

True flies (Insecta: Diptera): Diversity and Endemism in Himachal Pradesh, India

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ABSTRACT - There is 503 dipteran species from 44 families of order Diptera, of which 72 species (14.31%) are endemic to the state of Himachal Pradesh, a state of India from Western Himalayan region. A total of 175 species from suborder Nematocera and 328 species from suborder Brachycera are reported from this state. The maximum number of species are reported from the family Syrphidae (76 species) which is 15.11% of the total reported species from this state. There are nine families having only single representative in this state.

100% species of the families Nemestrinidae, Therevidae and Platystomatidae are endemic to this state and the least number of endemic species are found in the family Culicidae (2.12%).

Keywords: Diversity, Diptera, Himachal Pradesh, Endemism, Habitat, Food Diversity.

1.INTRODUCTION

The name Diptera (commonly known as true flies) was originally assigned by Aristotle and adopted by Linnaeus in 1744. Mosquitoes, flies (black, fruit, blow, house etc.), midges (biting, non-biting), gnats (fungus, root), keds, bots etc., are the members of the order Diptera. They are very minute to large insects (0.5-75 mm long), variable in colour and form, soft bodied and the adult flying forms with only one pair of mesothoracic wing and with a pair of modified hind wing i.e. haltere.

Himachal Pradesh is lying in between 30°22'40" N to 33°12'40" N latitudes and 75°45'55" E to 79°04'20" E longitudes, bordered by states of Jammu and Kashmir in the north, Haryana in the south and Panjab in the west and country of China in the east.

So far knowledge goes, the publication of Diptera of Simla district by Brunetti (1917) is the pioneering work on the Diptera fauna of Himachal Pradesh^[1]. There after Datta (1985, 1992)^{[2] [3]}, Parui et al (1999, 2006)^{[7] [8]}, Mitra et al (2003a & b, 2004a&b)^{[10] [11] [12] [13]}, Wagner, Leese and Panesar (2004)^[19], Mitra et al (2007, 2008)^{[14] [15]}, Mitra and Mehta (2010)^[16] have contributed and enriched the Diptera fauna of Himachal Pradesh. Recently, Ghorpade (2014)^[5] published a checklist of family Syrphidae from Indian sub-continent and Shah, et al (2014)^[17] published the checklist of hover flies of Western Himalaya.

The present article is a consolidated account of the Diptera fauna based on literature records and collections made by the first author. An attempt has also been made to examine the diversity as well as the endemism of the true flies within the state.

Altogether 503 dipteran species of 223 genera belonging to 44 families so far known from the state of Himachal Pradesh, among which 72 species are endemic to this Himalayan state (Table – 1).

2.IMPORTANCE OF FLIES

Flies are distributed worldwide, which has profound impacts on ecosystem. Among the 44 families of Diptera reported from Himachal Pradesh, some are pollinators (Syrphidae, Calliphoridae, Rhinidae, Muscidae, Bombyliidae, Stratiomyidae, Nemestrinidae), some are predators of other insects (Asilidae, Bombyliidae, Therevidae, Scathophagidae, Scenopinidae, Empididae and Dolichopodidae), some are stem borers (Agromyzidae, Chloropidae, Cecidomyiidae), some are fungus feeder (Mycetophilidae, Trichoceridae, Tipulidae, Scatopsidae, Dryomyzidae) and some are root borers (Bibionidae).

There are also some blood sucking families in Diptera, Culicidae, Ceratopogonidae, Tabanidae; some carrion feeders family like Muscidae, Calliphoridae, Sepsidae, Sarcophagidae. Some are used as food sources for other animals (Chironomidae, Anthomyidae. Some are pest (Tephritidae, Agromyzidae, Sciaridae) and some are parasites (Pipunculidae, Conopidae, Sciomyzidae). Each of them play an important role in maintaining the balance among population of organisms. (Table.1)

3.BIODIVERSITY OF FLIES

The Diptera is the fourth most diverse order and classified into about 10,000 genera, 150 families, 22–32 superfamilies, 8–10 infraorders and 2 suborders, Nematocera and Brachycera (McAlpine and Wood 1989, Yeates and Wiegmann 1999)^[9] ^[20]. Unlike the families of birds and mammals, most families of Diptera are nearly worldwide in distribution. Recently, Zhang, 2011 estimated 1, 59, 294 described species from the world. ^[21]

In India, within the suborder Nematocera, 24 families have been recognized of which 16 families are reported which includes 56 genera and 175 species from the state of Himachal Pradesh. Of them, Culicidae shares maximum species (47 species) followed by Mycetophilidae (21 species), Limoniidae (17 species), Simuliidae (14 species), Psychodidae, Chironomidae, Bibionidae (each with 13 species), Sciaridae (9 species), Blephariceridae (7 species), Cecidomyiidae (6 species), Tipulidae (5 species), Dixidae (3 species), Trichoceridae, Ceratopogonidae, Anisopodidae (each with 2 species), and Scatopsidae (1 species).

Whereas, suborder Brachycera is reported in India by 61 families of which 28 families are reported from Himachal Pradesh which includes 167 genera and 328 species. Of them, family Syrphidae shares maximum species (76 species) followed by Empididae (47 species), Muscidae (43 species), Agromyzidae (31 species), Bombyliidae, Calliphoridae (each with 21 species), Sarcophagidae (16 species), Sepsidae (10 species), Rhiniidae (9 species), Conopidae (7 species), Tabanidae, Tephritidae (each with 6 species), Stratiomyiidae, Asilidae, Anthomyiidae (each with 4 species), Nemestrinidae, Dolichopodidae, Pipunculidae, Sciomyzidae (each with 3 species) and Chloropidae (2 species), Therevidae, Scenopinidae, Diopsidae, Ulididae, Platystomatidae, Dryomyzidae, Fanniidae, Scathophagidae (each with 1 species).

4.HABITAT DIVERSITY OF FLIES

Flies are highly adaptive insects and their larvae develop successfully in a very wide range of media. Most larvae of Diptera are scavengers and contribute to the decomposition of organic material, which in turn, provides nutrients for plants and support for healthy ecosystems and clean environments.

Their diverse feeding habits too have insightful impact on ecosystems and the Earth as a whole. They provide varied ecosystem services.

Some specific habitats and food occupied by Diptera of Himachal Pradesh in their larval stages are listed in the table no.1 with an indication of those most likely to be found there.

5. ENDEMISM OF TRUE FLIES IN HIMACHAL PRADESH

A species is endemic if it is confined/restricted to a particular area irrespective of size and shape. There has been considerable discussion recently about priorities for conservation. Many authors have suggested the need to move away from a single species emphasis to a community or ecosystem-level approach (Franklin, 1993; Tasse, 1993; Grumbine, 1994) [4] [18] [6]. Information on diversity and distribution of various taxa and their habitat is the key to diversity conservation, especially for the endemic species.

Till to day 72 species of the 22 families are endemic to this state (Table.2). Of these, 17 species are from suborder Nematocera and 55 species are from sub-order Brachycera. Another 428 species of 22 families are non-endemic to this state ((Fig.1).

100 percent species of the families Nemestrinidae, Therevidae and Platystomatidae are endemic to this state and the least number of endemic species are found in the family Culicidae (2.12%).

The high degree of endemism in True fly fauna has been seen at the genus level (49 of 223 genera, 21.98%) and in lesser extent at the species level (72 of 503 species, 14.31%). Neither of the families is endemic or exclusively found in Himachal Pradesh.

6. DISCUSSION

The species composition indicates that Himachal Pradesh has a rich, highly diverse and distinctly recognizable true fly fauna (representing almost 50% of total Indian families).

Altogether 503 species were reported from this Himalayan state. Of them, the family Syrphidae is having the highest number of species (15.11%) followed by Culicidae and Empididae (9.34%), Muscidae (8.54%) and so on. The lowest number of species are having the families like Scathophagidae, Fanidae, Dryomyzidae, Platystomatidae, Ulididae, Diopsidae, Scenopinidae, Therevidae and Scatopsidae (0.2% each families). (Fig. 2).

The result also indicates that the families like Tipulidae (5 species of 409 from India), Limoniidae (17 species of 965 from India), Ceratopogonidae (2 species of 220 from India), Ceceidomyiidae (6 species of 398 from India), Stratiomyidae (4 species of 82 from India), Tabanidae (6 species of 244 from India), Asilidae (4 species of 482 from India), Dolichopodidae (3 species of 134 from India) and Tephritidae (6 species of 187 from India) of Himachal Pradesh are underexplored or poorly studied. (Table – 1)

Other than these families, Culicidae (47 species of 425 from India) and Chironomidae (13 species of 168 from India) are also poorly represented in this state which can be studied. (Table – 1)

As a whole, it can be said that the Diptera of this state is diversified and almost 10% of the Indian fauna is representing by this state. Of them, the family Syrphidae is sharing highest number of species (76 species). (Table – 1)

Only 14.31% of species are endemic to this state of them, hundred percent species of three families, namely, Nemestrinidae, Therevidae and Platystomatidae are endemic (Fig. 1).

Significant areas of Himachal Pradesh still remain insufficiently explored, and the focus of fresh efforts should be on new species discovery through increased collection in remote areas, and the refinement of taxonomic skills.

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Table – 1: Species composition of dipteran families reported from Himachal Pradesh along with their food and habitat diversity.

SL N O	FAMILY	SPECIES			HABITAT AND FOOD DIVERSITY
		WORL D	INDIA	HP	
Sub-Order: Nematocera					
1	Trichoceridae (Winter Crane Flies, Winter Gnats)	183	20	2	Larvae feed on decaying organic matter, dung, carrion etc. Adults may rest in the shaded places throughout the year.
2	Tipulidae (Crane Flies, Daddy Longlegs.)	4,415	409	5	Larvae lives in any fresh water bodies, organic mud, leaf litters, decaying plant materials and adults may live in decaying woods, mosses etc. larvae of some species may feeds on some small invertebrates but adults in their very short life span do not eat at all.
3	Limoniidae (Limonid flies)	10,777	965	17	They lives on humus, swamps and marshes, leaf litter and fed on fungi, small invertebrates etc.
4	Psychodidae (Moth Flies, Owl Midges, Sand Flies)	3,026	88	13	Usually maggots live in moist or sub-aquatic habitats while the adults mainly active at night and found in moist protected areas. At day time they rest in shaded habitats.
5	Blephariceridae (Net-Winged midges)	331	23	7	The adults frequent border of streams in hilly or mountainous areas and are weak fliers. In some species both sexes feed on nectar, in others, females feed on haemolymph. Larvae and pupae live in strong currents on smooth hard substrata in streams and may serve as food to other animals in aquatic ecosystem.
6	Ceratopogonidae (Biting midges)	5,902	220	2	This blood sucking predators are usually found near aquatic and semi-aquatic environment and the larvae are always found in some damp location.

7	Culicidae (Mosquitoes)	3725	425	47	Females are ectoparasites, feeds on blood of mammals and males feeds on plant saps. Larvae usually found in aquatic environment. Adults serves as disease vector.
8	Dixidae (Meniscus midges)	197	11	3	They are aquatic Diptera and larvae lives on non polluted fresh water. Important in food chain of aquatic environment
9	Chironomidae (Non-Biting midges)	7290	168	13	They resemble mosquitoes with lack of elongated mouthparts and wing scales; larvae usually found in aquatic environment. Larvae and pupae are used as food of fish and other aquatic organisms.
10	Simuliidae (Black Fly, Buffalo Gnat)	2,132	67	14	Adult females feeds on blood whereas males feeds on nectar. They depends upon the river ecosystems.
11	Mycetophilidae (Fungus Gnats)	4,525	77	21	They are generally found in damp habitats, and lives on mosses, fungi etc. This family shows bioluminescence.
12	Anisopodidae (Wood Gnats, Window Gnats)	196	8	2	Adults are commonly found in swarms preferably near trees, often sitting around windows and on walls in cooler, shaded sides of houses (especially bathrooms) The larvae develop in a wide variety of decaying materials including dung, decaying plant roots, fungi, tree rot holes, some species live in fermenting sap.
13	Bibionidae (Fever Flies, Love bugs, March flies)	1,102	39	13	Adults frequent meadows, grassy hillsides or decaying vegetation and often appear in large swarms. They feed on nectar of flowers, relatively short lived. Larvae are slow moving, feed gregariously on decaying vegetation, at the roots of grasses, cereals, tubers and leaf mould.
14	Sciaridae (Dark-winged Fungus Gnats)	2,455	61	9	These small Dipteras found mainly on household plants in moist environments. Usually they serve as pests of household plants or mushroom.
15	Scatopsidae (Minute Black Scavenger Fly, Dung Midge)	407	3	1	They are saprophagous and larvae are found in decaying animal and plant matter.
16	Cecidomyiidae (Gall Midges)	6,203	398	6	These fragile small insects usually feeds on plant tissues and abnormal plant growths (Galls) and serves as a pest of several crops and plants.
Sub-Order: Brachycera					
17	Stratiomyidae (Soldier flies)	2,690	82	4	They are saprophagous or mycophagous and larvae lives on either aquatic or terrestrial habitats. Nectar feeder.
18	Tabanidae (Horseflies)	4,434	244	6	They mainly feeds on nectar and sometimes pollens but require a blood meal before effective reproduction
19	Nemestrinidae (Tangle-veined flies)	300	6	3	Adult tangle-veined flies are fast fliers and are most often seen at flowers or hovering, motionless, with a high-pitched hum. Adults are nectar feeders and usually found hovering on flowers. Larvae are

					endoparasitic on grasshoppers and scarabaeid beetles.
20	Therevidae (Stiletto Fly)	1,143	16	1	Larvae prefers sandy soils, dry leaf litter and they are entomophagous in nature. Adults usually found near streams, woodlands and mainly feeds on nectar, pollen, honeydew etc.
21	Scenopinidae (Window Fly)	420	2	1	Larvae prefers dry litter, sandy soils; may be found in association with some stored grain pests. Larvae usually feeds on other larvae of insects or some soil microarthropods. Adults are predator and found in nest of birds, mammals and human habitation.
22	Bombylidae (Bee flies)	5,382	138	21	Adults usually feeds on nectar and serves as pollinator of some plants. Larvae are predators or parasitoids of larvae of other insects.
23	Asilidae (Robber flies)	7,531	482	4	They are predators (both juvenile and adult), feeds on other small arthropods. They are found in open and scattered vegetation, forest ecosystem.
24	Empididae (Dagger Fly, Balloon Fly)	3,142	89	47	They are found in plant leaves, tree trunks and sometimes also in aquatic vegetation. They serves as predators of small arthropods and also visits flower to obtain nectar.
25	Dolichopodidae (Long –legged flies)	7,358	134	3	Adults of many species are known to feed on nectar. Most larvae are predaceous and occur under the bark of trees, or in decaying vegetation.
26	Pipunculidae (Big-Headed Flies)	1,428	25	3	The larvae of Pipunculidae develop as Parasitoids almost exclusively in Homoptera. Some species are used as biological control agents in rice fields.
27	Syrphidae (Flower flies, Hover flies)	6,107	392	76	Adults are habitual visitors of flowers for obtaining pollen, nectar and honeydew, and are important pollinators. Larvae have a wide variety of food habits.
28	Diopsidae (Stalk-eyed Flies)	195	8	1	They feeds on decaying plant and animal matter, fungi, bacteria and found on low-lying vegetation in humid areas, often near streams and rivers.
29	Chloropidae (Eye gnats, Gout flies, Grass flies)	2,885	23	2	Adults occur in grasses, flowers, and some (the "eye gnats") are attracted to the eyes and open wounds of humans and animals. Larvae are mostly saprophagous or phytophagous, feeding in a variety of habitats including cereals and grasses, decaying plant matter, and fungi.
30	Conopidae (Thick-headed Flies)	831	48	7	The larvae serves as internal parasites and adults may found sometimes to visit flowers for nectar.
31	Ulididae (Picture-winged Flies)	678	2	1	The larvae are mostly saprophagous and develop in rotting matter, under bark or in dung; some apparently are phytophagous. The adults live in moist places, marshland habitats, woodland areas, sandy, salty or steppe meadows, and often occur on the leaves of shrubs, tree trunks, on flowers, and also on excrement and manure heaps.

32	Platystomatidae (Signal Flies)	1,164	16	1	Adults are found on tree trunks and foliage and are attracted to flowers, decaying fruit, excrement, sweat, and decomposing snails. Larvae are found on fresh and in decaying vegetation, carrion, human corpses, and root nodules. Most larvae are either phytophagous or saprophagous.
33	Tephritidae (Fruit flies, Gall flies)	4,716	187	6	Many species of this group are very common and usually found on flowers or vegetation. Larvae are plant feeders, and a few are pests of fruits.
34	Sciomyzidae (Marsh Flies)	618	10	3	The adults drink dew and nectar. The larvae prey on or become parasites of gastropods (slugs and snails). Some species which prey on bivalves have larvae adapted to breathing under water.
35	Dryomyzidae	30	1	1	Larvae feed on decaying organic matter, carrion, dung, and fungi.
36	Sepsidae (Black scavenger flies)	345	45	10	Adults are scavengers, and most often can be caught by sweeping grass in meadows or woods, or on dung. Larvae are often found in carrion or excrement.
37	Agromyzidae (Leaf miners)	3,017	137	31	Larvae eat living plant tissue. Most species feed between the upper and lower surfaces of leaves, making conspicuous mines, but others attack stems, roots and seeds.
38	Fannidae	359	5	1	Males congregate in characteristic dancing swarms beneath trees; females are more retiring in habit and can be collected by sweeping vegetation. Larvae live in decomposing organic matter and most adults are rarely encountered.
39	Scathophagidae (Dung Flies)	419	2	1	They include plant feeders, aquatic predators and predators of larvae of other insects.
40	Anthomyidae (Root eating flies)	1,941	19	4	The larvae live mainly in decaying vegetation, stranded seaweed on beaches, some are minor pest, sometimes attacking seedlings of onions, legumes and other plants, grasses.
41	Muscidae (Face Flies, Horn Flies, House Flies, Stable Flies)	5,218	258	43	Adults can be predaceous, haematophagous, saprophagous, or feed on a number of types of plant and animal exudates. They can be attracted to various substances including sugar, filth, sweat, tears and blood. Larvae occur in various habitats including decaying vegetation, dry and wet soil, nests of insects and birds, fresh water, and carrion. They can be predaceous, coprophagous, or saprophagous.
42	Calliphoridae (Blow Flies)	1,525	63	21	They are found to visits different flowers and serves as occasional pollinators. The larvae may found in decaying animal or plant matters.
43	Rhiniidae	376	57	9	Adult usually feeds on nectar. Larvae of some species can breed in the nest of termites.
44	Sarcophagidae (Flesh flies)	3,094	117	16	Usually acts as scavengers of small carrion. Maggots usually found in decaying vegetable and animal matters.

Table – 2: List of Endemic species from Himachal Pradesh

No	Family	Name of the Endemic Species
1	Tipulidae	1. <i>Tipula (Pterelachisus) brunnicosta</i> Brunetti, 1912
2	Limoniidae	1. <i>Antocha (Antocha) triangularis</i> (Brunetti, 1912) 2. <i>Limonia (Geranomyia) vinaceobrunnea</i> (Brunetti, 1911) 3. <i>Dicranota (Rhaphidolabis) sordida</i> (Brunetti, 1911) 4. <i>Erioptera (Erioptera) grandior</i> Brunetti, 1912
3	Psychodidae	1. <i>Pericoma mixta</i> Brunetti, 1911
4	Blephariceridae	1. <i>Blepharicera indica</i> Brunetti, 1911
5	Culicidae	1. <i>Anopheles (Anopheles) gigas</i> Giles var. <i>simlensis</i> James, 1911
6	Dixidae	1. <i>Dixa bifasciata</i> Brunetti, 1911 2. <i>Dixa montana</i> Brunetti, 1911
7	Chironomidae	1. <i>Tanipus riparius</i> (Kieffer, 1911) 2. <i>Tanipus saltatrix</i> (Kieffer, 1911) 3. <i>Chironomus oriplanus</i> Kieffer, 1911 4. <i>Metriocnemus callinotus</i> (Kieffer, 1911)
8	Simuliidae	1. <i>Simulium (Eusimulium) senile</i> Brunetti, 1911
9	Sciaridae	1. <i>Sciara hirtilineata</i> Brunetti, 1912 2. <i>Sciara luteiventris</i> Brunetti, 1912
10	Nemestrinidae	1. <i>Hirmoneura annandalei</i> Lichtwardt, 1913 2. <i>Hirmoneura cingulata</i> Lichtwardt, 1909 3. <i>Hirmoneura opaca</i> Lichtwardt, 1909
11	Therevidae	1. <i>Thereva bilineata</i> Brunetti, 1917
12	Bombyliidae	1. <i>Heteralonia scutellata</i> Bhalla, Grewal & Kapoor, 1991
13	Asilidae	1. <i>Trichomachimus himachali</i> Pauri, Kaur and Kapoor, 1999
14	Empididae	1. <i>Empis (Empis) marginata</i> Brunetti, 1917 2. <i>Empis (Empis) rostrata</i> Brunetti, 1913 3. <i>Hilara compacta</i> Brunetti, 1913 4. <i>Rhamphomyia (Rhamphomyia) himalayana</i> Brunetti, 1913 5. <i>Dolichocephala septemnotata</i> Brunetti, 1913 6. <i>Hemerodromia dorsalia</i> (Brunetti) 7. <i>Heleodromia obscura</i> (Brunetti, 1913) 8. <i>Platypalpus palliditibiae</i> Brunetti, 1913 9. <i>Tachypeza incisa</i> Brunetti, 1913 10. <i>Chelifera insneta</i> Wagner & Leese, 2004 11. <i>Chelifera multisetata</i> Wagner & Leese, 2004 12. <i>Chelifera multisetoides</i> Wagner & Leese, 2004 13. <i>Chelifera curvata</i> Wagner & Leese, 2004 14. <i>Chelifera rhombicercus</i> Wagner & Leese, 2004 15. <i>Chelifera standerae</i> Wagner & Leese, 2004 16. <i>Chelifera accomodata</i> Wagner & Leese, 2004 17. <i>Chelifera brevidigitata</i> Wagner & Leese, 2004 18. <i>Chelifera digitata</i> Wagner & Leese, 2004 19. <i>Chelifera haeselbarthae</i> Wagner & Leese, 2004
15	Syrphidae	1. <i>Asarkina assimilis</i> (Macquart, 1846) 2. <i>Blera himalaya</i> Thompson, 2000 3. <i>Callicera christiani</i> Ghorpade, 1982 4. <i>Cheilosia kalatopensis</i> Nayar, 1968 5. <i>Cheilosia plumbiventris</i> Brunetti, 1915 6. <i>Matsumyia dentata</i> Brunetti, 1908 7. <i>Eumerus perpensus</i> Brunetti, 1917 8. <i>Eumerus perplexus</i> Brunetti, 1917 9. <i>Graptomyza flavonotata</i> Brunetti, 1917

		10. <i>Megasyrphus himalayensis</i> Kohli, Kapoor and Gupta, 1988 11. <i>Monoceromyia multipunctata</i> (Hull, 1941) 12. <i>Myolepta himalayana</i> Brunetti, 1915 13. <i>Rhingia angusticincta</i> Brunetti, 1908 14. <i>Rhingia siwalikensis</i> Nayar, 1968 15. <i>Sphegina guptai</i> Mutin, 1998
16	Conopidae	1. <i>Conops (Conops) rufofasciatus</i> Brunetti, 1923
17	Platystomatidae	1. <i>Xenaspis synnephes</i> Hendel, 1914
18	Tephritidae	1. <i>Acidiella discalis</i> (Brunetti, 1917) 2. <i>Acidiella rioxaeformis</i> (Bezzi, 1913)
19	Agromyzidae	1. <i>Calcomyza (Dizygomyza) flavohalterata</i> Ipe, 1971 2. <i>Calcomyza (Dizygomyza) kalatopensis</i> Singh & Garg, 1970 3. <i>Calcomyza (Poemyza) siwalikensis</i> Singh & Garg, 1970 4. <i>Phytoliriomyza simlensis</i> (Ipe & Garg, 1971) 5. <i>Phytomyza himachali</i> Singh & Garg, 1970
20	Muscidae	1. <i>Limnophora perkensis</i> Malloch, 1929 2. <i>Phaonia curviseta</i> Emden, 1965 3. <i>Phaonia simulans</i> Malloch, 1931
21	Calliphoridae	1. <i>Pollenia townsendi</i> Senior-White, 1940
22	Sarcophagidae	1. <i>Parasarcophaga(Pandelleisca) curvata</i> Nandi, 1989 2. <i>Sarcosolomonina(Parkerimyia) chambaensis</i> Nandi, 1989

Figure.1. Percentage of endemic species in Himachal Pradesh (Family-wise)

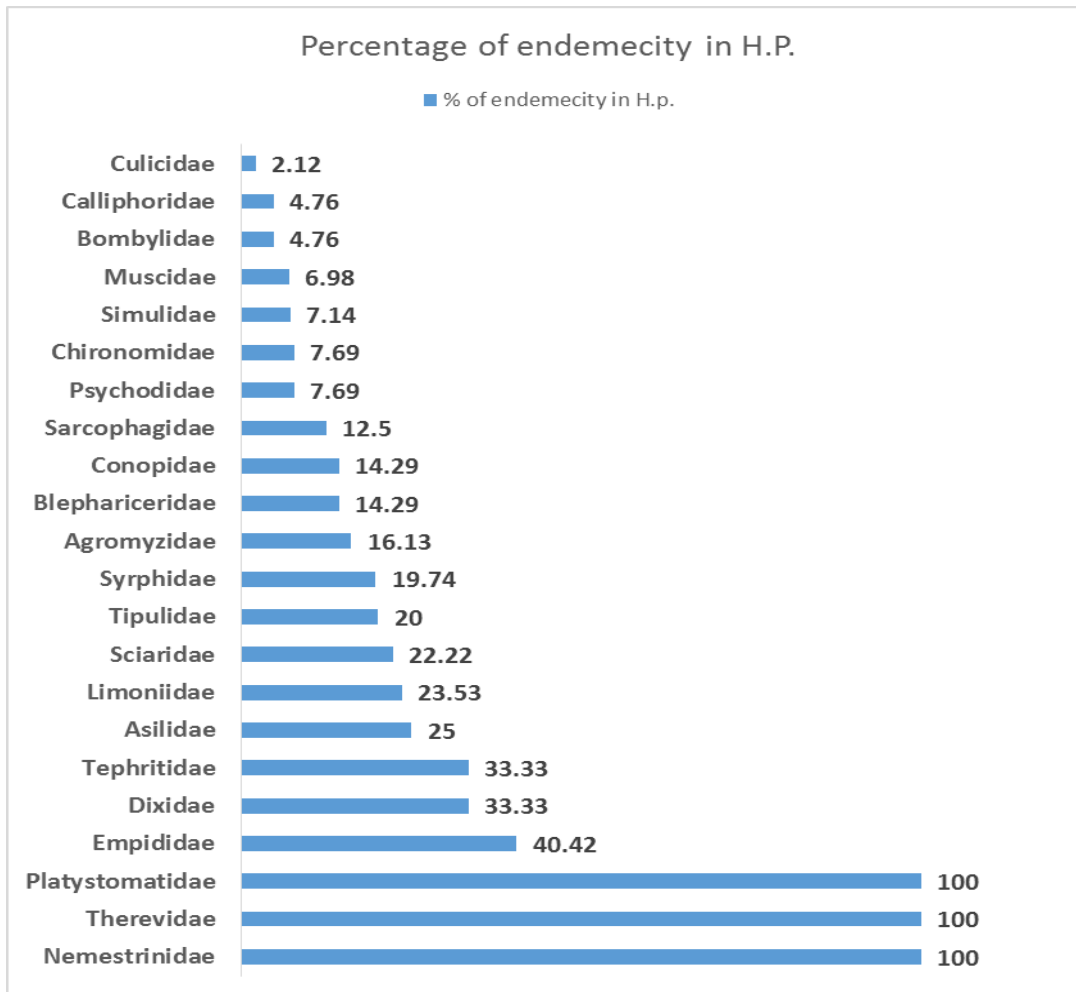
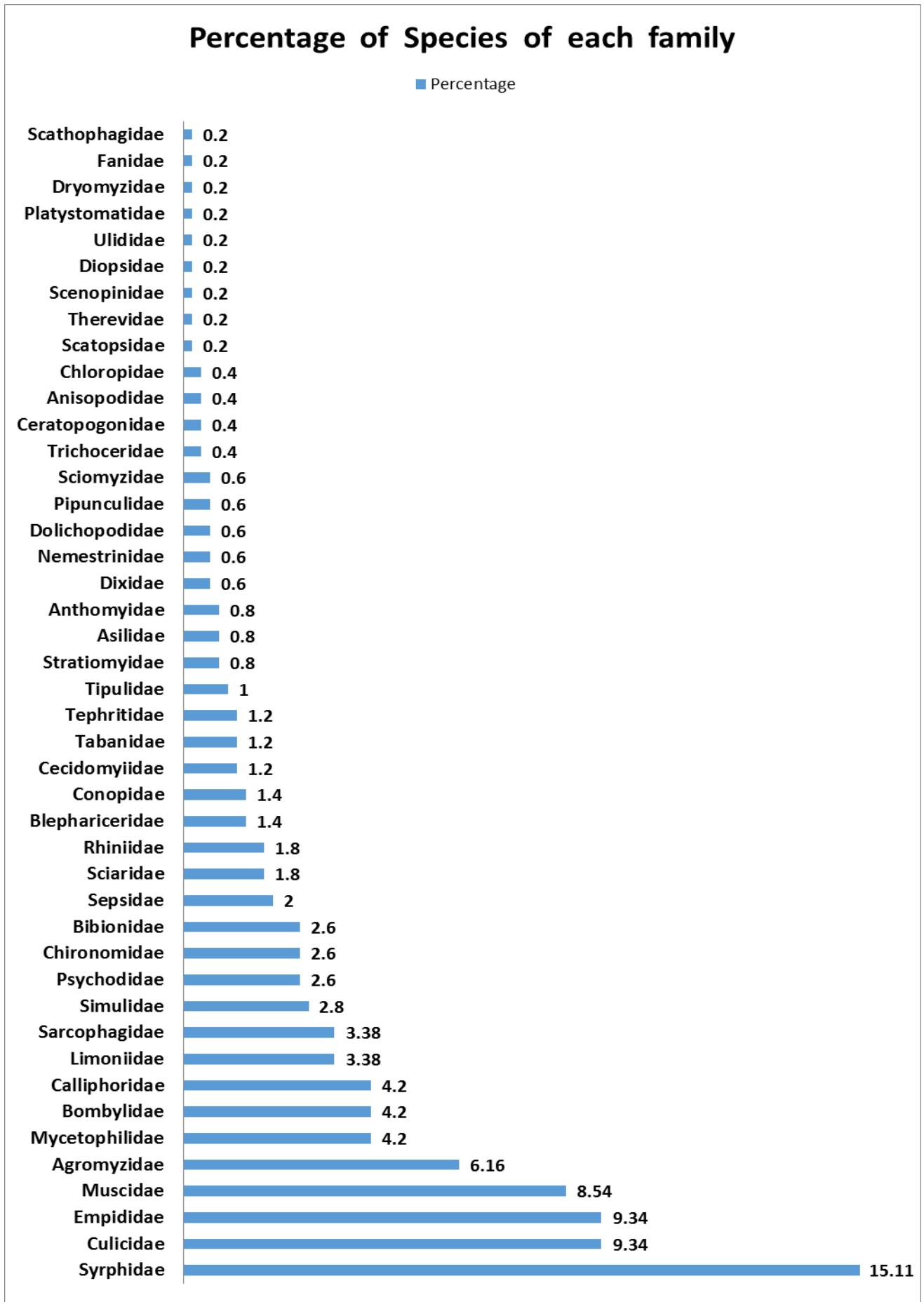


Fig. 2 : Family wise percentage of species from each family of Diptera reported from Himachal Pradesh



References

1. Brunetti, E. 1917. Diptera of Shimla district. *Records of Indian Museum.*, 13: 66
2. Datta, M. 1985. The subgenus *Odagmia* Enderlein (Diptera: Simuliidae) with a new species from Himachal Pradesh, India. *Bulletin of Zoological Survey of India*, 7: 25-32
3. Datta, M. 1992. Contribution to the knowledge on the black fly gauna (Diptera: Simuliidae) of Himachal Pradesh, India. *Proceedings of Zoological Survey of India*, Calcutta, 45(1): 39-52
4. Franklin, J. F. 1993. Preserving biodiversity: species, ecosystems, or landscapes? *Ecological Applications* 3:202-205.
5. Ghorpade, K. 2014. An updated Check-list of the Hover-flies (Diptera: Syrphidae) recorded in the Indian sub-continent. *Colemania* 44: 1-30
6. Grumbine, R. E. 1994. What is ecosystem management. *Conserv. Biol.* 8: 27-38
7. Parui, P., Kaur, K and Kapoor, V.C. 1999. Three new species of Asilidae (Diptera) from Himachal Pradesh, India. . *Rec. Zool. Surv. India*, 97 (1): 221-229
8. Parui, P, Mitra, B, and Sharma, R, M.2006. Diptera fauna of Punjab and Himachal Shiwalik Hills. *Rec. Zool. Surv. India*, 106(1):83-108.
9. McAlpine, J.F. and Wood, 1989. Manual of Nearctic Diptera, vol.3 Agricultural monograph 32.
10. Mitra,B. Parui, P. Mukherjee, M. Sharma, R.M. and Mehta, H.S. 2003a. Flower flies from the Pin Valley National Park, Himachal Pradesh. *BIONOTES* 5(4): 102.
11. Mitra, Bulganin, Parui, P. Banerjee, D. & Mukherjee, M. 2003b. First record of *Paragus bicolor* Fabricius. from India (Diptera: Syrphidae). *BIONOTES* 5(2):34.
12. Mitra B., Sharma,R.M. and Parui, P. 2004a. A Preliminary study on the Dipteran Flower visitors/Pollinators of Himachal Pradesh. *Annl. For.* 12 (1):119-124
13. Mitra, B, Parui, P, Banerjee, D and Sharma, R. M. 2004b. On a collection of Diptera from Kalatop- Khajjiar Wild life sanctuary, Himachal Pradesh. *Himalyan Chemical and Pharmaceutical Bulletin HCPB.* (20- 21):31-35
14. Mitra, B., Banerjee, D and Roy, S. 2007. A check-list of tabanid flies (Tabanidae: Diptera) of the Eastern Himalayas, India. *J.Adv. Zool.*, 28(2): 55-56
15. Mitra, B., Parui,P., Mukherjee, M., and Sharma, R.M. 2008. Insecta: Diptera , *In :Fauna of Pin Valley National Park, Conservation Area series*, 34: 75-84. *Zool. Surv. India.*
16. Mitra, Bulganin and Mehta, H.S. 2010. A preliminary note on the conservation of Saproxylic flies (Insecta: Diptera) in Himachal Pradesh. *Rec. Zool. Surv. India* 110 (3): 1-5
17. Shah, G. M., Jan Ulfat, Wachkoo, A. A. 2014. A checklist of Hover flies (Diptera: Syrphidae) in the Western Himalaya, India. *Acta Zoologica Academiae Scientiarum Hungaricae* 60(4): 283–305

18. Tasse, J. ed., 1993. Exploring an ecosystem approach to endangered species conservation. *Endangered species update* **10**: 1-62
19. Wagner, R, Leese, F & Panesar, A. R. 2004 Aquatic Dance Flies from a Small Himalayan Mountain Stream (Díptera: Empididae: Hemerodromiinae, Trichopezinae and Clinocerinae)
20. Yeates, D.K. and Wiegemann, B.M.1999. Congruence and controversy: toward a high level phylogeny of Diptera. *Ann. Rev. Entomol.*44:397-428.
21. Zhang, Z.Q (Ed.) 2011. Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness". *Zootaxa*: 4138