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The Broad Street Pump

**When it comes to mosquito-borne disease
prevention, awareness and surveillance is critical**

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Biting insects and the pathogens they transmit have been our constant companions throughout human history. The recent discovery of a 46 million year old blood filled mosquito fossil has provided a reminder of how, even our distant ancestors, had to protect themselves from annoying (and possibly dangerous) biting insects. Despite our ever expanding toolbox of strategies to prevent disease, malaria and dengue continue to represent some of the biggest threats to human health internationally. Bed nets have been used as effective physical barriers to mosquitoes. Pyrethrum has been used against biting insects for centuries but, once incorporated into “mosquito coils” in the 1890s, a widely available resource gave many the ability to protect themselves. However, it was in the mid-1900s that a revolution occurred. With the development of the insecticide DDT and insect repellent DEET, the impacts of vector-borne disease began to decline. The war is far from over and, on many fronts, the pests and pathogens thought to have been defeated are finding a way to fight back.

Despite continued advancement in “mosquito control” technologies, the burden of mosquito-borne disease remains. However, despite these technological “fixes”, the need for effective community education and vector-borne disease surveillance systems remains critical.

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When it comes to mosquito-borne disease prevention, awareness and surveillance is critical

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In 1943, the US War Department issued a small booklet on the dangers of malaria and suggested effective preventative measures. Many of those messages remain in public health awareness brochures, fact sheets and websites today. What is most noteworthy about this 70 year old booklet is the wonderful illustrations provided by Theodor Seuss Geisel (better known as Dr Seuss). Throughout this special edition of the Broad Street Pump are examples of these illustrations.

As the global community becomes more connected, health authorities need to work harder to ensure the correct information is available to our communities. Surveillance networks tracking both the vectors and pathogens will assist control strategies but personal protection measures will remain the first line of defence. How do we get the message out about how to avoid vector-borne disease and provide the community with ways to protect themselves?

In this edition of the Broad Street Pump, there are articles highlighting the recent involvement of staff and students with the Department of Medical Entomology and University of Sydney in research and research translation driven by both new technologies and the wishes of the community. What threats are Australians, and Australian travellers, going to face from biting, stinging and pathogen carrying arthropods? How can new technologies assist surveillance of vector-borne disease? How do we help Australian's to effectively choose and use insect repellents? How can we help countries in our region battle their mosquito-borne disease threats?

Why don't you join the conversation on social media? This may be the new frontier in public health education!
You can follow Cameron on Twitter: @mozziebites

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More than mozzies: The health risks associated with Australian arthropods

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It is universally accepted that the mosquito is the most dangerous creature on the planet. The pathogens they transmit are responsible for millions of cases of disease, including many thousands of deaths. There are, however, a range of other arthropods that can bite, sting, irritate or annoy and, in some circumstances, pose locally significant risks to the community. While Australia is fortunate to be free of some of the most serious vector-borne pathogens, we boast an impressive range of arthropods that can bite, sting and spread disease (1). Some of them are just plain annoying.

The term arthropod describes a group of animals with a hard exoskeleton. This includes insects as well as spider, ticks, mites, centipedes and millipedes. If it crunches when you step on it, it is probably an arthropod.

Humans have shown great ingenuity in adapting to life in every corner of the globe, which has in turn been of great benefit to many arthropod pests. These creatures have taken advantage of us, either exclusively or in an "as need be" basis, for both food and shelter. Whether it is feeding on our blood, food, homes or on our garbage, many arthropods have adapted to a life in close contact

with humans. For our part, we've moved our homes, businesses and holiday activities into areas where arthropods are abundant and it should come as no surprise that contact between people and pests will continue to increase as our population grows and our climate changes.

Australia is home to a diverse range of mosquitoes. Notwithstanding nuisance-biting and irritation, we also have our own disease-causing pathogens that, while rarely causing fatalities, can be seriously debilitating and exact a significant cost on the local community and economy (1). A changing climate is unlikely to see a flood of new mosquitoes and viruses (2) but the way we manage water in our urban developments (3; 4) may increase the risks of local and exotic mosquito pests.



More than mozzies: The health risks associated with Australian arthropods

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The recent discovery of the Asian Tiger Mosquito, *Aedes albopictus*, in the Torres Strait and subsequently predictions that the species may, if introduced into mainland Australia, spread as far south as Melbourne (5) has raised concerns among health authorities. The spread of this species is not directly related to a changing climate but rather human movement between Indonesia and Torres Strait (6). The movement of humans may facilitate, not just the movement of the mosquito but also the movement of pathogens. With a steady increase in the number of travellers returning to Australia infected with dengue over recent years (7) and outbreaks of Chikungunya virus in our region (8), there may be a shift in the pest and public health risks associated with future mosquito populations in Australia.

The rapid movement of people and their belongings around the world, facilitated by quick and affordable air travel, hasn't just increased the risks associated with mosquitoes. Since the late 1990s, there has been a global resurgence in bed bugs. Australia has been at the forefront of monitoring (9), assessing and developing control strategies to limit the public health and economic impacts of infestations (10). While they're not involved in the transmission of pathogens, the physical, emotional and psychological impacts of nuisance-biting resulting from heavy infestations are not insignificant (11). The substantial financial expense of disinfestation of bed bugs also often causes considerable emotional trauma. International organisations are now adopting the "Australian Code of Practice for Bed Bug Infestations" (12) to assist homeowners, pest control operators, government organisations and the hospitality industry better manage these pests.

As Australian's live closer to wetland and bushland areas, the arthropods associated with these environments and local wildlife become increasingly important pests. Ticks, especially the paralysis tick, *Ixodes holocyclus*, poses significant risks to both humans and their pets. Notwithstanding the risk of paralysis and pathogen transmission, allergic reactions to tick bite can vary from a mild itching with localised swelling, to widespread swelling with pain, to a severe and life threatening anaphylactic condition (13). Recently, a new clinical syndrome has been recognised, whereby people who are bitten by the paralysis tick can develop a life threatening allergy to red meat (14). With the emergence of this condition and the ongoing debate about Lyme disease in Australia, various expert panels have been established to deal with these tick related issues, with CIDMLS staff well represented on the committees.

Sometimes it isn't the insects that spread disease, or are present in large numbers, that cause the greatest concern. The occasional cockroach scuttling along the kitchen floor or the tiny spider up in the corner of the bedroom can represent a significant psychological threat to many self confessed entomophobes. Flies and biting midges can disturb our summer BBQs and head lice can cause a bout of anxiety in carers as our children return to school for the new term. For those who suffer a fear of insects and other arthropods, access to the world wide web has opened up a new world of myths and misinformation that often does little to alleviate these fears, and probably a lot more to intensify them. There is also the latest gimmick 'selling the dream' of a quick fix for our pest problems.

To address all these issues, the Department of Health and Aging has recently released "Arthropod Pests of Public Health Significance" (14). This freely available document represents the most comprehensive review of over a dozen groups of medically important arthropods, the threats they pose and how those pests can be managed. Despite improvements in surveillance, research and control of arthropod pests, it should be expected that many of the health concerns associated with them will remain well into the future. As our population grows and encroaches on wetland and bushland areas, we rapidly travel to far flung parts of the world and exotic pests knock on the front door, Australian authorities must ensure that they're vigilant in adapting to new and emerging arthropod pests. (See over for references)



More than mozzies: The health risks associated with Australian arthropods (continued from page 3)

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The reality of new technologies in arbovirus and mosquito surveillance in NSW

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Over 75 arboviruses have been reported from countries in the Australasian zoogeographic region, but only 13 are associated with human disease, and all are transmitted by mosquitoes [1,2]. These include the flaviviruses Murray Valley encephalitis (MVEV), Kunjin (KUNV), Japanese encephalitis (JEV), Kokobera (KOKV) and dengue (DENV) viruses; the alphaviruses Ross River (RRV), Barmah Forest (BFV) and Sindbis (SINV) viruses. The flaviviruses can cause severe encephalitis and in the case of dengue, febrile illness and in some cases, haemorrhage. The alphaviruses can cause a debilitating and sometimes chronic polyarthritis. In NSW, there is annual RRV and BFV activity. Over the past 20 years, there has been an average of over 700 cases of RRV infection per year reported from the state.

In the absence of pre-emptive broad scale mosquito control programs in Australia, reducing the risks associated with these viruses requires local authorities to disseminate warnings and advice on personal protection measures to the community. However, the early detection of arboviruses and mosquito surveillance is critical so that appropriate control meas-

ures can be implemented. Hence, there is a need to employ diagnostic methods that can rapidly and accurately detect and differentiate these viruses.

The NSW Arbovirus Surveillance and Mosquito Monitoring Program was established in 1984 and runs annually to provide local authorities with information on the risks of mosquito-borne disease. Mosquito collections from across the state are processed to determine the local abundance and diversity of mosquito populations and the presence of any arboviruses. So which methods of detection are currently used, and what other systems are available that can meet these criteria?

Viral culture

The routine method of screening for specific arboviruses is primarily by cell-culture methods followed by definitive identification using the Fixed-Cell Enzyme Linked Immunosorbent Assay (FC-ELISA) [3]. This pan-genus diagnostic approach has been utilised for three decades in antibody-based assays, with pan-flavivirus monoclonal antibodies (mAbs) developed in the early 1980s [4].

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Pools of 25 mosquitoes are ground using MOSAVEX (Mosquito Arbovirus Extractor), a mechanical device developed at Westmead Hospital to grind mosquitoes [5]. The supernatant is clarified from mosquito homogenate by centrifugation at 4°C and processed using FC-ELISA [3].

Culture-based systems for virus isolation have been the “gold standard” in clinical virology for decades, but evidently, the isolation of viruses in culture is slow, time-consuming, labour-intensive with specialised facilities and expertise required. Also, only modest improvements in culture-based systems have been made over many years and they are simply insufficient for sustainability [6]. Furthermore, viral culture systems are not standardised or scrutinised to the same extent as molecular testing and can vary considerably depending upon the selection of appropriate cell lines; the adequate collection transport and handling of specimens to ensure virus viability; and the maintenance of viable and healthy inoculated cells [6].

Within the past three decades, there has been a significant change in diagnostics with the development of a variety of molecular technologies designed to be quick and accurate that can differentiate and quantify many different virus of medical importance [6]. For these reasons, the introduction and eventual implementation of nucleic acid-based testing is being evaluated for the NSW Arbovirus and Mosquito Surveillance program.

Molecular methods

A combination of RNA extraction methods and real-time PCR assays were trialled and evaluated. Two mosquito sample types were tested: clarified supernatant from pooled mosquito grinds and primary C6/36 cell culture supernatant that showed up positive on a broadly reacting mAbs.

Viral RNA was extracted using the High Pure Viral RNA kit (Roche Diagnostics GmbH, Mannheim, Germany) and compared against the EZ1[®] Virus Mini Kit v2.0 on the BioRobot[®] (Qiagen, Limburg, Netherlands). A pan-genus, two-step fluorescent based real-time RT-PCR using Evagreen[™] to detect both alpha and flavivirus by means of universal primers comprising degenerate bases was tested. Universal primers for alphaviruses targeting a 559 bp region of the NSP4 protein was designed in-house, and for flaviviruses, primers [7,8] targeting the end of the region encoding the methyltransferase and the start of the region encoding the RNA-dependent RNA-polymerase in the flavivirus NS5 gene was selected. Definitive identification of amplified targets was by means of a second round real-time PCR using a multiplex of gene specific primers (GSPs). Differentiation between the viruses using High Resolution Melt Analysis (HRMA) and evaluation of dissociation curves was made in the multiplexed PCR. This method requires the inclusion of a laboratory reference strain for each of the viruses under investigation, as a comparator for every assay.

So what have we found so far?

Comparison of molecular procedures with virus cell culture and FC-ELISA were comparable and showed that the same viruses were identified. However, nucleic acid testing proved to be a great deal more rapid, with results available in half the time compared to virus cell culture. Nonetheless, molecular testing is not all a bed of roses and especially in arbovirus surveillance. Adopting molecular systems of identification is not without technical challenges. To mention one, a comparison between two RNA extraction methods showed a ‘cleaner’ extract from mosquito homogenates with the EZ1[®] Virus Mini Kit v2.0. This system employs a system of magnetic particle separation whereas the High Pure Viral RNA kit traps nucleic acids within a glass fibre membrane located in the spin column. Both the extraction kits performed equally well on cell culture supernatant and FTA cards, but not on mosquito grinds. A probable reason is that owing to the diverse nature of mosquito homogenates that comprise mosquito remnants, bacteria and fungi etc., large particles are more likely to be trapped onto the glass fibre membrane, thereby impeding elution of nucleic acids. Then again, magnetic bead-based nucleic acid extraction requires robotic liquid handling and is limiting in some laboratories. For this reason, careful consideration for selecting appropriate nucleic acid extraction is essential. Consequently, extraction efficiency depends on adequate homogenisation, the type of sample, target density, genetic complexity, and the amount of biomass processed [9]. Hence, poor RNA yield and quality will result in mediocre downstream PCR applications, dooming the assay to failure from the start.

Technically, in real-time PCR, there are other concerns such as false-negative results due to PCR inhibitors and viral genetic diversity or false positives attributed to contamination. Unlike molecular diagnostics in the clinical situation where suspicion of virus is based on signs, symptoms or circumstances, the detection and identification of a number of different viruses in a mosquito pool can be challenging and is equivalent to looking for a needle in a haystack. Also, a low number of virus particles in a test sample can be beyond the limit of detection (LOD) thereby reducing the analytical sensitivity of the PCR. So, how should results be reported – negative or more accurately – beyond detectable levels? Theoretically, the most sensitive LOD possible is 3 copies per PCR, assuming a Poisson distribution, a 95% chance of including at least 1 copy in the PCR [10]. Also, with stochastic fluctuation in low DNA input, PCRs are limited and <3 copies per reaction are reportedly not possible. There is also the possibility of some viral RNA degradation during mosquito grinding that can result in lower copy numbers. Conversely, the probability of a single virion to multiply in cell culture until visible evidence of growth is higher than detecting 1 virus particle by PCR.

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Nevertheless, nucleic acid-based assays have demonstrated their worth as highly sensitive and specific tests for known targets, but they require continuous adaptation [11]. The RNA viruses in particular, are genetically variable owing to high error rates in RNA polymerases and for this reason, tests for RNA viruses need continuous reviewing. This adaptation also applies to real-time PCR tests dependent on probe based hybridisation to complementary sequences. If the target sequence are prone to mutation, even closely related viruses can evade detection [11]. Hence, sequence variation in primer and probe regions are prone to drop out if a new subtype or mutation arises in regions of the virus recognised by the primers or probes. Then, there is the issue of identifying unknown virus, where the trend is toward non-specific amplification of treated culture supernatants followed by next generation sequencing.

Future strategies

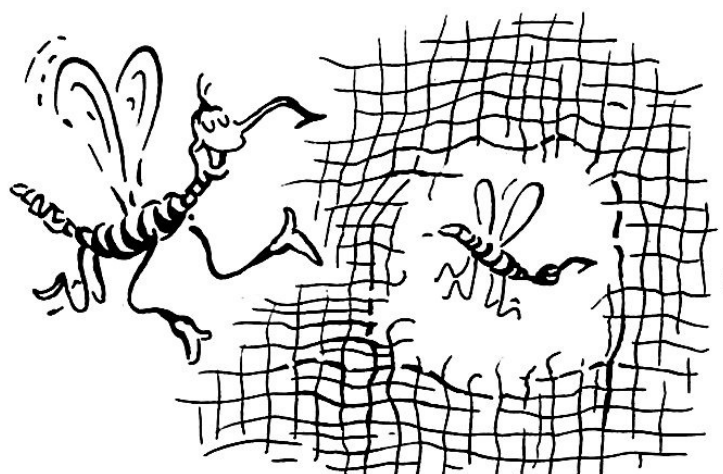
A combination of virus cell culture and molecular identification were considered most suited to detecting and identifying arboviruses in the mosquito surveillance program. Culture supernatant from first inoculations of mosquito homogenate in C6/36 cells, post incubation, is sampled for nucleic acid testing. Combining two detection systems minimises problems that are encountered in processing mosquito homogenates for real-time RT-PCR. It increases the probability of detecting virus and improves analytical sensitivity. To maximise virus detection, reverse-transcription with random hexamers, followed by a genus-level nucleic acid-based assay for flavivirus and alphavirus is implemented using broad-spectrum real-time PCR. If virus is present in the pan-PCR, a multiplexed-PCR using gene-specific primers is employed for definitive identification.

So, why bother with virus culture with the continual development of rapid molecular tests? Well, virus isolation is important in identifying unknown and emerging viruses and is required for *de novo* sequencing where no reference sequence is available. Also, cell culture methods are relatively unbiased, restricted only by the ability of the virus to grow in a particular cell line [12]. Furthermore, archived virus isolates are more suited for prospective and retrospective studies on viral phylogenetics since the stability of RNA and cDNA is compromised over long storage periods.

In summary, virus culture and molecular technologies in arbovirus surveillance are complementary. Undoubtedly, both systems have their advantages and shortcomings, but all things considered, diagnostic methods of detection are dictated by budget confines and analytical platforms available in a laboratory facility.

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The Yellow Fever mosquito, *Aedes aegypti*, is responsible for the spread of dengue and chikungunya viruses. This species bites during the day and while the distribution of this mosquito is currently limited to Far North QLD, it is common in many of the regions where Australians holiday, such as Bali.

(Photo: Stephen Doggett, Medical Entomology)

As urban developments continue to encroach on productive mosquito habitats, exposing residents to increased mosquito risk, constructed wetlands are also being incorporated into these new developments to assist waste-water treatment and provide wildlife refuge. The design and maintenance of these wetlands must be carefully considered so that potential public health risks are minimised.

(Photo: Cameron Webb, Medical Entomology)



Monitoring mosquito populations and the pathogens they carry is critical to informing local authorities and their mosquito-borne management strategies. Carbon dioxide baited light traps remain at the core of many surveillance programs.

(Photo: Cameron Webb, Medical Entomology)

Are we providing the right advice on personal protection measures against endemic and exotic mosquito-borne diseases

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There are many ways we can reduce the risk of mosquito-borne disease. The key components of personal protection strategies promoted by health authorities throughout the world are the use of insect repellents/insecticides (e.g. topical repellents, mosquito coils), behavioural practices (e.g. avoiding areas of times of the day when mosquitoes are most active) and physical barriers (e.g. bed nets, wearing long sleeved shirts). For most people, the first line of defence against mosquito-borne disease, either endemic or exotic is the use of a topical insect repellent. Do they know how to choose and use repellents correctly?

While there is debate surrounding the effectiveness of mosquito repellents to prevent endemic mosquito-borne disease (1), there is little doubt that the use of topical mosquito repellents, in conjunction with other personal protection measures, will greatly reduce the risks of mosquito-borne disease in travellers (2).

Cheap and rapid international travel, countries within regions generally considered to be free of many of the serious mosquito-borne diseases are seeing increases in travellers returning home suffering from illness (3). The use of bed nets, often in combination with prophylactics, have been the key personal protection strategies for those travelling to regions of endemic malaria. However, with increasing activity of mosquito-borne disease associated with day-biting mosquito species in our region, and the pathogens they transmit such as dengue (4) and Chikungunya (5) viruses, greater emphasis must be placed on the use of topical repellents.

The majority of recent cases of dengue in Australians returning from travel to Indonesia, particularly Bali, (4) and with the emergence of Chikungunya virus in our region, and Australian travellers are testing positive to infection (6), concern is rising. A record number of cases are expected to be recorded in 2013 with 112 cases confirmed as of 21 October 2013 compared to a five year average of 32.4 cases from 2008 through 2012 (7). In Australia, where day-biting mosquitoes are not widespread, our most important nuisance-biting pests and vectors of arboviruses are typically found in abundant populations and generally most active at dusk, dawn and during the evening. As a result, public health messages emphasise the use of repellents at those times (8). However, a different pattern of repellent use is required in countries where day-biting mosquitoes are present. These areas may also have substantially lower mos-

quito abundance and Australian travellers may be likely to be more complacent regarding the use of repellents.

Locally, there are around 5,000 cases of Ross River virus (RRV) disease reported every year across Australia (9). To reduce the incidents of mosquito-borne disease, there needs to be a reduction in contact between mosquitoes, the animals that may be reservoir hosts of the pathogens, and people. Broadscale mosquito control programs and a reduced risk of mosquito-borne disease has only been shown if control of mosquito populations is done pre-emptively (10). Mosquito control programs of this nature are not widespread in Australia and topical mosquito repellents are critical to reducing mosquito-borne disease risk.

The most effective repellents, shown to be effective (2), widely available in Australia are N, N-diethyl-3-methylbenzamide (commonly known as DEET) and 2-(2-hydroxyethyl)-1-piperidinecarboxylic acid 1-methylpropyl ester (commonly known as picaridin). There are distinct differences in the effectiveness and relative concentrations of these active ingredients and advice provided by local health authorities rarely reflects the wide range of commercially available repellents (11).

All products purporting to repel mosquitoes must be approved by the Australian Pesticides and Veterinary Medicines Authority (APVMA) who make an assessment on the effectiveness and safety of the products. The use of DEET-based repellents are routinely mentioned in public health warnings regarding mosquito-borne disease risk. Repeated reviews have shown that DEET is both effective and safe (12). However, repellents of this nature are often perceived to be unpleasant to use. These perceptions may lead individuals to use botanical based (or homemade) repellents. However, products of this nature provide only limited protection against mosquitoes. (13).

To effectively communicate to the community the best ways to choose and use mosquito repellents, health authorities must consider the changing formulations and new active ingredients in commercially available repellents. Perhaps there are lessons to be learnt from the campaigns associated with sun protection and use of sun screens that can be incorporated into how we encourage the community to use topical repellents.

Are we providing the right advice on personal protection measures against endemic and exotic mosquito-borne disease?

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The Centre for Infectious Diseases and Microbiology - Public Health (CIDM-PH), and Marie Bashir Institute for Infectious Diseases & Biosecurity (MBI) presents:

HEALTHCARE ASSOCIATED INFECTIONS - MORE NEW TRICKS FOR OLD DOGS SYMPOSIUM

This symposium will bring you up to date with the latest trends in HAI Prevention and Control research and practice by exploring issues such as the interface between hospital and community; innovative approaches to understanding and influencing healthcare worker behavior using video reflexive methods and advances in surveillance and control of MRSA. Our two keynote speakers, Professors Nicholas Graves and Jon Iredell will present current data on important areas of HAI prevention and control research.

Friday, 22nd November 2013
9.00am – 4.00pm
Lecture Theatre 3
Westmead Education & Conference Centre,
Westmead Hospital, Sydney

Enquiries
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Can botanical products assist the control of dengue outbreaks in Malaysia?

Liyana Mokhtar

Department of Medical Entomology, Pathology West—ICPMR Westmead, and University of Sydney

Dengue fever (DF) and dengue hemorrhagic fever (DHF) are mosquito-borne diseases of public health importance in many regions of the world (1) and is the most important arthropod-borne viral disease in Southeast Asia (2).

In Malaysia, dengue is considered as one the most important public health concerns. Although first reported in 1902 (4), the last decade has seen an increasing trend of reported dengue (5). National major dengue outbreaks exhibited a 4-year cycle as they were reported in 1974, 1978, 1982 and 1990 (6). According to the Malaysian Ministry of Health 2008 Health Facts, the incidence rate of dengue was 167.76 per 100,000 of the population with a mortality rate of 0.02.

In Southeast Asia, *Aedes aegypti* (L) has been incriminated as a primary vector of dengue viruses and *Ae. albopictus* (Skuse) as a secondary vector (3).

The geographic expansion in distribution of these two container-inhabiting mosquitoes has contributed heavily towards the increasing transmission of dengue worldwide (5). Many factors have created the ideal conditions for this expansion, especially in low- and middle-income countries, including Malaysia, with high rates of population growth, unorganized urbanization and the proliferation of slums, crowding, poor water, sewer, and waste management systems, global warming, rise in global commerce and tourism, changes in public health policy, decreasing resources for vector prevention and control, and the development of hyperendemicity.

Since no vaccine is currently available (7), and as *Aedes* breeding tends to occur in household containers, the most effective measure in dengue prevention is by management of these breeding sites and it is best achieved through vector control (8). At present in Malaysia, vector control is done primarily by spraying or fogging of the chemical insecticides. However, due to repeated use of these chemicals, there are reported cases of increased resistance of mosquitoes to commercial insecticides such as carbamates, organochlorides, organophosphates and also biological insecticides. In addition, these insecticides are potentially toxic to humans and animals and may contaminate the environment (9). These concerns have raised interest in pursuing alternatives to these products.

Plants may be a source of alternative control agents for dengue mosquitoes. They are rich in bioactive chemicals and have been shown to be active against a number of mosquitoes (10).

The chemical compositions and larvicidal properties of compounds found in the essential oil of Malaysian local plants were investigated. Extracts from *Acorus calamus*, *Litsea elliptica* and *Piper aduncum* were tested against *Aedes aegypti* according to the WHO 1981 standard guidelines. The larvicidal results showed that a component called 2-Tridecanone from *L. elliptica* demonstrated the greatest potential as a larvicide against *Ae. aegypti*.

Our current project (as part of my PhD candidature with the University of Sydney) will build on the work conducted on Malaysian plants for my MSc by investigating the potential of extracts from Australian native plants and their potential as control agents. Extracts from *Melaleuca* spp. and *Eucalyptus* spp. have been shown to exhibit repellency to *Ae. aegypti* in laboratory tests (11) and detailed laboratory testing and compositional analysis will be undertaken as part of this study. It is hoped that the results of this research may open new opportunities for the control of dengue in both Malaysia and northern Australia.

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Staff Profile

David Lilly

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Dave Lilly is a PhD candidature with the University of Sydney based in the Department of Medical Entomology, Pathology West – ICPMR Westmead/CIDM-PH, investigating insecticide resistance in bed bugs and the dynamics of infestations across Australia. He previously studied biological science at the University of NSW before completing honours in ant ecology with joint supervision from UNSW and the Australian Museum. He later worked as a volunteer at the museum on the Lord Howe Island Invertebrate Biodiversity Survey, before gaining several years of laboratory experience in insecticide screening and arthropod bioassay techniques as a Technical Officer with the Centre for Entomological Research & Insecticide Technology.

Since 2006, Dave has held the position of Technical Manager with Eagle Environmental Systems (later to become Ecolab Pest Elimination), where he received first-hand exposure to the dramatic resurgence of bed bugs across Australia. Pursuing the significant knowledge gap surrounding this pest, he undertook a Master of Entomology degree at the University of Queensland and determined that a strain of common bed bugs collected from around Sydney had developed high levels of resistance to the most commonly used insecticides.

With resistance to these insecticides being a key factor contributing to the global resurgence of bed bugs, understanding the genetic, behavioural and ecological drivers of resistance development is important. Research being undertaken to investigate the multiple mechanisms of resistance are present, or are very likely to be, in most field populations of bed bugs. One of the key areas of research will be an investigation of reduced cuticle penetration and hypersensitive behavioural avoidance of bed bugs to insecticides that may enhance other physiological forms of resistance (such as nerve insensitivity and increased detoxification). It is hoped that the findings of David's research, together with other research projects currently underway in Medical Entomology, will assist development of more effective pest control strategies.



CONTACT US

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UPCOMING EVENTS...

CIDM-PH Colloquium

Friday, 15 November 2013

Lecture Theatre 3, Westmead Education & Conference Centre, Westmead Hospital, Sydney

Program & Registration:

Visit the CIDM-Public Health website for a full copy of the program and registration form

Healthcare Associated Infections - More Tricks for Old Dogs Symposium

Friday, 22 November 2013

Lecture Theatre 3, Westmead Education & Conference Centre, Westmead Hospital, Sydney

Program & Registration:

Visit the CIDM-Public Health website for a full copy of the HAI program and registration form.

Collective Brainstorm Vexing Problems - Novel Approaches

Thursday, 28 November 2013

Liz Kernohan Conference Centre, Camden Campus, Werombi Road, Camden

More information: www.sydney.edu.au/mbi

Cost: Attendance is free. Morning Tea, Lunch and Afternoon Tea will be provided.

MBI Colloquium

Thursday, 5 December 2013

New Law School, University of Sydney

More information: www.sydney.edu.au/mbi

Official MBI Launch

Thursday, 5 December 2013

New Law School Foyer, University of Sydney

More information: www.sydney.edu.au/mbi