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Taxonomic studies on Tabanidae (Insecta: Diptera) from Himachal Pradesh, India

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Abstract

18 species belonging to the 6 genera of family Tabanidae have been recorded from Himachal Pradesh. The present study revealed 7 species of Tabanidae viz. *Tabanus (Tabanus) diversifrons* Ricardo, 1911; *Tabanus (Tabanus) fuscomaculatus* Ricardo, 1911; *Tabanus (Tabanus) gertrudae* Philip, 1960; *Haematopota inconspicua* Ricardo, 1911; *Haematopota lata* Ricardo, 1906; *Haematopota latifascia* Ricardo, 1911; *Hippocentroides striatipennis* (Brunetti, 1912) to be reported for the first time from the state of Himachal Pradesh. Taxonomic identification keys to these 18 species have been elucidated along with their distribution pattern in India and world wide. The Tabanidae of Himachal Pradesh exhibit highest species richness from the district of Mandi while the species richness is minimum in the districts of Sirmour, Shimla and Lahul and Spiti.

Keywords: Tabanidae; New records, Himachal Pradesh

Introduction

Flies of family Tabanidae are true Brachyceran flies under infraorder Tabanomorpha and superfamily Tabanoidea. They are commonly known as Dans machi in India. They are mainly large bodied sturdy flies and their size ranges from 7-33 mm, known for their furious bite to vertebrate animals including human. Flies of this family are mainly characterised on basis of sickle shaped antennae (3rd segment annulated), pulvilliform empodium, and 4th & 5th radial veins always terminate on either side of the wing. Males and females of this family are mainly differentiated in terms of eyes that are separated in females and are contiguous in males. They are generally found in sunny days flying near the cattle animals or sitting on tree trunks. They are distributed widely in various habitats such as cattle patches, pastures and forest areas near aquatic bodies. Adult tabanids of both sexes feed on nectar from pollens of flowers while only females prefer to suck bloods from vertebrates, essential to carry out their gonotrophic cycles. Some horseflies are seen to fly on alighted streets, stroking on window glasses in night or entering lighted house. However, most of them are liable in swamps, streams or moist places for oviposition. Larvae are generally aquatic or semi-aquatic in nature while pupae are preferably found in relatively dry soil. Various species under this family are known vectors and responsible for transmission of more than 80 viral, bacterial and protozoan diseases. Among them trypanosomiasis, loaia, anthrax are prevalent and at the same time even cause fatal in some cases left untreated. They are responsible for economical loss in dairy industry as their easy targets are domestic cattle across the rural belts of several states in this country. Thus they have become the flies of medical and veterinary importance and cause serious hazards to livestock and wild animals. Their abundance is usually found higher during monsoon especially in sunlight after rain. However their diversity is found to be noticeably high in hilly regions across the biodiversity hotspot around Himalayan region.

Himachal Pradesh is a state encompassing north-western Himalaya, bounded by Jammu & Kashmir in north, Uttarakhand in east, Punjab in west and Chandigarh in south. Some studies on dipteran fauna by Mitra *et al.* 2003; Mitra, 2004; Parui, 2006; Mitra, 2008, [7, 8, 9, 10] have been made in Himachal Pradesh. This is the first time that holistic approach for exploration of tabanid insects in this state has been done. Yet more tabanid fauna awaits for exploration from this state as different climatic regions and geographical location might favour high assemblage and diversity of flies of family Tabanidae.

Materials and Methods**(i) Field and laboratory techniques**

Tabanid flies especially females can be more convenient to be collected from cattle animals as they usually exhibit the characteristic haematophagy and males can be collected from tree trunks or on vegetation by sweeping with insect net in warm sunny weather or from lights at

night. Traps especially malaise trap, canopy trap etc. can also be known as most effective method to catch large amount of Tabanids in a short time with minimum effort. Larvae and pupae can also found to be collected from moist ground, preferably near edges of aquatic bodies i.e. river, swamps, etc. and reared to get the adults in natural media after brought to laboratory.

After catching, adults are killed in killing jars as it contains benzene and it should be pinned as early as possible for studying most of the characters that might be present at live condition. Then specimens kept in special envelopes composed of blotting papers. Special care should also be taken to pin a specimen through one side (preferably on left side of thorax) and then for proper labelling for recording their localities, district and state of availability with date of collection and collector's name. Pinned specimens should be preserved carefully by keeping them in wooden box with smashed naphthalene and cottons at hollow spaces in sides and cotton ball dipped in carbolic acid at bottom of the box. Then pinned specimens should be identified following a certain taxonomic key and all the diagnostic characters should be noted and material examined written following a particular format.

(ii) Morphology and terminology

Tabanids are bristle less flies, stout bodied with sickle shaped antennae i.e. flagellum with apical annulations. They have large bulging eyes and strong, sclerotized proboscis, well developed mandibles in females, wings with veins R₄ and R₅ diverge near apex, pulvilliform empodium articulating on the apex of the unguitactor plate.

The Tabanids exhibit considerable amount of intergeneric diversity in morphology but relatively less heterogeneity in interspecific level is helpful to identify a species. Generalised characters are presented for understanding key and definition of 6 genera, viz. *Philoliche* Wiedemann, 1828; *Atylotus* Osten-Sacken, 1876; *Tabanus* Linnaeus, 1758; *Hybomitra* Enderlein, 1922; *Haematopota* Meigen, 1803; *Hippocentrodes* Philip, 1961; that are known to occur from Himachal Pradesh. Flies of genus *Tabanus* are usually larger, but the latter are comparatively colourful and ornamental than the former. Some of these morphological characters are important for determining several species.

Head is one of the most essential part of the body talking about taxonomic importance most of the key morphological characters lie there especially in flies of genus *Tabanus* and *Haematopota*. Eyes occupy larger area of head on either side of the frons, anterior callus, basal callus and sub-callus. Eyes are contiguous and frons absent in males (holoptic), where in females eyes are usually separated by frons down to sub-callus (dichoptic). Frons in *Tabanus* is comparatively narrow and not like that of *Haematopota*, while a special character above frons, i.e. ocellar tubercle lies in *Hybomitra*. Colour of the sub-callus, face, hair or tomentum, shape of callus etc. are important characters to be considered during taxonomical identification. Basal callus in *Haematopota* is transverse strong protuberant to smooth and colour variations are also important. Besides that several other parts such as Sides of sub-callus are important due to presence of most of the ornamentations in several species of *Haematopota*.

Various characters of mouth parts especially palpi are found to be significant for taxonomical identification of various tabanid species. Mouth parts are composed of labrum (upper lip), epipharynx (long slender part above pharynx), labium (lower

lip), hypopharynx (part lies below pharynx), maxilla with maxillary palpus, labellum and mandible, which is sometimes reduced or absent in males, mainly meant for piercing and sucking during blood foraging in females.

The antennae is basically 3 segmented, composed of scape, pedicel and flagellum. Annulations at the apical part of the flagellum are known as flagellomeres. No. of flagellomeres in apical part of flagellum is also found to be key character on the basis of which several genera of Tabanidae can be distinguished from each other.

Abdomen and thorax bear in most cases either spots, stripes or bands of various shape and size either median, sub-median or both, which are also taxonomically very much significant in various species of *Tabanus*. Colour of scutellum, presence of hair or tomentum is again important in this respect.

Wings are found to be one point discrimination for distinguishing several species of *Haematopota*, specially colour of veins, pterostigma (ptstg), structure and no. of apical band, no. of rosettes and / or pale transverse streaks are very important characters. Basicosta (bc) arising from base of costa (C) is with or without setae. The humeral cross vein (h) joins the costa with sub-costa (Sc) shortly after its origin from base of radius (R). The first branch (R₁), 2nd and 3rd branch joined together to form R₂₊₃. R₄ and R₅ are bifurcated and ending at opposite to each other apically, characteristic to most brachycera. The extension of vein R₄ sometimes present and called as appendix. The media (M) is 4 branched leaving at discal cell (DC) behind 1st basal cell (BC₁) and 2nd basal cell (BC₂). There follow the first cubital (Cu₁) and 1st anal cell (1A) fused apically to form Cu₁+1A. The radio-medial cross vein (r-m) and medio-cubital cross vein (m-cu) are generally located at the base on either side of discal cell. The posterior cells variously numbered accordingly as PC₁, PC₂, PC₃, PC₄ and PC₅. Closing or opening of PC₁ are sometimes considered as important taxonomical character. Wings are generally hyaline or dusty in *Tabanus*, maculated or pictured in *Haematopota*.

Legs are composed of several parts i.e. coxae, femora, tibiae and tarsi. Presence of white bands on mid and hind tibiae and colouration of fore-femora and tarsi bear important characters especially in several species of *Haematopota*.

Indeed the genital structures often found to be indispensable for one-point discrimination of several tabanid species.

Results: Taxonomic accounts of each tabanid species is arranged following classification scheme of Berger and Thompson, 1981. Systematic account with key is given wherever deemed necessary along with first reference, current reference, type locality, material examined, diagnosis and distribution are given for each tabanid species.

Systematic Account

Family: Tabanidae

Key to the subfamily

1. Vertex with well-developed ocelli; hind tibiae with apical spurs.....Pangoniinae
2. Vertex with rudimentary or no ocelli; hind tibiae without apical spurs.....Tabaninae

1. Subfamily: Pangoniinae

Tribe Philolichini

Diagnosis: Sternite VIII with widely separated gonopophyses, distal edge chitinised. Male Gonocoxite with pointed style. Proboscis very elongated.

Genus *Philoliche* Wiedemann, 1828

1828. *Philoliche* Wiedemann, *Zweifl. Insekt.*, 1: 95.

Type species: *Tabanus rostratus* Linnaeus, 1764

Diagnosis: Third joint of antennae (flagellum) with eight or at least seven divisions (flagellomeres). Proboscis long. First posterior cell of wing open. Eyes bare.

1. *Philoliche (Philoliche) longirostris* (Hardwicke, 1823)

1823. *Pangonia longirostris* Hardwicke, *Trans. Linn. Soc. London*, 14: 135.

1969. *Philoliche longirostris* Chvala, *Acta Entomol. Bohemoslov.*, 66: 40.

Type locality: Nepal

Material examined: from literature (Veer, 2004) [12]

Diagnosis: Thorax ferruginous. Abdomen colour varies from brown to black. Rostrum about 12 times longer than the head. Scape and pedicel short, flagellum long and tapering at tip, composed of 8 flagellomeres. Eyes are large and conspicuous. Head and thorax hairy. Bright longer yellow hairs present under throat. Some brownish hairs present above throat. Wings longer than abdomen, hyaline. Veins brown. Abdominal segments are blackish and margin of each segment shining and hairy. Halteres short having yellow shafts and black, ovate knobs. Legs almost uniform in colour, yellowish to pale reddish.

Distribution: Himachal Pradesh, Assam, Gujrat, Kerala, Meghalaya, Sikkim, Uttarakhand, West Bengal

Elsewhere: China, Nepal

Remarks: Females of *Philoliche longirostris* have around 2 times longer proboscis than the body length. These flies are mainly seen in high altitudes from July to September, hovering around several plants of family Zingiberaceae. They exhibit both nectarophagy as well as haematophagy. They can be treated as link in evolution of feeding strategy in Diptera.

2. Subfamily: Tabaninae

Key to the tribes

1. Frons in females much longer than wide, frontal callus usually longitudinal when present, flagellum with large basal plate and 4 annuli; wing hyaline or dusty; basicosta in wing with strong setae.....Tabanini

2. Frons in females wider than long, frontal callus transverse, antennae long and slender, flagellum with narrow base and 3 annuli; pictured wing pattern with pale markings, basicosta with thin setae.....Haematopotini

Tribe: Tabanini

Key to the genus

1. Eyes bare.....2

Eyes hairy.....*Hybomitra* Enderlain

2. Antennal style with 4 annulations, frons with prominent callus.....*Tabanus* Linnaeus

Frons with reduced or spotted calli.....*Atylotus* Osten-Sacken

Genus *Atylotus* Osten-Sacken, 1876

1876. *Atylotus* Osten-Sacken, *Mem. Boston Soc. Nat. Hist.*, 2: 425-426.

Type species: *Tabanus bicolor* Wiedemann, 1821.

Diagnosis: Usually small sized fly, frons with spotted calli or without calli. Colour of eyes in living specimen green or yellow. Basal plate of flagellum broad and obtuse dorsal angle. Basicosta pale to brown setulose.

2. *Atylotus virgo* (Wiedemann, 1824)

1824. *Tabanus virgo* Wiedemann, *Analecta. Entomol.*, P 22.

1973. *Atylotus virgo* Philip, *Entomol. Scand. Suppl.*, 4: 57.

Type locality: "Indies orientalis"

Material examined: from literature (Veer, 2004) [12]

Diagnosis: Antennae bright rufous, palpi yellow, beard white, forehead yellowish grey with no callus. Thorax with faint white stripes and narrow median line. Abdomen greyish with light yellow haired segmentations, 2 white haired roundish spots on each segment. Wings hyaline with ochre yellowish veins. Legs ochre yellow with chamois-leather coloured femora.

Distribution: Uttarakhand, Madhya Pradesh, Punjab, Himachal Pradesh (Kangra), West Bengal, Andaman Island.

Elsewhere: Sri Lanka, Pakistan

Remarks: Burger (1981) [1, 2] put forwarded the conflict regarding placement of this species under genus *Atylotus* as it differs in many features from it. It can transmit Surra disease pathogens.

Genus *Hybomitra* Enderlein, 1922

1922. *Hybomitra* Enderlein. *Mitt. Zool. Mus. Berl.* 10: 347.

Type species: *Hybomitra solox* Enderlein, 1922.

Diagnosis: Medium sized fly; vertex with ocellar tubercle; eyes with dense pubescence and 3 green or purple band in live condition; basal and median callus usually broad; body blackish to dark greyish often with orangish side markings in at least 2 to 3 anterior abdominal segments.

Key to the species of genus *Hybomitra* Enderlain

1. Forehead with 2 transverse calli, subcallus brownish and convex. Abdomen black with white haired bands.....*H. subcallosa*

Forehead with one callus, subcallus grey tomentose.....2

2. Frontal callus black, triangular with spindle shaped extension, fore border broad. Abdomen blackish except at the sides of first 2 segments reddish brown, segmentations yellow haired intermixed with black hairs.....*H. hirta*

Frontal callus small, indistinct. Abdomen blackish, only reddish at 2nd segment.....3

3. Smaller species. Legs black and reddish yellow.....*H. wyvillei*

3. *Hybomitra subcallosa* (Ricardo, 1911)

1911. *Tabanus subcallosus* Ricardo, *Rec. Indian Mus.*, 4: 227.

1969. *Hybomitra subcallosa* Chvala, *Acta. Entomol. Bohemoslov.*, 66: 49.

Type locality: Mussoorie, India

Material examined: 1♀, collected from buffalo, 30°06'52.2" N, 77°10'29.1" E, 1887 m, Nagar castle, Kullu, 13.vii.2013, Coll. D. Banerjee; 1♀, collected from buffalo, 30°06'52.2" N, 77°10'29.1" E, 1887 m, Nagar castle, Kullu, 13.vii.2013, Coll. A. Naskar; 7♀♀, collected from buffalo, 32°09'16.0" N, 77°10'51.5" E, 1739 m, Jagatsukh, Kullu, 14.vii.2013, Coll. D. Banerjee; 1♀, collected from buffalo, 32°09'16.0" N, 77°10'51.5" E, 1739 m, Jagatsukh, Kullu, 14.vii.2013, Coll. R.S. Mridha; 2♀♀, collected from buffalo, 32°07'13.5" N, 77°10'01.5" E, 1703 m, Chakkinallah, Kullu, 14.vii.2013, Coll. R.S. Mridha; 1♀, collected from buffalo, 32°07'13.5" N, 77°10'01.5" E, 1703 m, Chakkinallah, Kullu, 14.vii.2013, Coll. A. Naskar; 1♀, collected from buffalo near agricultural field, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side, Mandi, 17.vii.2013, Coll. A. Naskar; 1♀, collected from buffalo,

32°32'45.4" N, 76°03'37.4" E, 1975 m, Khajjihar, Chamba, 26.vi.2012, Coll. T. K. Mondal; 1♀, collected from buffalo, 32°33'23.6" N, 76°07'46.9" E, 1063 m, Jammuhar, Chamba, 30.vi.2012, Coll. R. S. Mridha.

Diagnosis: Face greyish tomentose with white pubescence, palpi pale yellow, stout and tapering, grey tomentose on dorsal side, thickly covered with white pubescence intermixed with black hairs. Scape & pedicel yellowish and black pubescent, flagellum reddish. Subcallus brownish and convex. Forehead covered with brown tomentum, frontal callus dark brownish to blackish, border irregular at apex, median callus small, irregular and blackish. Eyes with hairs. Thorax appeared black and grey tomentose with black pubescence. Legs black, tibiae whitish at basal two thirds and black at apex. Pubescence at back side of femora and coxae. Wings hyaline, stigma whitish. Scutellum black with grey tomentum. Abdomen black with white haired bands at dorsum and white band becomes broader at venter.

Distribution: India: Himachal Pradesh (Kullu, Mandi, Chamba), Uttar Pradesh, Uttarakhand.

Elsewhere: None

Remarks: This is a common species in Himachal Pradesh and most of them were collected from Buffalo.

4. *Hybomitra hirta* (Walker, 1850)

1850. *Tabanus hirtus* Walker, *Insect. Saunders. Dipt.*, 1: 52.

1975. *Hybomitra hirta* Stone, *Cat. Dipt. Orient. Region*, 2: 50.

Type locality: East India. N. Comb.

Material examined: 1♀, collected from buffalo, 32°28'41.6" N, 77°36'38.7" E, 4149 m, Chandra Taal, Lahul & Spiti, 03.viii.2012, Coll. A. K. Sidhu.

Diagnosis: Face and subcallus grey tomentose, beard with pale yellowish hairs. Palpi light reddish, intermixed with black pubescence, stout with pointed end. Eyes densely pubescent. Forehead with blackish pubescence, frontal callus blackish, broad at base and spindle shaped at its apex. Thorax blackish with 3 indistinct narrow yellowish stripes, black pubescent with ferruginous appressed hairs intermixed. Underside greyish with black and yellow hairs intermixed. Tibiae at base are reddish brown, coxae yellow pubescent, tarsi and tibiae with black pubescence. Wings hyaline, stigma and veins brown, appendix present. Abdomen blackish except at the sides of first 2 segments reddish brown, segmentations yellow haired, dorsum yellow pubescent intermixed with black hairs. Venter blackish, grey tomentose with lighter segmentations.

Distribution: India: Himachal Pradesh (Lahul & Spiti), Arunachal Pradesh and Uttarakhand

Elsewhere: None.

Remarks: This is a common species in higher altitudes of Himachal Pradesh and the only specimen was collected from Buffalo.

5. *Hybomitra wyvillei* (Ricardo, 1911)

1911. *Tabanus wyvillei* Ricardo, *Rec. Indian Mus.*, 4: 229.

1975. *Hybomitra wyvillei* Stone, In: *Cat. Dipt. Orient. Region*, 2: 50.

Type locality: Narkanda (Himachal Pradesh)

Material examined: from literature (Veer, 2004) ^[12]

Diagnosis: Face grey covered with yellow tomentum and fine black hairs, beard yellowish. Palpi long and slender, reddish yellow in colour, ending in acute point. Antennae reddish, darker at apex, scape and pedicel black pubescent. Subcallus grey tomentose, frontal callus indistinct and blackish. Eyes with thin covering of light yellowish hairs and 3 cross bands.

Thorax black, covered with grey tomentum and light yellow hairs. Abdomen dark brownish to blackish, appear orangish on sides of 2nd segment. Ventrums blackish with yellow pubescence. Legs blackish, femora yellow pubescent, fore tibiae reddish yellow except at apices and with black pubescence intermixed with yellow hairs, fore tarsi brownish. Wings hyaline, veins and stigma brownish.

Distribution: Himachal Pradesh (Kasauli, Narkanda), Uttarakhand

Elsewhere: Nepal, China

Remarks: This fly usually exhibited narrow distribution pattern, usually available in high altitudes across Western Himalaya.

Genus *Tabanus* Linnaeus, 1758

1758. *Tabanus* Linnaeus, *Syst. Nat. Ed.*, 10: 601.

Type species: *Tabanus bovinus* Linnaeus, 1758

Diagnosis: Robust flies with colourful eyes in live condition; vertex without prominent ocellar tubercle; in males entirely pollinose when present; eyes bare.

Key to the species of genus *Tabanus* Linnaeus

1. Species with one or more stripes, usually continuous on abdomen.....2
- Species with median or lateral spots or both on abdomen, not usually forming continuous stripes.....3
- Species with paler bands and sometimes spots on abdomen.....4
- Species with unicolour abdomen or sometimes darker at apices.....5
2. Frontal callus with spindle shaped lineal extension. Median stripe continuous up to 6th segment, side stripes up to 4th segment on abdomen.....*T. striatus*
3. Frontal callus club shaped with extension rather spindle shaped. Abdomen blackish with greyish median spots, 2 rows of greyish brown lateral spots on each segment, front corners of tergite 2 light yellow with yellow hairs. Alula is broad. No facial band.....*T. bromius*
Abdomen brownish to blackish with light yellowish segmentations, 1st abdominal segment with greyish hairs concentrated at middle, lateral greyish spots present up to 6th abdominal segment. Alula is not much broad. No facial band.....*T. excelsus*
Abdomen reddish, dark at the apices with large black median spots on 2nd and 3rd segments. No facial band.....*T. fuscomaculatus*
- Abdomen with sub-lateral askew spots and indistinct elongated median spots. Transverse rectangular brown facial band runs through bases of antennae.....*T. leleani*
4. Abdomen reddish yellow, dark at apices with narrow light yellowish segmentations and median spots. Legs black, tibiae yellowish.....*T. orientis*
5. Frontal callus yellowish, irregular and indistinct. Abdominal terga except 1 with narrow yellow haired band. Wings hyaline.....*T. gertrudae*
Frontal callus reddish brown, prominent. Abdomen without any band, but segmentations of light coloured hairs in midline sometimes forming a faint stripe or triangle. Wings slightly tinged brown.....*T. diversifrons*

6. *Tabanus bromius* Linnaeus, 1758

1758. *Tabanus bromius* Linnaeus, *Syst. Naturae*, p. 824.

Type locality: Europe.

Material examined: from literature (Veer, 2004) ^[12]

Diagnosis: Eyes bare, forehead grey tomentose, frontal callus

dark brownish, club shaped with extension rather spindle shaped and some black hairs around callus. Antennae reddish brown, scape and pedicel with black hairs. Thorax black, scutellum blackish with greyish tomentum at posterior border. Abdomen blackish with greyish median spots, 2 rows of greyish brown lateral spots on each segment, abdominal segmentations white tomentose, with white hairs, front corners of tergite 2 light yellow with yellow hairs. Wings rather dusty, stigma reddish brown and veins brownish, alula is broad. Legs dark brownish to blackish, femora blackish with black pubescence and grey hairs, tibiae pale orangish basally, blackish at apices, tarsi blackish with white pubescence at back.

Distribution: Himachal Pradesh (Kalatop, Khazziar, Chamba). Elsewhere: Europe, Iraq, Iran, Central Asia.

Remarks: It is a common species in Europe and central Asia but however its distribution restricted to only Himachal Pradesh state of India.

Subgenus *Tabanus* Linnaeus, 1758

Diagnosis: Head hemispherical; vertex flat or slightly concave; post-ocular rim present; banding on eyes often present; frons usually slender; antennal scape nearly as long as it is wide, hairy.

7. *Tabanus (Tabanus) diversifrons* Ricardo, 1911

1911. *Tabanus diversifrons* Ricardo, *Rec. Indian Mus.* 4: 214.

Type locality: Shillong, Assam, India

Material examined: 1♂, collected from leg of cow, 31°43'51.5" N, 76°56'30.4" E, 1203 m, Bijnimandi, Mandi, 11.vii.2013, Coll. A. Naskar.

Diagnosis: Face with a few or no brown hairs above, palpi yellow, black pubescent and broad at base. Antennae yellow, scape and pedicel with black hairs. Frontal callus reddish brown, callus pear shaped with rather broad linear extension. Thorax blackish with few appressed ferruginous hairs. Tibiae reddish yellow, fore tibiae blackish at apex. Wings slightly tinged brown. Abdomen reddish yellow with dark apex, dorsum black pubescent with grey tomentum, segmentations pale yellow with some yellow hairs at venter.

Distribution: India: Himachal Pradesh (Mandi), Meghalaya (Ri-Bhoi), Assam and West Bengal.

Elsewhere: Bangladesh, Thailand and Vietnam.

Remarks: Burton (1978)^[3] discussed the taxonomic as well as distributional confusion about the species presumably occurs in the entire north-east India. The species described above is reported for the first time from the state of Himachal Pradesh.

8. *Tabanus (Tabanus) fuscomaculatus* Ricardo, 1911

1911. *Tabanus fuscomaculatus* Ricardo, *Rec. Indian Mus.* 4: 183.

Type locality: Simla, Myitkyina District, Upper Burma.

Material examined: 1♂, collected from leg of cow, 32°33'23.6" N, 76°07'46.9" E, 1063 m, Jammuhar, Chamba, 30.vii.2012, Coll. R.S. Mridha; 1♀, collected from ventral side of cow, 32°09'16.0" N, 77°10'51.5" E, 1739 m, Jagatsukh, Kullu, 14.vii.2013, Coll. D. Banerjee.

Diagnosis: Face greyish with yellow tomentose, Beard pale yellowish. Palpi stout, dark reddish with greyish tomentum and black pubescence and blunt end. Scape and pedicel dark reddish with black pubescence, flagellum broad at base. Forehead hardly narrow anteriorly, subcallus yellowish brown tomentose, frontal callus blackish club shaped with long linear extension. Thorax blackish, yellowish brown tomentose with some yellow hairs on lateral side of dorsum and scattered

black hairs over dorsum, scutellum with some long yellow hairs on posterior border. Legs blackish, coxae yellowish pubescent with long yellow hairs, femora with some grey tomentum and black pubescence, upper and underside with yellow hairs, tibiae dull reddish with black pubescence, tarsi with black pubescence and underside reddish. Wings tinged brown on foreborder, veins brownish, stigma yellowish brown. Abdomen reddish, last 3 segments entirely black, distinct black spots largest on 2nd segment and smaller and irregular on 3rd segment, pale yellow segmentations on first 4 tergites, black pubescence on dorsum, venter reddish yellow with broad median stripe and apex black with prominent golden yellow pubescence.

Distribution: India: Himachal Pradesh (Chamba, Kullu), Arunachal Pradesh (East Siang), Sikkim (East Sikkim district). Elsewhere: Myanmar, Sulawesi.

Remarks: The species described above is reported for the first time from the state of Himachal Pradesh. This species is also found to be rare in Himachal Pradesh.

9. *Tabanus (Tabanus) gertrudae* Philip, 1960

1911. *Tabanus flavicinctus* Ricardo, *Rec. Indian Mus.* 4: 130.

1960. *Tabanus gertrudae* Philip, *Stud. Inst. Med. Res. Malaya.* 29: 16.

Type locality: Shillong, Assam, India.

Material examined: 1♀, collected from leg of cow, 30°55'14.2" N, 77°06'18.1" E, 1454 m, Bergaon, Solan, 21.vii.2013, Coll. A. Naskar.

Diagnosis: Subcallus and palpi yellow, palpi with yellow pubescence. Frontal callus irregular and narrow. Antennae dark at apex. Tibiae yellowish, fore pair more blackish with white pubescence, coxae yellow pubescent. Wings hyaline and no appendix. Abdomen reddish yellow with yellow haired bands on every segment of abdomen except first.

Distribution: Himachal Pradesh (Solan), Meghalaya (Shillong, North Khasi Hills), Tamil Nadu, Uttarakhand.

Elsewhere: None.

Remarks: This species is mainly found in moderate altitudes across hilly region of Himachal Pradesh. The species described above is reported for the first time from the state of Himachal Pradesh.

10. *Tabanus (Tabanus) excelsus* Ricardo, 1913

1913. *Tabanus excelsus* Ricardo, *Ann. Mag. Nat. Hist.* (8) 11: 543.

Type locality: Mashorba, Simla Hills, 7000 ft., India

Material examined: from literature (Veer, 2004)^[12]

Diagnosis: Eyes bare, frontal callus rather rectangular and lineal extension, later broadened and form a spindle shape. Forehead with grey tomentum. Thorax with 2 lateral stripes orangish and 2 sub-lateral stripes greyish. Sides of thorax with whitish hairs intermixed with dark brownish hairs. Abdomen brownish to blackish with light yellowish segmentations, 1st abdominal segment with greyish hairs concentrated at middle, lateral greyish spots present up to 6th abdominal segment. Wings hyaline, stigma and veins yellowish and reddish brown respectively. Legs dark brownish, femora blackish with white hairs and black pubescence, tibiae light yellowish at basal 2/3rd and black at apex, tarsi dark brownish with black pubescence.

Distribution: Himachal Pradesh (Simla, Kangra), Uttarakhand Elsewhere: None

Remarks: This species was previously reported from Himachal Pradesh. This species also exhibited narrow distribution range.

11. *Tabanus (Tabanus) orientis* Walker, 18481848. *Tabanus orientis* Walker, *List. Dipt. British Mus.* 1: 152.

Type locality: Nepal.

Material examined: from literature (Veer, 2004) [12]

Diagnosis: Face pale yellowish to greyish tomentose with light yellowish pubescence, palpi ending at obtuse point with black pubescence and few white hairs. Forehead light yellowish tomentose with black pubescence. Frontal callus reddish brown to blackish, oblong. Antennae red, apex with black hairs. Thorax black with yellowish tomentum, black pubescence. Abdomen reddish yellow on first 3 segments with large black median spot on 2nd and 3rd segment, 4th abdominal tergite often blackish at its posterior border, all segmentations are yellow tomentose with yellow pubescence, ventrum with short yellow pubescence. Legs black, fore pair of tibiae with black apex, femora with yellowish tomentum and pubescence, tibiae and tarsi black pubescent. Wings hyaline.

Distribution: Himachal Pradesh (Dalhousie), Assam, Manipur, Nagaland, Sikkim, Uttarakhand, West Bengal.

Elsewhere: Bhutan, Pakistan, China, Nepal.

Remarks: This species is commonly available in North-east as well as North-west Himalaya.

12. *Tabanus (Tabanus) striatus* Fabricius, 17871787. *Tabanus striatus*. Fabricius, *Mantissa insect.* 2: 356.

Type locality: China.

Material examined: 1♀, collected from leg of cow, 32°33'27.6" N, 76°07'11.7" E, 829 m, Ravi river side, Chamba, 21.vii.2013, Coll. Vikas Kumar.

Diagnosis: Face grey haired, white pubescent, beard white, palpi light yellow, white tomentose with some curved black hairs. Antennae reddish yellow with dark apex, forehead about 6 times as long as it is wide with yellowish grey tomentum and short white pubescence. Frontal callus shining reddish brown, oblong, not reaching eyes anteriorly, posteriorly receding and continued in fine line, then become broadened. A proboscis on back part of head short & wide, thorax reddish brown with 4 distinct greyish white tomentose stripes with white pubescence. Sides of thorax black haired, venter grey with white pubescence. Scutellum concolours as thorax with white hairs on posterior border. Legs reddish yellow, fore femora rusty reddish, with black hairs on upper sides. Middle and posterior pair blackish with grey tomentum, pubescent predominantly white. Tibiae with dorsal black hairs, tarsi reddish brown with black pubescence, coxae white pubescent. Wings hyaline, stigma yellowish, veins reddish. Abdomen long and slender, varying from reddish brown to blackish brown, median stripe continuous up to 6th segment, composed of grey tomentose spots, side stripes up to 4th segment. Venter sides with long white hairs, reddish yellow and covered with grey tomentum. Halteres yellowish brown with lighter knob.

Distribution: India: Himachal Pradesh (Chamba), Arunachal Pradesh, Assam, Bihar, Delhi, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya (East Khasi Hills, South Garo Hills and Jaintia Hills), Orissa, Punjab, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal.

Elsewhere: Bangladesh, Bhutan, Cambodia, China, Laos, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand and Vietnam.

Remarks: There was taxonomic misinterpretation through ages and hence the distributional records associated with the species were in a mess everywhere before Burton (1978) [3] who took pains to sort out the perplexed identity of the species from its allies. Later, Burger and Thompson (1981) [1, 2] aptly

illustrated, keyed and discussed these species with a view to making away with the recurrent confusion. This is a very common and widespread species in India, and is often found to enter the house, being attracted by light in hot summer night.

13. *Tabanus (Tabanus) leleani* Austen, 19201920. *Tabanus (Tabanus) leleani* Austen, *Bull. Entomol. Res.*, 10: 312. Type locality: Wadi el kelt Jordan valley, near Jericho (Palestine). Material examined: from literature (Veer, 2004) [12]

Diagnosis: Eyes small, bare, with one conspicuous band, and indistinct median callus. Transverse rectangular brown facial band runs through bases of antennae. Thorax with broad white median stripe and 4 lateral white stripes. Abdomen with sub-lateral askew spots and indistinct elongated median spots. Wings hyaline, stigma and veins yellow and light brown respectively.

Distribution: Himachal Pradesh (Khaziar, Kangra valley), Jammu & Kashmir

Elsewhere: Pakistan, Iraq, S. Europe, N. Africa, Iran, China, Egypt, Palestine, Jordan, Ethiopia, Tanzania, Kenya, Nigeria.

Remarks: Its distribution mainly restricted to higher altitudes across temperate dry climatic zones. This species in general exhibited palearctic and afro-tropical distribution. Morphology of last instar larva and pupa described by Jezek (1980).

Tribe: Haematopotini**Key to the genus**

1. Eyes bare. Wings with infuscations and spots.....2
 2. Wings with pale spots, wavy lines or punctulate; mid and hind tibia usually with two pale rings.....*Haematopota* Meigen
- Wings infuscated with 6 or more pale transverse bands, no rosettes*Hippocentroides* Philip

Genus *Haematopota* Meigen, 18031803. *Haematopota* Meigen, *Magazin Insekt Kde*, 2: 67.Type species: *Tabanus pluvialis* Linnaeus, 1758.

Diagnosis: Generally small and slender flies of brownish to blackish grey in colour; eyes with several wavy bands in live condition; frons with velvety black spot on each side above the frontal callus and often a mid-frontal spot above these; picture wing pattern i.e. dark wing with pattern of pale spots; mid tibiae and hind tibiae often with pale rings.

Key to the species of genus *Haematopota* Meigen

1. Wings with single apical band.....2
- Wings with double apical band.....3
2. Wings grey, yellow veins and stigma with long appendix. Apical band single, divided in half, two rosettes distinct upper part of third one is prominent *H. lata*
- Wings pale brown, apical band short single, not reaching from outer to inner wing border, 3 rosettes distinct, stigma and veins reddish brown.....*H. inconspicua*
- Wings dark brown with 3 distinct rosettes. Apical band single starting from junction of 2nd vein and crossing in straight line to inner border, veins and stigma brown.....*H. latifascia*
3. Wings dark brown with fairly distinct rosettes and apical band double. 3rd rosette very irregular, anal cell has curved white streak.....*H. javana*

14. *Haematopota inconspicua* Ricardo, 19111911. *Haematopota inconspicua* Ricardo, *Rec. Indian Mus.* 4: 358.

Type locality: Igatpuri, Mumbai, India.

Material examined: 4♀♀, collected from buffalo, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side buffalo shed, Mandi, 17.vii.2013, Coll. D. Banerjee; 1♀, collected from buffalo, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side, Mandi, 17.vii.2013, Coll. A. Naskar; 1♀, collected from buffalo, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side buffalo shed, Mandi, 17.vii.2013, Coll. A. Maity.

Diagnosis: Face grey, white pubescent, blackish brown band between eyes and antennae. Palpi reddish yellow with pale pubescence. Antennae reddish yellow, cylindrical scape & small pedicel with black pubescence, first annulations little dilated and broader in comparison to rest at apex of slender flagellum. Forehead greyish yellow with prominent dark brown large round spots. Frontal callus narrow black. Thorax brown with 3 greyish yellow stripes and fore border greyish, underside grey. Abdomen reddish brown with grey segmentations with short ferruginous pubescence. 2 rings on middle and posterior tibiae, basal joints of middle and posterior tarsi yellow. Wings pale brown, apical band short single, not reaching from outer to inner wing border, 3 rosettes distinct, stigma and veins reddish brown.

Distribution: India: Himachal Pradesh (Mandi), Meghalaya (Ri-Bhoi), Arunachal Pradesh and Maharashtra.

Elsewhere: China, Thailand and Vietnam.

Remarks: The species described above is reported for the first time from the state of Himachal Pradesh. The species is presumed to be common in hot summer days.

15. *Haematopota javana* Wiedemann, 1821

1821. *Haematopota javana* Wiedemann, *Dipt.Exot.* 1: 100.

Type locality: Java.

Material examined: 8♀♀, collected from cow, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side cow shed, Mandi, 17.vii.2013, Coll. A. Naskar; 1♀, collected from buffalo, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side buffalo shed, Mandi, 17.vii.2013, Coll. D. Banerjee; 1♀, collected from buffalo, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side buffalo shed, Mandi, 17.vii.2013, Coll. A. Naskar; 1♀, collected from buffalo, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side buffalo shed, Mandi, 17.vii.2013, Coll. A. Maity; 1♀, collected from buffalo, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side, Mandi, 17.vii.2013, Coll. A. Maity; 2♀♀, collected from buffalo, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side, Mandi, 17.vii.2013, Coll. D. Banerjee; 2♀♀, collected from buffalo near agricultural field, 31°43'51.5" N, 76°56'30.4" E, 1203 m, Bijnimandi, Mandi, 11.vii.2013, Coll. A. Naskar.

Diagnosis: Frontal callus ochre brown, face grey with a black spot on each side. Antennae reddish yellow, scape little incrassate, scape and pedicel with black pubescence. Thorax greyish brown with 3 lineal white stripes. Scutellum grey tomentose with ferruginous pubescence. Triangular grey haired median spot on each segment and grey lateral spots up to 3rd segments. Venter grey haired with broad blackish median stripe. Femora pale reddish, white haired, hind tibiae with 3 brownish bands, fore tibiae white at base. Wings dark brown with fairly distinct rosettes and apical band double. Stigma is large white mark consisting of round white ring with dark centre. 3rd rosette very irregular, anal cell has curved white streak.

Distribution: India: Himachal Pradesh (Mandi), Bihar, Meghalaya (East Khasi Hills, Jaintia Hills), Mizoram, Kerala and Tamil Nadu.

Elsewhere: Andalus, Bangladesh, China, Java, Laos, Malaya,

Myanmar, Thailand and Vietnam.

Remarks: This is a common and widespread species, and hence it shows certain amount of variable characters (vide Stone & Philip, 1974) [11].

16. *Haematopota lata* Ricardo, 1906

1906. *Haematopota lata* Ricardo, *Ann. Mag. Nat. Hist.* (7) 18: 121.

Type locality: Khasi Hills, Meghalaya district, India

Material examined: 1♀, collected from buffalo, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side buffalo shed, Mandi, 17.vii.2013, Coll. A. Naskar

Diagnosis: Face grey, yellow stripe between antennae and eyes with some brown dots, beard white, palpi yellow, pubescent white intermixed with black hairs. Frontal callus shining brown, anterior border irregular with edges yellow. Black paired spots touching eyes. Forehead yellowish grey with black pubescence on vertex. Antennae reddish yellow with darker annulations at apex and black pubescent, scape incrassate, pedicel small, flagellum broad with blunt end at apices. Thorax brownish, grey median stripe continuous up to scutellum. Underside grey with white hairs, dorsum with silvery pubescence mixed with black pubescence. Abdomen brown with greyish borders to segments, from 4th segment large grey lateral spots apparent with grey median indistinct stripe. Fore tibiae white basally and dark brown at apices, middle and posterior tarsi pale at base, anterior and middle femora with white pubescence and posterior pair with few black hairs. Wings grey, yellow veins and stigma with long appendix. Apical band single, divided in half, two rosettes distinct upper part of third one is prominent.

Distribution: India: Himachal Pradesh (Mandi), Meghalaya (East Khasi Hills), Uttarakhand and West Bengal.

Elsewhere: China, Laos, Myanmar and Thailand.

Remarks: The species described above is reported for the first time from the state of Himachal Pradesh. This is an uncommon species in Himachal Pradesh.

17. *Haematopota latifascia* Ricardo, 1911

1911. *Haematopota latifascia* Ricardo, *Rec. Indian Mus.* 4: 356.

Type locality: Shillong, Assam, India.

Material examined: 1♀, collected from human, 30°55'23.8" N, 77°60'19.6" E, 1254 m, Borapani, Solan, 21.vii.2013, Coll. D. Banerjee; 1♀, collected from leg of cow, 31°43'51.5" N, 76°56'30.4" E, 1203 m, Bijnimandi, Mandi, 11.vii.2013, Coll. A. Naskar; 1♀, collected from leg of cow, 30°57'44" N, 77°12'03.5" E, 2005 m, Chail wildlife sanctuary, Solan, 20.vii.2013, Coll. A. Naskar.

Diagnosis: Face grey tomentose with white pubescence. Distinct black band reaching from one eye to other. Palpi narrow, fawn with grey tomentose and black pubescence. Antennae reddish yellow, stout scape and small pedicel with black pubescence, flagellum at first annulations broad and narrower at apex. Frontal callus dark brown straight on borders, paired spots large and black. Thorax reddish brown with reddish yellow pubescence. Abdomen brown with greyish segmentations, venter brown. Legs dark brown, rings on middle and posterior tibiae, middle and posterior tarsi with pale basal joints. Wings brown with 3 distinct rosettes. Apical band single starting from junction of 2nd vein and crossing in straight line to inner border, veins and stigma brown.

Distribution: Himachal Pradesh (Mandi, Solan), Meghalaya, Tamil Nadu.

Elsewhere: Myanmar, Laos, Thailand.

Remarks: The species described above is reported for the first time from the state of Himachal Pradesh. This species is also found to be common near aquatic bodies such as dam side or river side in Himachal Pradesh.

Genus *Hippocentroides* Philip, 1961

1961. *Hippocentroides* Philip, *Indian J. Entomol.*, 21: 82.

Type species: *Hippocentroides desmotes* Philip, 1961.

Diagnosis: Small dark bodied flies; frons wider than long with anteriorly shining brownish to blackish callus; eyes with greenish lower border and 3-4 thin green or purple bands in live condition; slender scape and basal segment of flagellum cylindrical; wings infuscated with 6 or more transverse pale bands; knob of halteres brown.

18. *Hippocentroides striatipennis* (Brunetti, 1912)

1912. *Haematopota striatipennis* Brunetti, *Rec. Indian Mus.*, 7: 460.

1974. *Hippocentroides striatipennis* Stone and Philip, *US. Dip. Agric. Res. Serv. Tech. Bull.*, 1489: 29.

Type locality: Dehra Dun, Mussoorie Hills, India.

Material examined: 1♂, collected from buffalo near agricultural field, 31°32'31.1" N, 76°53'37.0" E, 856 m, Ropa dam side, Mandi, 17.vii.2013, Coll. R.S. Mridha.

Diagnosis: Eyes brown, frontal callus yellow and bi-lobed. Face grey with dark hairs. Antennae yellowish and dark at apex, flagellum cylindrical. Palpi pale brown with black hairs. Thorax dark grey, sides of scutellum yellowish. Abdomen reddish brown with black hairs, venter also dark with less hair. Coxae dark grey, fore coxae pale, fore tibiae with apical half dark, fore tarsi black, mid and hind tarsi yellowish brown. Wings grey with 6 slender transverse pale bands, two small streaks across 1st and 2nd posterior cell, sub-apical band nearly reaching hind margin, band just beyond stigma reaching anterior margin, rests neither reaching anterior nor reaching hind margin.

Distribution: Himachal Pradesh (Mandi), Uttar Pradesh, Uttarakhand.

Elsewhere: None

Remarks: The species described above is reported for the first time from the state of Himachal Pradesh. This species is rare in Himachal Pradesh.

Discussion

Himachal Pradesh, comprising of 12 districts: Chamba, Lahul & Spiti, Kinnaur, Kullu, Shimla, Mandi, Sirmour, Kangra, Hamirpur, Una, Bilaspur and Solan and is bounded by Tibet in east, Jammu & Kashmir in north, Punjab in west, Haryana and Uttarakhand in south-west and south-east respectively and Uttar Pradesh in south. Zoo-geographically not too far off countries are Pakistan, Afghanistan and China. This vast area under Indo-Chinese and Indian sub-region of the oriental region and residual influence of palearctic region is pretty remarkable and interesting because of its varied physiographical features from mountain, low hills, mid hills and high hills with varied climatic conditions as well from Sub-tropical, temperate dry, temperate humid to sub humid containing diverse and interesting flora and fauna.

Tabanidae are abundant mainly throughout the year with a little decline in mid to higher elevations during winter. So far tabanid fauna are qualitatively rich and diverse. We have recorded 18 species from the Himachal Pradesh. 1 species of genus *Philoliche*, 1 species of genus *Atylotus*, 8 species of

genus *Tabanus*, 3 species of genus *Hybomitra*, 4 species of genus *Haematopota* and 1 species of genus *Hippocentroides* are represented here. Of these only 2 species viz. *Tabanus (Tabanus) striatus* Fabricius, 1787 and *Haematopota javana* Wiedemann, 1821 are known to be widespread and show nearly cosmopolitan distribution also distributed up to Java, Myanmar, Thailand, etc. Of these 5 species viz. *Hybomitra subcallosa* (Ricardo, 1911); *Hybomitra hirta* (Walker, 1850); *Tabanus (Tabanus) gertrudae* Philip, 1960; *Tabanus (Tabanus) excelsus* Ricardo, 1913; *Hippocentroides striatipennis* (Brunetti, 1912) exhibited limited distribution pattern and their availability so far known to be restricted to temperate climatic zones of Himachal Pradesh, Uttarakhand and Uttar Pradesh. While *T. diversifrons*, *T. fuscomaculatus*, *T. orientis*, *H. lata*, *H. latifascia* are distributed along the whole stretch of Himalayan sub-region starting from Assam to Himachal Pradesh. *T. diversifrons*, *T. orientis* are having extended distribution up to Vietnam in far-east, China in north-east and Pakistan in north-west. *H. Latifascia* and *H. lata* are also known to be recorded from Thailand. It is however quite possible that certain species occurring in Himachal Pradesh, may emigrate to similar physiographic areas and climatic zones of adjoining or neighbouring countries. Indeed nearly all species exhibit discontinuous distribution and this appears to be due to unfavourable natural conditions for survival and colonisation, mis-interpretation of species and insufficient collection data.

Concerning fauna within India, two species viz. *T. striatus* and *H. javana* are found to be widely distributed. Remaining species are distributed along the stretch of temperate zones of Himalayan sub-region in few other states besides type locality. However the current study investigated and interestingly recorded 7 species viz. *Tabanus (Tabanus) diversifrons* Ricardo, 1911; *Tabanus (Tabanus) fuscomaculatus* Ricardo, 1911; *Tabanus (Tabanus) gertrudae* Philip, 1960; *Haematopota inconspicua* Ricardo, 1911; *Haematopota lata* Ricardo, 1906; *Haematopota latifascia* Ricardo, 1911; *Hippocentroides striatipennis* (Brunetti, 1912) for the first time from the state of Himachal Pradesh. Maximum no. of species i.e. 7 tabanid species are recorded from Mandi district of Himachal Pradesh (Fig. 8) indicating highest species richness and high diversity zone may be due to the presence of favourable geographic condition and maximum number of cattle patches across rural belts of the district. Majority of the species described here are, however expected to show extensive distribution pattern across the western Himalaya in the long run.



Fig. 1

Fig 1: Generalised view of head of tabanid flies [*Tabanus (Tabanus) gertrudae* Philip, 1960], showing ommatidia in eye, position of ocellar tubercle in upper portion of fore head, anterior callus before basal callus and behind the basal callus the sub callus.

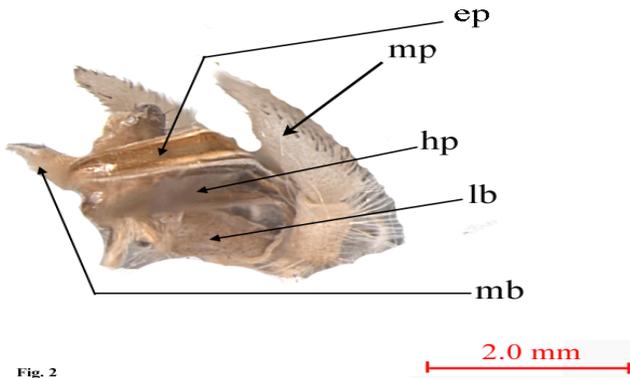


Fig. 2

Fig 2: A generalised view of Mouthparts of Tabanid flies [*Tabanus (Tabanus) gertrudae* Philip, 1960] showing brown flat epipharynx (ep) tapering at proximity; dull whitish maxillary palpi (mp) with short black hairs at apex and large white hairs at base; hypopharynx (hp) below epipharynx; labellum (lb) below the hypopharynx and mandible (mb) at each side of maxillary palpi.

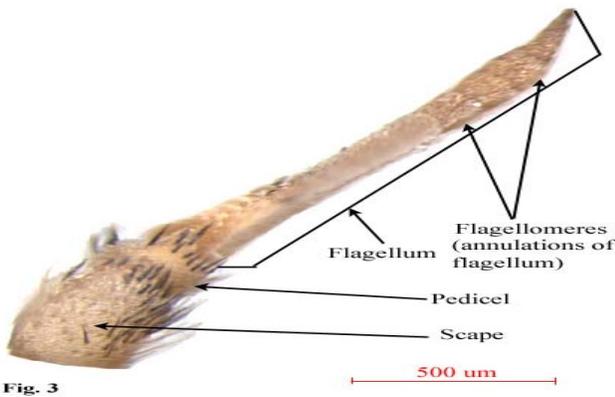


Fig. 3

Fig 3: Generalised view of antennae of tabanid fly [*Tabanus (Tabanus) gertrudae* Philip, 1960], consisting of 3 main parts such as scape, pedicel and flagellum. Flagellum in turn consists of several annulations known as flagellomeres.

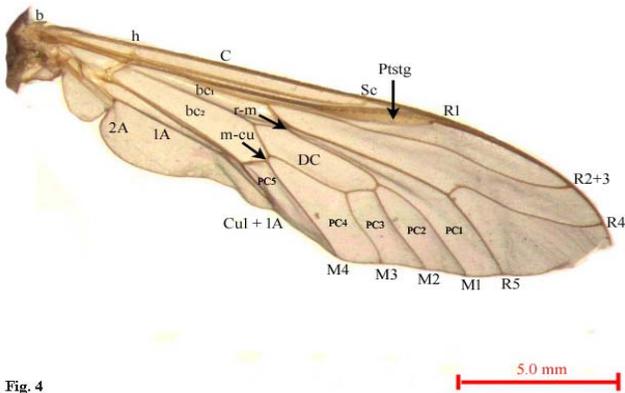


Fig. 4

Fig 4: A generalised view of right wing of Tabanid flies of genus *Tabanus* showing different parts such as basicosta (b) at the base of costa (C), below costa lies sub-costa (Sc), costa and subcostal are joined by humeral cross vein (h), light brownish pterostigma (Ptstg), R1- anterior branch of radius, R2+3 (R2 and R3 fused in Tabanidae), R4, R5- posterior branches of radius, medial veins M1, M2, M3 originating from discal cell (DC), M4 originating from medial-cubital vein (m-cu), 5 posterior cells PC1, PC2, PC3, PC4 and PC5 are present, 1A and 2A are branches of anal veins, first cubital (Cu1) and 1st anal cell (1A) fused apically to form Cu1+1A, first basal cell (bc1) and second basal cell (bc2) are present just above discal cell, radial medial vein (r-m) present behind first basal cell.

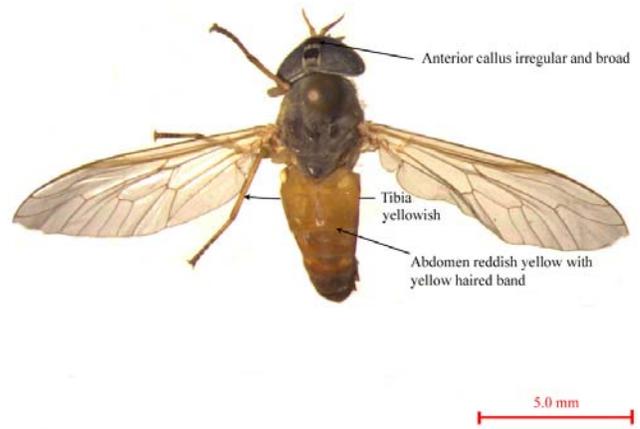


Fig. 5

Fig 5: Habitus of *Tabanus (Tabanus) gertrudae* Philip, 1960, one of the representative flies of genus *Tabanus*, showing important diagnostic characters of this fly viz. irregular and broad anterior callus, reddish yellow abdomen with yellow haired band, and yellowish tibia.



Fig. 6

Fig 6: Habitus of *Hybomitra subcallosa* (Ricardo, 1911) one of the representative flies of genus *Hybomitra*, showing key diagnostic characters such as presence of ocellar tubercle, blackish abdomen with orangish side markings at 3 anterior tergites and presence of white haired narrow band at each tergite.

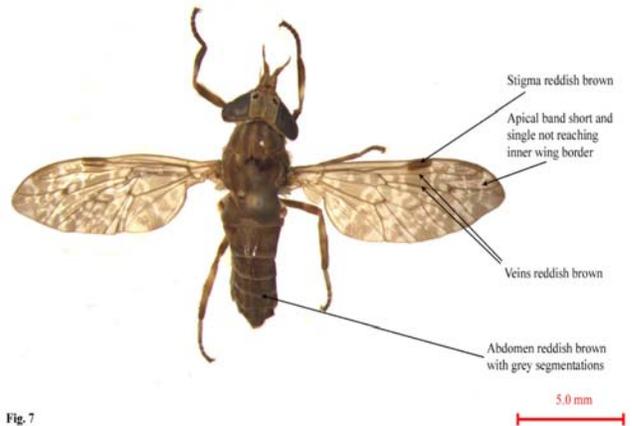


Fig. 7

Fig 7: Habitus of *Haematopota inconspicua* Ricardo, 1911, one of the representative flies of genus *Haematopota*, showing important diagnostic characters like reddish brown stigma in wing, short and single apical band not reaching inner wing border, reddish brown vein and reddish brown abdomen with grey segmentations.

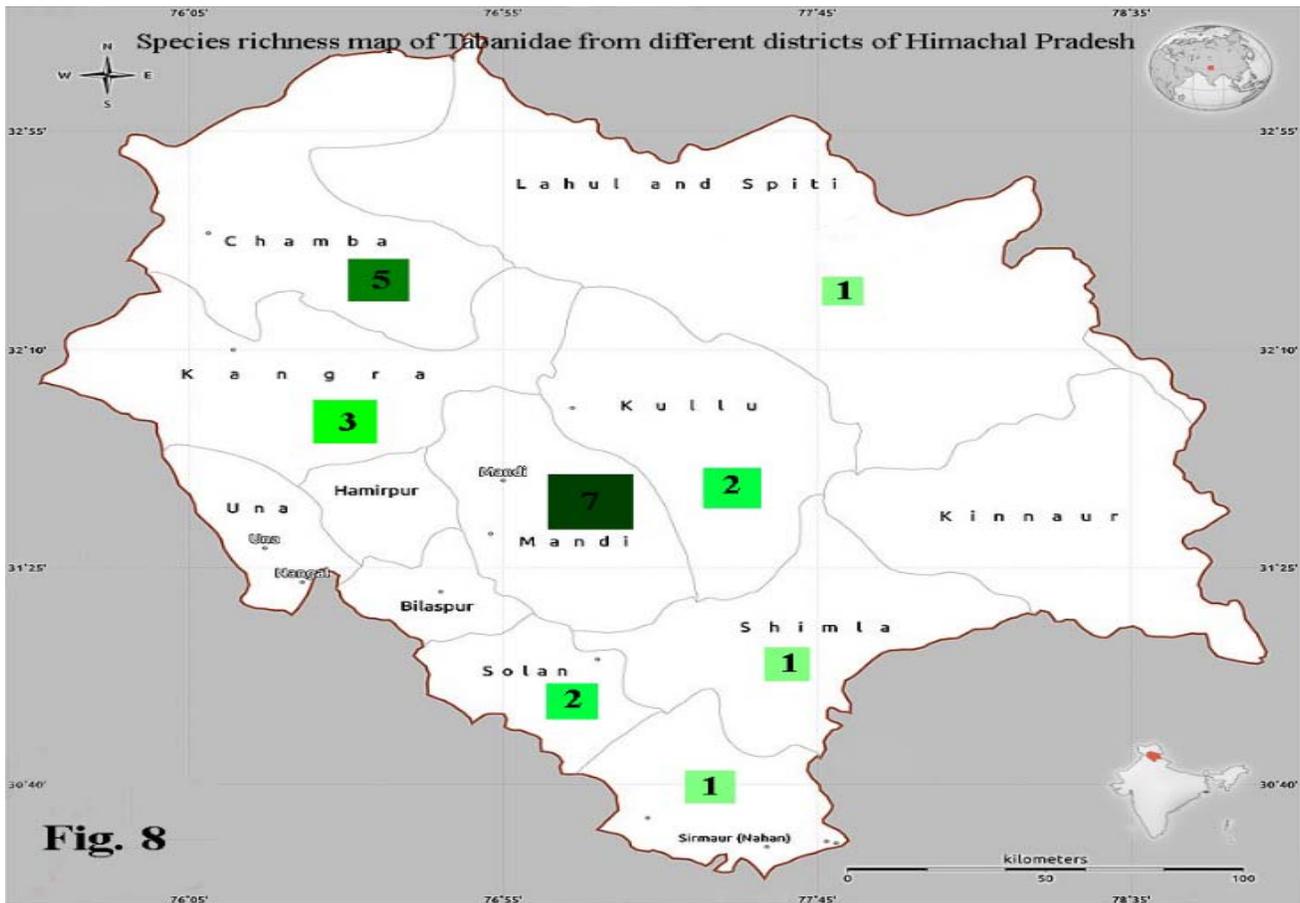


Fig. 8

Fig 8: Species richness Map of tabanid species collected from different districts of Himachal Pradesh during survey showing highest number of species recorded from Mandi district i.e. 7 species, 5 species recorded from Chamba and 3 species recorded from Kangra district, 2 species recorded from Kullu and Solan district, only single species recorded from Simla, Lahul & Spiti, and Sirmour.

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