Original Article

SPECIES COMPOSITION AND HABITAT DISTRIBUTION OF HAEMATOPHAGOUS MUSCID FLIES (DIPTERA: MUSCIDAE) IN WEST BENGAL, INDIA

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ABSTRACT

Haematophagous or blood-feeding muscid flies belonging to the family Muscidae (Diptera) are potential mechanical and biological vectors for several bacterial, viral, protozoan and helminths diseases associated with livestock, pets, wild animals, and humans. An entomological survey was conducted from October 2019 to June 2023 across various geographical

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regions of West Bengal, India, to explore species composition and habitat distribution of haematophagous muscid flies. Sampling techniques included sweep nets collected from host animals and visual surveys. Flies were morphologically identified into 16 species within the subfamilies Muscinae and Stomoxyinae, which are prevalent having significant veterinary and medical importance. The survey revealed a diverse community of haematophagous muscid flies with several prevalent species, including *Stomoxys calcitrans* (Linnaeus, 1758); *Stomoxys indicus* Picard, 1908; *Haematobia exigua* de Meijere, 1906; *Musca crassirostris* Stein, 1903; *Musca convexifrons* Thomson, 1869; *Musca ventrosa* Weidemann, 1830; *Musca conducens* Walker, 1859; *Musca inferior* Stein, 1909. The findings addressed a foundation for future research, offering insights into the presence of blood-feeding muscid species in the area and their potential implications for livestock and public health.

Keywords: Haematophagous, muscid flies, Muscinae, Stomoxyinae, West Bengal

INTRODUCTION

Several muscid flies are found to fly around livestock, pets, wild animals and even humans, possess specialised mouthparts adapted for sucking blood by directly penetrating the host skin and licking serum or oozing blood from sores and wounds considered as haematophagous nature[1,2,3,4]. Haematophagous muscid flies belong to the subfamilies Muscinae and Stomoxyinae[1,2,27]. However, many taxonomists have classified these flies under the single subfamily Muscinae, encompassing the tribes Muscini and Stomoxyini[5,6,7,28]. The most well-known haematophagous muscid flies around the world are members of the subfamily Stomoxyinae, which comprises ten genera, including *Bruceomyia*, *Haematobosca*, *Haematobia*, *Haematostoma*, *Neivamyia*, *Parastomoxys*, *Prostomoxys*, *Rhinomusca*, *Stygeromyia* and *Stomoxys*[2]. On the other hand, the subfamily Muscinae includes only one genus *Musca*, recognised as having haematophagous tendencies (not all species, though the status of haematophagy of certain species remains controversial)[1,3]. In India, four genera of Stomoxyinae flies (*Stomoxys*, *Haematobia*, *Haematobosca*, and *Stygeromyia*) and some species of *Musca* in the subfamily Muscinae are known for their haematophagous feeding habits[1]. Both adults and larvae of these flies serve as

potential mechanical and biological vectors for several viral, bacterial, protozoan and helminths diseases affecting livestock, wildlife and companion animals[8,9]. Besides their indirect effects, the painful bites and annoyance directly cause blood loss, reduced food intake, and decreased milk and meat production in livestock, leading to significant economic losses in livestock industries[18].

West Bengal harbours a large number of livestock compared to other states in India, with nearly 37.5 million animals (20th livestock census in 2019)[33]. Farmers in the state primarily rear livestock in backyard systems, where management practices often fail to meet recommended standards, particularly regarding disease vector control. The state also has many protected forest areas with abundant wildlife. Several diseases in livestock and wild animals transmitted by haematophagous muscid flies have been frequently reported in India[25,29]. One of the early measures to support vector control efforts, involves monitoring fly presence and identifying their habitats[30]. Although many researchers have expanded the data and knowledge on Muscidae in West Bengal[1,10,11,12,13,14,15,24], information regarding the species composition and habitat distribution of haematophagous Muscidae remains scarce. This study aims to fill the knowledge gap and provide updated insights into the species composition and habitat distribution of haematophagous muscid flies in West Bengal, India, associated with livestock, wildlife and companion animals.

MATERIAL AND METHODS

Study area

The survey was carried out in several regions of West Bengal, India (Fig. 1) from October 2019 to June 2023. Flies were usually collected from various habitats, including livestock farms, open grazing lands, local forest patches, village residential places, animal dung sites, and garbage areas.

Collection and identification methods:

Flies were collected using sweep nets (15 & 30 cm diameter). After collection, the flies were euthanized by exposing a small amount of liquid benzene vapour in a killing jar[15] and brought to the laboratory for further investigation. The flies were identified under a binocular microscope (SYS-45ETR) in the laboratory by studying chaetotaxy and morphological descriptions[1,2,16,17]. Male terminalia dissection was

performed under a dissecting binocular microscope (SYS-45ETR) and glass slide mounted for species confirmation.

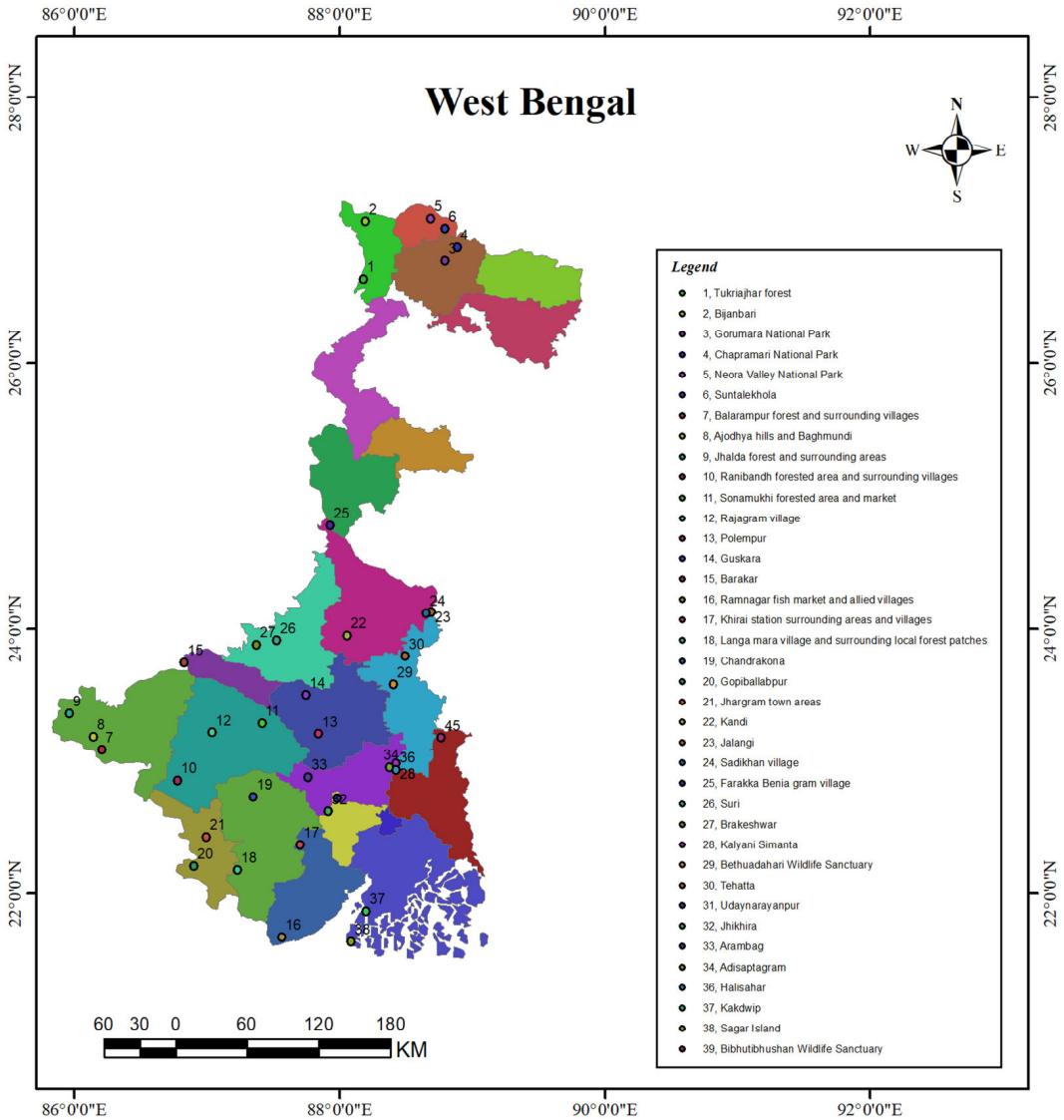

Fig. 1: Study map of West Bengal with sampling sites (map prepared using ArcMap 10.8 software).

RESULTS

Out of the entire collection, a total of 16 species of Muscidae were identified as haematophagous (Table 1; Fig. 2). Flies belonging to the subfamilies Muscinae and Stomoxyinae were identified as haematophagous. The subfamily Stomoxyinae comprises six species in three genera: *Stomoxys* (3 species), *Haematobia* (2 species) and *Haematobosca* (1 species). Conversely, the subfamily Muscinae includes ten species within the genus *Musca*. A brief account of these 16 species follows:

Fig. 2. Haematophagous muscid flies recorded from West Bengal, India. (A) *Stomoxys calcitrans*, (B) *Stomoxys sitiens*, (C) *Stomoxys indicus*, (D) *Haematobia sanguinolenta*, (E) *Haematobia exigua*, (F) *Haematobia minuta*, (G) *Musca bezzii*, (H) *Musca conducens*, (I) *Musca convexifrons*, (J) *Musca crassirostris*, (K) *Musca formosana*, (L) *Musca inferior*, (M) *Musca pattoni*, (N) *Musca sorbens*, (O) *Musca ventrosa*, (P) *Musca* sp.

Table 1: List of haematophagous muscid flies recorded in West Bengal, India

Sl. No.	Species
Subfamily Muscinae	
1	*Stomoxys calcitrans* (Linnaeus, 1758)
2	*Stomoxys indicus* Picard, 1908
3	*Stomoxys sitiens* Rondani, 1873
4	*Haematobosca sanguinolenta* (Austen, 1909)
5	*Haematobia exigua* de Meijere, 1903
6	*Haematobia minuta* (Bezzi, 1892)
Subfamily Stomoxyinae	
7	*Musca bezzii* Patton and Cragg, 1913
8	*Musca conducens* Walker, 1860
9	*Musca convexifrons* Thomson, 1869
10	*Musca crassirostris* Stein, 1903
11	*Musca formosana* Malloch, 1925
12	*Musca inferior* Stein, 1909
13	*Musca pattoni* Austen, 1910
14	*Musca sorbens* Wiedemann, 1830
15	*Musca ventrosa* Wiedemann, 1830
16	*Musca* sp.

1. SUBFAMILY STOMOXYINAE

(i) Stomoxys calcitrans (Linnaeus, 1758)

Habitat: Flies of this species were collected from diverse habitats, including livestock farms, pasturelands, forest areas and dung sites.

Distribution in India: Widespread and found in all the geographical regions within West Bengal.

Diagnosis: Head with a strong, elongated and highly sclerotized proboscis; dorsum of the thorax displays four distinct longitudinal stripes; wing vein M_{1+2} slightly rounded at apex; abdomen checkered marking with one median and two lateral spots on second and third segments[1,2].

Bionomics: This species is commonly called stable fly, and the only blood-sucking Stomoxyinae fly found worldwide. Both males and females primarily target warm-blooded vertebrate hosts for blood meals, including cattle, buffaloes, goats, sheep, pigs, dogs, wild animals, and occasionally humans when other hosts are scarce. Although they feed on diverse hosts, they notably engage in mass attacks on cattle, mainly targeting their lower legs. They are diurnal, with feeding activity occurring during the daytime and taking approximately 5–6 minutes to engorged under undisturbed conditions. Females mainly lay their eggs in cattle dung and decaying vegetation. They transmit pathogens of several livestock diseases, including trypanosomiasis, anthrax, habronemiasis, lumpy skin disease and bovine leukosis[8].

***(ii) Stomoxys indicus* Picard, 1908**

Habitat: This species is found in and around cattle sheds, pasturelands, and forest areas.

Distribution in India: Assam, Bihar, Kerala, Karnataka, Madhya Pradesh, Uttar Pradesh and West Bengal (districts covering the lower Gangetic plain, coastal belt and Chotanagpur plateau regions).

Diagnosis: The morphological characteristics of the head, thorax and wings closely resemble those of *S. calcitrans*. A key distinguishing feature is the presence of transverse dark posterior marginal bands on the second, third and fourth abdominal segments, instead of rounded spots typically seen in *S. calcitrans*[1,2].

Bionomics: Adult flies of this species are potent haematophagous on cattle. The peak activity of adult flies mostly occurs in the evening. Females deposit their eggs on cattle dung.

***(iii) Stomoxys sitiens* Rondani, 1873**

Habitat: Flies of this species were collected from forested areas in Neora Valley National Park, Kalimpong.

Distribution in India: Odisha, Tamil Nadu, Uttar Pradesh, and West Bengal (Kalimpong).

Diagnosis: The morphological characteristics of the head, thorax and wings closely resemble those of *S. calcitrans* but the lateral spots on the abdominal segments of this species appear to be more elongated[1,2].

Bionomics: This species prefers forested environments, and its adults are supposed to target wild animals and other vertebrates. However, previous studies have indicated a preference for donkeys over cattle and buffaloes for feeding[2]. Females oviposit on the dung of cattle, buffaloes, and donkeys.

***(iv) Haematobia exigua* de Meijere, 1903**

Habitat: Adult flies of this species were primarily gathered on domesticated animals, including cattle and buffaloes.

Distribution in India: Punjab and West Bengal (encompassing the regions of lower Gangetic plain and Chotanagpur plateau).

Diagnosis: Small-sized body with length measure is about 2.5-4.0 mm; palpi as long as proboscis; arista with only dorsally plumose; male hind leg second tarsal segment contains 4-6 long curled hairs[1].

Bionomics: Despite being commonly referred to as buffalo flies, this species is predominantly found on cattle. Studies have also reported their feeding activity on pigs and horses[2]. They usually remain active on their hosts throughout the day. Unlike *Stomoxys* spp. adult flies feed on blood with their heads oriented downwards. They are primarily responsible for causing skin lesions in cattle[25].

***(v) Haematobia minuta* (Bezzi, 1892)**

Habitat: Adult individuals of this species were captured in and around animal sheds, especially cattle and buffaloes.

Distribution in India: Chhattisgarh and West Bengal (Himalayan Mountain regions, districts of Darjeeling and Kalimpong).

Diagnosis: The morphological characteristics are similar to the preceding species, but the key differences of this species include prosternum setulose; male hind leg second tarsal segment simple; sixth wing vein relatively short[1].

Bionomics: Adults persistently irritate and bite host animals with their strong proboscis. They mostly hover around the neck and hump of cattle. In Oriental regions, cattle and buffaloes serve as the primary hosts for this species[2]. They share a similar ecology with *H. exigua*.

***(vi) Haematobosca sanguinolenta* (Austen, 1909)**

Habitat: Flies of this species were collected from pasturelands around grazing cattle.

Distribution in India: Arunachal Pradesh, Assam, Bihar, Karnataka, Maharashtra, Tamil Nadu, and West Bengal (Nadia and Kalimpong).

Diagnosis: Palpi as long as proboscis; arista both dorsally and ventrally plumose; dorsum of the thorax with four longitudinal stripes; third and fourth abdominal tergites contain a pair of rounded spots[2].

Bionomics: Adult flies of this species feed on the blood of cattle, horses and wild animals by directly penetrating the host skin. In this study, adult flies of this species were found in much smaller numbers than other Stomoxyinae flies. Larvae and other preimaginal stages have been reported in herbivorous animal dung[16].

2. SUBFAMILY- MUSCINAE

***(vii) Musca bezzii* Patton and Cragg, 1913**

Habitat: Adult flies of this species were collected from wounds and sores and around the eyes of cattle, buffaloes, and other domestic animals in animal sheds and pasturelands.

Distribution in India: Arunachal Pradesh, Assam, Jharkhand, Jammu & Kashmir, Kerala, Karnataka, Nagaland, Odisha, Punjab, Uttar Pradesh, Uttarakhand, Sikkim, Tamil Nadu and West Bengal (Kalimpong).

Diagnosis: Large-sized fly with body length is about 7-9 mm; arista with dorsally and ventrally long plumose; dorsum of the thorax covered with four dark longitudinal stripes; suprasquamal ridge hairy; wing vein M_{1+2} strongly upcurved at apex; abdomen yellowish-orange with a narrow median dark line extending to the last segment; dorsum of the first

abdominal segment wholly dark brown[1].

Bionomics: Adults of this species are commonly found around open wounds, sores, and the eyes of host animals, particularly cattle. Their abundant presence around the eyes of cattle suggests a potential association with vectors of *Thelazia* spp. (eye worms, nematode parasites) responsible for causing thelaziasis disease in livestock[16]. They lay eggs on freshly deposited cow dung, and larvae are coprophagous in nature.

***(viii) Musca conducens* Walker, 1860**

Habitat: Adult flies of this species are extensively collected from various habitats, including cattle sheds, pasturelands, and forest areas, especially near dung sites and garbage areas.

Distribution in India: Arunachal Pradesh, Assam, Chhattisgarh, Madhya Pradesh, Nagaland, Punjab, Uttarakhand, Tamil Nadu, and West Bengal (widespread, covering all geographical regions).

Diagnosis: Body medium-sized, measuring 4-5 mm in length; dorsum of the thorax characteristics with four dark longitudinal stripes; suprasquamal ridge bare; second abdominal tergite dark brownish; third and fourth tergites yellowish-orange with a narrow dark median stripe reaching to the last segment[16].

Bionomics: Adults are often attracted to open wounds and sores on cattle and other animals, where they suck or lick mucus and blood. Flies of this species have been reported to have a biological association with *Stephanofilaria assamensis*, which is known to cause hump sores in cattle[13,16,20].

***(ix) Musca convexifrons* Thomson, 1869**

Habitat: Flies of this species were collected from cattle sheds, pasturelands, forest habitats and around human settlements.

Distribution in India: Arunachal Pradesh, Assam, Karnataka, Kerala, Tamil Nadu, and West Bengal (widespread, covering all geographical regions).

Diagnosis: Large fly with length of about 6.5-8.0 mm; thorax blackish with four longitudinal stripes; suprasquamal ridge hairy; abdomen yellowish-

silver checkered pattern; dorsum of the first abdominal segment pale yellowish; second to fifth tergites feature a dark longitudinal stripe; stem vein of wing with 1-3 setulae on the posterior margin[16].

Bionomics: This species is frequently encountered near the habitats of cattle sheds, pasturelands and forested regions. Adult flies are often seen around animal wounds, sores and the oozing blood punctures caused by other biting flies such as Tabanids. Gravid females deposit their eggs in the dung of cattle.

***(x) Musca crassirostris* Stein, 1903**

Habitat: Flies of this species were extensively collected in cattle sheds, pasturelands and forest habitats.

Distribution in India: Arunachal Pradesh, Bihar, Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Punjab, Rajasthan, Uttar Pradesh, Tamil Nadu, and West Bengal (widespread, covering all geographical regions).

Diagnosis: Greyish-brown colour median-sized fly; proboscis stout and highly sclerotized; dorsal surface of the thorax displays four narrow dark longitudinal stripes; suprasquamal ridge bare; abdomen greyish with triangular spots on intermediate segments[1].

Bionomics: Adult flies of this species possess a robust and stout proboscis used to draw blood by scratching the skin of animals. They are primarily seen near cattle sheds, perching on either the bodies of cattle or nearby vegetation. Studies have documented their ability to also feed on horses and donkeys[1,3]. They lay eggs in patches on freshly deposited cow dung.

***(xi) Musca formosana* Malloch, 1925**

Habitat: Adult flies were collected from local forest patches within Gopegarh Eco Park and pasturelands.

Distribution in India: Bihar, Karnataka, Kerala, Uttar Pradesh, Tamil Nadu, and West Bengal (Murshidabad and Paschim Medinipur districts).

Diagnosis: The head and thorax morphology closely resemble those of *M. convexifrons*. A key distinguishing feature of this species is the presence

of 3-7 setulae on the posterior margin of the stem vein of the wing, instead of 1-3 seen in *M. convexifrons*[1].

Bionomics: Adult flies of this species feed on blood or serum from open wounds and sores on animals.

***(xii) Musca inferior* Stein, 1909**

Habitat: Flies were collected near livestock farms in urban and rural areas, as well as local forest patches surrounding Wildlife Sanctuaries.

Distribution in India: Arunachal Pradesh, Assam, Andaman Islands, Odisha, Tamil Nadu and West Bengal (widespread, covering all geographical regions).

Diagnosis: Body greyish-brown, large fly with measures 6-8 mm in length; arista with long plumose hair dorsally and ventrally; proboscis stout and sclerotized; dorsum of the thorax characterized by four dark longitudinal vittae; suprasquamal ridge hairy; dorsum of the lower calypter hairy[1].

Bionomics: This species is potent haematophagous on livestock, feeding by puncturing host skin with their fully developed prestomal teeth[3]. Adults are commonly observed around cattle dung.

***(xiii) Musca pattoni* Austen, 1910**

Habitat: Found on and around cattle sheds, pasturelands and local forest patches.

Distribution in India: Arunachal Pradesh, Assam, Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Uttar Pradesh, Tamil Nadu, and West Bengal (regions of the lower Gangetic plain, coastal belt and the Chotanagpur plateau).

Diagnosis: Median-sized fly with body length is about 5-7 mm; thorax shiny blackish with greyish pollen and features four longitudinal stripes on the dorsum; suprasquamal ridge bare; abdomen yellowish-orange and a median stripe gradually narrows toward the posterior margin[1].

Bionomics: Flies of this species usually feed blood or serum on wounds and sores and/or nasal secretions of animals. Females lay eggs on freshly deposited animal dung[1].

***(xiv) Musca sorbens* Wiedemann, 1830**

Habitat: Adults of this species are found in and around cattle sheds, pasturelands, local forest patches, dung sites, and garbage areas.

Distribution in India: Arunachal Pradesh, Chhattisgarh, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Mizoram, Manipur, Odisha, Punjab, Rajasthan, Uttar Pradesh, Tamil Nadu, and West Bengal (widespread, covering all geographical regions).

Diagnosis: Body blackish-orange colouration; face and facial parts usually black with greyish to silvery pollen; dorsum of the thorax displays two broad dark longitudinal stripes; abdomen usually yellowish-orange with silvery pollen; dorsum of the second tergite brownish; a median longitudinal stripe extends across the third and fourth segments[1,2].

Bionomics: Adult flies are found around wounds and the eyes of cattle, feeds on oozing blood and tears. Adults serve as significant vectors for trachoma disease in cattle. Flies of this species have been reported as vectors for various bacteria such as *Shigella dysenteriae, Shigella flexneri, Haemophilus influenzae, Streptococcus* sp. and *Staphylococcus* sp. They serve as essential mechanical carriers by transferring germs from diseased animal hosts to other animals through open wounds or skin lesions[21.]

***(xv) Musca ventrosa* Wiedemann, 1830**

Habitat: Cattle sheds, pasturelands, local forest patches, dung sites, and garbage areas.

Distribution in India: Arunachal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Odisha, Punjab, Tamil Nadu, and West Bengal (widespread, covering all geographical regions).

Diagnosis: The head and thorax morphology closely resemble those of *M. conducens*. A notable distinguishing feature of this species is the abdomen uniformly orange[1].

Bionomics: Adults of this species usually feed on blood or serum from open wounds and sores. This species has been reported to serve as biological vectors for *Habronema megastoma* and *Habronema muscae*, parasitic nematodes mainly affecting horses[22].

***(xvi) Musca* sp.**

Habitat: Pasturelands, cattle sheds, local forest patches and flowering plants.

Distribution in India: West Bengal (regions of the lower Gangetic plain and the Chotanagpur plateau covering districts of Purba Medinipur, Paschim Medinipur, Jhargram, Purba Bardhaman, Paschim Bardhaman and Bankura).

Diagnosis: Body bluish colour; dorsum of the thorax with two dark longitudinal stripes; first abdominal segment wholly dark brownish to blackish; a dark median stripe extended from second to fourth segments; fourth abdominal segment with silvery margin.

Bionomics: Feed on blood from wounds and sores of domestic cattle.

DISCUSSION

Several studies on Muscidae have been conducted in India, but few are concerned about these pestiferous flies of their impacts on hosts. In our study, 16 species of haematophagous muscid flies of significant medico-veterinary implications for livestock, companion animals and wildlife were identified from the state of West Bengal, India. These flies are known to transmit various pathogens, including viruses (Equine Infectious Anaemia Virus; Lumpy Skin Disease Virus; Bovine Leukosis Virus; Bovine Herpes Virus), bacteria (*Bacillus anthracis*; *Shigella dysenteriae*; *Dermatophilus congolensis*), protozoa (*Trypanosoma evansi*; *Leishmania tropica*), helminths (*Habronema microstoma*; *Habronema megastoma*; *Stephanofilaria assamensis*; *Heterotylenchus autumnalis*; *Thelazia* spp.) and rickettsia (*Anaplasma marginale*)[8,9,16,18,19,26]. Among the identified species, several Stomoxyinae and Muscinae flies including *S. calcitrans*, *S. indicus*, *H. exigua*, *M. crassirostris*, *M. convexifrons*, *M. ventrosa*, *M. conducens* and *M. inferior* were found to be widely distributed and abundant around livestock farms and pasturelands. The presence spans across diverse ecosystems of these identified species, including animal sheds, pasturelands, and forest landscapes, making them severe pests to livestock, pets, and wild animals in the state. The absence of some *Stomoxys* flies in our study, such as *Stomoxys bengalensis* Picard, 1908 which was previously reported in West Bengal, may be due to the use of only a single collection trap (sweep nets). Various studies in Thailand have reported this species

using Vavoua traps[31,32], suggesting that alternative trapping methods may be necessary for collecting blood-feeding muscid flies. Our study is preliminary and findings addressed a foundation for future research, offering insights into the presence of blood-feeding muscid species in the area and their potential implications for livestock, wildlife, and companion animals.

CONCLUSION

The survey reflects the overall presence, habitat distribution and bionomics of haematophagous muscid flies in the state of West Bengal, India. Sixteen species of haematophagous muscid flies within the subfamilies Muscinae (ten species) and Stomoxyinae (six species) were documented. Among them species like *S. calcitrans*, *S. indicus*, *H. exigua*, *M. crassirostris*, *M. convexifrons*, *M. ventrosa*, *M. conducens* and *M. inferior* were found to be highly abundant in and around livestock farms and pasturelands. The findings serve as baseline information for future research on haematophagous Muscidae in West Bengal associated with livestock, wildlife, and companion animals.

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