



Community composition of black fly (Simuliidae: Diptera) in India

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Abstract

Black flies fauna in South-East Asia has been studied extensively, however their taxonomic status and ecology of Indian black flies are still remaining unexplored. The present study was focused to cover the current status of black fly taxonomy in India. The species data is gathered from the world black fly inventory 2022. The information on morphological characters of respective species with distribution was studied from the original publications and subsequent reviews. A total of 88 black fly species are recorded under six subgenera (*Eusimulium*, *Gomphostilbia*, *Montisimulium*, *Nevermannia*, *Simulium* and *Wilhelmia*) in the genus *Simulium*. North-east region had 61% of species and their majority is found in West Bengal. Of these, seven biting species have recorded. Conclusion: The details of diversity, scope, ecology, taxonomy and medical importance of black flies would helpful for studying black fly in India.

Keywords: taxonomy, *Simulium*, black fly, onchocerciasis, India

Introduction

The monitoring of human and animal health is challenging amidst climate change, global warming, reemergence of virus infections (severe acute respiratory syndrome-related coronavirus-2) and diseases through vectors. With this situation, baseline bio-medical research is mandatory to understand the current status and therapeutics of any kind of human and animal diseases. After invention of deoxyribonucleic acid structure by Watson and Crick, most of the researchers eager to work in gene-oriented study and received less attention on basic biology. Although several molecular and advanced studies have been conducted against infectious diseases, the fundamental research on medical field is inadequate and most of the basic research done before three decades in India.

According to World Health Organization ^[1], 19 important communicable diseases included in neglected tropical diseases group, which are prevail in tropical and subtropical conditions in 149 countries and affect more than one million people. In the last decade, the large outbreak of chikungunya infections transmit through mosquitoes affected many people in India ^[2] and it renewed interest on chikungunya virus. Vector-borne diseases are sensitive in different ways to weather and climate conditions, so that the ongoing tendencies of rising temperature and more variable weather threaten to challenge recent global progress against these diseases ^[3]. Hence, the focusing of vector-borne diseases is one of the imperative measure to uphold human health.

The disease, human onchocerciasis (known as river blindness) is one of the significant vector-borne parasitic disease next to malaria. The disease of onchocerciasis causes by nematode *Onchocerca volvulus*, which is transmitted by black flies of the genus *Simulium*. This disease is most common in Africa and the infection results in visual impairment and blindness, in addition cause skin disease (intense itching, rashes or nodules under the skin) ^[4]. The most species of adult female black flies require a blood meal to mature their eggs, but only 10 to 20% of species are pests of humans and domesticated animals ^[5]. The black fly larvae are restricted running freshwater environment where the filter-feeding larvae play a key ecological role ^[6].

In total, 2,401 black fly species (2,384 living species and 17 fossil species) have been recorded under 26 genera of the family Simuliidae ^[7]. Of these, 90% of the species described under the genus *Simulium*. In India, 88 species (74 named and 14 unnamed) undersix subgenera in the genus *Simulium* are recorded. About 80% of black fly species have been recorded three decades ago in India. Recently, some taxonomy and ecological work on black fly have been conducted by Anbalagan *et al.* ^[8-13]. Fortunately, few black fly species are biting behavior and are found in north-eastern India ^[14]. Due to climate change and anthropogenic impact, the fundamental of

vector species is important to understand the disease control and surveillance. Therefore, the present study focused to cover the current status and scope of black fly taxonomy in India.

Materials and methods

The species data is gathered from the world black fly inventory 2022 [7]. The taxonomic status on black fly in India is collected from Datta [15], Mitra *et al.* [16] and Anbalagan *et al.* [10]. The information on morphological characters of respective species with distribution were studied from the original publications and subsequent reviews. The larvae of black fly can be collected from substrates (leaf litter, woody debris, boulders, pebbles, etc.) in flowing water with the help of fine brushes (Fig. 1). The adult black flies for identification or taxonomic purpose will be collected through pupal rearing that mature pupae will be removed from the respective substrates in streams and placed in a plastic container containing wet cotton. This container will be kept for 3 days at room temperature until adult emergence. All larvae, pupae and adults will be preserved in 70% ethanol [6]. The morphological characters and taxonomic description of specimen can be followed by Adler [17].



Fig 1: Larval black fly association with leaf litter

Results

Diversity and distribution

A total of 88 black fly species (74 named and 14 unnamed) are recorded under six subgenera in the genus *Simulium* in India (Table 1). Of 74 named species, the subgenus *Eusimulium* has one species, 20 species in

Gomphostilbia, 4 species in *Montisimulium*, 8 species in *Nevermannia*, 40 species in *Simulium* and one species in *Wilhelmia*. In 14 unnamed species, one species in *Eusimulium* and *Montisimulium*, two species in *Gomphostilbia* and *Nevermannia* and seven species in *Simulium*.

In India, north-east part has 61% of species and 36% of southern region. In north-east region, the majority of species are found in West Bengal. In south India, Tamil Nadu and Karnataka have high number of species. Globally, 4% of species are found in India. In the five states covering Western Ghats, Kerala and Maharashtra should more concern to explore the species distribution, where the taxonomy of black fly species is little known.

Table 1: The biodiversity of black flies in India

No.	Species	No.	Species	No.	Species
	<i>Eusimulium</i>		<i>Simulium</i>	70	<i>Simulium (S.) striatum</i>
1	<i>Simulium (E.) aureum</i>	34	<i>Simulium (S.) adventicium</i>	71	<i>Simulium (S.) tenuitarsus</i>
	<i>Gomphostilbia</i>	35	<i>Simulium (S.) alajense</i>	72	<i>Simulium (S.) valparaiense</i>
2	<i>Simulium (G.) agasthyamalaiense</i>	36	<i>Simulium (S.) asishi</i>	73	<i>Simulium (S.) yanaense</i>
3	<i>Simulium (G.) bucolicum</i>	37	<i>Simulium (S.) barnesi</i>		<i>Wilhelmia</i>
4	<i>Simulium (G.) cauveryense</i>	38	<i>Simulium (S.) barraudi</i>	74	<i>Simulium (W.) pseudequinum</i>
5	<i>Simulium (G.) darjeelingense</i>	39	<i>Simulium (S.) biforamiferum</i>		
6	<i>Simulium (G.) decuplum</i>	40	<i>Simulium (S.) christophersi</i>		
7	<i>Simulium (G.) dinakarani</i>	41	<i>Simulium (S.) consimile</i>		Unnamed species
8	<i>Simulium (G.) fidum</i>	42	<i>Simulium (S.) dentatum</i>		<i>Eusimulium</i>
9	<i>Simulium (G.) kottooreense</i>	43	<i>Simulium (S.) digitatum</i>	75	<i>Simulium (E.)</i> sp. "A"
10	<i>Simulium (G.) krishnani</i>	44	<i>Simulium (S.) ephemerophilum</i>		<i>Gomphostilbia</i>
11	<i>Simulium (G.) kumbakkaraiense</i>	45	<i>Simulium (S.) gravelyi</i>	76	<i>Simulium (G.)</i> Lakhimpur
12	<i>Simulium (G.) litoreum</i>	46	<i>Simulium (S.) griseifrons</i>	77	<i>Simulium (G.)</i> 'Ranga'
13	<i>Simulium (G.) metatarsale</i>	47	<i>Simulium (S.) grisescens</i>	78	<i>Montisimulium</i>
14	<i>Simulium (G.) panagudiense</i>	48	<i>Simulium (S.) gurneyae</i>	79	<i>Simulium (M.)</i> "C"
15	<i>Simulium (G.) parahiyangum</i>	49	<i>Simulium (S.) himalayense</i>		<i>Nevermannia</i>
16	<i>Simulium (G.) pattoni</i>	50	<i>Simulium (S.) hirtipannus</i>	80	<i>Simulium (N.)</i> 'sp. 2'
17	<i>Simulium (G.) peteri</i>	51	<i>Simulium (S.) howletti</i>	81	<i>Simulium (N.)</i> 'D'
18	<i>Simulium (G.) sachini</i>	52	<i>Simulium (S.) indicum</i>		<i>Simulium</i>
19	<i>Simulium (G.) takaokai</i>	53	<i>Simulium (S.) kapuri</i>	82	<i>Simulium (S.)</i> 'Assam'
20	<i>Simulium (G.) tenuistylum</i>	54	<i>Simulium (S.) lineothorax</i>	83	<i>Simulium (S.)</i> 'Diju'
21	<i>Simulium (G.) williei</i>	55	<i>Simulium (S.) nigrifacies</i>	84	<i>Simulium (S.)</i> 'Doigroon'
	<i>Montisimulium</i>	56	<i>Simulium (S.) nilgircum</i>	85	<i>Simulium (S.)</i> 'Kamti'
22	<i>Simulium (M.) dasguptai</i>	57	<i>Simulium (S.) nitidithorax</i>	86	<i>Simulium (S.)</i> 'Pabho'
23	<i>Simulium (M.) dattai</i>	58	<i>Simulium (S.) nodosum</i>	87	<i>Simulium (S.)</i> 'Rengma'
24	<i>Simulium (M.) ghoomense</i>	59	<i>Simulium (S.) novolineatum</i>	88	<i>Simulium (S.)</i> 'Subansiri'
25	<i>Simulium (M.) nemorivagum</i>	60	<i>Simulium (S.) pallidum</i>		
	<i>Nevermannia</i>	61	<i>Simulium (S.) palmatum</i>		
26	<i>Simulium (N.) aureohirtum</i>	62	<i>Simulium (S.) palniense</i>		
27	<i>Simulium (N.) gracile</i>	63	<i>Simulium (S.) pothigaiense</i>		
28	<i>Simulium (N.) karavalliense</i>	64	<i>Simulium (S.) pradyai</i>		
29	<i>Simulium (N.) praelargum</i>	65	<i>Simulium (S.) ramosum</i>		
30	<i>Simulium (N.) purii</i>	66	<i>Simulium (S.) rashidi</i>		
31	<i>Simulium (N.) rufithorax</i>	67	<i>Simulium (S.) rufibasis</i>		
32	<i>Simulium (N.) senile</i>	68	<i>Simulium (S.) singtamense</i>		
33	<i>Simulium (N.) subratai</i>	69	<i>Simulium (S.) stevensoni</i>		

Biting species

In total 88 black flies are recorded in India. Of these, 91% of species are non-biting, which feed nectars and 9% of species are biting to man and animals. The biting species are known from north-east India (Dhiman *et al.* 2014). In these region, seven species are recorded: *S. (N.) aureum*, *S. (G.) tenuistylum*, *S. (S.) christophersi*, *S. (S.) himalayense*, *S. (S.) novolineatum*, *S. (S.) rufibasis* and *S. (S.) striatum*. In South India, there is no biting black flies are recorded and all known species are nectar feeders.

Scope of black fly in India

Although the black flies immature play vital role in aquatic environment, adult flies nuisance to human and cause health illness and create great economic loss. The emerged adults can fly distance from 15 km to 500 km for the purpose of feeding and breeding. For these credits, research on Indian fauna of black flies envisages various conduit of black fly study, for example, basic research (taxonomy and phylogeny), ecological, medical, microbiological, physiological and biochemical aspects, molecular and biomedical features.

Taxonomy

In the fauna of India, many works can be done in black fly. Of these, some important studies are highlighted in this paper that revision of the subgenus *Eusimulium* species recorded in north India and the vector species of *Simulium indicum* is mandatory, more than 50% of larval taxonomy of Indian species is unknown; species detail in Andaman and Nicobar Islands and Lakshadweep islands is not known, fauna in Kerala state is uncompleted, unnamed species recorded in West Bengal is necessary to understand black fly distribution and phylogeny based on morphological characters are vital to know the distributional status and comparison between vector and non-vector species.

Ecology

Some important ecological studies carried out on black fly in particular south India: black fly production dynamics^[18], diversity and distribution^[19,20], dispersal behavior and substrate selection^[21], effect of tourism^[22], distributional pattern of black fly larvae^[23] and spatio-temporal pattern^[6]. Effect of temperature, water flow, and substrate influence on immature stages of larvae and pupae, distribution and habitat preference of vector species, diversity and distribution of midgut microbes and phoretic association are quiet not understood.

Molecular studies

An integrated research approach using a combination of morphological traits and molecular markers is essential for understanding and identification of simuliid fauna. In India, few molecular studies have been carried out: genetic diversity of *S. gravelyi* using RAPD markers^[24], molecular phylogeny and vector potential of black flies^[25], DNA barcoding of south Indian black flies^[9], phylogeny based on COI gene^[10]. DNA barcoding of Indian black fly fauna would be helpful to identify the species if morphologically misidentified species. The midgut microbial flora based on ITS1 and 2, and 16S rRNA is necessary for studying vector ecology and blood feeding pattern.

Medical importance

The vector species from total number of recorded black flies in India is not known and not be carried out any parasitic diseases. Though some biting species found in north India, the record and current status of parasitic diseases caused by black fly are not known. As many species of black flies are vectors in South Africa and south-east countries, the understanding and mechanism of transmission of parasite is necessary. In south India, all recorded species feed nectar and not biting species. Due to weather condition and environment, Indian black flies does not carry any parasite. It should be checked by social monitoring, tribal health assessment and RT-PCR techniques.

Discussion

To monitor and manage the public and animal health, the correct identification of vector group is of a fundamental importance in order to deliver precise information on species distribution, biology and behavior, to facilitate targeted control measures could be correctly implemented. Therefore, standard method in both morphology and molecular level identification of species would be helpful for identification of species. Simuliids are tiny insects, which develop their young stage in aquatic environment and adults are terrestrial habitat. Of total black fly population in the world, some species are blood feeders, requiring for their egg maturation like mosquitoes. These species are responsible for parasite transmission and cause diseases. Taxonomy of black fly species is so difficult in adult and developmental stages.

In India, black fly is distributed in all regions from south to north, and they found in variety of substrates in lotic environment. The higher abundance of black fly is found where the low to high anthropogenic impacted stream. Due to climate change, deforestation, anthropogenic impact and urbanization, there is a chance for changing nectar feeding to blood feeding behavior or increasing abundance and diversity or capable for carrying parasite of black flies. However, the complete understanding and knowledge on species identification is vital and would useful controlling vector species in future.

Conflict of Interest

Author declare that there is no conflict of interest

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