

NEW DISTRIBUTIONAL RECORDS OF ROBBER FLIES (INSECTA: DIPTERA: ASILIDAE) FROM THE DARJEELING HIMALAYA OF WEST BENGAL

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ABSTRACT: Eight species namely *Ommatius jonesi* Joseph & Parui, 1985; *Promachus maculatus* (Fabricius, 1775); *Machimus bicolor* Joseph & Parui, 1985; *Machimus indianus* Ricardo, 1919; *Machimus inutilis* Bromley, 1935; *Trichomachimus himachali* Parui, Kaur & Kapoor, 1999; *Trichomachimus pubescens* (Ricardo, 1922) and *Stenopogon subtus* (Bromley, 1935); belonging to five genera viz., *Ommatius* Wiedemann, 1821; *Promachus* Loew, 1848; *Machimus* Loew, 1849; *Trichomachimus* Engel, 1933 and *Stenopogon* Loew, 1847; of three subfamilies Ommatini, Asilinae and Stenopogoninae, are recorded for the first time from the Himalayan and sub-himalayan region of West Bengal, are listed, keyed, and discussed. Distribution pattern is also included wherever deemed necessary, along with morphology and methodology in aid of understanding the flies of family Asilidae.

KEY WORDS: Taxonomy, Asilidae, new records, Darjeeling Himalaya, West Bengal

Biodiversity or Biological Diversity plays a most crucial role in ecosystem functioning (Chapin et al., 1998; Tilman, 1999; Naeem, 2002; Ives et al., 2005). The diversity response to several ecological process for maintaining the ecosystem stability. The stability of populations and critical ecosystem process is the main phenomenon in community ecology. The most important ecological process is prey-predator relationship, where a single species or multiple species by changing the strength of its interaction with co-existing species affect the ecosystem function. Moreover, the pattern and strength of species interactions determine the stability of populations and food webs (May, 1973; De Ruiter et al., 1998; Neutel et al., 2002, 2007; Emmerson & Yearsley, 2004; Brose, 2010; Rall, 2010).

Robber flies or assassin flies (Insecta: Diptera: Asilidae), are an important group of predators in all zoogeographical regions. Asilidae comprises of approximately 7187 species (Geller-Grimm et al., 2015) belong to 776 genera (Dikow, 2016) distributed throughout the world and therefore is one of the most speciose family taxa among the Diptera or 'true flies' (Dikow, 2009). Robber flies are predatory, generally catching prey insects on the wing; they are distributed worldwide, with the exception of Antarctica (Bosák & Barták, 2000). The robber flies are most diverse in warm and arid regions, with species numbers rapidly decreasing toward the tropics and the temperate regions (Lyneborg, 1965). Adult Asilidae prey on multiple other insect orders and spiders (Wood, 1981; Dennis & Lavigne, 2007).

This predaceous mode of life is reflected in the distinctive morphology of the adults, which can be used to identify the family (Lyneborg, 1965). Especially conspicuous are the eyes, which are separated by the sunken vertex and provide forward- and backward- as well as stereoscopic vision. When prey is detected it is

seized by the legs, which are unusually long, robust and usually covered with bristles and hairs. As diagnostic for the family as the eyes is the so-called mystax, which consists of hairs and bristles that are found in the middle of the face and are thought to protect the eyes from struggling prey. The mystax extends in some cases to the antennal bases and is often found on a protuberance (Wood, 1981). The victims of Asilidae are mostly insects, which are paralyzed by a neurotoxin injected through the hypopharynx (Geller-Grimm, 2003). The liquefied content of the victim is then imbibed through the proboscis of the predator (Geller-Grimm, 2003).

Asilidae, like most Diptera of the infraorder Asilomorpha, has stages like the egg, three free living larval instar, a pupa inside a puparium (the contracted and hardened integument of the mature third instar larva) and the adult. The phenology of the Asilidae in general is poorly known (Lyneborg, 1965). Information about the early immature stages exists only for 16 species (Musso, 1981) and complete life-cycle descriptions are restricted to four species: *Promachus yesonicus* Bigot, 1887, *Mallophora ruficauda* (Wiedemann, 1828), *Mallophora media* Clements & Bennett, 1969, and *Machimus rusticus* (Meigen, 1820) (Musso, 1981). Larvae of many genera live in soil while those of the Laphriinae and Laphystiinae usually occur in decaying logs and stumps, where they are predators of the larvae and pupae of other insects (Geller-Grimm, 2003). Much literature on the biology of immature Asilidae is related to their importance as predators (Larsen & Meier, 2004).

As Asilids are able to exploit a wide variety of prey, as a result they can respond to fluctuations in the relative abundances of alternative prey and occupy habitats with different prey communities (O'Neil et al., 1992). Populations of such predators may appear to be specialists if they switch to near exclusive use of the most abundant prey type (McCravy & Baxa, 2011). Due to their habitat specialization and role as top insect predators, robber flies are becoming increasingly important as a group of special conservation concern (Barnes et al., 2007). The specialized habitat associations of some species may also make them valuable as bio-indicators (Van Veen & Zeegers, 1998).

Despite this high value as bio-indicators, taxonomic studies on the family Asilidae are not sufficiently advanced, and the family is considered one of the least studied in Diptera and neglected as subject of interest (Geller-Grimm et al., 2015). As a result, details systematic studies of this group is essential to maintain biodiversity and to be able to react to climate change.

On the other hand, by many measures of biodiversity, the eastern Himalayas Region stands out as being globally important. It has been included among Earth's biodiversity hotspots (Myers et al., 2000) and includes 200 global ecoregions (Olson and Dinerstein, 1998). Several factors contribute to the exceptional biological diversity of the eastern Himalayas. The eastern Himalayas has multiple biogeographic origins. Its location at the juncture of two continental plates places it in an ecotone represented by flora and fauna from both. But unfortunately, most of the available recent studies of geographic distribution and occurrence of Asilid fauna in India had been focused on the southern, Western and northern region (Joseph & Parui, 1987a). Different taxonomist who has done research of immense importance about robber flies from this area are Macquart, 1838 followed accordingly by Lal, 1960; Joseph & Parui, 1983, 1986a,b,c, 1987b,c,d,e,f,g. As per the knowledge is concern there are very scatter studies conducted in the eastern Himalayan regions (Joseph & Parui, 1983). All the studies are hundred or more than hundred or near to hundred years old. Therefore a thorough study is essential to understand the real scenario of the top

level predator and a potential bio-indicator species of robber flies from this area to react to climate change and maintain biodiversity.

With an aim to study the taxonomy of predator robber flies from this vast region of Eastern Himalaya, Himalayan and Sub-himalayan region of West Bengal was chosen as the representative study area. The Himalayan and Sub-himalayan region comprises of three district of West Bengal, mainly in the Darjeeling District, which comprises of the 'Darjeeling Himalaya', falling under Eastern Himalaya and the Himalayan foot hills and also in the Alipurduar and Jalpaiguri district, which mainly consists of the Terai region or Sub-Himalaya region of West Bengal. This region houses a unique pattern in its annual climatic scenario as well as in vegetation and topographic fashion. Thus, this region is remarkably recognized for being the habitat locality of many asilid species (Joseph & Parui, 1983). The data on Indian Asilidae from his region was not updated and sufficient (Joseph & Parui, 1983). Moreover, stray survey had been done in this long period of time by different dipterists since the British era. However major contribution was lacking in the field of asilid fauna from the Himalayan and Sub-himalayan region of West Bengal. Consolidated information regarding asilid fauna was never be available from this region. Therefore, the present study is the first exhaustive study of the robber flies fauna from the Himalayan and Sub-himalayan region of West Bengal. Thus this study, includes a thorough survey of Asilidae fauna and represent the overall picture of this region. As it leads to the discovery of biodiversity including description of new asilid fauna of *Heligmonevra paruii* sp. nov. (Naskar et al., 2018). Therefore, it also depicts the extensive species richness of robber flies fauna from this region, that may help for future implementation of effective biological control and improvising better management plan to counteract occasional attack of several pest species in agricultural field to prevent economical loss.

MATERIALS AND METHODS

(i) Collection and Preservation

Flies belonging to the family Asilidae are found in diverse habitats and method for collecting them is also different. Asilids were collected from different habitats such as dense vegetation surrounding water bodies, agricultural fields in village patches, rocks and crevices around the riverine belt of high altitudinal landscape, long patches across the forest area etc.

The Asilidae are very agile and swift on wings. A little practice was needed in netting the adults with an ordinary insect net. The greatest number of individuals of different species could be intercepted with help of several trapping and baited trap methods and also by sweeping with regular insect net. Traps specially malaise trap, canopy trap etc. can also be known as most effective method to catch large amount of asilids in a short time with minimum effort. For night collection light trap is an essential method. After collecting samples were usually killed by exposing them to the killing jar filled with ethyl acetate or high dose chloroform. The procedure took just fraction of time, immediately after that the entomo-fauna were transferred to the special drying envelope for the dehydration purpose. Then those specimens were kept there until they were brought back to the lab (ZSI, HQ) for further identification purpose.

(ii) Identification and taxonomic studies

Diptera structurally comprises the most highly specialised members of the class Insecta. All the subfamilies, tribe, genera and species of family Asilidae

followed the classification scheme of Dikow, 2009 for convenience. Taxonomic analysis of asilids were carried out by consulting available literature followed by comparison with authentically identified reference collection, on availability basis. Several taxonomic keys were used for identifying several species during taxonomic studies as followed earlier by Hardy (1948), Hull (1962), Geller-Grimm (2003), Dikow (2009), and Trautwein et al., (2010). Morphological terminology was followed recommended earlier in Manual of Nearctic Diptera (Wood, 1981). Terminology of the antennae was carried out from Hennig (1972), Stuckenberg (1999), and Dikow and Londt (2000), and terms pertaining to male terminalia were used from Sinclair et al. (1994).

After taxonomic identification of all individuals of each representing species, specimens along with their associated data were digitised and all the important taxonomic characters were recorded by taking photographs. The photographs of habitus and different body parts of Asilid fauna were taken using Leica stereo-iso microscope M205A coupled with a LEICA DFC 500 camera and software Leica Application Suite LAS V3.6 for digital image processing. Photos of the terminalia were captured using a LEICA EZ4 HD optical microscope. The entire collection afterwards were deposited in the National Repository of the Zoological Survey of India, Ministry of Environment, Forests and Climate Change, Kolkata.

RESULTS

Taxonomy

(i) List of taxa

ORDER: DIPTERA
SUBORDER: BRACHYCERA
SUPER FAMILY: ASILOIDEA
FAMILY ASILIDAE

Subfamily OMMATIINAE Hardy, 1927

Genus *Ommatius* Wiedemann, 1821

Ommatius jonesi Joseph & Parui, 1985

Subfamily ASILINAE Latreille, 1802

Genus *Promachus* Loew, 1848

Promachus maculatus (Fabricius, 1775)

Genus *Machimus* Loew, 1849

Machimus bicolor Joseph & Parui, 1985

Machimus indianus Ricardo, 1919

Machimus inutilis Bromley, 1935

Genus *Trichomachimus* Engel, 1933

Trichomachimus himachali Parui, Kaur & Kapoor, 1999

Trichomachimus pubescens (Ricardo, 1922)

Subfamily STENOPOGONINAE Hull, 1962

Genus *Stenopogon* Loew, 1847

Stenopogon subtus (Bromley, 1935)

(ii) Systematic and diagnostic accounts

FAMILY ASILIDAE

Key to the subfamilies

1. R2+3 ending in Costa; neither a strong bristle present on the supero-posterior angle of anepisternum nor a row of bristles present on the katatergite. **Stenopogoninae** Hull, 1962 - R2+3 joining R1 proximal to end of R1, with cell r1 thus separated from wing margin; either anepisternum with at least one strong bristle on its supero-posterior angle, or katatergite with a vertical row of bristles or bristly hairs.....2
2. Anatergite pilose, the hair situated on top of it; R4 never with an extra vein.....**Asilinae** Latreille, 1802
- Anatergite bare, or if some hairs, these placed mostly on latero-internal margin of anatergite and on immediately adjacent area of mediotergite, but never on top of anatergite; R4, in this case, always with a short extra vein present at its junction with R5.....**Ommatiinae** Hardy, 1927

Subfamily OMMATIINAE Hardy, 1927

Ommatiinae Hardy, 1927. Type genus *Ommatius* Wiedemann, 1821.

Diagnosis: Some median ommatidia larger than surrounding ones, post pedicel short and medially broadest, post metacoxal area entirely sclerotized.

Genus *Ommatius* Wiedemann, 1821

Ommatius Wiedemann, 1821. Dipt. exot., 1: 213. Type species: *Asilus marginellus* Fabricius; designated by Coquillett (1910:579).

Empysomera Schiner, 1866. Verh. Zool. Bot. Ges. Wein., 16: 649-722. Type species: *Asilus conopsoides* Wiedemann; original designation.

Ommatius Becker, 1925. Ent. Mitt., 14: 18. Type species: *Asilus pinguis* van der Wulp; designated by Engel (1926: 37).

Diagnosis: The genus can be easily distinguished by its short; pyriform third antennal segment and a long style bearing one or two rows of short hairs throughout its length.

***Ommatius jonesi* Joseph & Parui, 1985**

Plate – 1A

1984b. Joseph A.N.T and Parui P. Oriental Insect, 18: 57. India.

Type Locality: Holotype [♂: NHM, London] India. Uttarakhand: Ranikhet, 1524-1821 m, 18 Aug 1945, Collector: C.G. Jones.

Material Examined: 2♂♂, collected from leaf litter on forest floor, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 4♂♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 24 May 2015, Coll. A. Naskar; 2♂♂, collected from stones nearby streams, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar; 1♀, collected from stones nearby streams, 27.02.32.800N, 88.41.32.800E, 1103 m, Kuapani roadside 2, Kalimpong, 29 May 2015, Coll. A. Naskar.

Diagnosis: Black mystax, postocular bristles thin and black below which white setae present; setose pronotum, indistinct medio-longitudinal stripe on scutum, pleuron grey tomentose, dark brown legs with black bristles, coxa with reddish hairs laterally; lightly infuscated wing; Abdominal terga I and II with long white setae; male genitalia black with ark brown and pale yellow setae covered.

Global Distribution: Oriental region.

Distribution in India: West Bengal: Darjeeling; Kalimpong, Uttarakhand, Himachal Pradesh.

Prey: Spider.

Remarks: This species is closely resembled with *Ommatius ater* Bromley but differs from it by the not metallic, but black, coloured abdomen, terga I and II with long, white setae and distally infuscated wing (Parui et al., 1999). This species is recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Subfamily ASILINAE Latreille, 1802

Asilinae Latreille, 1802. Type genus *Asilus* Linnaeus, 1758.

Diagnosis: Macrosetae on lateral margin of frons present, prosternum and proepisternum separated and prosternum triangular and pointed dorsally, female S8 proximally plate like and distally hypognynial valves forming a keel, male gonocoxites entirely free.

Key to genera of subfamily ASILINAE Latreille, 1802

1. Submarginal cells there, metanotal slopes devoid of bristly piles.....***Promachus* Loew**
- Submarginal cells two, Metanotal slopes bristly pilose.....2
2. Disc of scutellum and abdominal tergites from second to fifth matted with dense piles, antennal style quite short and stout.....***Trichomachimus* Engel**
- Scutellum and abdomen not densely pilose, scutellar disc with long bristly hairs, antennal style long.....***Machimus* Loew**

Genus *Promachus* Loew, 1848

Promachus Loew, 1848. Linn. Ent., 3: 390. Type-species: *Asilus maculatus* Fabricius; designated by Coquillett (1910: 595).

Trypanoides Becker, 1925. Ent. Mitt., 14: 71. Type-species: *Trypanoides testaceipes* Macquart; designated by Engel (1926: 22).

Enagaedium Engel, 1930. Konowia, 8: 459. Type-species: *Asilus poetinus* Walker, 1849; original designation.

***Promachus maculatus* (Fabricius, 1775)**

Plate – 1B

1775. Fabricius, J. C. Systema entomologiae, sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus. Kortii, Flensbvirgi et Lipsiae [= Flensburg & Leipzig]. [32] + 832 p.

1920. Ricardo, G. Notes on the Asilidae: sub-division Asilinae [part 30]. Ann. Mag. nat. Hist., (9) 5: 209-241.

Type locality: Holotype [unknown] India. Tamil Nadu: Tharangambadi.

Material Examined: 1♂, collected from leaf litter on forest floor, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 2♂♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 24 May 2015, Coll. A. Naskar; 1♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar.

Diagnosis: Pale yellow moustache, yellow haired palpi; black bristles and yellow hairs present on the scutellum; tibia reddish in appearance, mid and fore femur covered with pale yellow hairs anteriorly; black spot present on both side of the abdomen with yellow band surroundings; hypandrium large and forked with short epandrium.

Global Distribution: Oriental region.

Distribution in India: West Bengal: Jalpaiguri; Kalimpong; Kurseong; Alipurduar, Tamil Nadu, Kerala, Orissa, Andhra Pradesh, Rajasthan.

Prey: Spider.

Remarks: Macquart's species is evidently identical with this widely distributed species, he described the hind tarsi as black (Joseph & Parui, 1983). This species is recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Genus *Machimus* Loew, 1849

Machimus Loew, 1849. Linn. Ent. 4: 1. Type species: *Asilus chrystis* Meigen; designated by Coquillett, 1910.

Diagnosis: The flies of this genus can be separated from the remaining genera of the tribe by the prominent facial pilosity with dense bristles; ovipositor laterally strongly compressed with eighth segment moderately long and ninth segment short.

Key to species of the genus *Machimus* Loew, 1849

1. All femora wholly black, Wings largely infuscated, hyaline only at base, eighth sternite without long black hairs at apex.....*indianus* Ricardo
- All femora differently coloured, wings with no such infuscation, eight sternite with long black hairs at apex.....2
2. Superior forceps prolonged into a process apically, mystax black with pale yellow-bristles below.....*bicolor* Joseph & Parui
- Superior forceps without any process apically, mystax black with a few white bristles intermixed.....*inutilis* Bromley

***Machimus bicolor* Joseph & Parui, 1985**

Plate – 1C

1984. Joseph and Parui. On some Asilidae (Diptera) from India and adjoining countries present in the British Museum (Natural History). Oriental Insect. 18 (1): 63.

Type Locality: Holotype [σ : BMNH] India: Himachal Pradesh: Kangra district: Kulu, Dibibokri Nal Runi Thach, 3901 m, 10 Jul 1952.

Material Examined: 2 $\sigma\sigma$, collected from leaf litter on forest floor, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 5 $\sigma\sigma$, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 24 May 2015, Coll. A. Naskar; 3 $\sigma\sigma$, collected from stones nearby streams, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar; 1 φ , collected from stones nearby streams, 27.02.32.800N, 88.41.32.800E, 1103 m, Kuapani roadside 2, Kalimpong, 29 May 2015, Coll. A. Naskar.

Diagnosis: Mystax black with some pale yellow bristles below, Palpi and proboscis both are black with pale yellow hairs; mesonotum with two black spot laterally and with a black medio-longitudinal stripe; black cox and trochanter, dorsally and anteriorly fore and mid femora black; basally hyaline wing with apically light infuscation; abdomen covered with black densely grey tomentose, hypandrium with few black hairs.

Global Distribution: Oriental region.

Distribution in India: West Bengal: Darjeeling; Kalimpong; Jalpaiguri, Himachal Pradesh, Rajasthan.

Prey: Spider.

Remarks: This species relatively abundant in comparison to other newly recorded asilid species and therefore commonly found throughout the study area. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

***Machimus indianus* Ricardo, 1919**

Plate – 1D

1919. Ricardo. Ann. Mag nat Hist., 3 (9): 50.

Type Locality: Lectotype [σ : BMNH] India: Uttarakhand: Kumaon, Takula, 29.vi.1912. Paralectotype [Female: BMNH] India: Uttarakhand: Kumaon, Takula, 15 May 1919.

Material Examined: 2 $\sigma\sigma$, collected from leaf litter on forest floor, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 4 $\sigma\sigma$, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 27 May 2015, Coll. A. Naskar; 3 $\sigma\sigma$, collected from stones nearby streams, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar.

Diagnosis: Narrower head with dense grey tomentum; pale yellow mystax with one black bristle on both the side of lower margin, median transverse row of pale bristles present in pronotum, a medio-longitudinal stripe divided by a narrow grey stripe present on mesonotum; fore tibia and basitarsus ventrally with mat of golden hairs, remaining hairs predominantly white, bristles black; largely infuscated wing; Abdomen black with transverse white bands.

Global Distribution: Oriental region.

Distribution in India: West Bengal: Darjeeling; Kalimpong; Alipurduar, Uttarakhand, Punjab, Himachal Pradesh.

Prey: Spider.

Remarks: This species also commonly found throughout the study area. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

***Machimus inutilis* Bromley, 1935**

Plate – 2A

1935. Bromley. Rec. Indian Mus., 37: 221.

Type Locality: Holotype [σ : ZSI Registration No. 641/H6] India: Himachal Pradesh: Dalhousie. Collector S.L. Hora.

Material Examined: 2 $\sigma\sigma$, collected from rocks nearby streams, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 2 $\sigma\sigma$, collected from high altitude forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 24 May 2015, Coll. A. Naskar; 2 $\sigma\sigma$, collected from high altitude forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar; 1 σ , collected from dense forest floor, 27.02.32.800N, 88.41.32.800E, 1103 m, Kuapani roadside 2, Kalimpong, 29 May 2015, Coll. A. Naskar.

Diagnosis: Broader head covered with grey tomentum; mystax black with a few white bristles intermingled; mesonotum with a medio-longitudinal black stripe divided by a narrow grey stripe, scutum covered with disc pale yellow haired; femur covered with dark brown anteriorly and ventrally and rest brownish yellow, mid tibia darker anteriorly; hyaline wing with fuscous apex; abdomen covered with grey and greyish-brown black tomentum; superior forceps terminating in a long slender process which is directed backwards.

Global Distribution: Oriental region.

Distribution in India: West Bengal: Darjeeling; Kalimpong; Kurseong, Himachal Pradesh, Uttarakhand.

Prey: Spider.

Remarks: This species is also commonly encountered throughout the moderate altitudes of Himalayan and sub-himalayan region. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Genus *Trichomachimus* Engel, 1933

Trichomachimus Engel, 1933. Ark. Zool. (A), 25 (22): 10. Type-species: *Machimus pubescens* Ricardo, 1922; original designation.

Diagnosis: The genus can be distinguished from the allied *Machimus* Meigen by the densely matted stiff piles on disc of scutellum and from second to fifth abdominal tergites, denser and larger piles on pleurae and more prominent pilosity of the face.

Key to the species of genus *Trichomachimus* Engel, 1933

1. Body and leg covered with whitish or pale yellow pile, particularly covering the whole of abdomen extending to the male genitalia; tergites 1-3 without any black pile; eighth sternite slightly produced bearing a fringe of dense white pubescence.....*pubescens* (Ricardo)
- Pale yellow pile not covered all abdominal tergites; some portion of legs with black pile, rest with pale yellow, tergites 1-3 with black pile; eight sternites devoid of such dense white pubescence.....*himachali* Parui, Kaur & Kapoor

Trichomachimus himachali Parui, Kaur & Kapoor, 1999

Plate – 2B

1994. Parui P., Kaur N. & Kapoor V.C. Three new species of Asilidae (Diptera) from Himachal Pradesh, India. Rec. Zool. Surv. India. 97: 221-229.

Type Locality: Holotype [♂: NZC, ZSI] India: Himachal Pradesh: Simla. 7 Oct 1992 Collector: C.N. Meeta.

Material Examined: 1♂, collected from rocks nearby streams, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 27 May 2015, Coll. A. Naskar; 2♂♂, collected from rocks nearby streams, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 28 May 2015, Coll. A. Naskar; 1♂, collected from hill top, 27.04.52.300N, 88.40.21.700E, 2209 m, Rachila, Kalimpong, 30 May 2015, Coll. A. Naskar; 1♂, collected from leaf litter in forest floor, 27.03.02.300N, 88.40.48.400E, 1599 m, Neora valley national park buffer zone, Kalimpong, 31 May 2015, Coll. A. Naskar.

Diagnosis: Antenna black with black piles and bristles. Palpi black with black piles; proboscis black with white piles ventrally; numerous yellowish brown tomentose, scutum unstriped, piles anteriorly black; reddish tarsi with black legs, long white piles ventrally covered fore coxa, yellow and black piles covered tibia;

wing with prominent infuscation in anterior half, squamal fringe black-brown and white; terga 1-3 with black piles, the remaining terga with yellowish-red piles; piles of sternites dense, black.

Global Distribution: Oriental region.

Distribution in India: West Bengal: Kalimpong; Darjeeling, Himachal Pradesh.

Prey: Small asilid species of subfamily Asilinae, spider.

Remarks: This species is relatively rare in occurrence and mainly encountered from higher altitudes of the study area. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Trichomachimus pubescens (Ricardo, 1922)

Plate – 2C

1922. Ricardo G. Notes on the Asilinae of the South African and Oriental regions [conl.]. Ann. Mag. nat. Hist., (9) 10: 36-73.

Type Locality: Holotype [σ : BMNH] Tibet: Gyangtse, 3900 m. Tibet Expedition 1905. Collector: H.J. Walton. Paratype: [ρ : BMNH] Tibet: Gyangtse, 3900 m. Tibet Expedition, 1905. Collector: H.J. Walton.

Material Examined: 1 σ , collected from rocks nearby streams, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 28 May 2015, Coll. A. Naskar; 2 σ , collected from hill top, 27.04.52.300N, 88.40.21.700E, 2209 m, Rachila, Kalimpong, 30 May 2015, Coll. A. Naskar; 1 σ , collected from leaf litter in forest floor, 27.03.02.300N, 88.40.48.400E, 1599 m, Neora valley national park buffer zone, Kalimpong, 1. Jun 2015, Coll. A. Naskar.

Diagnosis: Mustache composed of long soft black and yellow hairs, blackish antennae, two or three yellowish tomentose stripe present on thorax; the hind pair with white hairs and with stout reddish-yellow bristles; upper side of femora with white hairs; tibiae with white hairs, long and black on the underside of the fore pair; tarsi with chiefly black hairs, the posterior branch of the cubital vein with a slight bend inwards; epandrium stout, ending in a point curved downwards; the hypandrium shorter but stout; between them appear three reddish and black long processes.

Global Distribution: Palearctic region, Oriental region.

Distribution in India: West Bengal: Darjeeling; Kurseong; Sikkim, Himachal Pradesh.

Prey: Spider; small asilid species of subfamily Asilinae.

Remarks: This species is relatively rare in occurrence and mainly encountered from higher altitudes of the study area. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

Subfamily STENOPOGONINAE Hull, 1962

Stenopogoninae Hull, 1962. Type genus *Stenopogon* Loew, 1847.

Diagnosis: Facial swelling and mystax extending over lower facial half, all ommatidia same size, postpedicel cylindrical throughout, setae on anteroventral prothoracic tibiae absent, female spermathecal reservoir formed by more or less expanded and coiled ducts.

Genus *Stenopogon* Loew, 1847

Stenopogon Loew, 1847. Linn. Ent., 2: 453 Type-species: *Dasyopogon sabaudus* Fabricius (1794); original designation.

Diagnosis: Medium to large flies; third antennal segment with two microsegments and usually as long as the first two segments together; scutellum micro pubescent, sternopleuron with a distinct patch of fine hairs, metanotal callosity with micropubescence only which separates the genus from *Scleropogon* Loew; males with epandrium widely divided from base hypandrium forms a broad basal plate to triangular process, females with seven pairs of curved, blunt spines on acanthophorites.

***Stenopogon subtus* (Bromley, 1935)**

Plate – 2D

1935. Bromley S. W. New Asilidae from India. Rec. Indian Mus., 37: 219-230.

Type locality: Holotype [♀: NZC, ZSI Registration No. 653/H6] India. Himachal Pradesh: Dayankund Nallah, below bridge, between milestones 14 and 15 on Dalhousie-Khajjar Road, 2400 m. Collector: S L Hora.

Material Examined: 1♂, collected from leaf litter on forest floor, 27.02.50.900N, 88.41.05.000E, 1409 m, Upper kuapani, Kalimpong, 23 May 2015, Coll. A. Naskar; 1♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 24 May 2015, Coll. A. Naskar; 1♂, collected from dense forest floor, 27.02.10.800N, 88.41.50.800E, 990 m, Phaperkheti, Kalimpong, 28 May 2015, Coll. A. Naskar.

Diagnosis: Reddish yellow antennae, third segment black, Mystax composed of black bristles above and on sides whitish bristles anteriorly, becoming more numerous toward the lower portion. Scutellum grayish-yellow pollinose, legs reddish with black bristles and pale hairs. Anterior femora black above, with a black line above, extending three fourths of the length and a black area below basally seven-eighths the length. Middle femora basal anterior portion seven-eighths the length black. Posterior femora with the anterior portion black to seven-eighths; of the length, abdomen reddish with pale yellowish hairs.

Global Distribution: Oriental region.

Distribution in India: West Bengal: Kalimpong; Darjeeling; Punjab, Andhra Pradesh, Himachal Pradesh.

Prey: Spider.

Remarks: This species exhibited moderate pattern of distribution throughout the study area in Himalayan and sub-himalayan region of the West Bengal. This species is also recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

DISCUSSION

Eight species namely *Ommatius jonesi* Joseph & Parui, 1985; *Promachus maculatus* (Fabricius, 1775); *Machimus bicolor* Joseph & Parui, 1985; *Machimus indianus* Ricardo, 1919; *Machimus inutilis* Bromley, 1935; *Trichomachimus himachali* Parui, Kaur & Kapoor, 1999; *Trichomachimus pubescens* (Ricardo, 1922) and *Stenopogon subtus* (Bromley, 1935) under five genera were recorded for the first time from the Himalayan and sub-himalayan region of West Bengal.

The asilid fauna exhibited fascinating diurnal pattern of activity (Joseph & Parui, 1983). Likewise maximum activity of these newly recorded asilid species were observed and recorded between 11 am to 3 pm. Certain extreme weather conditions like strong breeze and cloud accumulation also reported to interfere with their daily activity pattern (Hull, 1962). In several studies, it has been observed that their daily activity pattern may change depending on several meteorological factors and largely depending on their distribution pattern (Geller-Grimm, 2003; Dikow, 2009; Geller-Grimm, 2015).

So far, in respect of qualitative richness of fauna, no asilid species and genus were endemic to the state of West Bengal. Of these, only single species of *Trichomachimus pubescens* (Ricardo, 1922) exhibited far wide spread in distribution, i.e. recorded from more than one zoo-geographical realms of Oriental and Palearctic region. Rest of the seven asilid species were recorded only from the single zoo-geographical realm of Oriental region.

In respect to the distribution of these asilid fauna in India, it can be said that six out of eight newly recorded asilid species namely *O. jonesi*; *M. bicolor*; *M. indianus*; *M. inutilis*; *T. pubescens* and *S. subtus* exhibited moderate pattern of distribution i.e. they were recorded from more than two and less than five states of India. Only single species of *P. maculatus* exhibited common distribution pattern, i.e. it was recorded from more than five states of India viz. Andhra Pradesh, Orissa, Kerala, Rajasthan, Tamil Nadu and West Bengal.

In respect to the distribution of these asilid species within the Himalayan and sub-himalayan region of the state of West Bengal, it can be said from the best of the knowledge accumulated on this family, that certain species occurring in West Bengal may immigrate at least to the neighbouring countries, such as Bangladesh, Nepal, Bhutan, Myanmar, Thailand, etc. or emigrate from those countries in the influence of allied topographic and climatic conditions. Indeed, nearly several species showed discontinuous distribution pattern, and this appears to be due to the need of thorough exploration of several area, unfavourable natural conditions in the area for survival and colonization, inaccessible area specially hilly mountain area, and border areas. Therefore Himalaya itself hereby acting as geographical barrier for migration of asilid species from upper Oriental region to higher altitudes of Palearctic region. Lastly, it can be concluded that more thorough exploitation of high altitude habitat in this Himalayan and sub-himalayan region of the state is largely wanted to accurately interpret on their distribution pattern, which is expected to be continuous in near future after proper taxonomic exploration.

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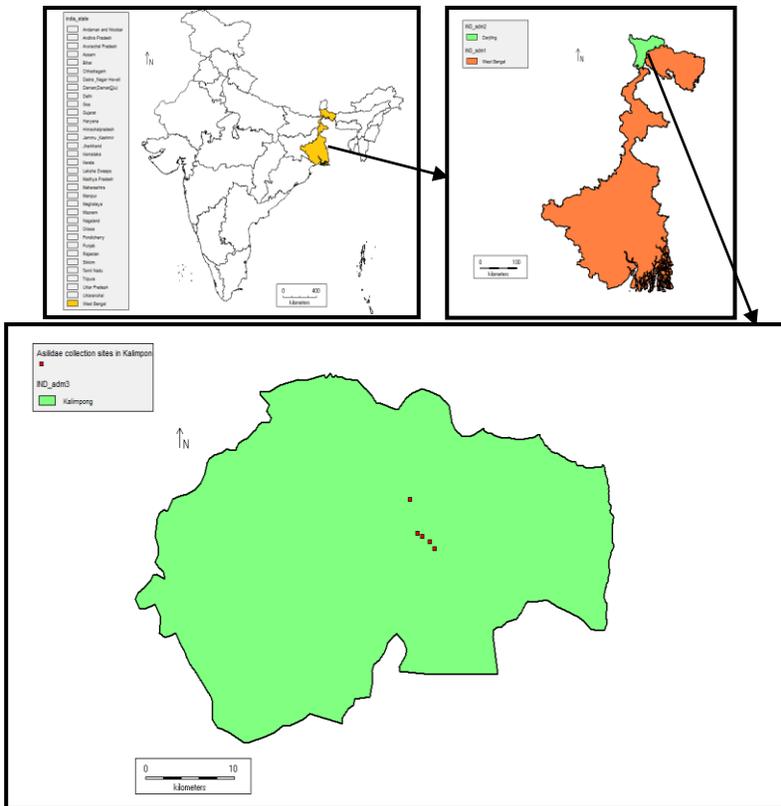


Figure 1. GIS map representing the study sites from where newly recorded asilid fauna were collected in Himalayan and sub-himalayan region of Darjeeling Himalaya, West Bengal.

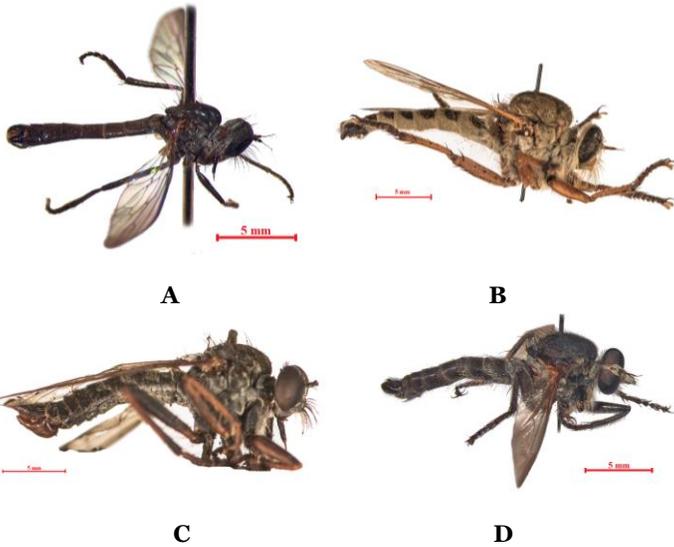


Plate 1A-D. Lateral view of habitus of **A:** *Ommatius jonesi* Joseph & Parui, 1985; **B:** *Promachus maculatus* (Fabricius, 1775); **C:** *Machimus bicolor* Joseph & Parui, 1985 and **D:** *Machimus indianus* Ricardo, 1919 (Scale bar – 5 mm).

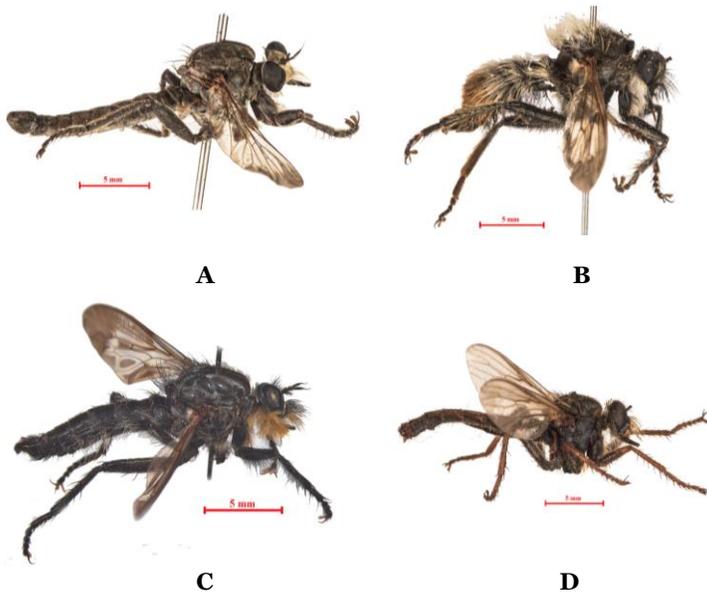


Plate 2A-D. Lateral view of habitus of **A:** *Machimus inutilis* Bromley, 1935; **B:** *Trichomachimus himachali* Parui, Kaur & Kapoor, 1999; **C:** *Trichomachimus pubescens* (Ricardo, 1922) and **D:** *Stenopogon subtus* (Bromley, 1935) (Scale bar – 5 mm).