

A close-up photograph of a mosquito against a solid orange background. The mosquito is positioned vertically, with its head at the top and legs extending downwards. Overlaid on the mosquito's abdomen is a white network diagram consisting of eight circular nodes connected by thin white lines, representing an interaction network.

# ECOLOGICAL AND EPIDEMIOLOGICAL INSIGHTS FROM BLOOD MEALS

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## ***Using interaction networks to explore the community structure and network ecology of biting insects and their hosts***

**K**nowledge of variations in insect biting behaviour and feeding patterns of insect disease vectors is important in understanding disease epidemiology and establishing effective control methods. Blood feeding insects are embedded within complex ecological communities and interact with other species acting as predator, prey, or competitor. These interactions are likely to impact the population dynamics of those co-occurring species<sup>1</sup>.

Biting insects exist within a variety of landscapes, where landscape change is likely to influence host-insect interactions<sup>2,3</sup>. For example, deforestation within the Peruvian Amazon resulted in 278 times more human interactions with the malaria vector *Anopheles darlingi* than in undisturbed habitat, leading to a rise in malaria transmission<sup>4</sup>. Consequently, creating vector controls requires an understanding of how the landscape modifies biting insect community structure and biting interaction

frequencies. Similarly, community structure, host availability, and the frequency of interactions may all be affected by time, again with consequences for disease transmission. For example, the Leishmaniasis vector, sand flies, are most active at dawn and dusk, with a resultant increase in transmission risk to nocturnal hosts<sup>5</sup>.

Biting insect research has primarily focused on the analysis of single biting insect species or small sets of interacting species to examine host usage and to screen vectors for pathogens of interest (such as Zika virus and malaria). As many biting insects are medically important, research has also focused on the effects of specific control initiatives, such as examining *Anopheles* mosquito abundances following the implementation of long-lasting insecticidal nets. Whilst limited work has examined the effect of habitat modification and temporal variations on feeding patterns and species abundances, this work has broadly overlooked the community aspect<sup>6</sup>. Therefore,

there is currently an incomplete understanding of the degree to which these variations and distance from human habitation<sup>7</sup>, impact interaction frequencies, and the structural properties of the wider biting insect-host community. Indeed, as insect communities themselves are rarely studied, the full ecological and epidemiological implications of their interactions is currently unknown, so that the design of control strategies is potentially compromised.

Understanding such interactions is possible by constructing interaction networks, which provide a visual and mathematical representation of a community of species, connected through their feeding interactions<sup>8,9</sup>. I will create biting insect-host interaction networks using data from insect bloodmeals, focusing on the communities of biting flies in Ghana. I will explore the impact of landscape, comparing distinct habitat categories (such as scrubland and fallow land), and temporal variations (day or night), and the effect of proximity to human habitation on biting insect-host community composition, structural properties, such as how specialised the network is, and relative species' abundances. I will use metabarcoding to create data on species interactions as it allows for the identification of animal DNA in a mixed sample collected from biting insect bloodmeals<sup>10</sup>.

I have augmented this fieldwork with a [literature-based analysis](#) of published blood meal interaction data. This provides an in-depth opinion on the value of interaction networks in understanding host-insect-disease interactions and highlights their future applications in identifying and monitoring emerging diseases and unrecognized vectors<sup>11</sup>. Further, using a global data set extracted from the literature, I aim to examine structural variations of biting insect-host communities between distinct habitat types and latitudes. The results generated by my work will provide valuable insight into biting insect community ecology, evaluate the potential impact of interventions on community structure and interactions. A vector, especially as current interventions typically rely on insecticide sprays and insecticide-treated bed nets that are less species-specific and therefore affect a broader range of species.

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**THIS RESEARCH IS PART OF A LARGER EFFORT BY TARGET MALARIA IN GHANA TO UNDERSTAND THE ROLE OF THE *AN. GAMBIAE* MOSQUITO IN THE BROADER ECOSYSTEM.**

For more information see:

[\*The important interactions behind the itch\*](#)