**Why are MBDs important?**

Mosquitoes are the primary vector of many debilitating arboviruses. These arboviruses are far reaching, affecting every continent. In sub-tropical and tropical regions, diseases like zika, dengue and yellow fever cause significant mortality and morbidity. The burden of these diseases both socially and economically is extreme and all are transmitted by mosquitoes. In more temperate regions, arboviruses that cause fevers and encephalitis are more widespread, similarly costing millions of dollars each year to control, treat and research.

Europe regularly experiences imported cases of these arboviruses from countries where their vectors are prolific. European health agencies also treat several endemic arboviruses such as WNV on a regular basis, with reported cases reaching a peak of 468 in November 2019. While Europe is well suited and accustomed to dealing with these endemic diseases and imported cases of others, the likelihood of experiencing local transmission of introduced arboviruses is increasing. Increased globalisation and a changing climate are the main drivers behind this increased risk of arbovirus transmission, allowing previously unsuitable habitats to become established breeding areas for invasive mosquitoes.

Invasive mosquito species (IMS) have been discovered in eastern and central Europe, consisting almost solely of those from the genus *Aedes*. In the past decade local transmission of dengue has been recorded in France, and the Spanish island of Madeira, both are assumed to be associated with the vector *Ae. Aegypti* (Auerswald et al. 2019; Marchand et al. 2013). Recently, more locally transmitted cases of dengue have arisen in France and Spain, suggesting that dengue outbreaks are likely to continue in the future (WHO 2019). Epidemics of Chikungunya virus outbreaks in southern Europe have also been recorded. The invasive species *Ae. Albopictus* is suspected as the primary vector (Angelini et al. 2007; Grandadam et al. 2011).

Importantly, for transmission to occur a mosquito species must be a competent vector of the arbovirus. This means that after becoming infected by an arbovirus, the virus can then be transmitted to another host through a mosquito bite. The underlying mechanisms for each mosquito and virus combination are complex and poorly understood. Usually the evolution of these virus-mosquito interactions is the result of a classic evolutionary arms race. Though the life history characteristics and behaviour of some mosquitoes means they are more likely to transmit a broader range of viruses competently.

For Europe, the increased risk of arbovirus transmission in naïve populations presents itself through multiple processes:

Host mediated (Most Likely)

Introduction of hosts that act as reservoirs of arboviruses. Changes in distributions of migratory birds as ranges shift in response to climate and environmental change exposes naïve mosquito populations to arboviruses. If these mosquitoes are competent vectors, transmission of the arbovirus may then occur in local fauna, eventually leading to establishment of the arbovirus in the region and potential endemics.

Mosquito mediated (Likely)

Invasive mosquitoes continue their spread across Europe, with them they bring arboviruses that are transmitted to local populations and become established. These mosquitoes become the primary cause of the arbovirus epidemics in region. It is possible that the arboviruses are then exposed to naïve populations of mosquitoes which take over a portion of the local transmission.

Arbovirus mediated (Least Likely)

Evolution in arboviruses or mosquito populations as a result of arbovirus infection could lead to the generation of new pathogens. The interactions between arboviruses and mosquitoes are complex and ever changing. If a change in these interaction dynamics inside the mosquito occurs in such a way that the mosquito becomes a more competent vector, then transmission may occur in areas where mosquitoes are endemic with no changes in the composition of local fauna.

Understanding how mosquitoes and arboviruses interact with their local environments, including responses to abiotic and biotic factors will improve our understanding of the driving forces behind mosquito distribution and arboviral risk in the coming years. How these vector-pathogen interactions function across abiotic gradients, and in the presence of new host species and habitats (biotic factors), will add extra dimensions to an already complicated system. Despite this, untangling the effects of biotic and abiotic gradients on the resulting distributions of both viruses and moquitoes. Much of this current interaction level data can hopefully be distilled from lab based studies and scaled up to an ecological level.

**Traits and their importance**

Traits are a measurable part of an organism’s phenotypic composition, which is produced through a combination of environmental, genetic and evolutionary factors (Funk et al., 2017; Shipley et al., 2016; Wong et al., 2019). Grouping organisms by “functional traits” (i.e. what they do in an ecosystem) provides an alternative to the classic taxonomic and hierarchical phylogenetic perspective (Cadotte et al., 2013). Trait based applications and explanations of ecological phenomena have since proliferated across many organisational scales of biology, from bacterial community composition, mutualistic interactions of soil microbiota and even the spatial distribution of pollinators in response to land use change (Funk et al., 2017; Potts et al., 2010; Rath et al., 2019; van der Heijden and Scheublin, 2007)

This functional grouping, also known as a trait-based approach gained significant momentum in plant ecology, promising to provide a better insight on how and why species are distributed where they are and how they could change in the future (Funk et al., 2017). This approach has since been extended to explore the explanatory power of traits on invasive status (ref), and even the vectoral potential of many under reasearched arthropods (han ref).

Five categories for classsifying terrestrial invertebrate traits have been suggested: morphology, feeding, physiology, life histroy and behaviour (morreti 2017). These trait categorisations are further expanded on by Brousseau *et al*., [2018a](https://onlinelibrary.wiley.com/doi/full/10.1111/brv.12488" \l "brv12488-bib-0027), where all current arthropod traits in use are listed and categorised. Importantly, how these traits impact a species response to the environment helps with understanding the effects of traits on ecological processes (trait based ecol ref). Further work has suggested this assocaiton be reffered to as the “response-effect” paradigm, Whereby species traits can either respond to environmental processes or effect the outcome (Lavorel & Garnier, [2002](https://onlinelibrary.wiley.com/doi/full/10.1111/brv.12488" \l "brv12488-bib-0133); Suding *et al*., [2008](https://onlinelibrary.wiley.com/doi/full/10.1111/brv.12488" \l "brv12488-bib-0236))

Applying the respones-effect process to mosquitoes, froma viewpoint of predicting distribution and infering risk of arbovirus transmission means that identifying the most important traits that respond or effect this process is a priority (table of traits for mosqs). Mosquito traits and their influence on the vectoral capacity of arboviruses has been explored before, albeit with a limited dataset of traits and a set of species localised around south america (zika paper ref).

The problem with many arthropod trait databases is the inability to measure traits directly. Often traits are used as a proxy for measurments such as fitness, body size being a largely correlative trait. For others like fecundity, body size and clutch size may also play roles but we may never discern a true value because it remains impractical to measure these in the field. Regarding trait measurments many lab based studies would be severely limted in their scope for field experiments.

Because mosquitoes are small ectothermic invertebrates, their traits are heavily influenced by temperature.

Mosquitoes have received little attention from a trait-based perspective. There are many records of how feeding regimes, temperature and water chemistry impact mosquito larvae fitness (ref). Yet, the explanations of these differences between species are lacking, except for a few prominent vectors.

Frameworks have been suggested to help tackle these problems, and even extend the explanatory power of traits to risk of arbovirus trnasmission to human populations (cator ref). However, the avilability of trait data for mosquitoes is sparce, especially if the research community wants to make broad comparative analysis, the current records are heavily weighted towards prominent vector and invasive specie (ref or maybe diag?).

Incorporating evolutionary history has been crucial to understanding the processes that underlie the assembly of communities and distributions of populations in ecology (Cavender-Bares et al., 2009).

Behaviour of mosquitoes is a critical factor in this. Few species of mosquitoes preferentially feed on human hosts, with exceptions to largely domesticated species of *Ae. Aegypti* and *Anopheles*. Though despite this host preference for non-human species mosquitoes can in many cases be opportunistic feeders, changing host preference based on access to hosts. This