



Diversity of Hover flies (Insecta: Diptera: Syrphidae) with 3 New Record From High Hill Zone of Himachal Pradesh, India

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Abstract

The present study of High hill zone, Himachal Pradesh is an inimitable example of establishment of alternative pollinators as a main pollination service renderer. Present study is imperious at this juncture to explore the present status of syrphid fauna prevalent in this important high hill zone ecosystem, not only to provide a baseline data for future entomo faunal studies but also to discuss the potential role of hoverflies as pollinator in this ecosystem. Altogether, 19 species under 13 genera over 2 subfamilies have been reported from High hill zone of Himachal Pradesh. 3 species namely *Syrphus (Syrphus) vitripennis* Meigen, 1822, *Eristalis (Eristalis) tenax* (Linnaeus, 1758) and *Eristalinus (Eristalinus) arvorum* (Fabricius, 1787) are reported for the first time from this High hill zone as well as from the state of Himachal Pradesh. Their taxonomic keys and detail diagnosis of the reported species has been discussed along with the distributional pattern of these species along the High hill zone of Himachal Pradesh.

Keywords: Hover flies, New Record, High hill zone, Syrphidae, Taxonomy.

Introduction

Flies always have played important roles as primary and secondary consumers, nutrient recyclers, provide food for wildlife, and indicators of ecosystem utility (Anderson and Vondracek, 1999; Batzer *et al.*, 1992; De Szalay and Resh, 1997; Euliss *et al.*, 1991). The flies are directly pertinent to human society as Pollinator (Sengupta *et al.*; 2019), Vector (Maity *et al.*; 2019) or sometime as bio-controllers (Naskar *et al.*; 2019) and nutrient recyclers in agrarian and wild ecosystems (Ghahari *et al.*; 2008). Undoubtedly, out of this diversification in role, one of the most

appreciated one is the part of pollination (Sengupta *et al.*; 2018). Whenever dipteran pollination is being discussed, the role of charismatic Hover flies (Insecta: Diptera: Syrphidae) as an efficient pollinator is always highlighted. It is a group of pollinating insects which is one of the most speciose groups comprising of morphologically and biologically diverse organisms (Sengupta *et al.*; 2016b), makes up 4.90% of the known Dipteran fauna from India (Sengupta *et al.*; 2016a, Banerjee *et al.*; 2018). They are omnipresent and cosmopolitan in their distribution (Evenhuis &

Pape, 2019). As revealed from molecular and morphological evidences, the Hoverflies are monophyletic in evolutionary pattern (Teskey *et al*; 1981).

Role of hoverflies as natural pest controller (Potts *et al*;2006) is also widely accepted apart from their pollination services. Unfortunately, the contribution of this hovering flies rendered towards food security of surrounding ecosystem is highly neglected. (Ssymank *et al*;2008) Especially in high elevational landscape, where the first liner pollinator superheroes are not efficient enough (Sengupta *et al*; 2019). The elevational hazards, environmental harshness, reduced flight capability, loss of partial pressure of oxygen etc together act as a barrier for the main pollinators of agro ecosystems including honey bees, Lepidoptera, ladybird beetles etc. (Mani,2013). Here lies the importance of hoverflies as an alternative pollinator in all of this agricultural landscape of higher altitudinal gradient. From agro economic aspect in the present research, the study area of Himachal Pradesh has been also classified in four zones namely Shivalik Hill zone (601-1200 mt), Mid Hill zone (1201-1800 mt), High Hill zone (1801-2200 mt), Cold & Dry Zone (2201-6500 mt) (Joshi *et al*;2013). Present research has been based upon the data collected from throughout survey from High hill zone of Himachal Pradesh in the year 2015-2018 in the elevational range of 1801 to 2,200 mt. The present study of High hill zone, Himachal Pradesh is an inimitable example of establishment of alternative pollinators as a main pollination service renderer. Present study is imperious at this juncture to explore the present status of syrphid fauna prevalent in this important high hill zone ecosystem, not only to provide a baseline data for future entomo faunal studies but also to discuss the potential role of hoverflies as pollinator in this ecosystem.

Materials and Methods

Syrphid fauna was collected from the field during day time by using insect sweep nets as well as specimens were also collected from different traps including. The collected samples are narcotized by using ethyl acetate

and stored for further study in insect envelopes in the field. After bringing the specimens back in laboratory, specimens are pinned and kept in insect boxes. Identification of the adults followed the keys of Miranda *et al*; 2013, Vockeroth 1992, Thompson *et al*; 1982, Teskey *et al*; 1981; and Brunetti 1907 keeping in mind the recent nomenclatural changes (Evenhuis & Pape, 2019). All the identified specimens were deposited in the designated repository of National Zoological Collection, Diptera section, Zoological Survey of India, Kolkata. The graphical representations here were made by using Microsoft Excel 2016. The 3D map of the study area has been generated by using ARC GIS software version 10.1. The photograph of habitus and insect body and parts were taken by using Leica Microscope M205A, where 0.32x Acro lense was used for for habitus photography and PLANAPO 1.0X lense was used for the photography of body parts and Nikon D7000 (Nikkor normal and macro lens) were used for field photographs.

Results

The current study includes the total list of available syrphid species from High hill zone of Himachal Pradesh along with their systematic account, diagnostic taxonomic key, and distributional affinity in India as well as in all other zoogeographical realms. This study altogether recorded 19 species of hoverflies under 13 genera over 2 subfamilies. Of which 2 species recorded for the first time from the state of Himachal Pradesh.

List of taxa

Subfamily Syrphinae

Tribe Syrphini

- I. Genus *Episyrphus* Matsumura & Adachi, 1917
 1. Subgenus *Episyrphus* Matsumura & Adachi, 1917
 1. *Episyrphus (Episyrphus) balteatus* (De Geer, 1776)
 - II. Genus *Ischiodon* Sack, 1913
 2. *Ischiodon scutellaris* (Fabricius, 1805)
 - III. Genus *Sphaerophoria* Lepelletier & Serville, 1828

- Subgenus *Knutsonia* Barkalov, 2012
- 3. *Sphaerophoria (Knutsonia) viridaenea* Brunetti, 1915
- IV. Genus **Syrphus** Fabricius, 1775
 - Subgenus **Syrphus** Fabricius, 1775
 - 4. *Syrphus(Syrphus) torvus* Osten Sacken, 1875
 - 5. *Syrphus (Syrphus) vitripennis* Meigen, 1822**
- V. Genus **Chrysotoxum** Meigen, 1800
 - 6. *Chrysotoxum convexam* Brunetti, 1915
 - 2. Tribe Bacchini
- VI. Genus *Melanostoma* Schiner, 1860
 - 7. *Melanostoma orientale* (Wiedemann, 1824)

<http://www.publications.gc.ca/pub?id=9.610315&sl=0>

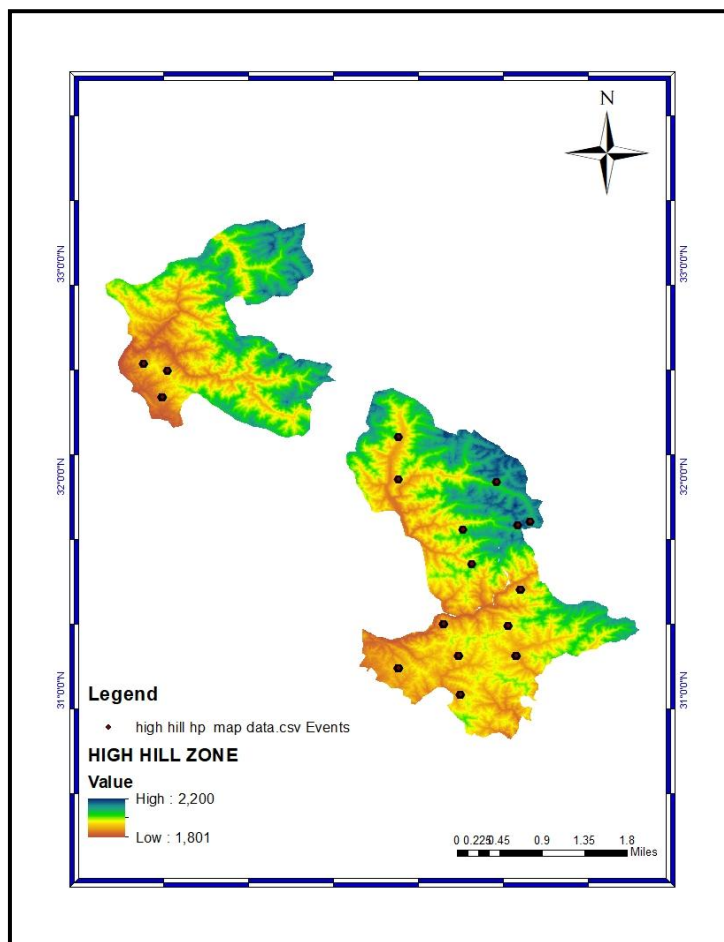


Figure 1: 3D Map showing study area and syrphid species richness from High hill zone from the state of Himachal Pradesh.

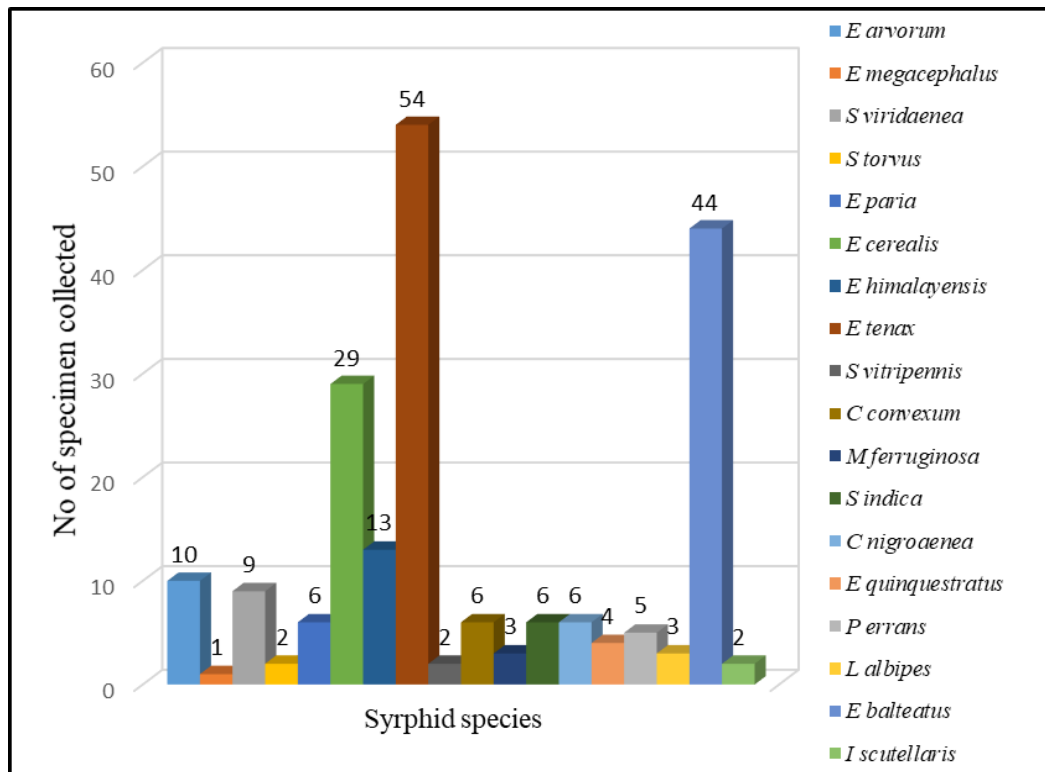


Figure 2: Abundance status of syrphid species from High hill Zone, Himachal Pradesh

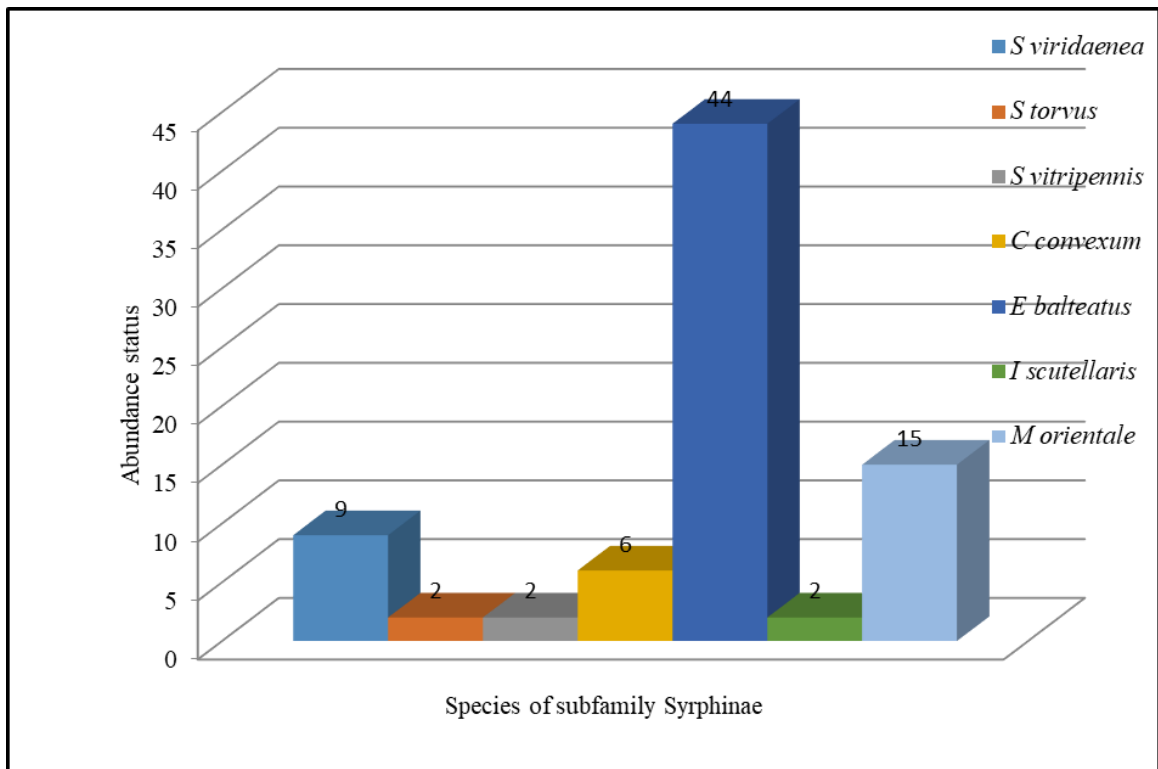


Figure 3: Abundance status of species belonging to Syrphinae subfamily from High hill Zone, Himachal Pradesh

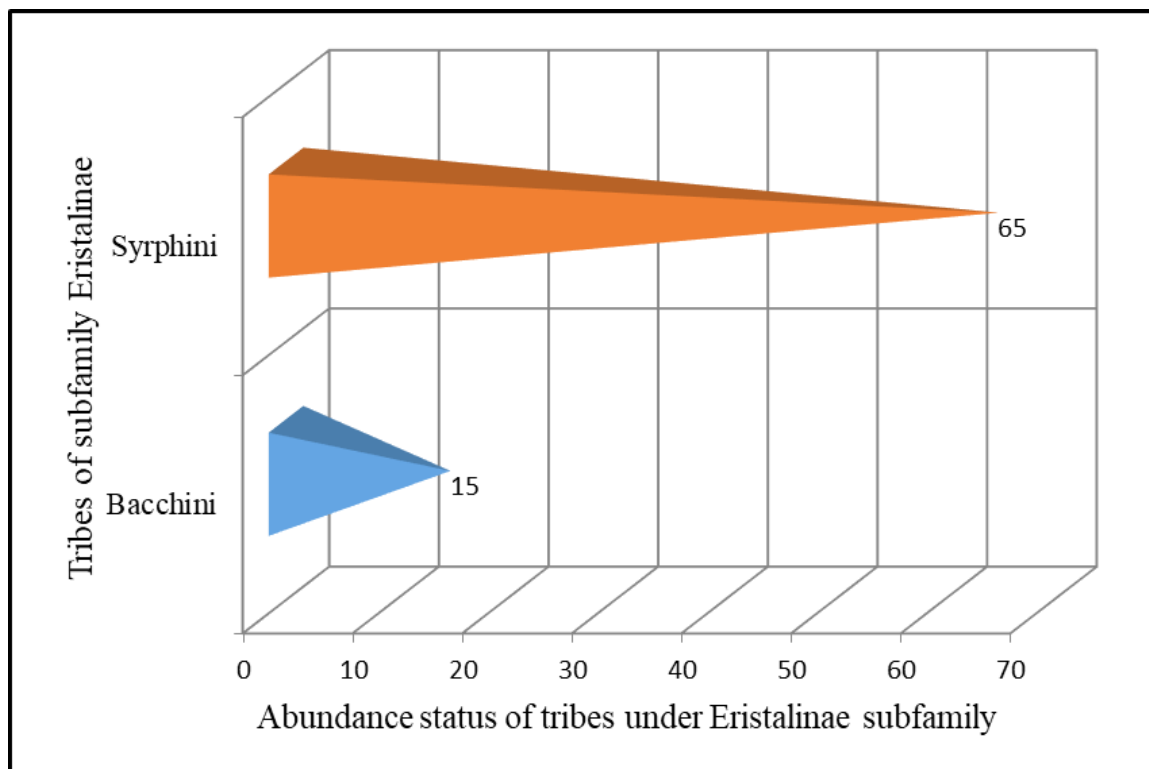


Figure 4: Abundance status of different tribes under Syrphinae subfamily from High hill Zone, Himachal Pradesh

Subfamily Eristalinae

Tribe Rhingiini

- VII. Genus *Cheilosia* Meigen, 1822
 8. *Cheilosia nigroaenea* Brunetti, 1915

Tribe Eristalini

- VIII. Genus *Eristalinus* Rondani, 1845
 ➤ Subgenus *Eristalinus* Rondani, 1845
 9. *Eristalinus (Eristalinus) arvorum* (Fabricius, 1787) **
 10. *Eristalinus (Eristalinus) megacephalus* (Rossi, 1794)
 11. *Eristalinus (Eristalinus) quinquestriatus* (Fabricius, 1794)
 ➤ Subgenus *Eristalodes* Mik, 1897
 12. *Eristalinus (Eristalodes) paria* (Bigot, 1880)
 IX. Genus *Eristalis* Latreille, 1804
 ➤ Subgenus *Eoseristalis* Kanervo, 1938
 13. *Eristalis (Eoseristalis) cerealis* Fabricius, 1805

14. *Eristalis (Eoseristalis) himalayensis* Brunetti, 1908

- Subgenus *Eristalis* Latreille, 1804
 15. *Eristalis (Eristalis) tenax* (Linnaeus, 1758) **

- X. Genus *Phytomia* Guerin-Meneville, 1833

- Subgenus *Phytomia* Guerin-Meneville, 1833

16. *Phytomia (Phytomia) errans* (Fabricius, 1787)

- XI. Genus *Lycastris* Walker, 1857

17. *Lycastris albipes* Walker, 1857

- XII. Genus *Milesia* Latreille, 1804

18. *Milesia ferruginosa* Brunetti, 1913

Tribe Milesiini

- XIII. Genus *Syritta* Lepeletier & Serville, 1828

19. *Syritta indica* (Wiedemann, 1824)

*** New record of hoverfly species from state of Himachal Pradesh

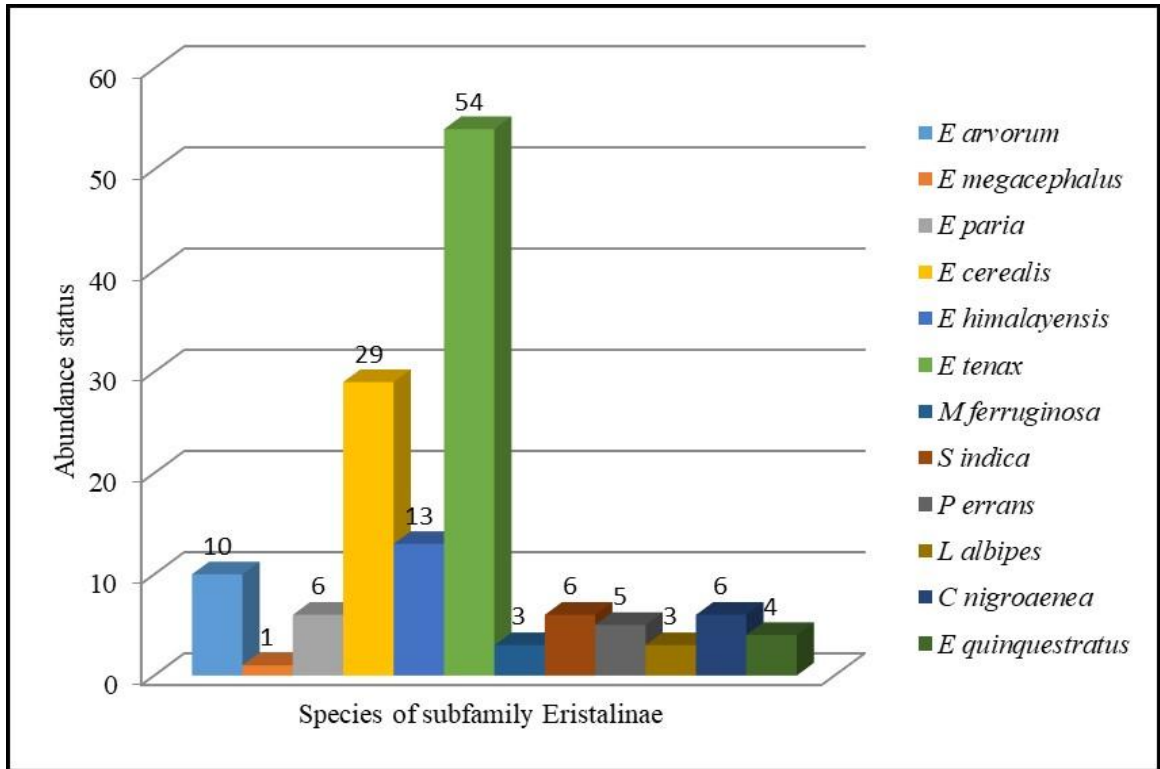


Figure 5: Abundance status of species belonging to Eristalinae subfamily from High hill zone, Himachal Pradesh

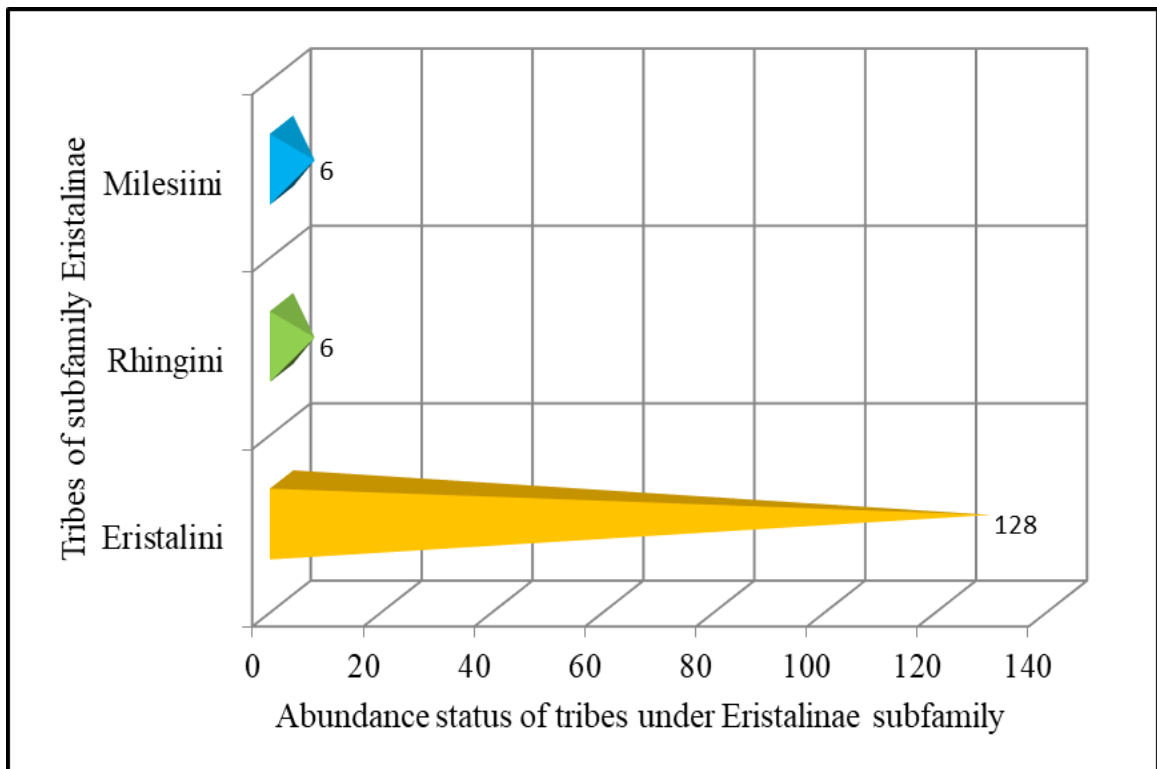


Figure 6: Abundance status of different tribes under Eristalinae subfamily from High hill Zone, Himachal Pradesh

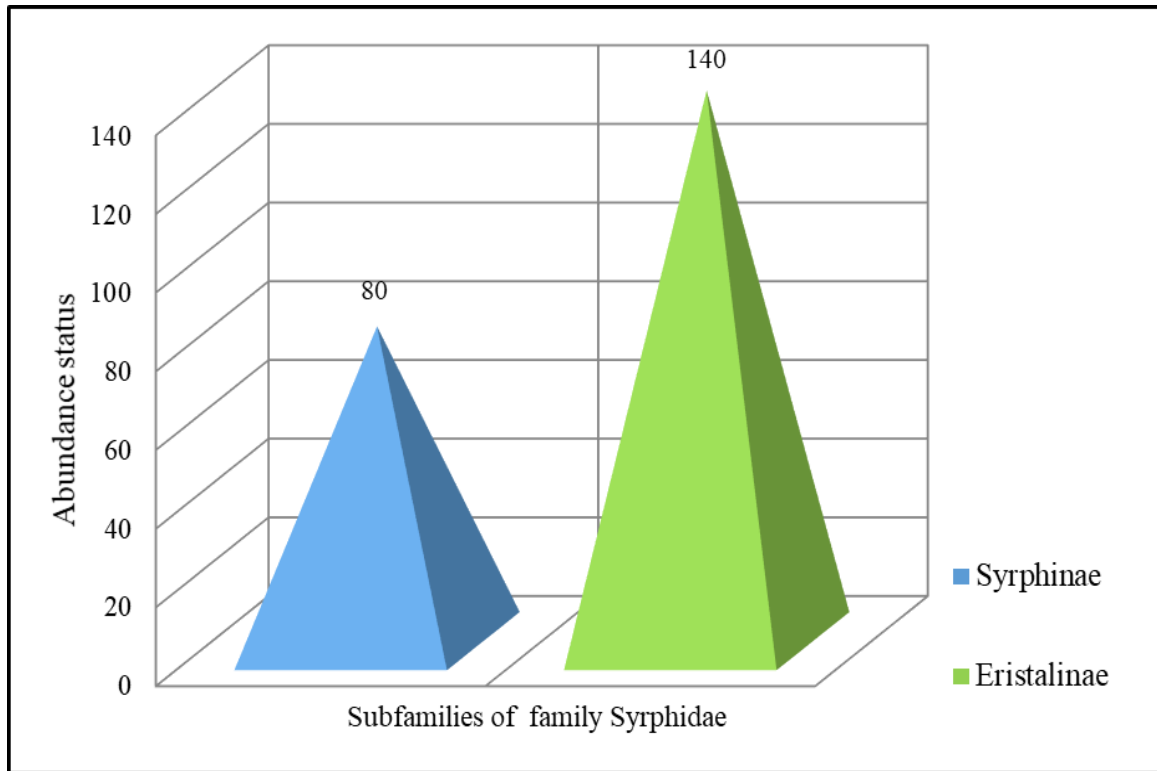


Figure 7: Comparative account of Abundance status of two subfamilies from High hill Zone, Himachal Pradesh.



Figure 8: Habitat of hoverflies from High Hill zone of Himachal Pradesh



Figure 9: Upper elevation Landscape from High Hill zone of Himachal Pradesh

Key to sub families, tribe, genera and species of hover flies from the High Hill zone of Himachal Pradesh.

Systematic account

Family Syrphidae

Key to subfamily

1. Post pronotum bare, male abdominal 5th tergite visible in dorsal view..... **Syrphinae**
 - Post pronotum with at least a few suberrect or appressed hairs, male abdominal 5th tergite not visible in dorsal view... **Eristalinae**

Subfamily Syrphinae

Key to tribe

1. Abdomen usually slender in appearance..... **Bacchini**
 - Abdomen usually equilateral in appearance..... **Syrphini**

Tribe SYRPHINI

Key to the Genera

1. Antennae elongate, may be longer than head; scape and pedicel often longer than broad; abdomen strongly convex dorsally and margined..... **Chrysotoxum** Meigen, 1800
 - Antennae shorter than head; scape and pedicel not longer than broad; abdomen variable, but posterolateral angles of tergites without projecting.....2
2. Calypter with lower lobe pilose; Antennae short, 1st flagellomeres twice as long as wide; abdomen without posterolateral angles of tergites projecting, lower lobe of calypter pilose above, especially on posteromedial portion..... **Syrphus** Fabricius, 1775
 - Calypter bare.....3
3. Anterior anepisternum bare..... **Ischiodon** Sack, 1913

- Anterior anepisternum pilose at least posterodorsally.....
..... ***Episyrphus*** Matsumura & Adachi, 1917

Genus *Syrphus* Fabricius, 1775

Key to species

1. hind tibia with a row of black bristles below outer side..... ***torvus*** Osten Sacken, 1875

- hind tibia with golden yellow bristles on inner side..... ***vitripennis*** Meigen, 1822

Subfamily Eristalinae

Key to tribe

Tribe Eristalini

Key to the genera

2. Eyes bare; submarginal cell of normal length; metathoracic spiracular pile patch present... ***Phytomyia*** Guerin-Meneville, 1833

- Eyes at least partially pilose, if bare then submarginal cell narrowed, basally due to a r-m cross vein; metathoracic spiracular patch usually absent.....3

3. Katepiterium bare, eyes densely hairy with two vertical bands of longer hairs; antennal arista with short hairs on basal half..... ***Eristalis*** Latreille, 1804

- Katepiterium haired; antennal arista practically bare; eyes with dark spots; post alar ridge with tuft of strong black hairs..... ***Eristalinus*** Rondani, 1845

Genus *Eristalis* Latreille, 1804

Key to the subgenera

1. Eyes bare in appearance.....
..... ***Eoseristalis*** Kanervo, 1938
- Eyes densely haired with two vertical bands of longer hairs.....
..... ***Eristalis*** Latreille, 1804

Key to the species of subgenus *Eoseristalis* Kanervo, 1938

1. Abdominal tergite 3 within male with a triangular or oblique spot on anterior margin reaching laterally in female spot smaller, narrower in the same position.....
..... ***cerealis*** Fabricius, 1805

- Abdominal tergite with such triangular spot.....
..... ***himalayensis*** Brunetti, 1908

Genus *Eristalinus* Rondani, 1845

Key to the subgenera

1. Metathoracic spiracle dorsally with a distinct patch of hairs; eyes with longitudinal dark stripes.....
..... ***Eristalodes*** Mik, 1897
- Metathoracic spiracle in front without any patch of hairs; eyes with spots or irregular markings.....
..... ***Eristalinus*** Rondani, 1845

Subgenus *Eristalinus* Rondani, 1845

Key to the species

1. Scutum with 5 distinct black longitudinal dust bands.....
megacephalus (Rossi, 1794)
3. - Scutum with 4 distinct black longitudinal bands.....2
4. 2. Femora normally all orange or brownish orange; fore and mid tibia on apical half; hind pair wholly except narrowly at base blackish.....
..... ***arvorum*** (Fabricius, 1787)
5. - Femora black; tips generally more or less pale.....
quinquestriatus (Fabricius, 1794)

Tribe MILESSINI

Key to genera

1. Marginal cell (R2+3) closed before wing margin; cross vein r-m always oblique; usually beyond middle of discal cell (dm).....
Milesia Latreille, 1804
6. - Marginal cell (R2+3) open to wing margin.....2
2. Epistome conspicuously produced, snout-like; very densely pubescent species; proboscis slender and highly produced; twice as long as epistome; ventrum conspicuously.

Abnormal.....**Lycastris** Walker,
1857

- Epistome not conspicuously produced, never snout-like, face not more than normally produced at upper mouth edge; comparatively bare species...
Syritta Lepeletier & Serville, 1828

1. **Episyrphus (Episyrphus) balteatus (De Geer, 1776)**

1776. *Musca balteata* De Geer, *Mem. pour. serv. Hist. Ins.*6: 116

Type locality: Sweden

Material examined: 7♀♀ Khajjiar, Chambadistrict, 1809mt, 32°33'20.8"N, 76°3'56.09"E, 04.vii.15, coll: J. Sengupta, 8♀♀ Shimla, Shimla district, 2100mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta. 9♂♂ Kothi, Shimla district, 2408 mt, 31°28'21.46"N, 77°44'36.79"E, 18.iv.17, coll: J. Sengupta. 9♀♀ 7♂♂ Shimla, Shimla district, 2100mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta, 4♂♂ Kullu, Kullu district, 2195mt, 31° 59' 16.7994"N, 77° 10' 19.1994"E, 28.iv.18, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, West Bengal.

Distribution: elsewhere: Australasian Region (Australia), Oriental Region (Widely distributed), Palearctic Region (England).

Remarks: The main noticeable remarks regarding this species are that in spite of changes in elevation gradient and habitat types, this species is found to be most abundant.

2. **Ischiodon scutellaris (Fabricius, 1805)**

1805. *Scaeva scutellaris* Fabricius, *Syst. Antliat.*: 252

Type locality: India: West Bengal.

Material examined: 1♂♂ Dasholi, Shimla district, 2421 mt, 31° 2'30.38"N, 77°35'41.18"E, 18.iv.17, coll: J. Sengupta. 1♂♂ Noli, Shimla district,

2004mt, 30°58'45.79"N, 77°27'42.42"E 18.iv.17, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, Andhra Pradesh, Assam, Delhi, Jammu & Kashmir, Karnataka, Kerala, Meghalaya, Madhya Pradesh, Manipur, Meghalaya, Orissa, Punjab, Tamil Nadu, Tripura, and West Bengal)

Distribution: Elsewhere: Australasian Region (Australia, Pacific island), Oriental Region (Indonesia, Java), Palaeartic Region (Japan).

Remarks: This species is not so much abundant in this high hill zone area which may be affected by the fact of higher altitudinal landscape.

3. **Sphaerophoria (Knutsonia) viridaenea Brunetti, 1915**

1915. *Sphaerophoria viridaenea* Brunetti, *Rec. Ind. Mus.*11:216

Type locality: Simla, Himachal Pradesh.

Material examined: 4♀♀ 5♂♂ Noli, Shimla district, 2004mt, 30°58'45.79"N, 77°27'42.42"E 18.iv.17, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, Jammu & Kashmir, Uttarakhand.

Distribution: Elsewhere: Oriental Region (Afghanistan, Pakistan, Nepal).

Remarks: These species are moderately abundant in this high hill zone area.

4. **Syrphus (Syrphus) torvus Osten Sacken, 1875**

1875. *Syrphus torvus* Osten Sacken, *Pros. Boston Soc. Nat. Hist.*18:139

Type locality: Canada; Colorado, N.H., R.I., USA

Material examined: 2♀♀ Shimla, Shimla district, 2100mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, Jammu & Kashmir, Uttarakhand.

Distribution: Elsewhere: Nearctic Region (Alaska, Greenland, North Carolina, New

Mexico), Oriental Region (Nepal, Pakistan).

Remarks: This species are rare in distribution in study area

5. ***Syrphus (Syrphus) vitripennis* Meigen, 1822****

1822. *Syrphus vitripennis* Meigen, *europ.zwiefl. Insekten*. 10:308

Type locality: Germany.

Material examined: 2♀♀ Khajjiar, Chamba district, 1809 mt, 32°33'20.8"N, 76°3'56.09"E, 04.vii.15, coll: J. Sengupta

Diagnosis: Epicranium dark, densely yellow-gray pruinose on upper half in male, where as in female the upper one third of epicranium is shining black. Antennal sockets yellow in colour. Both gene and sub gene region yellow. Wing axillary membrane with extensive bare areas. Fore and mid femora black on basal one-third, otherwise yellow, with yellow hairs on posterior surface; Abdominal 3rd and 4th Tergites with entire yellow bands, broadly and shallowly emarginated posteriorly, reaching lateral margins on about half their length.

Distribution: India: **Himachal Pradesh**, Arunachal Pradesh, Jammu & Kashmir, Meghalaya, Sikkim.

Distribution: Elsewhere: Oriental Region (Afghanistan, Mangolia), Palearctic Region (China, Europe, Japan, Russia, Siberia), Nearctic Region (Canada).

Remarks: This species is reported for the first time from the state of Himachal Pradesh.

6. ***Chrysotoxum convexum* Brunetti, 1915**

1915. *Chrysotoxum convexum* Brunetti, *Rec. Indian Mus.* 11: 249

Type locality: Garhwal District, Andarban

Material examined: 3♀♀ 3♂♂ Tandali, Shimla district, 2149mt, 31° 9'44.46"N, 77°43'16.87"E, 18.iv.17, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, Jammu & Kashmir, Mizoram, Uttar Pradesh and Uttarakhand.

Distribution: Elsewhere: Oriental Region (Pakistan), Palearctic region (China)

Remarks: This species was less abundant and habitat specific in study sites.

7. ***Melanostoma orientale* (Wiedemann, 1824)**

1824. *Syrphus orientalis*, Wiedemann, *Analec. Ent.*: 36

Type locality: India: Tamil Nadu: Tharangambi.

Material examined: 3♀♀ Khajjiar, Chamba district, 1809mt, 32°33'20.8"N, 76°3'56.09"E, 04.vii.15, coll: J. Sengupta, 6♀♀ Shimla, Shimla district, 2100mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta, 4♂♂ Chamor, Shimla district, 1972mt, 31°18'29.72"N, 77°22'57.66"E, 18.iv.17, coll: J. Sengupta, 2♂♂ Ghiaghi, Banjar, Kullu district, 2205mt, 31° 45' 17.9994"N, 77°28' 26.4"E, 28.iv.18, coll: J. Sengupta,

Distribution: India: **Himachal Pradesh**, Assam, Arunachal Pradesh, Jammu & Kashmir, Karnataka, Meghalaya, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, and West Bengal.

Distribution: elsewhere: Oriental Region (Bhutan, Nepal, Pakistan, Sri Lanka)

Remarks: This species was quite abundant across the study area

8. ***Cheilosia nigroaenea* Brunetti, 1915**

1915. *Chilosia nigroaenea* Brunetti, *Rec. Indian Mus.* 11: 204

Type locality: Matiana, Simla, Himachal Pradesh.

Material examined: 5♂♂ 1♀♀ Noli, Shimla district, 2004mt, 30°58'45.79"N, 77°27'42.42"E 18.iv.17, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, Sikkim.

Distribution: elsewhere: Oriental Region (Nepal)

Remarks: This hoverfly is unique because of wholly black in appearance which is quite different from the regular yellow-black patterns of syrphids.

9. *Eristalinus (Eristalinus) arvorum* (Fabricius, 1787)

1787. *Syrphus arvorum* Fabricius, *Mantissa insectorum*.2(2): 335

Type locality: Tamil Nadu: Tharangambadi.

Material examined: 2♀♀ Tandali, Shimla district, 2149mt, 31° 9'44.46"N, 77°43'16.87"E, 18.iv.17, coll: J. Sengupta. 2♀♀ Khajjiar, Chamba district, 1809mt, 32°33'20.8"N, 76°3'56.09"E, 04.vii.15, coll: J. Sengupta. 2♀♀ 4♂♂ Chamor, Shimla district, 1972mt, 31°18'29.72"N, 77°22'57.66"E, 18.iv.17, coll: J. Sengupta.

Diagnosis: Ommatidium on upper part of eyes are much larger than on lower half. eyes bear with minute dots especially in lower part. Vertical tubercle small and blackish. All of the Epicranium, genae and sub genae region covered with yellowish grey tomentum. Post cranium area grey with small yellowish pubescences, fronto genal sutures covered with yellowish grey hairs. Base of flagellomere darker with carrotish bare arista. Meso notum and meso pleuron covered with yellowish grey dust. Presence of 4 equidistant shining black stripes on dorsum area of mesonotum. scuto scutellar suture brownish yellow; Katepimeron with grayish yellow pubescences. Abdominal coloration mainly black. 2 large oblong yellow spots on 2nd abdominal tergites. Pair of diamond shaped yellow spot on 3rd abdominal segment. Abdominal tergites covered with ground coloured pubescences. brownish yellow to carrotish in appearance. Tarsi all orange, trochanter and basal tibia is blackish in appearance. Both stalk and blade area of wing are clear, a small brownish black spot at each end of costa. Halteres ochre yellow in colour. Length: 10-12 mm.

Distribution: India: **Himachal Pradesh**, Arunachal Pradesh, Jammu & Kashmir,

Manipur, Meghalaya, Mizoram, Orissa, Sikkim, Tripura, West Bengal.

Distribution: Elsewhere: Afro tropical region (Seychelles), Australasian region (Australia), Oriental Region (Entire SE Asia), Indo Australian region (Hawaii, Micronesia), Palearctic region (China, Japan Mariana)

Remarks: This species is a new record from High hill zone as well as from the state of Himachal Pradesh.

10. *Eristalinus (Eristalinus) megacephalus* (Rossi, 1794)

1794. *Syrphus megacephalus* Rossi, *Mantissa insectorum*.2: 63

Type locality: Toscana, Italy.

Material examined: 1♀ Shimla, Shimla district, 2100mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta. (check from diversity)

Distribution: India: **Himachal Pradesh**, Andhra Pradesh, Bihar, Gujarat, Jammu & Kashmir, Karnataka, Kerala, Maharashtra, Meghalaya, Orissa, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, West Bengal.

Distribution: Elsewhere: Indo Australian region (Singapore), Oriental Region (Afghanistan, Buru, Nepal, Pakistan), Palearctic region (China, Japan)

Remarks: This species is distinguished by narrow conical abdomen along with uniformly dotted eyes.

11. *Eristalinus (Eristalinus) quinquestriatus* (Fabricius, 1794)

1794. *Syrphus quinquestriatus* Fabricius, *Entomol. Syst. Emendat. et auct...*4(6):289

Type locality: Tharangambadi, Tamil Nadu.

Material examined: 1♂ Chamor, Shimla district, 1972mt, 31°18'29.72"N, 77°22'57.66"E, 18.iv.17, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, Arunachal Pradesh, Assam, Bihar, Karnataka, Kerala, Madhya Pradesh,

Meghalaya, Nagaland, Orissa, Tamil Nadu, Tripura, Uttarakhand, West Bengal.

Distribution: Elsewhere: Oriental Region (Buru), Palearctic region (China, Japan)

Remarks: This species is distinguished by narrow conical abdomen along with uniformly dotted eyes.

12. *Eristalinus (Eristalodes) paria* (Bigot, 1880)

1880. *Eristalomyia paria* Bigot, *Ann. Soc. Ent. Fr. ser. 5*, 10: 218

Type locality: Sri Lanka.

Material examined: 4♀♀ Tandali, Shimla district, 2149mt, 31° 9'44.46"N, 77°43'16.87"E, 18.iv.17, coll: J. Sengupta, 2♀♀ Shimla, Shimla district, 2100mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, Arunachal Pradesh, Chandigarh, Jammu & Kashmir Karnataka, Manipur, Meghalaya, Mizoram, Sikkim, Tamil Nadu, Uttarakhand, Uttar Pradesh, West Bengal.

Distribution: elsewhere: Oriental Region (Sri Lanka, Taiwan), Indo-Australian Region (Java, Moluccas)

Remarks: This species of hoverfly can be easily distinguished by greenish striped pattern in both of the eyes in both gender.

13. *Eristalis (Eoseristalis) cerealis* Fabricius, 1805

1805. *Eristalis cerealis* Fabricius, *Syst. Antliat.*14: 232

1880. *Eristalis barbata* Bigot, *Ann. Soc. Ent. Fr. ser.5*, 10:214

Type locality: China.

Material examined: 2♀♀ 11♂♂ Khajjiar, Chamba district, 1809mt, 32°33'20.8"N, 76°3'56.09"E, 04.vii.15, coll: J. Sengupta, 2♂♂ Chamor, Shimla district, 1972mt, 31°18'29.72"N, 77°22'57.66"E, 18.iv.17, coll: J. Sengupta, 1♂♂ Kothi, Shimla district, 2408mt, 31°28'21.46"N, 77°44'36.79"E, 18.iv.17, coll: J. Sengupta, 6♂♂ Kullu, Kullu district, 2908 mt, 31° 47' 31.2"N, 77° 47' 20.4"E,

28.iv.18, coll: J. Sengupta. 7♀♀ Ghiaghi Tindar, Banjar, Kullu district, 2125mt, 31° 46' 22.7994"N, 77° 43' 55.1994"E, 28.iv.18, coll: J. Sengupta,

Distribution: India: **Himachal Pradesh**, Assam, Jammu & Kashmir, Meghalaya, Sikkim, Tamil Nadu, West Bengal.

Distribution: elsewhere: Widespread in Oriental region, Palearctic region (Russia)

Remarks: This species is moderately abundant throughout different habitat of this high hill zone.

14. *Eristalis (Eoseristalis) himalayensis* Brunetti, 1908

1908. *Eristalis himalayensis* Brunetti, *Rec. Indian Mus.*2:70

Type locality: Indostan

Material examined: 1♀ Shimla, Shimla district, 2100mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta. 1♀ Bishog, Shimla district, 2004 mt, 30°58'45.79"N, 77°27'42.42"E, 18.iv.17, coll: J. Sengupta. 1♀ Jangal Lakhoti Kujwi, Chaupal, Shimla district, 2421mt, 31° 2'30.38"N, 77°35'41.18"E, 18.iv.17, coll: J. Sengupta. 1♀ Bishog, Shimla district, 1963 mt, 31° 9'35.22"N, 77°27'14.84"E, 18.iv.17, coll: J. Sengupta. 1♂ Dasholi, Shimla district, 2421 mt, 31° 2'30.38"N, 77°35'41.18"E, 18.iv.17, coll: J. Sengupta. 1♂ Guthan, Shimla district, 1963 mt, 31° 9'35.22"N, 77°27'14.84"E, 18.iv.17, coll: J. Sengupta. 1♂ Shimla, Shimla district, 2100 mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta. 1♂ Guthan, Shimla district, 1963 mt, 31° 9'35.22"N, 77°27'14.84"E, 18.iv.17, coll: J. Sengupta. 1♂ Jangal Lakhoti Kujwi, Chaupal, Shimla district, 2190 mt, 31° 2'30.38"N, 77°35'41.18"E, 18.iv.17, coll: J. Sengupta. 2♂♂ Guthan, Shimla district, 1963 mt, 31° 9'35.22"N, 77°27'14.84"E, 18.iv.17, coll: J. Sengupta. 1♂ Dalhousie Chamba district, 1985 mt, 32°31'50.21"N, 75°58'46.60"E, 18.iv.17, coll: J. Sengupta. 1♂ Jangal Lakhoti Kujwi, Chaupal, Shimla district, 2190mt, 31° 2'30.38"N, 77°35'41.18"E, 18.iv.17, coll: J. Sengupta,

Distribution: India: **Himachal Pradesh**, Arunachal Pradesh, Jammu & Kashmir, Sikkim, Uttarakhand, West Bengal

Distribution: elsewhere: Oriental Region (China, Java, Myanmar, Nepal Sri Lanka). Indo-Australian Region (Malaya, Philippines, Sumatra, Sumbawa.)

Remarks: This species of hoverfly found to be confined in upper elevational habitats only during study.

15. *Eristalis (Eristalis) tenax* (Linnaeus, 1758)

1758. *Musca tenax* Linnaeus, *Syst. Nat. Ed. 10*: 591

1924. *Eristalis claripes* Abreu, *Mems R. Acad. Cienc. Artes. 19*(1): 104

Type locality: Europe

Material examined: 3♀♀ Khajjiar, Chambadistrict, 1809mt, 32°33'20.8"N, 76°3'56.09"E, 04.vii.15, coll: J. Sengupta, 9♀♀ Shimla, Shimla district, 2100mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta, 1♀ Mandhol, Shimla district, 1986mt, 31°8'18.52"N, 77°41'1.65"E, 19.iv.17, coll: J. Sengupta, 9♂♂ 3♀♀ Kothi, Shimla district, 2408mt, 31°28'21.46"N, 77°44'36.79"E, 18.iv.17, coll: J. Sengupta, 2♀♀ Khajjiar, Chamba district, 1809mt, 32°33'20.8"N, 76°3'56.09"E, 04.vii.15, coll: J. Sengupta, 9♀♀ 3♂♂ Shimla, Shimla district, 2100mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta, 4♂♂ Chamor, Shimla district, 1972mt, 31°18'29.72"N, 77°22'57.66"E, 18.iv.17, coll: J. Sengupta, 1♂ Mandhol, Shimla district, 1986mt, 31°8'18.52"N, 77°41'1.65"E, 18.iv.17, coll: J. Sengupta, 1♂ Mall Road, Shimla Krishna Nagar, Shimla district, 1809mt, 32°33'20.8"N, 76°3'56.09"E, 04.vii.15, coll: J. Sengupta, 1♂ 2♀♀ Mall Road, Shimla Krishna Nagar, Shimla district, 2100 mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta, 1♂ 2♀♀ Kullu, Kullu district, 2197mt, 31° 35' 27.6" N, 77° 30' 54"E, 28.iv.18, coll: J. Sengupta, 2♂♂ 1♀ Ghiaghi Tindar, Banjar,

Kullu district, 2135 mt, 31° 35' 27.6" N, 77° 30' 54"E, 28.iv.18, coll: J. Sengupta,

Diagnosis: Ommatidium pubescent with 2 rows of longitudinal bands of brown trichia along the eyes. Epicranium distinctly large, shining black with black and ochre yellow coloured trichia, both sub cranial cavity, genae and sub genae region appear black. scape and pedicle usually brownish black; maxillary part bears bare arista. Meso notum shining brownish black in appearance, scuto scutellar suture brownish yellow; sub scutellar fringe absent, Katepimeron with concolourous pubescences. Abdominal coloration bright carrotish to black. Basal blackish band in both 2nd and 3rd abdominal segments. Venter in both sexes is carrotish yellow in appearance. blackish legs, trochanter and basal 3rd of fore and basal half of middle tibia is ochre yellow in appearance, coxa with yellow coloured macro trichia. Both stalk and blade area of wing are greyish or brownish on anterior half, a small quadrate dark brown spot below the tip of auxillary vein enclosing a small cross vein. Halteres dull brownish yellow in colour. Length: 13-15 mm.

Distribution: India: **Himachal Pradesh**, Arunachal Pradesh, Chandigarh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Punjab, Sikkim, Uttarakhand, West Bengal.

Distribution: elsewhere: Australasian Region (Australia, New Zealand), Indo-Australian Region (Hawaii), Palaearctic Region (China, Japan), Oriental Region (Myanmar, Pakistan, Sri Lanka).

Remarks: This robust species is a new record from High hill zone as well as from the state of Himachal Pradesh.

16. *Phytomia (Phytomia) errans* (Fabricius, 1787)

1787. *Syrphus errans* Fabricius, *Mantissa insectorum. 2*: 337

Type locality: Tamil Nadu: Tharangambadi.

Material examined: 1♂ Kothi, Shimla district, 2408 mt, 31°28'21.46"N,

77°44'36.79"E, 18.iv.17, coll: J. Sengupta. 1♂ Chamor, Shimla district, 1972 mt, 31°18'29.72"N, 77°22'57.66"E, 18.iv.17, coll: J. Sengupta, 3♂♂ Jangal Lakhoti Kujwi, Chaupal, Shimla district, 2190mt, 31° 2'30.38"N, 77°35'41.18"E, 18.iv.17, coll: J. Sengupta,

Distribution: India: **Himachal Pradesh**, Arunachal Pradesh, Chandigarh, Jammu & Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Punjab, Sikkim, Uttarakhand, West Bengal.

Distribution: elsewhere: Australasian Region (Australia, New Zealand), Oriental Region (Myanmar, Pakistan, Sri Lanka). Palaearctic Region (China, Japan),

Remarks: This species is comparatively robust and also appears to be dark purple in colour which is different from normal syrphid's appearance.

17. *Lycastris albipes* Walker, 1857

1857. *Lycastris albipes* Walker, *Trans. Ent. Soc. Lond.* 4: 155

Type locality: Hindostan

Material examined: 2♀♀ 1♂ Shimla, Shimla district, 2100mt, 31°6'16.5"N, 77°10'24.3"E, 18.iv.17, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, Uttarakhand, West Bengal.

Distribution: elsewhere: Nil.

Remarks: This species have shown limited availability during collection at study areas. Apart from this, this species is also endemic to the state of Himachal Pradesh.

18. *Milesia ferruginosa* Brunetti, 1913

1913. *Milesia ferruginosa* Brunetti, *Rec. Indian Mus.* 9: 268

Type locality: Kumaon district, Darjeeling

Material examined: 2♂♂ Tandali, Shimla district, 2149mt, 31° 9'44.46"N, 77°43'16.87"E, 18.iv.17, coll: J. Sengupta, 1♂ Kothi, Shimla district, 2408mt, 31°28'21.46"N, 77°44'36.79"E, 18.iv.17, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, West Bengal.

Distribution: elsewhere: Oriental Region (Laos)

Remarks: This species is also robust in appearance and has shown limited distribution and abundance.

19. *Syrirta indica* (Wiedemann, 1824)

1824. *Eumerus indica* Wiedemann, *Analecta entomologica*: 33

Type locality: East Indies

Material examined: 5♂♂ 1♀ Dalhousie Chamba district, 1985mt, 32°31'50.21"N, 75°58'46.60"E, 18.iv.17, coll: J. Sengupta.

Distribution: India: **Himachal Pradesh**, Madras, Pondicherry, West Bengal.

Distribution: elsewhere: Oriental Region (Nepal, Taiwan)

Remarks: This species is distinguished by the presence of swollen hind part of legs.

Discussion & Conclusion

No doubt that the studies regarding conservation strategies (Ferrier *et al.*, 2016) of pollinating groups are usually focused with non-dipteran pollinators only (Sengupta *et al.*, 2019). That's why it has become utmost important to establish the proficiency of pollinating hoverflies especially in higher elevational landscapes. The present studies thus have focused on the availability of one of the major group of this second line pollinating flies from High hill zone of Himachal Pradesh. Altogether 19 species under 13 genera over 2 subfamilies have been reported from this zone (figure 2). Among subfamilies Syrphinae (36.36%) has shown a higher abundance percentile value than Eristalinae (63.63%) (figure 3,5,7). Further calculation among Syrphinae subfamily has shown that tribe Syrphini exhibited the maximum abundance value with a percentile of 81.25% while Bacchini has shown the least value (18.75%) (figure 4). On the other hand, within the Eristalinae subfamily, Eristalini tribe has shown the maximum abundance value (91.4%) followed by Milesini (4.28%) and

Rhingini (4.28%) (figure 6). On the other hand among the reported species *E. tenax* found to be most abundant (24.54%) whereas *E. megacephalus* have shown the least abundance value of 0.45%. while *E. balteatus* (20%), *E. himalayensis* (5.90%), and *E. cerealis* (13.18%), has shown moderate value in terms of their abundance. 3 species found to be recorded newly from the state, whereas 1 species found to be endemic to state of Himachal Pradesh. Among 19 species 94.73% of total available syrphid has shown large distributional affinity towards Oriental region, 26.31% of total available syrphid species shown distributional affinity towards both Australian and Indo Australian realms. While 21.05% of total available syrphid species shows confinement in distribution within Palearctic region and 10.52% towards Nearctic realm. On the other hand, only 5.26% of total species available from High hill zone has shown distributional affinity towards Afro Tropical realm. Such a wide distributional range and high index of abundance values of the species in the studied zone have suggested towards a balanced ecosystem health from this region. This will in turn

strongly support the factor of establishment of syrphids as alternative pollinator from higher elevational landscape of Himachal Pradesh.

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Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this work.

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