceae
		<i>Syzygium jambos</i>	Myrtaceae
		<i>Callistemon citrinus</i>	Myrtaceae
		<i>Zizyphus mauritiana</i>	Rhamnaceae
		<i>Polygonum chinensis</i>	Polygoniaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
3. Family CERATOPOGONIDAE			
31	<i>Forcipomya</i> sp. (1)	<i>Ceropogia bulbaza</i>	Asclepiadaceae
32	<i>Forcipomya</i> (2)	<i>C. lushi</i> v. <i>acuminata</i>	Asclepiadaceae
4. Family CULICIDAE			
33	<i>Culex</i> sp.	<i>Polygonum chinensis</i>	Polygoniaceae
5. Family DIOPSISIDAE			
34	<i>Sphyracephala hearsiana</i> (Wiedemann)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
6. Family DROSOPHILIDAE			
35	<i>Drosophila (Sopophora) rufa</i> Kikkawa & Peng	<i>Cosmostigma racemosum</i>	Asclepiadaceae
7. Family MUSCIDAE			
36	<i>Musca (M) domestica</i> Linnaeus	<i>Wedelia calendulaceae</i>	Asteraceae
		<i>Allium cepa</i>	Liliaceae
		<i>Daucus carota</i>	Umbelliferae
		<i>Brassica oleracea</i> v. <i>botrytis</i>	Cruciferae
		<i>Zizyphus mauritiana</i>	Rhamnaceae
		<i>Ammi majusa</i>	Apiaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
37	<i>Musca (Philaematomyia) crassirostris</i> Stein	<i>Allium cepa</i> L.	Liliaceae
38	<i>Musca (Byomya) conducens</i> Walker	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
39	<i>Musca (Byomya) pattoni</i> Austen	<i>Cosmostigma racemosum</i>	Asclepiadaceae
40	<i>Musca (Byomya) sorbens</i> Wiedemann	<i>Cosmostigma racemosum</i>	Asclepiadaceae
		<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
41	<i>Musca (Byomya) ventrosa</i> Wiedemann	<i>Polianthes tuberosa</i>	Amarylloidaceae

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
42	<i>Musca</i> sp.	<i>Brassica campestris</i> v.sarson	Cruciferae
43	<i>Dichaetomyia luteiventris</i> (Rondani)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
44	<i>Orthellia timorensis</i> (Robineau-Desvoidy)	<i>Scaevola sericea</i>	Goodeniaceae
		<i>Althaea rosea</i>	Malvaceae
45	<i>Orthellia viridis</i> (Wiedemann)	<i>Castanea sativa</i>	Fagaceae
		<i>Aesculus indica</i>	Hippocastanaceae
		Unidentified Aster	Asteraceae
46	<i>Orthellia</i> sp.	<i>Brassica campestris</i> v.sarson	Cruciferae
		Almond	
47	<i>Atherigona</i> (<i>Atherigona</i>) <i>falcata</i> (Thomson)	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
	<i>Atherigona</i> (<i>Atherigona</i>) <i>punctata</i> Karl	<i>Cosmostigma racemosum</i>	Asclepiadaceae
48	<i>Atherigona</i> (<i>Acritochaeta</i>) <i>oreintalis</i> Schiner	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
49	<i>Myospila lenticeps</i> (Thomson)	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
50	<i>Myospila laevis</i> (Stein)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
51	<i>Limnophora</i> sp.	<i>Cosmostigma racemosum</i>	Asclepiadaceae
8. Family ULIDIDAE			
52	<i>Physiphora aenea</i> (Fabricius)	<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
9. Family OESTRIDAE			
53	<i>Gasterophilus</i> sp.	<i>Brassica oleraceae</i> v. <i>botrytis</i>	Cruciferae
		<i>Daucus carota</i>	Umbelliferae
		<i>Allium cepa</i>	Liliaceaea
10. Family SARCOPHAGIDAE			
54	<i>Iranihindia futilis</i> (Senior- White)	<i>Tabernaemontana. Coronaria</i>	Apocyanaceae
55	<i>Sarcophaga</i> sp.	<i>Brassica oleraceae</i> v. <i>botrytis</i>	Cruciferae
		<i>Daucus carota</i>	Umbelliferae
		<i>Allium cepa</i>	Liliaceaea
		<i>Ammi majusa</i>	Apiaceae
11. Family SEPSIDAE			
56	<i>Sepsis rufa</i> Macquart	<i>Cosmostigma racemosum</i>	Asclepiadaceae
57	<i>Sepsis nitens</i> Wiedemann	<i>Cosmostigma racemosum</i>	Asclepiadaceae
58	<i>Australosepsis frontalis</i> (Walker)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
59	<i>Australosepsis niveipennis</i> (Becker)	<i>Cosmostigma racemosum</i>	Asclepiadaceae
12. Family STRATIOMYIDAE			
60	<i>Sargus metallinus</i> (Fabricius)	<i>Bauhinia variegata</i> v. <i>candida</i>	Leguminosae
61	<i>Oplodontha rubrithorax</i> (Macquart)	<i>Tagetes patula</i>	Asteraceae
62	<i>Adoxomyia heminopla</i> Wiedemann	<i>Nerium indicum</i>	Apocyanaceae
		<i>Zizyphus</i> sp	Rhamnaceae
63	<i>Microchrysa flaviventris</i> (Wiedemann)	<i>Tagetes patula</i>	Asteraceae
13. Family SYRPHIDAE			
64	<i>Asarkina</i> (<i>Asarkina</i>) <i>ericetorum</i> (Fabricius)	<i>Amaranthus spinosa</i>	Amaranthaceae

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
		<i>Commelina sp</i>	Commelinaceae
		<i>Commelina bengalensis</i>	Commelinaceae
		<i>Cassia tora</i>	Fabaceae
		<i>Solanum nigrum</i>	Solanaceae
		<i>Lantana camara</i>	Verbenaceae
		<i>Sida acuta</i>	Malvaceae
		<i>Polygonum chinensis</i>	Polygoniceae
65	<i>Baccha (Allobaccha) amphithoe</i> (Walker)	<i>Helichrysum sp.</i>	Asteraceae
66	<i>Chrysotoxum baphyrus</i> (Walker)	<i>Climatis sp</i>	Ranunculaceae
		<i>Ipomea sp</i>	Convolvulaceae
		<i>Cynodon sp.</i>	Gramineae
67	<i>Eristalinus (Eristalinus) arborum</i> (Fabricius)	<i>Tagetes patula</i>	Asteraceae
		<i>Helichrysum sp</i>	Asteraceae
		<i>Santalum album</i>	Santalaceae
		<i>Mangifera indica</i>	Anacardiaceae
		<i>Zizyphus mauritiana</i>	Rhamnaceae
		<i>Polygonum chinensis</i>	Polygoniceae
		<i>Brassica campestris v.sarson</i>	Cruciferae
68	<i>Eristalis (Eoseristalis) arbustorum</i> (Linnaeus)	<i>Sida rhombifolia</i>	Malvaceae
		<i>Chrysanthemum sp</i>	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
		<i>Sonchus asper</i>	Asteraceae
		<i>Melilotus alba</i>	Leguminosae
		<i>Lindenbergia sp.</i>	Scrophulariaceae
69	<i>Episyrphus balteatus</i> (De Geer)	<i>Launea aspleniifolia</i>	Asteraceae
		<i>Commelina bengalensis</i>	Commelinaceae
		<i>Wedelia calendulaceae</i>	Asteraceae
		<i>Coriandrum sativum</i>	Umbelliferae
		<i>Lantana camera</i>	Verbenaceae
		<i>Nicotiana plumbaginifolia</i>	Solanaceae
		<i>Justica simplex</i>	Acanthaceae
		<i>Commelina obliqua</i>	Commelinaceae
		<i>Climatis sp</i>	Ranunculaceae
		<i>Cannabis sp.</i>	Cannabiaceae
		<i>Zinnia elegance</i>	Asteraceae
		<i>Duranta plumieri</i>	Verbeneceae
		<i>Foeniculum vulgare</i>	Umbelliferae
		<i>Trifolium repens</i>	Umbelliferae
		<i>Rubus elipticus</i>	Rosaceae
		<i>Solanum nigrum</i>	Solanaceae
		<i>Anacardium occidentale</i>	Anacardiaceae
		<i>Sorghum vulgare</i>	Graminae
		<i>Solanum melongena,</i>	Solanaceae

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
		<i>Capsicum frutescens</i>	Solanaceae
		<i>Malus domestica</i>	Rosaceae
		<i>Brassica campestris v.sarson</i>	Cruciferae
		<i>Almond</i>	
		<i>Foeniculum vulgare Mill</i>	Umbelliferae
		<i>Anethum graveolens Linnaeus</i>	Umbelliferae
70	<i>Dideopsis aegrotus</i> Fabricius	<i>Foeniculum vulgare Mill</i>	Umbelliferae
		<i>Anethum graveolens Linnaeus</i>	Umbelliferae
71	<i>Eristalis</i> sp.	<i>Brassica oleraceae v. botrytis</i>	Cruciferae
		<i>Daucus carota</i>	Umbelliferae
		<i>Allium cepa</i>	Liliaceaea
		<i>Ammi majusa</i>	Apiaceae
		<i>Almond</i>	
72	<i>Eristalis (Eoseristalis) cerealis</i> (Fabricius)	<i>Sonchus asper</i>	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
		<i>Chrysanthemum sp</i>	Asteraceae
		<i>Helianthus sp</i>	Asteraceae
		<i>Xanthium strumarium</i>	Asteraceae
		<i>Dahlia sp.</i>	Asteraceae
		<i>Erigeron licifolia</i>	
		<i>Ricinus communis</i>	Euphorbiaceae
		<i>Meliolotus alba</i>	Leguminosae
		<i>Unidentified Aster</i>	Asteraceae
73	<i>Eristalinus laetus</i> (Wiedemann)	<i>Tagetes patula</i>	Asteraceae
74	<i>Eristalinus (E) obscuritarsis</i> (de Meijere)	<i>Aegle marmelos</i>	Rutaceae
		<i>Tagetes patula</i>	Asteraceae
75	<i>Eristalinus quinquestriatus</i> (Fabricius)	<i>Tagetes patula</i>	Asteraceae
76	<i>Eristalinus taphicus</i> (Wiedemann)	<i>Tridax sp.</i>	Asteraceae
		<i>Zinnia sp</i>	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
77	<i>Eristalis paria</i> (Bigot)	<i>Helianthus sp.</i>	Asteraceae
78	<i>Eristalis (Eristalis) tenax</i> (Linnaeus)	<i>Ammi majus</i>	Apiaceae
		<i>Blumea sp.</i>	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
		<i>Chrysanthemum sp</i>	Asteraceae
		<i>Helianthus sp.</i>	Asteraceae
		<i>Sonchus asper</i>	Asteraceae
		<i>Dahlia sp.</i>	Asteraceae
		<i>Pyrus amygdalus</i>	Rosaceae
		<i>Brassica campestris v.sarson</i>	Cruciferae
		<i>Almond</i>	
		<i>Foeniculum vulgare Mill</i>	Umbelliferae
		<i>Allium cepa</i>	Liliaceaea

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
		<i>Anethum graveolens</i> Linnaeus	Umbelliferae
		<i>Unidentified Aster</i>	Asteraceae
79	<i>Eristalis angustimarginalis</i> Brunetti	<i>Brassica campestris</i> v.sarson	Cruciferae
		<i>Almond</i>	
80	<i>Eristalis polymacharus</i> (Brunetti)	<i>Brassica campestris</i> v.sarson	Cruciferae
81	<i>Graptomyza brevirostris</i> Wiedemann	<i>Herpestis</i> sp.	Scrophulariaceae
82	<i>Ischiodon scutellaris</i> (Fabricius)	<i>Anogeissus pendula</i>	Combretaceae
		<i>Cassia tora</i>	Fabaceae
		<i>Panicum</i> sp.	Graminae
		<i>Tagetes patula</i>	Asteraceae
		<i>Solanum melongena</i>	Solanaceae
		<i>Capsicum frutescens</i>	Solanaceae
		<i>Brassica campestris</i> v.sarson	Cruciferae
		<i>Zizyphus mauritiana</i> Lamk.	Rhamnaceae
83	<i>Ischyrosyrphus</i> sp.	<i>Cannabis sativa</i>	Cannabiaceae
84	<i>Melanostoma</i> sp.	<i>Solanum nigrum</i>	Solanaceae
		<i>Cynodon</i> sp.	Graminae
		<i>Chrysanthemum</i> sp	Asteraceae
		<i>Cannabis</i> sp.	Cannabiaceae
		<i>Eleusine indica</i>	Graminae
85	<i>Melanostoma orientale</i> (Wiedemann)	<i>Solanum nigrum</i>	Solanaceae
		<i>Rubus elipticus</i>	Rosaceae
		<i>Justica simplex</i>	Acanthaceae
		<i>Cannabis sativa</i>	Cannabiaceae
		<i>Digitaria sanguinalis</i>	Graminae
		<i>Cynodon</i> sp.	Graminae
		<i>Ammania</i> sp.	
		<i>Sida</i> sp.	Malvaceae
		<i>Lantana camara</i>	Verbanaceae
		<i>Digitalis purpurea</i>	Scrophulariaceae
86	<i>Melanostoma univittatum</i> Wiedemann	<i>Brassica campestris</i> v.sarson	Cruciferae
87	<i>Mesembrius bengalensis</i> (Wiedemann)	<i>Sida acuta</i>	Malvaceae
		<i>Wedelia calendulaceae</i>	Asteraceae
		<i>Tagetes patula</i>	Asteraceae
		<i>Polygonum chinensis</i>	Polygoniaceae
		<i>Spilanthus acmella</i>	Asteraceae
		<i>Rhodiola</i> sp.	Crassulaceae
88	<i>Mesembrius quadrivittatus</i> (Wiedemann)	<i>Wedelia calendulaceae</i>	Asteraceae
		<i>Aegle marmelos</i>	Rutaceae
	<i>Rauvolfia serpentina</i>	Apocyanaceae	
		<i>Polygonum chinensis</i>	Polygoniaceae
		<i>Spilanthus acmella</i>	Asteraceae
		<i>Foeniculum vulgare</i> Mill	Umbelliferae
	<i>Anethum graveolens</i> Linnaeus	Umbelliferae	

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
89	<i>Metasyrphus (Metasyrphus) corollae</i> (Fabricius)	<i>Brassica campestris</i> v.sarson <i>Almond</i>	Cruciferae
90	<i>Metasyrphus (M) latifasciatus</i> (Macquart)	<i>Rosa webbiana</i> <i>Cannabis sativa</i>	Rosaceae Cannabiaceae
91	<i>Paragus (Paragus) serratus</i> (Fabricius)	<i>Polygonum orientale</i> <i>Solanum nigrum</i> <i>Lantana camera</i> <i>Wedelia calendulaceae</i> <i>Ageratum conyzoides</i> <i>Zizyphus mauritiana</i> Lamk.	Polygonaceae Solanaceae Verbenaceae Asteraceae Asteraceae Rhamnaceae
92	<i>Paragus (Pandasyophthalmus) atratus</i> de Meijere	<i>Cynodon sp.</i> <i>Solanum nigrum</i>	Graminae Solanaceae
93	<i>Paragus (Pandasyophthalmus) tibialis</i> (Fallen)	<i>Cynodon sp.</i> <i>Amaranthus spinosa</i> <i>Solanum nigrum</i>	Graminae Amaranthaceae Solanaceae
94	<i>Paragus (Pandasyophthalmus) rufiventris</i> (Brunetti)	<i>Lantana camera</i> <i>Cynodon sp.</i> <i>Solanum nigrum</i>	Verbenaceae Graminae Solanaceae
95	<i>Paragus bicolor</i> Fabricius	<i>Choerophyllum sp.</i>	Umbelliferae
96	<i>Phytomia(Phytomia) errans</i> (Fabricius)	<i>Lantana camera</i>	Verbenaceae
97	<i>Phytomia(Dolichomerus) crassa</i>	<i>Foeniculum vulgare</i> Mill <i>Anethum graveolens</i> Linnaeus	Umbelliferae Umbelliferae
98	<i>Sphaerophoria sp.</i>	<i>Justica simplex</i> <i>Eleusine indica</i> <i>Sonchus asper</i>	Acanthaceae Graminae Asteraceae
99	<i>Sphaerophoria indiana</i> Bigot	<i>Brassica campestris</i> v.sarson	Cruciferae
100	<i>Sphaerophoria scripta</i> (Linnaeus)	<i>Tridax sp.</i> <i>Cynodon sp.</i> <i>Chenopodium ambrosoides</i> <i>Digitaria sanguinalis</i> <i>Duranta plumieri</i> <i>Foeniculum vulgare</i> <i>Justica simplex</i> <i>Nicotiana plumbaginifolia</i> <i>Chrysanthemum sp</i> <i>Cannabis sativa</i> <i>Solanum nigrum</i> <i>Sida sp.</i> <i>Sonchus asper</i> <i>Polygonum orientale</i> <i>Launea sp.</i> <i>Lantana camara</i> <i>Ammania sp.</i>	Asteraceae Graminae Choenopodiaceae Graminae Verbeneceae Umbelliferae Acanthaceae Solanaceae Asteraceae Cannabiaceae Solanaceae Malvaceae Asteraceae Polygonaceae Asteraceae Verbanaceae

Table-1 : Cont'd.

	POLLINATOR	PLANT	FAMILY
		<i>Eleusine sp.</i>	Graminae
		<i>Eleusine indica</i>	Graminae
		<i>Panicum sp.</i>	Graminae
101	<i>Syrphus latifasciatus</i> (Macquart)	<i>Cannabis sp.</i>	Cannabiaceae
		<i>Polygonum sp.</i>	Polygonaceae
		<i>Justica simplex</i>	Acanthaceae
102	<i>Betasyrphus serarius</i> (Wiedemann)	<i>Ammi majusa</i>	Apiaceae
103	<i>Syrphus torvus</i> Osten-Sacken	<i>Ammi majusa</i>	Apiaceae
104	<i>Syrpitta orientalis</i> Macquart	<i>Ephedra geardiana</i>	Ephedraceae
105	<i>Syrpitta indica</i> (Wiedemann)	<i>Polygonum chinensis</i>	Polygoniaceae
106	<i>Syrpitta pipiens</i> (Linnaeus)	<i>Anthemis cotula</i>	Asteraceae
		<i>Solanum nigrum</i>	Solanaceae
		<i>Panicum sp.</i>	Graminae
		<i>Cynodon dactylon</i>	Graminae
		<i>Cynodon sp.</i>	Graminae
		<i>Amaranthus spinosa</i>	Amaranthaceae
		<i>Nicotiana plumbaginifolia</i>	Solanaceae
		<i>Cannabis sativa</i>	Cannabiaceae
		<i>Eleusine indica</i>	Graminae
		<i>Eleusine sp.</i>	Graminae
		<i>Chloris sp</i>	
		<i>Duranta plumieri</i>	Verbanaceae
		<i>Zizyphus mauritiana Lamk.</i>	Rhamnaceae
107	<i>Scaeva latimaculata</i> (Brunetti)	<i>Melilotus officinalis</i>	Leguminosae
		<i>Brassica campestris v.sarson</i>	Cruciferae
108	<i>Scaeva selenitica</i> (Meigen)	<i>Scrophularia sp.</i>	Scrophulariaceae
14. Family TABANIDAE			
109	<i>Chrysops dispar</i> (Fabricius)	<i>Merremia vitifolia</i>	Convolvulaceae
	<i>Allium cepa L.</i>	Liliaceae	
	<i>Daucus carota</i>	Umbelliferae	
110	<i>Hybomitra hirta</i> (Walker)	<i>Anacardium occidentale</i>	Anacardiaceae
		<i>Sorghum vulgare</i>	Graminae
		<i>Coriandrum sativum</i>	Umbelliferae
15. Family TEPHRITIDAE			
111	<i>Bactrocera (Zeugodacus) cucurbitae</i> Coquilett	<i>Cucurbita maxima</i>	Cucurbitaceae
		<i>Zizyphus mauritiana Lamk.</i>	Rhamnaceae
		<i>Cosmostigma racemosum</i>	Asclepiadaceae
112	<i>Euphranta (Staurilla) crux</i> (Fabricius)	<i>Lantana camera</i>	Verbenaceae
		<i>Tectona grandis</i>	Verbanaceae
113	<i>Campiglossa cribellata</i> Bezzi	<i>Polygonum chinensis</i>	Polygoniaceae
16. Family TACHINIDAE			
114	<i>Thelaira macropus</i> (Wiedemann)	<i>Helichrysum sp.</i>	Asteraceae
		<i>Psidium guajava</i>	Myrtaceae
115	<i>Blepharipa sp.</i>	<i>Cosmostigma racemosum</i>	Asclepiadaceae
116	<i>Lophosia imbuta</i> (Wiedemann)	<i>Cosmostigma racemosum</i>	Asclepiadaceae