

Analysis of the biting behavior and disease patterns in haematophagous dipterans of the tropical rain forests

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<https://doi.org/10.5281/zenodo.19134281>

Article Received: 07- November -2024, Revised: 27-November-2024, Accepted: 17-December-2024

ABSTRACT:

Haematophagous dipterans including mosquitoes, sandflies, blackflies, tsetse flies, tabanids, and biting midges play an essential role in the ecology and epidemiology of infectious diseases in tropical rain forests. Their biting behavior, host specificity, and ecological plasticity enable the maintenance of complex zoonotic networks involving wildlife, humans, and multiple pathogens. Tropical rain forests provide ideal conditions for vector proliferation due to their high humidity, thermal stability, dense vegetation, and availability of diverse vertebrate hosts. These ecosystems sustain sylvatic cycles of protozoal diseases such as malaria and leishmaniasis, viral diseases including yellow fever, dengue, Mayaro, Oropouche, and numerous arboviruses, as well as helminth and bacterial infections. Rapid environmental change, including deforestation, agricultural expansion, mining, logging, and climate variability, alters vector habitats and feeding behavior, amplifying human exposure. The disruption of wildlife communities and increased human settling near forest edges create interfaces that favor zoonotic spillover. Despite their global significance, many rain-forest vector species remain poorly studied, and pathogen cycles often remain cryptic. This dissertation investigates the ecology, biting behavior, host-feeding patterns, and disease-transmission dynamics of haematophagous dipterans in tropical rain forests. It synthesizes contemporary research, identifies key biological drivers, and outlines methodological frameworks for future studies in vector ecology and disease surveillance.

Keywords: *Biting behavior, Disease pattern, Haematophagous dipterans, Tropical rain forests*

INTRODUCTION:

Tropical rain forests harbor the world's richest biodiversity, including a vast array of invertebrate vectors. Haematophagous dipterans blood-feeding flies belonging to families such as Culicidae, Psychodidae, Glossinidae, Simuliidae, Ceratopogonidae, and Tabanidae are central to disease ecology (Lehane, 2005). Their evolutionary specialization for blood-feeding enables them to transmit protozoa, viruses, bacteria, and helminths. Tropical rain forests are among the most biodiverse ecosystems on Earth, hosting an extraordinary array of invertebrate and vertebrate species. Haematophagous dipterans mosquitoes, sandflies, blackflies, biting midges, tsetse flies, and tabanids form a crucial ecological guild within these habitats. Their blood-feeding behavior links them intimately with wildlife, human populations, and the pathogens circulating between them (Lehane, 2005).

Rain-forest environments, characterized by high humidity, stable temperatures, and abundant breeding sites, support dense and diverse vector populations

(Bates, 1949; Forattini, 2002). The complexity of vector–host–pathogen interactions in these ecosystems sustains a wide range of zoonotic and vector-borne diseases, many of which are poorly understood or remain cryptic within sylvatic cycles (Gomes *et al.*, 2013).

Human encroachment into forested regions through logging, agriculture, mining, and settlement has increased exposure to forest vectors and consequently the risk of zoonotic spillover events (Patz *et al.*, 2004). Understanding the ecological and behavioral patterns of these vectors is essential for anticipating novel disease emergence, informing public health interventions, and guiding biodiversity conservation.

The structural complexity and microclimatic stability of tropical rain forests promote vector proliferation. High humidity, stable temperatures, and an abundance of vertebrate hosts support year-round biting activity (Bates, 1949; Forattini, 2002). Many forest vectors exhibit vertical stratification, feeding on canopy-dwelling mammals and birds, while others inhabit the forest floor or ecotones.

The public health significance of forest-dwelling dipterans extends beyond well-known vectors such as anopheline mosquitoes. Sandflies, biting midges, blackflies, and tabanids each contribute to disease transmission cycles that are often poorly characterized. As human activities increasingly interface with forest environments through agriculture, settlement, mining, and tourism, the ecological balance governing vector populations and biting behaviors is shifting, sometimes with profound epidemiological consequences. This review provides a comprehensive synthesis of current knowledge on haematophagous dipterans in tropical rain forests, with particular emphasis on biting behavior, feeding ecology, pathogen transmission, and the implications of environmental change. Despite their epidemiological importance, haematophagous dipterans in rain forests remain understudied. The rise of emerging infectious diseases such as Zika, sylvatic dengue, Mayaro virus, and zoonotic malaria is closely linked to forest vectors. Ongoing deforestation and climate change alter vector habitats, increasing human exposure. Lack of comprehensive ecological data limits effective disease prediction and management.

METHODOLOGY:

Study Area:

Characterized by high rainfall, dense vegetation and high species richness. Examples include Amazonia, Congo Basin, and Southeast Asia.

Sampling Procedures:

- 1. CDC light traps
- 2. BG-Sentinel traps
- 3. Human landing catches (with ethical approval)
- 4. Aspirators and resting collections
- 5. Canopy sampling platforms

Laboratory Procedures:

- 1. Species identification (morphology + DNA barcoding)
- 2. Blood-meal analysis via PCR
- 3. Pathogen detection using RT-PCR, ELISA, and metagenomics

Research Design:

- 1. A combination of descriptive, analytical, and ecological modeling approaches.

Data Analysis:

- 1. Biodiversity indices
- 2. GIS mapping of vector distribution
- 3. Network analysis for host vector pathogen interactions
- 4. Statistical modeling of environmental variables

RESULTS:

Data are structured into two analytical tables, each capturing a distinct dimension of *haematophagous dipteran* ecology and disease dynamics in tropical rain-forest ecosystems:

- 1. Species composition and ecological distribution
- 2. Biting behavior and temporal feeding patterns

Table 1: Species composition and ecological distribution of *haematophagous dipteran* in tropical rain-forest shows that Dipteran species display clear ecological partitioning across vertical and horizontal forest gradients. The canopy and forest edges host species that frequently contact arboreal mammals and humans respectively, influencing disease emergence. Analytical Summary of Biting Behaviour and temporal feeding patterns (Table 2) shows that Temporal patterns are species-specific and shaped by microclimate, host availability, and ecological niche. Diurnal vectors (e.g., *Aedes*, *Tabanidae*) increasingly dominate disturbed forest landscapes.

Table 1: Species composition and ecological distribution of *haematophagous dipteran* in tropical rain-forest

Dipteran Family	Representative Genera/Species	Ecological Zone	Breeding Sites	Distribution
Culicidae (Mosquitoes)	<i>Anopheles</i> , <i>Aedes</i> , <i>Culex</i> , <i>Haemagogus</i> , <i>Sabethes</i>	Canopy, understory, forest edge	Tree holes, phytotelmata, puddles, streams	Most diverse; copnopy-dwelling Haemagogus linked to YF sylvatic cycle
Psychodidae (Sandflies)	<i>Lutzomyia spp</i>	Understory, forest floor	Leaf litter, soil, buttress roots	High abundance in humid forest undergrowth
Simuliidae (Blackflies)	<i>Simulium spp</i>	Fast-flowing forest streams	Running water	Abundant in riverine zones; major vectors of onchocerciasis
Ceratopogonidae (bitin Midges)	<i>Culicoides spp</i>	Forest edge, canopy	Mud, decaying vegetation	Thrive in shaded, wet microhabitats

Glossinidae (Tsetse flies)	<i>Glossina fuscipes, G. palpalis</i>	Riverine forests (Africa)	Vegetation near water	Require shade and high humidity; transmit trypanosomes
Tabanidae (Horseflies, Deerflies)	<i>Tabanus, Chrysops</i>	Understory, forest edges	Marshy edges, moist forest sites	Strong diurnal bites; mechanical transmitters

Table 2: Analytical Summary of Biting Behaviour and temporal feeding patterns

Vector Group	Peak Biting period	Biting Rhythm	Preferred Hosts	Behavioural Notes
<i>Anopheles spp</i>	21:00-04:00	Nocturnal	Humans, primates	Strong involvement in sylvatic malaria cycle
<i>Aedes spp. (A. aegyoti, A. albopictus, Sabethes, Haemagogus)</i>	06:00-18:00	Diurnal	Humans, monkeys, birds	Major arbovirus vectors; Haemagogus > canopy-feeding
<i>Culex spp.</i>	19:00-03:00	Night-active	Birds, humans, reptiles	Opportunistic feeders; bridge-vector potential
Sandflies (<i>Lutzomyia spp.</i>)	19:00-01:00	Crepuscular/Nocturnal	Rodents, sloths, humans	Weak fliers; very host-specific in some taxa
Blackflies (<i>Simulium spp.</i>)	07:00-17:00	Diurnal	Humans, ungulates	Strong diurnal attack; cycles near rivers
TseTse flies (<i>Glossina spp.</i>)	08:00-14:00	Diurnal	Wildlife, Humans	Visual host-seeking; dominates
Biting midges (<i>Culicoides spp</i>)	18:00-22:00	Nocturnal	Birds, mammals	Very small size; unnoticed bites

DISCUSSION:

Forest vectors exhibit strong ecological specialization. Vertical stratification influences exposure of different host species, with canopy mosquitoes feeding on arboreal primates while understory species feed on ground-dwelling mammals. Biting activity synchronized with host behavior significantly affects pathogen transmission. Opportunistic generalist feeders act as bridge vectors facilitating zoonotic spillover. Deforestation increases mosquito abundance by opening sunlight gaps that create warm, productive breeding sites (Vittor *et al.*, 2006). Climate change accelerates developmental cycles, shortening the extrinsic incubation period for pathogens (Paaijmans *et al.*, 2010).

Forest workers, agricultural settlers, hunters, and ecotourists face heightened exposure. Many arboviruses remain underdiagnosed due to low surveillance.

Haematophagous dipterans in tropical rain forests exhibit complex behavioral and ecological dynamics that sustain rich pathogen biodiversity. Environmental changes increase human exposure to sylvatic vectors and heighten spillover risks. Integrated ecological and molecular studies are essential for disease prediction and control.

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