Project MOSI briefing notes (August 2011)

An international zoo and wildlife park initiative to monitor the effects of climate change on mosquito species range spread, activity periods and behaviour

Participating ISIS institutions illustrate the monitoring potential of the international zoo community

Introducing Project MOSI

In October 2010 the World Association of Zoos and Aquariums (WAZA) and the Institute for Zoo and Wildlife Research (IZW), in concert with the Zoological Society of London (ZSL) and Imperial College, agreed to develop a permanent international mosquito monitoring programme - Project MOSI (Mosquito Onset Surveillance Initiative). Utilising the unique monitoring potential of the world's zoo and wildlife park networks, the core remit of this initiative is to monitor the effects of climate change on mosquito species range shift, activity periods and behaviour. Good progress has been made establishing new monitoring sites and, over the next 18 months, the programme aims to involve up to 60 zoos, wildlife parks and associated institutions around the world. Background information, involvement rationale and associated details are provided below.

The importance of studying mosquitoes

A large number of mosquito species are principle vectors of a wide range of vector-borne diseases (human and avian malaria, dengue, West Nile encephalitis, elephantiasis and so on). All blood-feeding mosquito species use chemicals produced by their vertebrate host to locate them in order to have a blood meal essential for egg production. This "cocktail" of attractive odors produced by the host varies greatly from host species to host species and mosquitoes can be more or less attracted to them depending on their feeding preference (mosquito species can be mammophilic if they're attracted by mammals; ornithophilic if attracted by birds; batracophilic when attracted by amphibians and so on).

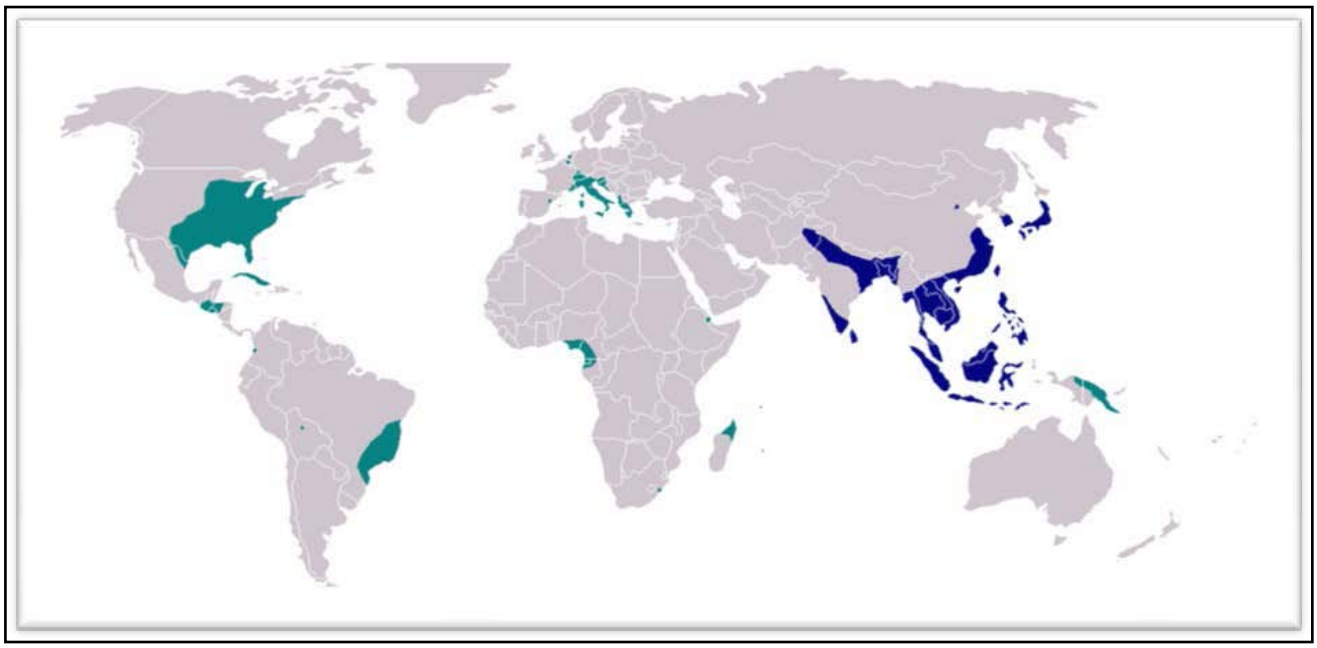
In addition to its intrinsic biodiversity information value, monitoring mosquito species distribution, population abundance, activity periods and behavior (host preference, feeding and oviposition etc.) is essential for better protection of human and wildlife communities. Human, wildlife and disease vector communities establish an equilibrium over centuries of association. What might happen when vector species and their associated transmittable diseases experience more favorable conditions and are introduced or spread to new areas? To detect, study and effectively respond to such developments ongoing monitoring is vital.

Mosquitoes in a changing world

Human activities have long influenced the distribution and behaviour of many mosquito species. Historically, this has largely been due to a combination of habitat alteration and the movement of goods and people. In addition to these ongoing influences, global warming has emerged as an important contributory factor that, on current trends, is set to become increasingly significant in lengthening activity periods and creating new colonisation opportunities with potentially serious human and wildlife health implications. The Asian tiger mosquito *Aedes albopictus* is a good example of a species having its range greatly extended as a result of human activities. This forest-living, dendrophilic species (laying eggs in water-filled tree-holes) has spread around the world (predominately via used tyres and the tropical plant trade). It has established itself in cities where elevated temperatures and humidity and artificial water pools, combined with little or no predation or competition, have enabled it to thrive.

The tiger mosquito can transmit a number of pathogens such as, the West Nile Virus, Yellow fever virus, St. Louis Encephalitis, Dengue fever, and Chikungunya fever. Higher temperatures also allow parasites and diseases to live longer and consequently become more likely to complete their life-cycles (and transmission ability) even in previously inhospitable northern and high elevation regions. The 2007 Chikungunya fever outbreak in Italy demonstrates that the introduction of vector species, such as the tiger mosquito, can be followed by their associated transmissible diseases.

Another example is provided by *Anopheles plumbeus.* This dendrophilic European species has adapted to breed in a range of artificial breeding sites and as a consequence has



Worldwide distribution of the tiger mosquito (*Ades albopictus*) in 2007. Blue denotes the natural range and green shows extent of known colonisation.

greatly increased in numbers and area over the last few decades (Becker, 2003). Due to its aggressive biting behaviour and population increase, this mosquito has become a significant nuisance. Although endemic malaria has disappeared from Germany, travellers import approximately 1000 registered cases of malaria every year over the last decade. Two cases of autochthonous *Plasmodium falciparum* malaria in Germany with evidence for local transmission by indigenous *Anopheles plumbeus* were recorded in 2001 (Krüger, 2001).

Zoos and wildlife parks as valuable monitoring stations

Zoos provide unique mosquito monitoring environments with large numbers of exotic host species, micro-habitats and shelters suitable for breeding and overwintering. Such situations provide an incomparable opportunity to study the behavior of mosquitoes offered with multiple choices of hosts and environments.

Exotic species in a zoo environment are exposed to local indigenous fauna, their vectors and diseases. Zoo animals are routinely screened for any sign of illness and new acquisitions are quarantined and monitored. This means that infection routes are invariably from local wild fauna to zoo animals. This makes zoos uniquely valuable local, regional and international health surveillance sites, providing advance warning to wildlife parks and human settlements of non-native mosquito's species introductions, population explosions and behavioral changes. Indeed, there is a significant history of valuable zoo based mosquito study and associated monitoring.

Wildlife parks provide remote monitoring areas that without such a surveillance programme would be unlikely to be regularly (if at all) monitored for mosquito species composition and activity patterns. This data can be very valuable for health management of the species in the parks and for nearby human settlements, again, providing advance warning of non-native mosquito species introductions, population explosions and behavioral changes.

The combined regional and global-scale monitoring potential of zoos, wildlife parks and their associated institutions is clearly tremendous. Utilising this potential is key to enabling any initiative of the scale of project MOSI to succeed. This programme will also greatly benefit other mosquito recording schemes and control endeavors.

Principle objectives of Project MOSI

1. Establish an international network of 60 permanent mosquito monitoring sites.
2. Confirm baseline species composition, abundance and activity profiles.
3. Continually monitor for changes in species composition, abundance & activity profiles.
4. Help clarify the impact of climate change on a large number of mosquito species.
5. Provide an early warning network for detecting movement of disease vector species.
6. Help efforts to evaluate and better control mosquito vector disease threats.
7. Help develop improved mosquito attractants and trapping methods.

Pilot study summary

From 2005 onwards, monitoring of mosquito populations at ZSL London Zoo, in collaboration with Imperial College, has been undertaken by mosquito specialist Giovanni Quintavalle Pastorino with a focus on species composition, population abundance and seasonal activity profiles. Different trapping methods have been tested (resting boxes, mosquito Magnet traps, ovitraps, gravid traps and Biogents Mosquitaire traps) to determine their relative suitability. This has provided sufficient confidence for the cheap and easy to maintain Biogent Mosquitaire traps to be utilised as the standard monitoring trap for Project MOSI. Comparative trials (including the efficacy of different attractants) are continuing as part of the Project MOSI initiative and Giovanni is providing the specialist support role of specimen identification, training and generation of technical reports for the full programme.

Biogents Mosquitaire trap near zoo enclosure

Removable capture net at base of trap funnel

What participating institutions derive from joining the programme

- An additional practical measure to help protect sensitive species.
- Monthly up-date on species composition and population abundance via free identification of the collected samples posted to ZSL.
- Real time feed-back on seasonal mosquito activity – enhancing possibility of rapid intervention to reduce population growth (using BTI larvicides for example).
- Integration of data from other surveillance sites to monitor regional and global changes in species distributions and behaviour with opportunities for advance warning of species range shifts and potential deeper investigation (at request of institution's veterinary department) of local mosquito-vector disease cycles.
- A comprehensive annual report.
- At the discretion of each participating institution, site-specific data can be either incorporated into wider research findings and collaborative publications or kept confidential.
- At institution's discretion, support with undertaking the specimen identification role in-house.
- A novel and engaging opportunity for an institution to convey the practical significance of climate change and wider human impacts on disease vector species.

What's required of participating institutions.

- Placement of a Biogents Mosquitaire mosquito trap in an appropriate site location (In zoos this is often near a bird enclosure or any other animal considered sensitive to mosquito bites that would benefit from the added protection a trap provides).
- Weekly collection of mosquitoes trapped in the Mosquitaire and storage in a normal fridge (at around 4°C).
- Monthly postage of the collected specimens to ZSL in a labelled plastic tube with the date of collection and trap number.

Labeled tubes used to post specimens Giovanni Quintavalle Pastorino identifying specimens

Safety assurances

Some assurances to allay any public relations concerns associated with a zoo or wildlife park participating in the monitoring programme:

- Due to the wide range of potential host species, a zoo or wildlife park environment are among the least likely outside environments for people to be bitten by mosquitoes.
- The majority of mosquito species are active at times when these facilities are normally closed but in any case having mosquito traps on site reduces the incidence of being pestered by mosquitoes.
- The majority of mosquito borne diseases that might present in a zoo or wildlife park are non-human related.
- Mosquitoes found in the grounds of a zoo or wildlife park are invariably indicative of a wider local/regional presence. By establishing mosquito monitoring initiatives zoos and wildlife parks provide a valuable surveillance service for the local community and for the region's effective wildlife health management.
- Participating in such initiatives constitutes an additional practical measure to protect our animals and local communities.

Costs and staff time involved in participating in the monitoring programme

Other than the electricity cost of running the trap and monthly postage of specimens to ZSL the only notable costs involved in participating is the initial outlay for the Biogents Mosquitaire trap (approx €150), and replacement 'sweetscent' attractants (approx €210 a year per trap). The replacement attractant packs include spare trap nets at no additional cost. For a single trap, staff time involved in trap maintenance and specimen processing averages around 30 minutes a week.

Sharing information
As this permanent monitoring initiative will increasingly be filling significant knowledge gaps on mosquito species range status, activity and behaviour changes, an ongoing remit is to ensure that annual reports and significant developments are communicated to relevant organisations and agencies. These include the World Organization for Animal Health (OIE), World Health Organization (WHO), United Nations Framework Convention on Climate Change (UNFCCC), United Nations Environment Programme (UNEP) and IUCN's Species Survival Commission.

For further information on any aspect of this programme please contact:
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