



DIVERSITY OF MUSCIDAE (DIPTERA) IN NEORA VALLEY NATIONAL PARK, WEST BENGAL

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ABSTRACT

Understanding the local biodiversity and associated ecosystem services is important for organisms such as muscids (Diptera: Muscidae). This study aimed at the spatial diversity of muscid flies and their bionomics in the Neora Valley National Park, India. The survey was conducted over an altitude variation of 460–3200 masl having relatively high tree diversity. The study area preserves good ecological balance and provides every habitat that is ideal for the survival of muscid flies. The results revealed 31 species under 13 genera of three subfamilies. The highlight is the new records of two species, *Limnophora (Heliographa) ceylanica* (Emden, 1965) and *Neomyia pacifica* (Zimin, 1951) from India.

Key words: Muscidae, Neora Valley National Park, West Bengal, species diversity, bionomics, new record, *Limnophora (Heliographa) ceylanica*, *Neomyia pacifica*, altitudinal variation, distribution

The muscid flies belong to the most diverse family Muscidae of Diptera distributed throughout the world. Its members can be found in all terrestrial and aquatic habitats, except for the most arid environments (Skidmore, 1985). These have medical, veterinary and agricultural importance as they are synanthropic indicating the association of a given species with human or human-modified environments (Ishijima, 1967; D'Almeida, 1992). These flies also play a key role in pollination, as in many alpine and arctic areas, these have been identified as the most common flower visitors (Mitra, 2010; Orford et al., 2015; Tiusanen et al., 2016). Muscidae is recognized as important for medico-legal purposes (Grzywacz et al., 2017). A few faunistic surveys had been carried out in India (Joseph and Parui, 1977; Dutta and Chakraborti, 1985; Mitra, 2000; 2003; 2004; 2006a; 2006b; 2010; Nandi and Sinha, 2004; Mitra et al., 2005; 2015; 2016; 2017; Sinha, 2014). More studies with surveys and evaluation of bionomics and lifecycle on muscid flies had been done in West Bengal in comparison to other parts of India- The diversity and bionomics were studied in the Sundarban Biosphere Reserve (Sinha, 2009; 2004). The spatial diversity patterns of Muscidae in the northeast of India, and specifically in the protected forest areas, have not yet been explored. This study is a preliminary one compiling information and listing of the species of Muscidae inhabiting the forest areas of Neora Valley

National Park (NVNP), West Bengal, India. In this study, the spatial diversity of muscid flies in NVNP has been explored and bionomics of recorded species are explained.

MATERIALS AND METHODS

The Neora Valley National Park (NVNP) of West Bengal, India is encircled by two states, namely Sikkim and Bihar and two neighboring countries, Nepal and Bhutan. The National Park is situated in the Kalimpong district of West Bengal. It has been nominated as the oldest National Park in India covering an area of over 88 km² (26° 52'3"- 27° 3'3"N, 88° 45'- 80° 50'E). The insect diversity of this National Park is exceedingly high and, due to high altitudes in some places, often showing close similarities with Palearctic species. Consecutively, four Biodiversity Assessment Camps were organized by the Department of Forest (North Division), Government of West Bengal, mostly initiated by the Chief Conservator of Forests of North Bengal to explore the rich biodiversity of the NVNP (Fig. 1). Many surveys were made to explore muscid flies in this oldest National Park, for which insect collecting hand net and Malaise trap were used. Specimens collected by hand net were killed with benzene vapour in a killing jar and kept in an envelope for future use. Some specimens were pinned (no. 2) and preserved in insect box. Specimens collected by the Malaise trap were sorted out

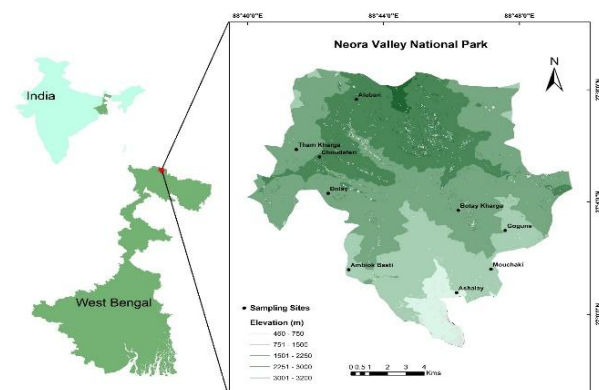


Fig. 1. Sampling sites in Neora Valley National Park

according to subfamily and preserved in 70% alcohol. For identification in the laboratory, collected insects were placed in a wet chamber overnight and then pinned inserting an insect-pin through the prothoracic segment slightly laterally. Pinned specimens were labeled with all details, before identifying following chaetotaxy (Emden, 1965) under a stereozoom microscope; in some cases, genitalia were dissected for identification. Abbreviations used: R-M – Radio-Medial cross vein, M1+2 – 1st and 2nd medial vein, Stpl – Stern pleural, DC – Dorso central bristles, PD – Postero-dorsal, AD – Anterior-dorsal, PRST – Presutural seta, and NVNP – Neora Valley National Park.

RESULTS AND DISCUSSION

A total of 31 species belonging to 13 genera under three subfamilies from the Neora Valley National Park (NVNP) were collected. The details of classification (key to species etc.) according to Emden (1965) and Shinonaga and Singh (1994), their distribution and bionomics are discussed herein.

Key to subfamilies

1. M1+2 almost straight or slightly bends at the apex. Black bristles on the lower margin of metathoracic spiracle.....Phaoniinae
2. M1+2 bends anteriorly. No bristles on meta thoracic spiracle.....2
Proboscis is of licking type with distinct labella; arista plumose.....Muscinae
Proboscis is strongly sclerotized and blood sucking type; arista pectinate.....Stomoxyinae

I. Muscinae

Key to genera

1. Metallic coloration; no distinct stripe or marking on the thorax and abdomen.....3

No metallic coloration; with distinct stripes on the thorax.....2

2. M1+2 vein sharply bends anteriorly*Musca*
M1+2 vein gradually bends anteriorly and bow shaped*Morellia*
3. Metallic blue or purple in colour; no distinct median vittae.....*Neomyia*
Black in colour with metallic reflection; distinct median vittae present.....*Rypellia*

Key to species

1. Suprasquamal ridge entirely bare.....2
Suprasquamal ridge hairy.....3
2. 3rd and 4th tergites pale yellow with a black median vittae; 5th tergite dark brown with silver pollinosity*Musca conducens*
Thorax without distinct whitish dust; no median vittae present.....*Musca tempestiva*
3. Suprasquamal ridge hairy but posterior part without erect hair; 2nd to 4th tergites brown or black. Female abdomen entirely black.....*Musca hervei*
Posterior part of suprasquamal ridge with erect hair; 3rd to 5th tergites yellow with a black median vittae.....*Musca bezzii*

A. *Musca* Linnaeus

Musca Linnaeus. 1758, Systema Nature Edition 10: 589. Type-species: *Musca domestica* Linnaeus.

i. Subgenus *Byomyia* Robineau-Desvoidy

sbg. *Byomyia* R.-D., 1830, Myod., p. 392 (*Byomya*) (nec *Biomyia* Rond., 1856). Genotype: *tempestiva* Flin.

1. *Musca* (*Byomyia*) *conducens* Walker

1860. *Musca conducens* Walker., Journal of the proceedings of the Linnean Society IV, 138. Type: Macassar. B.M.

1864. *Musca praecox* Walker, l.c., VII, 236. Type: Ceram. B.M.

1910. *Pristirhynchomyialineata* Brun., Records of the Indian Museum IV, 91, Pl. 8, Figs. 1-2. Types: Calcutta. Indian Museum, Calcutta and B.M.

1965. *Musca* (*Byomyia*) *conducens*: Emden, Fauna India, Muscidae, 7(1): 68.

Material examined: India, 2♂ NVNP, Ashalay, 04.III.2018; 3♂, 2♀, Choudaferi, 07.X.2019; 5♂, 8♀, Mouchaki, 07.III. 2018.

Bionomics: This fly is basically found on dung of different phytophagous animal and haematophagous in nature. This fly is biologically associated with *Stephanofilaria assamensis* (Greenberg, 1971; Shinonaga and Kano, 1971). In NVNP, this fly was captured from sores and wound of cows.

Distribution: India [West Bengal (NVNP), Andaman Island, Andhra Pradesh, Arunachal Pradesh, Assam, Madhya Pradesh, Orissa, Punjab, Uttar Pradesh]. This species is distributed through whole Ethiopian and Oriental region to Burma, China, Java, Malaya, New Guinea, Philippines, Sri Lanka, Sumatra, and Thailand.

2. *Musca (Byomyia) tempestiva* Fallen

1817. *Musca tentpestiva* Fallen., K. Sven. Vetenskapsakad. Handl. 1816 (2), 226-254.

Types: S. Sweden (Kivik in Skane). Muscidae Stockholm and Lund.

1965. *Musca (Byomyia) tempestiva*: Emden, Fauna India, Muscidae, 7(1): 65.

Material examined: 2♂, Gogune, NVNP, 3.XI.2018. 3♀ Botay Kharga, 4.XI.2018

Bionomics: Haematophagous in nature. Found on cattle (Cow, horses). Found on batches. In NVNP, this fly was collected from cattle.

Distribution: India [Kashmir, West Bengal (NVNP)], Arabia, Central Asia, Egypt, Europe, Iraq, Persia.

ii. Subgenus *Eumusca* Townsend

sbg. *Eumusca* Townsend., 1911, Proceedings of the Entomological Society of Washington. XIII, p. 170. Genotype: *autumnalis* Deg. (= *corvina* F.).

Emusca Mall., 1925, Annals Magazine of Natural History, (9), XVI, p. 372. Genotype: *autumnalis* Deg.

3. *Musca (Eumusca) hervei* Villeneuve

1922. *Musca hervei* Villeneuve. *Annales des sciences naturelles* (Zoology), (10)5: 335.

1965. *Musca (Eumusca) hervei*: Emden, Fauna India, Muscidae, 7(1): 75.

Material examined: 5♂, Ashalay, 4.III.2018. 2♂, 3♀ Botay Kharga, 20. X.2019.

Bionomics: This fly basically found on cattle, cow, horses. Generally, this fly laid eggs in patches on fresh cow-dung. This is haematophagous species. Also feeds on tears and wounds of cattle. It was reported as vector of *Thalazia* sp. (Shinonaga and Kano, 1971). In NVNP,

many of this species were collected from forest village, precisely from the cattle.

Distribution: India [West Bengal (NVNP), Assam, Himachal Pradesh, Punjab, Sikkim, Shimla, Uttar Pradesh], Burma, China.

iii. Subgenus *Viviparomusca* Townsend

sbg. *Viviparo musca* Tns., 1915, Journal of Academy of Sciences, Washington, V, p. 435. Genotype: *bezzii* Patton and Cragg

4. *Musca (Viviparomusca) bezzii* Patton and Cragg

1913. *Musca bezzii* Patton and Cragg., Indian Journal of Medical Research, I, 19, Pl. IV;

1917. *Musca pilosa* Awati, Indian Journal of Medical Research., IV, 137; l.c., V, 165 (*bezzii*). Types: India.

1965. *Musca (Viviparo musca) bezzii*: Emden, Fauna India, Muscidae, 7(1): 83.

Material examined: 2♂, 3♀, Botay Kharga, NVNP. 20.X.2019. 2♂, Ashalay, 4.III.2018.

Bionomics: Larviparous in nature. Single larva deposited at a time in cow dung. Found near human habitation. Purely haematophagous in nature. Vector of Thelaziasis. In NVNP, this flies were collected from bushes, cow dung and sores of cow.

Distribution: India [West Bengal (NVNP), Assam, Kashmir, Missouri, Nainital, Punjab, Sikkim, Uttar Pradesh], Burma, China, Japan, Korea, Malaya.

B. *Neomyia* Walker

1860. *Neomyia* Walker, Proceedings of the Linnean Society (Zoology), IV, 138. Genotype: (*gavisa* Walk. =) *Chalybea* Wied.

1863. *Orthellia* R.-D., *Dipteres des environs de Paris*, II, 837. Genotype: *cornicina* F.

1994. *Neomyia*: Shinonaga and Singh, Japanese Journal of Sanitary Zoology, 45: 115.

Key to species

1. DC 2+4/ 5. Para frontals black, bare on upper two thirds, which are slightly shining and purplish in colour.....*Neomyia fletcheri*
Presutural Dorsocentral bristle absent or very fine2
2. DC 0+1. Sternopleural bristle 1.*Neomyia chalybea faceta*
DC 0-1+1-2. Sternopleural bristle 1+2.....*Neomyia pacifica*

5. *Neomyia chalybea faceta* Enderlein

1928. *Orthellia coeruleifrons* Macquart, Malloch, Entomologische Mitteilungen, XVII, 392 (nec Macquart).

1934. *Neomyia faceta* End., Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin, 1934, 420; Hennig, 1952, Beiter. Ent., II, 88. Types: Formosa (Ko. sempo). Mus. Berlin.

1965. *Orthellia chalybea faceta*: Emden, Fauna India, Muscidae, 7(1): 131.

Material examined: 3♂, 2♀ from Botay Kharga, 20.X.2019. 2♂, 2♀ Tempola, 22.X.2019.

Bionomics: Found on cow dung, cattle manure, human stool. Sometimes they visit flowers though. In NVNP, these flies were collected from cattle manure and bushes near cattle.

Distribution: India [Assam, Punjab, Sikkim, Shimla, Uttar Pradesh, West Bengal (NVNP)], Burma, China, Java, Nepal, Pakistan, Sri Lanka, Sumatra.

6. *Neomyia fletcheri* Emden

1965. *Neomyia fletcheri* (Emden, 1965), Emden, Fauna India, Muscidae, 7(1): 122.

Material examined: 2♂, 1♀ Gogune, 2.X.2018. 3♂ Choudaferi, 4.X.2018, 1♂, 2♀ Alubari, 6.X.2018. 1♂, Botay Kharga, 20.X.2019.

Bionomics: Found on cow dung, cattle manure, human stool. In NVNP, collected from bushes, flowers, and cattle manure.

Distribution: India [Assam, West Bengal (NVNP, Darjeeling, Siliguri)], Burma, Sri Lanka.

7. *Neomyia pecifica* Zimin (Fig. 2)

1951. *Orthellia pacifica* Zimin, Fauna USSR, 18(4): 85

1967. *Orthellia pacifica* Zimin, Kano and Shinonaga. Japanese Journal of Sanitary Zoology. 18(4): 199.

Material examined: 1♀, 1♂ Botay Kharga, 20.X.2019. 1 Alubari, 3.X.2018.

Bionomics: Found on cow dung, horse dung, flowers, bushes. Eggs are deposited on horse or cow dung. In NVNP, this fly was collected from flowers and bushes. It looks like *Neomyia fletcheri* in appearance, but genitalia study reveals the real species, and its first report from India (Fig. 2).

Distribution: New record from India (West Bengal: NVNP), China, Japan, Korea.

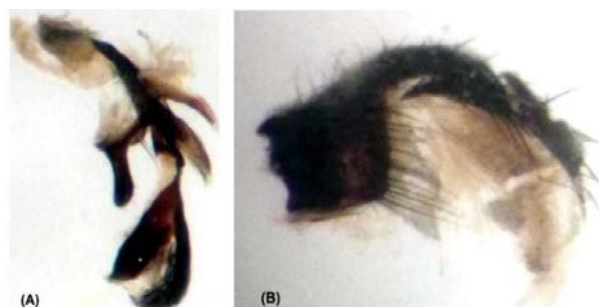


Fig. 2. A, B- Genitalia of *Neomyia pecifica* Zimin.

C. *Morellia Robineau-Desvoidy*

1830. *Morellia* Robineau-Desvoidy, Essai sur les Myodaires, 405. Genotype: *hortorum* FIn.

Key to species

1. Lower calyptrae dark brown. Mid tibia with 3-4 p setae.....*Morellia nigrisquama*
Lower calyptrae whitish. Mid tibia with 5-7 p setae.....*Morellia pectinipes*

8. *Morellia nigrisquama* Malloch

1928. *Morellia nigrisquama* Malloch, Entomologische Mitteilungen, XVII, 329. Type: Sumatra, Gunung Singgalang. B.M.

1965. *Morellia nigrisquama*: Emden, Fauna India, Muscidae, 7(1): 108

Material examined: 1♂, 4♀ Botay Kharga, 20.X.2019. 1♂ Gogune, 2.X.2018. 2♂, Ambik Basti, 15.III.2020.

Bionomics: Laid eggs on dung of herbivorous animal. Basically found on cattle, near cattle manure, animal dung. In NVNP, this fly was collected from bushes, dead leaf and cattle manure.

Distribution: India [West Bengal (NVNP), Assam, Uttarakhand], Burma, Malaya, Sumatra.

9. *Morellia pectinipes* Emden

1965. *Morellia pectinipes*: Emden, Fauna India, Muscidae, 7(1): 112.

Material examined: 1♂, Dolay, 8.III.2018. 1♂ Ashalay, 6.III.2018.

Bionomics: Found on cow dung, cattle, cattle manure. In NVNP, collected from bushes and dead leaves.

Distribution: India [West Bengal (NVNP), Bihar, Uttar Pradesh, Uttarakhand], Sri Lanka.

D. *Rypellia Malloch*

1931. *Rypellia* Malloch, Annals Magazine of Natural History, (10)7: 190

1965. *Dasyphora* (Sbg. *Rypellia*): Emden, Fauna India, Muscidae, 7(1): 145

1994. *Rypellia* Shinonaga and Singh, Japanese Journal of Sanitary Zoology, 45: 119.

Key to species

1. Eyes covered with long dense hair. Prst dorsocentral bristle 3.....*Rypellia malaise*
Eyes with microscopic hairs. Prst dorsocentral bristle 2.....*Rypellia flavipes*

10. *Rypellia flavipes* Malloch

1931. *Rypellia flavipes* Malloch. Annals Magazine of Natural History (10)7: 190

1965. *Dasyphora* (*Rypellia*) *flavipes*: Emden, Fauna India, Muscidae, 7(1): 146.

1994. *Rypellia flavipes*, Shinonaga and Singh, Japanese Journal of Sanitary Zoology, 45: 119.

Material examined: 2♀, Botay Kharga, 20.X.2019.

Bionomics: Unknown in India. In NVNP, flies were collected from dead leaves, bushes.

Distribution: India [West Bengal (NVNP), Assam], Burma, Indonesia, Nepal, Sumatra.

11. *Rypellia malaise* Emden

1965. *Dasyphora* (*Rypellia*) *malaise*: Emden, Fauna India, Muscidae, 7(1): 145.

1994. *Rypellia malaise* Shinonaga and Singh, Japanese Journal of Sanitary Zoology, 45: 119.

Material examined: 1♀, Thusum Khola, 23.X.2019. Gogune, 1♂ Alubari, 6.X.2018, 2♂, 1♀ Choudaferi, 7.X.2018.

Bionomics: Unknown. In NVNP, flies were collected from bushes.

Distribution: India [West Bengal (NVNP), Assam], Burma, Nepal.

II. Stomoxyinae

E. *Stomoxys* Geoffroy

1762. *Stomoxys* Geoffroy, Histoire abrégée des Insectes qui se trouvent aux environs de Paris, II, 538.

Key to species

1. Eyes separated in male by less than one-sixth (0·15-0·16) head-width (Holoptic)

.....*Stomoxys dubitalis*

Eyes in male separated by a quarter head-width or somewhat more of head-width (Dichoptic)

..... *Stomoxys calcitrans*

12. *Stomoxys calcitrans* Linnaeus

1758. *Conops calcitans* Linnaeus, Systema Nature Edition, 10, 1: 604.

1965. *Stomoxys calcitrans*: Emden, Fauna India, Muscidae, 7(1): 160.

Material examined: 4♂, 2♀, Thusum Khola, 23.X.2019. 2♂, 1♀ Choudaferi, 4.X.2018. 6♂, 2♀ Ambik Basti, 15.III.2020.

Bionomics: This fly is a haematophagus in nature. Found on cow, cattle shed. Laid eggs on the dung of a herbivorous animal. Very distinct and found in batches near cattle shed. In NVNP, these flies were collected from sores and wounds of cow.

Distribution: India [West Bengal (NVNP), Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Goa, Kerala, Orissa, Sikkim, Tamil Nadu and Uttar Pradesh].

13. *Stomoxys dubitalis* Malloch

1932. *Stomoxys dubitalis* Malloch, Annals Magazine of Natural History (10), IX, 426

1965. *Stomoxys dubitalis*: Emden, Fauna India, Muscidae, 7(1): 165.

Material examined: 2♀, 1♂ Ambik Basti, 15.III.2020.

Bionomics: Flies of this species are haematophagus in nature. These flies are basically found on cattle. In NVNP, collected from cattle shed.

Distribution: India [Madras, Orissa, Uttar Pradesh, West Bengal (NVNP)], Burma, China, Malaya, Philippine.

III. Phaoniinae

Key to tribes

1. Metathoracic spiracle with some black setulose hairs. (Inserted along lower margin) in addition to the feather like operculum..... *Dichaetomyiini*
Metathoracic spiracle without black setulose hairs2
2. Hind tibia with one weak pd bristle on distal 2/3. Yellow bodied small fly.....*Atherigonini*
Hind tibia with one strong pd bristle.....3
3. Hind tibia with strong pd setae between the middle of the leg and d pre apical.....*Phaonini*

- Hind tibia without strong pd setae between the middle of the leg and d pre apical.....4
4. Well-developed Ad preapical. Femur with pre apicalMydaeini
- Without an Ad preapical. Mid femur without preapical.....Limnophorini

Atherigonini

F. *Atherigona* Rondani

1865. *Atherigona* Rondani, Dipterologiae Italicae prodromus, 1:97.

14. *Atherigona orientalis* Schiner

1868. *Atherigona orientalis* Schiner. Reise Ost. Fregatte Novara, Dipt. 295.

Material examined: 3♂ Ashalay, 6.III.2018.

Bionomics: These flies are generally found on crops (Sorghum, wheat). Larva causes a huge loss in crop production causing dead heart. In NVNP, these flies were collected from bushes.

Distribution: India [West Bengal (NVNP), Arunachal Pradesh, Andhra Pradesh, Bihar, Chhattisgarh, Kerala, Madhya Pradesh, Maharashtra, Nicobar Island, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh], widely distributed in oriental region.

Dichaetomyiini

G. *Dichaetomyia* Malloch

1921. *Dichaetomyia* Malloch, Annals Magazine of Natural History. (9)7: 163

1927. *Lophomala* Enderlein., Konowia, VI, 54. Genotype: *Mydaea flavipalpis* Stein.

1952. Hennig, Beiträge zur Entomologie, II, 82. Genotype: *Dichaetomyia polita* Mall., 1921

Key to species

1. Scutellum setulose at lower edge.....2
Scutellum bare at the lower edge. Longest hair of arista is not or slightly longer than the width of the 3rd antennal segm.....
.....*Dichaetomyia indica* Walker)
2. Arista long-plumose, longest rays almost half as long as width of the third antennal segment
.....*Dichaetomyia bibax*.
Arista long-plumose, longest rays fully twice as long as the width of third antennal segment
.....*Dichaetomyia nubiana*.

15. *Dichaetomyia indica* Walker

1856. *Anthomyia indica* Walker Diptera Saunders, 325♀. Type: E. Indies. B.M.

1901. *Spilogaster indica* (Walker), Stein, Zeit. Hymen. Dipt., I, 198.

1965. *Dichaetomyia indica* Emden, Fauna India, Muscidae, 7(1): 369.

Material examined: 1♂, 1♀, Joributi, 8.III.2018.

Bionomics: In NVNP, these flies were collected from bushes, stones and from the mountain path.

Distribution: India [West Bengal (NVNP), Assam], Sumatra, Java, North Burma.

16. *Dichaetomyia nubiana* Bigot

1885. *Spilogaster nubianus* Bigot, Annales de la Société Entomologique de France (6), IV, 288.

1885. *Spilogaster pruinosus*, Bigot, Annales de la Société Entomologique de France, 287.

1904. *Spilogaster lineata* Stein, Tijdschrift voor Entomologie, XLVII, 102.

1965. *Dichaetomyia nubiana*. Emden, Fauna India, Muscidae, 7(1): 357.

Material examined: 1♀, 2♂ Alubari, 3X.2018.

Bionomics: In NVNP, the flies were collected from bushes, stone and along mountain path.

Distribution: India [West Bengal (NVNP), Bombay, Uttar Pradesh, Vizag], Burma, Java, Nepal, Sri Lanka, Sumatra, Entire Ethiopian Region.

17. *Dichaetomyia bibax* Wiedemann

1830. *Anthomyia bibax* Wiedemann, Aussereuropäische Zweiflügelie Insekten, II, 431

1915. *Mydaea laeviventris* Stein, Supplementa entomologica, IV, 16; 1915.

1927. *Lophomala laeviventria* (Stein), End., Konowia, VI, 55.

1928. *Dichaetomyia laeviventris* (Stein), Malloch, Entomologische Mitteilungen, XVII, 319.

1965. *Dichaetomyia nubiana* Emden, Fauna India, Muscidae, 7(1): 365.

Material examined: 2♂, 3♀, Tham Kharga, 15.III.2020.

Bionomics: Found on bushes, plant leaves, dead leaves. In NVNP, the flies were collected from bushes along mountain path.

Distribution: India [West Bengal (NVNP), Assam, Shimla], China, Japan, Java, Malaya, North Burma, Sumatra, Taiwan.

Limnophorini

H. *Limnophora* Robineau-Desvoidy

1830. *Limnophora* R. -D., Myodaires, 517. Genotype, *L. palustris* R-D.

Subgenus *Limnophora*

Key to species

1. Arista plumose, slightly wider, including plumosity than the 3rd antennal segment. Rays evenly decrease in length from 2nd to 5th onwards. The longest rays about three fifth as long as the width of third antennal segment.....*Limnophora latiseta*
Arista is very short-haired, including hair about one quarter the width of the 3rd antennal segment. The longest hairs are about as long as the basal diameter.....*Limnophora brunnescens*

18. *Limnophora latiseta* Emden

1965. *Limnophora latiseta*. Emden, Fauna India, Muscidae, 7(1): 568.

Material examined: 2♂, 1♀ Alubari, 6.X.2018, 1♂ Choudapheri, 7.X.2018.

Bionomics: Unknown.

Distribution: India [West Bengal (NVNP), Assam, Manipur, Mysore], Burma.

19. *Limnophora brunnescens* Emden

1965. *Limnophora brunnescens*. Emden, Fauna India, Muscidae, 7(1): 580.

Material examined: 2♂ Gogune, 2.X.2018. 1♂, Ambik Basti, 15.III.2020.

Bionomics: Unknown. In NVNP, the species was collected from soil and stone along mountain path.

Distribution: India [West Bengal (NVNP), Assam, Silong], Burma.

Subgenus *Heliographa* Malloch

Key to species

1. 1+1 stpl. Underside scutellum bare.....
.....*Limnophora (Heliographa) ceylanica*
1+2 stpl. Underside scutellum with some black documented hairs on lateral part.....
.....*Limnophora (Heliographa) tonsa*

20. *Limnophora (Heliographa) tonsa* Stein

1851. *Hydrotaea javana* Macquart., Dipt. exot., suppl. 4, 262

1909. *Limnophoratonsa* Stein, Tijdschrift voor Entomologie, LII, 244, 245.

1921. *Heliographatonsa* (Stein), Malloch, Annals Magazine of Natural History (9), VII, 169.

1965. *Limnophora (Heliographa) tonsa*. Emden, Fauna India, Muscidae, 7(1): 609.

Material examined: 3♂, 2♀, Botey Kharga. 20.X.2018.

Bionomics: Unknown. In NVNP, these species were collected from stream side soil and stones.

Distribution: India [Northern part of West Bengal, Darjeeling], Buru, Formosa, Java, Malaya, Siam, Sumatra.

21. *Limnophora (Heliographa) ceylanica* Emden

1965. *Limnophora (Heliographa) ceylanica*. Emden, Fauna India, Muscidae, 7(1): 607.

Material examined: 8♂, Panch Pokhri, 17.III.2020. 3♂ Tham Kharga Zero point, 16.III.2020.

Bionomics: Found exclusively on stream side soil, stone, moshes. In NVNP, it was seen on stone covered with moshes, beside a stream. They are very slow mover. Seen in batches.

Distribution: First time report from India [West Bengal (NVNP)], Sri Lanka.

I. *Graphomyia* Robineau-Desvoidy

1830. *Graphomyia* Robineau-Desvoidy, Mémoires presents a L'Institut des Sciences, Lettres et Arts, par divers savants et lus dans ses assemblées: Sciences, Mathématiques et Physiques 2: 403. Type-species: *Musca maculate* Scopoli.

22. *Graphomyia maculata* Scopoli

1763. *Musca maculate* Scopoli, Entomologia Carniolica : 326.

1935. *Graphomyia maculata* (Scop.), Karl, Arbeiten Uber Morphologische Taxonomische Entomologie II, 37.

1965. *Graphomyia maculata*. Emden, Fauna India, Muscidae, 7(1): 552.

Material examined: 1♂, Tham Kharga Zero Point, 16.III.2020.

Bionomics: In NVNP, the species was found on stones near stream water. A single fly was collected from the stone surface. Very slow mover.

Distribution: India [Kashmir, Missouri, Uttar Pradesh, West Bengal(NVNP)], Burma, Philippine, Sri Lanka. Palearctic, Nearctic and Neotropic region.

23. *Graphomyia stipata rufitibia* Stein

1918. *Graphomyia rufitibia* Stein, Annales Hiistorico-Naturales Musei Nationalis Hungarici. XVI, 147;

1926. *Graphomyia vittata* Stein of Malloch (nec Stein), Treubia, VIII, 340;

1965. *Graphomyia stipatarufitibia*. Emden, Fauna India, Muscidae, 7(1):550.

Material examined: 1♂, Tham Kharga Zero Point, 16.III.2020.

Bionomics: Unknown.

Distribution: India [West Bengal (NVNP), Maharashtra], Burma, China, Colombia, Java, Mexico, Sumatra.

Tribe Mydaeini

J. *Helina* Robineau-Desvoidy

Key to species

1. Post DC 3. Hind tibia black in colour.....
.....*Helina appendiculata*
Post DC 4. Hind tibia orange in colour.....
.....*Helina iwasai*

24. *Helina appendiculata* Stein

1910. *Mydaea appendiculata* Stein, Annales Hiistorico-Naturales Musei Nationalis Hungarici., VIII, 547.

1918. *Mydaea duplex* (Stein), Stein, Annales Hiistorico-Naturales Musei Nationalis Hungarici. XVI, 180

1928. *Helina duplex* (Stein), Malloch., *Ent. Mitt.*, XVII, 316.

1965. *Helina appendiculata*. Emden, Fauna India, Muscidae, 7(1):534.

Material examined: 1♂, Botey Kharga, 20.X.2019. 1♂ Gogune, 2.X.2018.

Bionomics: In NVNP, the species was collected from bushes, and stones along the mountain path.

Distribution: India [Assam, West Bengal(NVNP)], Java, Sumatra.

25. *Helina iwasai* Shinonaga

1994. *Helina iwasai*. Shinonaga and Singh, Muscidae of Nepal (1):175.

Material examined: 1♂, Botey Kharga, 20.X.2019. 2♂ Gogune, 2.XI.2018. 1♂, Ambioik Basti, 15.III.2020. 1♀, Tham Kharga Zero Point, 16.III.2020.

Bionomics: In NVNP, the species was collected from bushes, and stones along the mountain path.

Distribution: India [West Bengal(NVNP)], New species from Nepal in 1994.

K. *Myospila* Rondani

1856. *Myospila* Rondani, Dipterologiae Italicae prodromus, 1:91

Key to species

1. A pair of faint shifting elongate fuscous black paramedian spots on the 2nd and 3rd abdominal segment.....*Myospila tenax*
A pair of small brown spot near hind margin of the 2nd and 3rd abdominal segment.....
.....*Myospila bina*

26. *Myospila bina* Wiedemann

1830. *Anthomyia bina* Wied., Aussereurzweifel. Ins., II.426.

1909. *Mydaea unguolata* Stein, Tijdschrift voor Entomologie LII, 233

1921. *Xenosia unguolata* (Stein), Malloch, Annals Magazine of Natural History (9) VII, 422;

1965. *Xenosia bina* (Wiedemann). Emden, Fauna India, Muscidae, 7(1):432.

Material examined: 1♂ Gogune, 2.XI.2018. 1♂, Tham Kharga Zero Point, 16.III.2020.

Bionomics: Unknown. Collected along the mountain path.

Distribution: India [West Bengal (NVNP), Bihar, Sikkim, Shimla], Burma, China, Java, Malaya, Philippine, Sri Lanka, Sumatra.

27. *Myospila tenax* Stein

1918. *Mydaea tenax* Stein, Annales Hiistorico-Naturales Musei Nationalis Hungarici., XVI, 172, 181; Hennig, 1952. Beiträge zur Entomologie, II.86. Type: Hong Kong.

1965. *Xenosia tenax* (Stein.) Emden, Fauna India, Muscidae, 7(1):442

Material examined: 2♂ Ashalay, 2.XI.2018. 1♂, Ambik Basti, 15.III.2020.

Bionomics: Unknown. Collected from bushes along mountain path.

Distribution: India [Assam, West Bengal (NVNP)], Burma, China.

Tribe Phaoniini

L. *Phaonia* Robineau-Desvoidy

28. *Phaonia kambaitiana*

1965. *Phaonia kambaitiana*. Emden, Fauna India, Muscidae, 7(1): 236.

1994. *Phaonia kambaitiana*, Shinonaga and Singh, Muscidae of Nepal (1):159.

Material examined:

Bionomics: Unknown. The species was seen on bushes along jungle path.

Distribution: India [West Bengal (NVNP), Dehradun, Himachal Pradesh, Sikkim], Burma, Nepal.

M. *Brontaea* Kowarz

Key to species

1. Mid tibia with two p setae. Eyes with long hairs
.....*Brontaea lasiopa*
Mid tibia with one p setae. Eyes without long hairs2
2. R1 reaching the R-M. Vibrissa at mouth-margin
.....*Brontaea distincta*
R1 exceeding the R-M. Vibrissa at above mouth-margin*Brontaea ascendens*

29. *Brontaea ascendens* Stein

1915. *Limnophora ascendens* Stein, Supplementa entomologica, IV, 32

1928. *Gymnodia ascendens* (Stein), Malloch, Entomologische Mitteilungen, XVII, 296.

1965. *Gymnodia ascendens*. Emden, Fauna India, Muscidae, 7(1):626

1994. *Brontaea ascendens*. Shinonaga and Singh, Muscidae of Nepal, (1):157.

Material examined: 2♂ Choudaferi, 2.X.2018. 1♂, Ambik Basti, 15.III.2020.

Bionomics: Unknown. The species was seen on bushes and stones along the jungle path.

Distribution: India [West Bengal (NVNP)], Burma, Ceylon, China, Philippines, Japan, Taiwan, Nepal.

30. *Brontaea distincta* Stein

1909. *Limnophora distincta* Stein, Tijdschrift voor Entomologie 52, 251.

1947. *Gymnodia distincta* (Stein), Muirhead Thomson, Proceedings of the Royal Entomological Society London (A), XXII, 98.

1965. *Gymnodia distincta*. Emden, Fauna India, Muscidae, 7(1):630.

1994. *Brontaea distincta*. Shinonaga and Singh, Muscidae of Nepal (1):158.

Material examined: 2♂, Botay Kharga, 20.X.2019. 1♂ Alubari, 2.XI.2018.

Bionomics: Unknown.

Distribution: India [West Bengal (NVNP), Assam, Bihar, Punjab], Burma, Ceylon, China, Nepal.

31. *Brontaea lasiopa* Emden

1965. *Gymnodia lasiopa* Emden, Fauna India, Muscidae, 7(1):636.

1994. *Brontaea lasiopa*, Shinonaga and Singh, Muscidae of Nepal, (1):158.

Material examined: 2♂ Doley, 3.X.2018. 1♀, Tham Kharga Zero Point, 16.III.2020.

Bionomics: Unknown. The species was seen on bushes, soil and stones along the mountain path.

Distribution: India [West Bengal (NVNP), Shimla], Burma, Nepal.

Habitat figures of some species are given in Figs. 3-15. The diversified environment of the forests of NVNP in association with altitudinal variation harbors lots of flies of family Muscidae. The present work has reported 31 species of Muscidae belonging to 13 genera of three subfamilies. There may be a significant contribution to the muscid fly family diversity in this national park in which most parts were untouched till the survey (Fig. 3). It was found that muscid flies play a significant role in pollination in this National Park in scarcity or complete absence of honey bees (a scientific observation has been communicated to a journal for publication). From the diversity of muscid flies, it can easily be concluded that the National Park preserves good ecological balance and provides every habitat that is ideal for the survival of insect species. The new records of two species viz., *Limnophora (Heliographa) ceylanica* (Emden, 1965) and *Neomyia pacifica* (Zimin, 1951) from India is a significant outcome of this study.

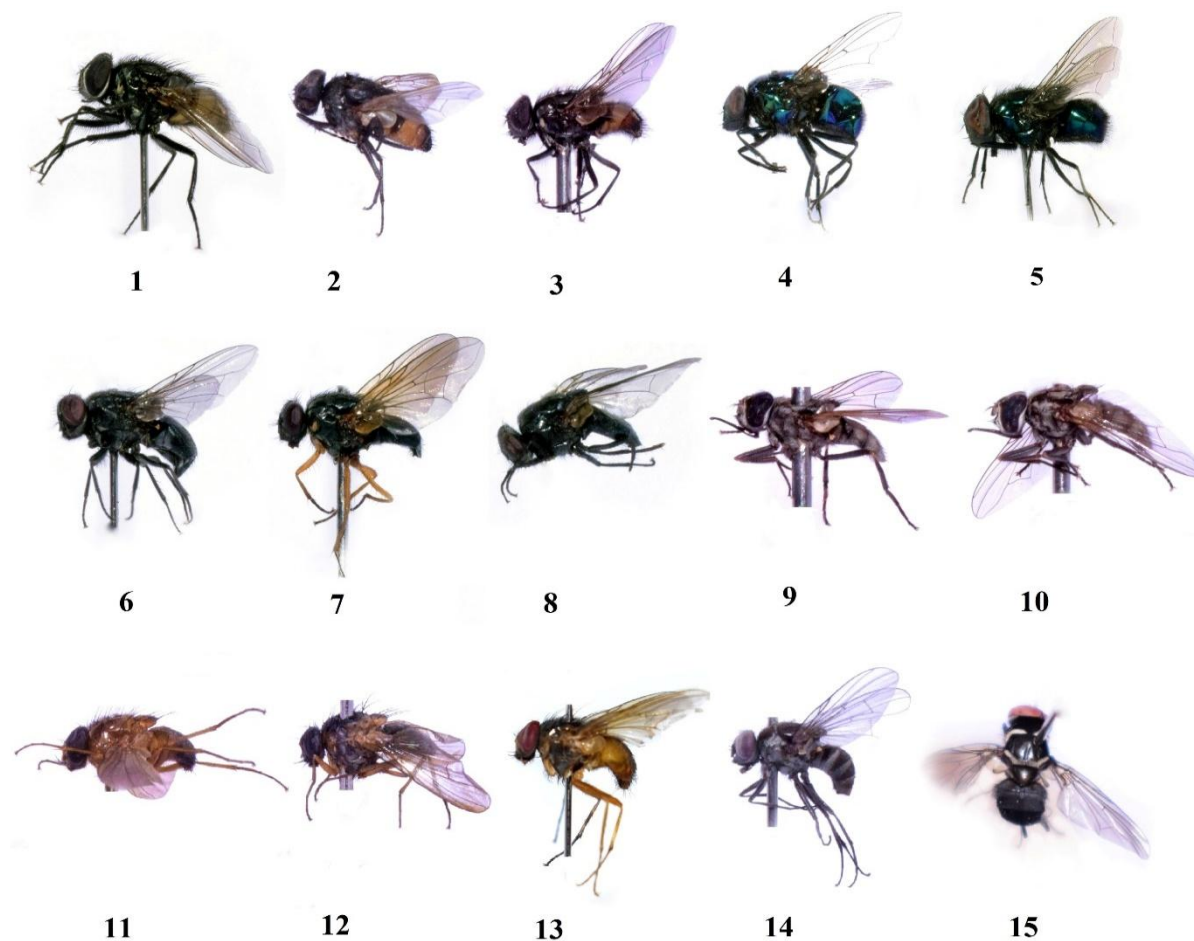


Fig. 3-15. Habitus figures of: (1) *Musca (Viviparomusca) bezzi* Patton and Crag, (2) *Musca (Byomyia) conducens* Walker, (3) *Musca (Eumusca) hervei* Villeneuve, (4) *Neomyia chalybeifaceta* (Enderlein), (5) *Neomyia pecifica* (Zimin), (6) *Morellia nigrisquama* Stein, (7) *Rypellia flavipes* Malloch, (8) *Rypellia* Malaise Emden 1965, (9) *Stomoxys calcitrans* (Linnaeus), (10) *Stomoxys dubitalis* Malloch, (11) *Dichaetomyia indica* (Walker), (12) *Dichaetomyia bibax*, (13) *Dichaetomyia nubiana* (Bigot), (14) *Limnophora (Heliographa) tonsa* Stein, (15) *Limnophora (Heliographa) ceylanica* (Emden, 1965).

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