NEW ZEALAND BIOSECURE

BORDER HEALTH NEWSLETTER – March 2015

WELCOME!

Hi everybody. Mosquito numbers are decreasing slightly in New Zealand after the summer. We hope Australia can experience this soon. The outbreaks of Ross River Virus are alarming and we recently had a case in Nelson. Zika is also spreading: not only in Polynesia but Zika has now occurred in Germany and Belgium. But every month more research is carried out to help in the fight against arboviruses.

WEBSITE

The URL for the National Online Mosquito Database has been changed.
Please use http://www.nzbiosecure.neocom.geek.nz/sampling/Login.asp for your login.
As usual you can access the database through our website smsl.co.nz via NZBEL – Entomology Laboratory page.
We have added a new mosquito profile of *Aedes vexans* after the recent interception last month.

SAMPLES

During March 989 samples were collected by staff from 12 DHBs with 424 positive.
We had less adults *Aedes notoscripus* and *Coquilettidia iracunda* but more *Culex pervigilans* than last month and last year. In terms of larvae we had more *Ae. notoscriptus* and *Cx. quinquefasciatus* larvae than last year.

Species	Adults		Larvae	
New Zealand Mozzies	**Mar 2015**	**Mar 2014**	**Mar 2015**	**Mar 2014**
Aedes antipodeus (winter mosquito)	2	3	Nil	Nil
Ae. australis (saltwater mosquito)	1	Nil	19	56
Ae. notoscriptus (striped mosquito)	840	1990	4593	1379
Coq. iracunda	3	21	Nil	Nil
Culex astilae	Nil	Nil	16	Nil
Cx pervigilans (vigilant mosquito)	88	7	2241	1468
Cx. quinquefasciatus (southern house mosquito)	950	957	5829	1595
Opifex fuscus (saltpool mosquito)	Nil	Nil	58	59
Total	**1884**	**2982**	**12756**	**4557**

INCURSIONS/INTERCEPTIONS

We have had 2 Interceptions in March:

14.3.2015: One damaged *Cx. quinquefasciatus* male and two *Cx. pervigilans* larvae (third and fourth instar) were found at the Auckland airport X-ray room.

31.3.2015: One live female *Aedes aegypti* was found in the same X-ray room.

NEWS OF THE MONTH

News of Neglected Tropical Diseases
BIOMEDCENTRAL Bugbitten
Hilary Hurd 30 Mar 2015

Participants at the ISNTD Bites meeting, 2015

What are neglected tropical diseases (NTDs)? Mathew Baylis gives his definition at the annual ISNTD Bites meeting held in London this month.
"I see it as meaning a disease that is understudied relative to its impact".
Many of these diseases are vector transmitted or are zoonoses (diseases that can be transmitted from animals to humans) and emergent frontiers of some of them were explored during the meeting; chaired by International Society for Neglected Tropical Diseases Director, Marianne Comparet.

Many neglected tropical diseases are spread by vector insects and Matthew Baylis explained that Japananese encephalitis spanned the two major themes of the meeting as it is both a zoonosis and a vector born disease.
This mosquito borne disease is caused by an arbovirus that uses pigs and water fowl as reservoir hosts and is the most important viral encephalitis in Asia. He identified rice paddy fields as important environments for transmission and reported that the disease was spreading to higher altitudes in Nepal, possibly as a result of climate change though other factors such as rapid economic development may be involved. Matthew and colleagues have visualised his definition of a NTD (see figure below) by comparing the DALYS of many human diseases (measuring their impact) with the diseases' H indices (measuring the level of scientific interest). The diseases that fall well below the line of best-fit are under-researched and thus neglected.
One such disease, dengue fever, was the topic of several presentations. Ana Clara Silva described how education campaigns played a large part in the control of an outbreak in Madeira in 2012 while another expansion of the disease, occurring, in the Cape Verde Archipelago in 2009, was described by Patricia Salgueiro.
Her study of the population genetics of the vector mosquito, *Aedes aegypti,* showed that the Cape Verde halotypes belonged to a basal clade associated with West African mosquito populations. There were no new founder events associated with the 2009 outbreak.
Kun (Maggie) Hu stressed the importance of modelling the vector population, as well as antibody-dependent enhancement associated with the presence of four different virus serotypes, before producing an epidemiological model. The audience was directed to The Spatiotemporal

Epidemiological Modeler (STEM) tool that can be used as a framework for predictive modeling. The importance of collecting quality field work date for modeling the spatial distribution of disease vectors was emphasised by Guy Hendrickx who proposed that prospective modelers should spend at least two of their early career years devoted to field work.

The increasing recognition that a better understanding of vector response to odours is essential if repellents and baited traps are to be an important weapon in our armoury against disease vectors was reflected in a whole session devoted to this topic. Spyros Zographos outlined his rational approach to the development of mosquito repellents that entails both screening known compounds for their ability to bind to odour binding proteins and their activity in behavioural assays.
James Logan, on the other hand, focused on odours that attract mosquitoes; odour profiles changing dependent upon the stage of malaria infection, the strain of parasite and the number of infectious bites. In addition, mosquitoes are significantly more attractive to human odour when the infective sporozoites stage is present, suggesting that both parasite-induced changes in human odour production and infected-mosquitoes' response to odour could enhance transmission of the parasite by causing more bites to occur.

To find attractants for the blackflies that transmit the parasite causing onchocerciasis (River Blindness), Ryan Young describes an approach based on the identification of odours collected from arm pit and groin sweat and incubated to allow microbes too grow in it. Interestingly, field studies using traps baited with beads of sweat and carbon dioxide (produced from fermentation of sugar by yeast) collected more blackflies than human landing catches.

A novel trap that runs on energy from solar panels was profiled by Jeksle de Boer on behalf of Willem Takken's group at Wageningen University. Field tests have demonstrated that this trap, baited with a blend of carbon dioxide, ammonia and several volatiles competes well with human odour and can be used to catch mosquitoes outdoors.

Technology was the final focus of the meeting. The need for new insecticides that are long-lasting, fast working and can be brought to market quickly was emphasised by Nick Hamond from IVCC and the industry's perspective on insecticide developments, including the use of combinations of compounds with different modes of action was put by Justine McBeath from Bayer Vector Control.
The roll out of the Oxitec programme releasing genetically modified sterile male Aedes aegypti mosquitoes (see our recent blog) in the Caribbean was described by Hayden Parry, and Jeremy Bouyer (CIRAD) outlined the combination of irradiation and insecticide treatment to produce sterile male tsetse flies that will deliver insecticide to females and will soon be released from drones. A lively debate concerning the public's perception and acceptance of these new technologies ensued, during the panel discussion with participants advocating local engagement and complete transparency.

Sadly there is little room to do justice to the all the work presented at this ISNTD meeting, but I think it is becoming clear that recent efforts by the community are ensuring that the diseases discussed are emerging from under the radar of researchers, funders and industry and are, perhaps, becoming not so neglected.

Researchers Find La Crosse Virus in *Aedes japonicus* Mosquitoes

April 9, 2015 by Entomology Today
By Harvey Black

Researchers have found another invasive mosquito species that carries the virus responsible for La Crosse encephalitis in the Appalachian region. In the April 2015 edition of Emerging Infectious Diseases, Dr. Camille Harris, a wildlife disease ecologist, and her colleagues report finding *Aedes japonicus* mosquitoes carrying the virus in southwestern Virginia. This is the first time that field-collected *Ae. japonicus* mosquitoes have been found with La Crosse virus.

Prior to 2001, the only mosquito known to transmit the disease was the Eastern treehole mosquito, *Aedes triseriatus*. Then it was discovered that an invasive species known as the Asian tiger mosquito (*Aedes albopictus*) could also transmit La Crosse virus.

"With three mosquito species being able to carry the virus, there is the potential that it could persist in areas that it might not have been found before," said Harris, who conducted the research as a graduate student at Virginia Tech.

La Crosse encephalitis is the leading cause of arboviral encephalitis in children.

While many infected people remain symptom-free, the virus can cause fever, headache, nausea, vomiting, and lethargy. Children under 16 are particularly vulnerable, according to the U.S. Centers for Disease Control, and may suffer swelling of the brain, seizures, paralysis and coma. Most cases occur from early spring through the fall.

According to the CDC, most cases have been reported in the upper Midwest. But increasingly there have been more cases found in the Southeast. Between 2004 and 2013, for instance, 182 cases were reported in North Carolina and 102 cases in Tennessee. Typically, 80 to 100 cases are reported annually. "The findings certainly are very interesting in the context of states where these mosquitoes might be more abundant and more likely to feed on humans in comparison with *Ae. triseriatus*," said Dr. Susan Paskewitz, an entomologist at the University of Wisconsin-Madison who was not involved in this research.

In order to get a better handle on the situation, Dr. Harris says that researchers need to see if the live virus can be found in *Ae. japonicus* in states like West Virginia and North Carolina. Harris and her colleagues obtained samples of *Ae. japonicus* as far back as 2005, demonstrating that the invasive species had indeed found a home in the region. She obtained the samples using mosquito traps in a forested area in southwestern Virginia.

Dr. Camille Harris collecting mosquitoes from a field site, including *Ae. japonicus* mosquitoes.

Ae. albopictus was first detected in Houston in 1985 and is thought to have arrived in tire casings from Asia. It has since become widespread in the U.S. and is now found as far north as southern Ohio, Indiana, Illinois, and Pennsylvania.
Like *Ae. albopictus, Ae. japonicus* is also from East Asia and is native to Japan and Korea. It is commonly known as the Asian bush mosquito or the rock pool mosquito. It was initially found in the U.S. in 1998, and, like *Ae. albopictus*, it has become widespread around the world.
Ae. japonicus breeds in standing water, and is commonly found in forests and high elevations.
While much is known about these two species, questions still remain. For instance, researchers would like to find out more about how *Ae. japonicus* transmits the La Crosse virus. Mosquitoes are infected by the virus when females take blood meals from infected rodents, like squirrels or chipmunks. But scientists do not yet know whether *Ae. japonicus* can spread the virus vertically — that is, whether an adult mosquito can pass it on to its eggs and larvae. If so, it would clearly increase the likelihood that the virus is transmitted to humans.
Another question concerns how the virus affects the feeding behavior of *Ae. japonicus* mosquitoes. Dr. Harris points to research by Dr. Bryan Jackson and colleagues showing that it alters the way *Ae. triseriatus* feeds. In a laboratory study, infected mosquitoes took smaller blood meals from rodents and fed more frequently than uninfected mosquitoes. The same study reported that infected *Ae. albopictus* mosquitoes also took smaller blood meals from rodents, but did not feed more frequently.
In addition to La Crosse virus, there is evidence that *Ae. japonicus* may also be a competent vector of dengue fever, chikungunya, and other diseases.

VECTOR-BORNE DISEASES
Recent Local News

Zika fight underway
Solomon Star
08 April 2015
The Honiara City Council (HCC) vector borne disease division kicked off its Zika outbreak response action as of last week.
The response team carried out spraying exercise on targeted localities within the Honiara city, using backpackers bottle spraying and the ultra violet (ULV) spraying machine mounted on a truck, spraying the road sides.
HCC vector born program manager George Fafale told the paper, "As part of our response to Zika outbreak, we start our spraying exercise last week. We started again today (yesterday) after the long Easter weekend.
"Our boys use bottle backpackers to spray homes, and ULV machine to spray road sides and drains where we believe mosquitoes breed."
He said that Zika and dengue has one carrier mosquito, so his team are mainly targeting localities where suspected cases are recorded.
"The spraying exercise is mainly targeted to localities where suspected cases were, and areas vulnerable to Zika and dengue outbreak. We started at White River and will be going around the entire city."
Mr Fafale urged communities to work closely with them, and to do their own clean up around their home.
"Residents need to clean their surrounding, to prevent further out break", Fafale added.

The first case of Zika virus was confirmed by the Ministry of Health and Medical Services (MHMS) on 12th March.
Zika virus is a mild illness transmitted by an infected mosquito. It is closely related to dengue virus and causes a similar illness.
Symptoms include fever, redeye, joint pain (mainly in the hands and feet) and a rash that often starts on the face and spreads throughout the body. These symptoms usually last for two to seven days.
An outbreak of Zika has not been declared in Solomon Islands; however outbreaks have been recently reported in other Pacific Island countries.
There is no vaccine or any specific medicine to treat Zika, but people can protect themselves and their families from being bitten by mosquitoes. Insect repellent, mosquito nets and wearing long sleeves and pants can prevent mosquitoes bites. Throwing away or emptying the water from containers lying around gardens can prevent mosquitos laying their eggs around houses.
The Disease Surveillance Unit and National Vector Borne Disease Control Program of the Ministry of Health and Medical Services (MHMS) are working with the World Health Organization to identify the emergence of any zika-like cases in Solomon Islands and to reduce mosquito populations.
How to protect yourself and your family from Zika:

Urine Sample Better Test Than Serum Test in Zika Virus Patients
MD, Feb 13, 2015 by Rachel Lutz

Urine samples can successfully be used for the detection of the Zika virus (ZIKV), a mosquito borne pathogen, according to a study published in Emerging Infectious Diseases.
Researchers from the Institut Pasteur in New Caledonia investigated the diagnostic utility of urine as a source for detection of ZIKV RNA by real-time reverse transcription PCR (RT PCR). Previously, confirmation of ZIKV infection is based on detection of virus RNA in serum by using RT PCR.
In humans, ZIKV manifests in the form of a mild fever, arthralgia in small joints like hands and feet, myalgia, headache, retro-orbital pain, conjunctivitis, and cutaneous maculopapular rash. The disease is often asymptomatic or mildly symptomatic in most cases. However, because of this it is often also misdiagnosed. It is believed to be transmitted to humans by infected mosquitoes, and was isolated in 1947 from a rhesus monkey in the Zika forest in Uganda. An epidemic of ZIKV occurred in the South Pacific region in 2007, leading researchers to determine that ≤70 percent of the region had been infected.

The clinical symptoms of 6 ZIKV patients were recorded, including maculopapular rash of the trunk and extremities. A blood count demonstrated discreet perturbation common in many viral infections like mild leucopenia and thrombocytopenia associated with activated lymphocytes.
In order to detect ZIKV in samples, 2 sets of primers/probes specific for ZIKV were used. The blood samples were tested for dengue virus and chikungunya virus by real time RT PCR and showed negative results.

http://www.huffingtonpost.com/2013/09/08/what-is-in-pee-urine-chemistry

ZIKV virus was initially detected in 4 out of the 6 patients in which symptoms were demonstrated. Then, urine samples from 2 other patients were also ZIKV positive, and showed a higher viral load than corresponding serum samples. To compare, the researchers tested urine samples from 6 healthy patients and found no detection of ZIKV.

The researchers commented that because ZIKV is primarily benign and poorly described, the infection has likely been underdiagnosed and underreported in disease endemic settings or in returning travelers.

"ZIKV was detected in patient serum until a rash was observed (days 2-3 after disease onset)," the authors wrote, while noting that future studies into this topic would likely evaluate whether live infectious ZIKV are excreted in patients' urine to observe for other arboviruses. "However, urine was preferred for virus detection. We observed a slight increase in ZIKV RNA from urine over the first few days after disease onset and rash."

Though it was a small sample of ZIKV positive patients, the results suggest that urine would be useful in ZIKV positive confirmation because the virus was detected at higher levels and for a longer duration than in serum samples, the authors concluded.

Hundreds infected by Ross River Fever virus after mosquito onslaught in Sydney and coast

The Sydney Morning Herald

March 18, 2015 by Harriet Alexander

A rampant summer of Ross River fever is set to extend into autumn, with high tides and predicted warm weather expected to cause a fresh outbreak of the mosquito-borne virus in time for the Easter holidays.

The virus has infected NSW residents at a rate seven times higher than last year, with 539 notifications in the year to date, compared with 79 this time last year.

NSW Health issued its second alert of the year on Wednesday warning people to take extra precautions to avoid becoming infected.

Director of Communicable Diseases Dr Vicky Sheppeard said the next few weeks, when many people would be spending the Easter break outdoors, were ideal breeding conditions for mosquitoes.

"Autumn is the peak time of the year for these insects to carry such infections so it is also when there is the highest number of mosquito-borne viral infections," she said.

"It is possible that these mosquitoes will be carrying the even more serious viruses such as kunjin and Murray Valley encephalitis," she said.

A mosquito boom is expected to ensue from the high tides this weekend, which will inundate the wetlands where they laid their eggs during summer.

The University of Sydney's Cameron Webb, who is also principal scientist at NSW Health Pathology, said the conditions were set last year, when the warmest spring on record was followed by a wet start to summer.

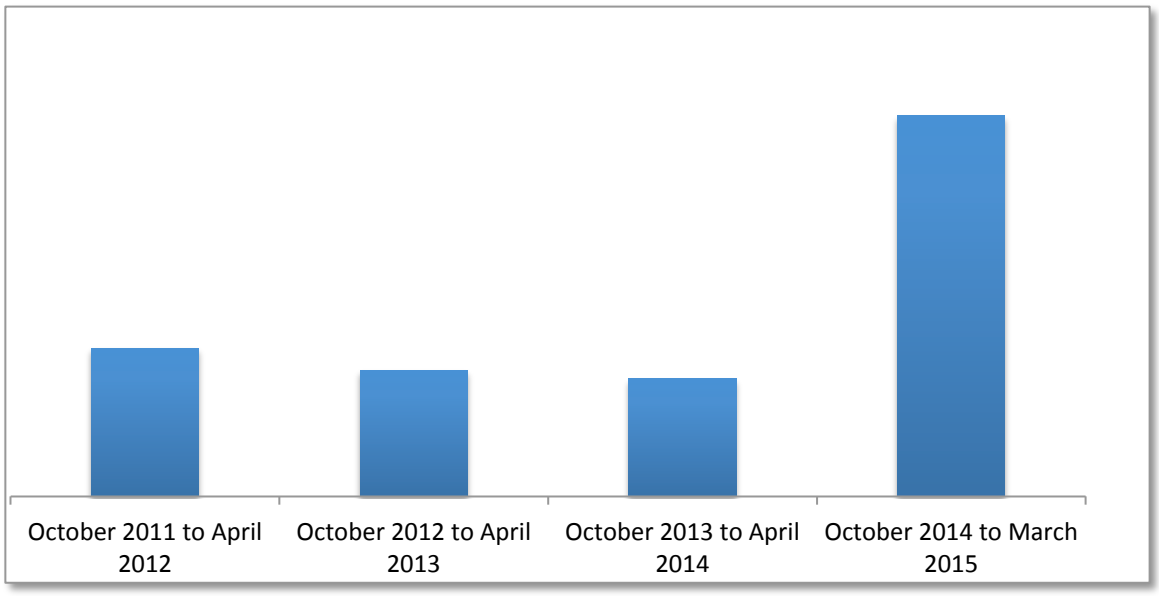
"That really kickstarted one of the worst years for that we've had for mosquitos for quite a while," Dr Webb said.

"We're currently expecting a lot of our coastal wetlands to be flooded by high tides so the environmental conditions are probably conducive to mosquito populations in the next few weeks and unfortunately that continues with the school holidays."

The areas facing the greatest risk of disease outbreak in the Sydney metropolitan area were the Hawkesbury River, the Parramatta River and especially the Georges River, which is surrounded by bushland and hopping with kangaroos and wallabies who spread the virus, Mr Webb said.

Most people who have contracted the virus this year lived on the NSW north coast.

Symptoms included tiredness, a rash, fever or swollen joints and could take anything from days to months to resolve.
NSW Health is urging people to use mosquito repellant and fly screens and to ensure that items that hold water around the house are emptied.



W

Ross River virus infection in NS by highest months of disease onset January 2011 to March 2015

The arbovirus monitoring program has detected Ross River virus and Barmah Forest virus among mosquitos around the Georges River, Hawkesbury and Homebush.
Dr Sheppeard said symptoms included tiredness, a rash, fever or swollen joints and could take anything from days to months to resolve.
"There is no specific treatment for these viruses," Dr Sheppeard said.
"The best way to avoid infection is to avoid being bitten by mosquitoes."
NSW Health advises people to cover up when outside, use mosquito repellant and fly screens and to ensure that items that hold water around the house are emptied.
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WPRO: Pacific syndromic surveillance report
Week 14, ending 5 April, 2015
Zika virus: Solomon Islands- samples of suspected cases sent to the Institut Louis Malardé (ILM), French Polynesia have been confirmed RT-PCR positive for Zika virus. As of 6 April 2015 there have been 240 Zika like illness cases since February 2015.

Chikungunya outbreak is on-going in Cook Islands. Weekly number of cases in American Samoa, Kiribati and Samoa has reduced significantly.

Dengue outbreak is occurring in the Macuata Province, Northern Health Division, Fiji. Dengue serotype-2 has been identified by the ILM, French Polynesia. The number of cases is decreasing.
Tonga dengue serotype-3 has been identified by Labplus, Auckland, New Zealand. There have been 32 dengue-like illness cases for week ending 5 April 2015.

ESR: 2014 Monthly Surveillance Report
Monthly Notifiable Disease Surveillance Report - Mar 2015

Chikungunya fever: 10 cases (9 confirmed and 1 probable) were notified in February 2015 compared to no cases notified during the same month of the previous year All cases reported overseas travel during the incubation period to Samoa (6 cases), Kiribati (2 cases), Cook Islands, Fiji, French Polynesia and South America (1 case each). Two cases reported travel to more than one country.

Ross River virus infection: One confirmed case was notified in February 2015. The case was a female in the 60–69 years age group from Nelson Marlborough DHB who was in Australia during the incubation period.

USA

Florida Keys Hope To Add New Weapon In War Against Mosquitoes: Genetic Modification
LRN Miami South Florida
8.4.2015 by NANCY KLINGENER

In the fight against mosquitoes in the Florida Keys, domestic inspector Carrie Atwood has a few indispensable tools. She carries a dipper — essentially, a plastic cup at the end of a stick. She has a flashlight for looking into the backs of plants and pots. And she has a turkey baster.
"That's good for getting into bromeliads, which is a plant that holds water at the base of the leaf," Atwood said. "We use that to dip in there, or just any other kind of tight space where the dipper won't go."

The Florida Keys Mosquito Control District deployed domestic inspectors like Atwood to look for mosquito larvae, especially aedes aegypti mosquito larvae, after a 2009 outbreak of dengue fever on the island city. And the effort has been effective. The Keys haven't had a reported case of dengue since 2010 and have never had a reported case of chikungunya, another disease carried by aedes aegypti.
But the Keys agency is still seeking FDA approval to add a new high-tech weapon to its war against mosquitoes: genetic modification. If the FDA approves, it will be the first such release in the nation.

Carrie Atwood, a domestic inspector for the Florida Keys Mosquito Control District, uses a flashlight to search for aedes aegypti larvae. Credit Nancy Klingener / WLRN

"It's prevention," said Michael Doyle, executive director of the district. "If you're building a house, you put in a sprinkler system not because the house is on fire right now but because, at some point someone's going to drop a match or something's going to happen that could cause a fire," Doyle said. "As far as dengue or chikungunya is concerned, if infected people were matches, there's matches dropping in Key West or the Keys all the time."
The Keys have long used aggressive tactics in one of the country's most challenging places to combat mosquitoes. And it's not just the aedes aegypti. Outside of Key West, in the more rural

areas of the Keys, mangroves and tidal pools breed billions of salt-marsh mosquitoes.
"It's one of the reasons why people didn't live much out of Key West for centuries, really," Doyle said.
The district sends planes and helicopters to spray those areas with larvicide.
"I did the math once," Doyle said. "We cover an area from Key West to Bangor, Maine each year — a football field wide. That's the surface area of the water that grows mosquitoes."
Because of its small population and a large mosquito breeding territory, Keys residents pay the most per capita for mosquito control in the state of Florida, about $160 per resident. That's more than seven times as much as Pasco County and about 100 times as much as Orange County. Compared to Miami-Dade, the Keys' closest neighbor, Monroe residents pay 280 times more per person.
Michael Doyle said that's why his agency is open to new ideas for beating back the insect.
"We grow more mosquitoes per capita than anywhere else in the state, probably the country," he said.
The genetically modified mosquitoes are bred in a lab in England and would be shipped to the Keys as eggs. The modified male mosquitoes would breed with wild females. The genetic modification kills the offspring before they become adults that sting.
The testing ground for the experiment would be Key Haven, a peninsula with 440 homes about a mile and a half up the road from Key West.
Real estate agent Beth Eliot has lived on Key Haven for six years. She says she researched the issue and opposes the test. She's concerned that a few genetically modified female mosquitoes could be released along with the males — and female mosquitoes bite.
"Right now, they're saying they think it's safe and they don't think it will pose a problem," she said. "But I don't want to be part of that human experiment."
Doyle said that, while this may be the first test in the U.S., the genetically modified mosquitoes have been tried in other places, like Brazil and the Cayman Islands, and they've worked there. He's hoping they'll work in the Keys as well, so the district can reduce its reliance on existing technology from turkey basters to helicopters — at least when it comes to aedes aegypti.

Europe

Profile: Mosquitoes - bringing disease to Britain?
The National
MARCH 24TH, 2015 - 12:30 AM NAN SPOWART
THE world’s most effective killer has arrived in the UK and could soon become widespread.
The mosquito, which is responsible for around half the deaths in human history, has been found in England and it is predicted that this is just the start of a mass invasion.
A species of Culex mosquito, the main carrier of the West Nile virus, has been discovered in the south of England and it is feared that climate change will bring the even more deadly Asian tiger mosquito, a carrier of the tropical diseases, chikungunya and dengue fever.
This mosquito, the Aedes albopictus, has already been found in 25 different countries in Europe but the UK has so far been spared as frosts kill the larvae and eggs.
However, health experts believe climate change will bring warmer and wetter rainfall which will create ideal conditions for the deadly mosquitoes.
Just a two degree rise in temperature could extend the creature’s geographical spread by 30 per cent according to a new report in Lancet Infectious Diseases which goes on to state that the UK should be on guard against the invasion.
“We are not suggesting that climate change is the only or the main factor driving the increase in vector-borne diseases in the UK and Europe, but that it is one of many factors including socio-economic development, urbanisation, widespread land-use change, migration, and globalisation that

should be considered," said Professor Steve Leach, from the emergency responses department at Public Health England.

"Lessons from the outbreaks of West Nile virus in North America and chikungunya in the Caribbean emphasise the need to assess future vector-borne disease risks and prepare contingencies for future outbreaks."

There have already been outbreaks of chikungunya in France and Italy, malaria in Greece and the West Nile virus in Easter Europe. No human cases of the latter have been recorded in England so far despite the arrival of the carrier mosquito.

"Given the on-going spread of invasive mosquitoes across Europe, with accompanying outbreaks of dengue and chikungunya virus, Public Health England has been conducting surveillance at seaports, airports, and some motorway service stations," said co-author Dr Jolyon Medlock.

"A better system to monitor imported used tyres, in which disease-carrying mosquitoes lay their eggs, needs planning."

MOSQUITO WORLD OF SCIENCE

UGA researchers find hormone receptor that allows mosquitoes to reproduce

April 8, 2015 by J. Merritt Melancon and Mark Brown

Athens, Ga. - University of Georgia entomologists have unlocked one of the hormonal mechanisms that allow mosquitoes to produce eggs.

The results provide insight into how reproduction is regulated in female mosquitoes, which transmit agents that cause malaria and other diseases in humans and domestic animals. Their work was published in the April edition of the Proceedings of the National Academy of Sciences.

Mosquitoes feed on sugar water in Mark Brown's endocrinology lab at the University of Georgia. (Credit: April Sorrow/UGA)

The model for this research is the yellow fever mosquito, *Aedes aegypti.* Females have to consume a blood meal before they are able to produce a batch of eggs. The blood meal triggers the mosquito's brain to release two hormones, an insulin-like peptide known as ILP and an ovary ecdysteroid-ogenic hormone known as OEH, which activate processes in the female mosquito that result in mature eggs. Many hormones, including OEH and ILP, act through receptors on the surface of cells. In 2008, study co-authors Mark Brown, a professor of entomology, and Michael Strand, a Regent's Professor, characterized the receptor for ILP in mosquitoes, which helped reveal many details about its role in egg formation. OEH plays an equally important role in female reproduction, but its receptor was more difficult to identify.

"From previous work, we knew that the fruit fly Drosophila melanogaster does not produce OEH. A different group of fruit flies, including Drosophila mojavensis—as well as all mosquitoes we had genomes for—do have OEH," said the study's lead author Kevin Vogel, a postdoctoral fellow also in the College of Agricultural and Environmental Sciences' entomology department.

"Most hormones bind a single receptor, so we hypothesized that an OEH receptor should be found in mosquito genomes as well as Drosophila mojavensis, but not in the genome of Drosophila melanogaster."

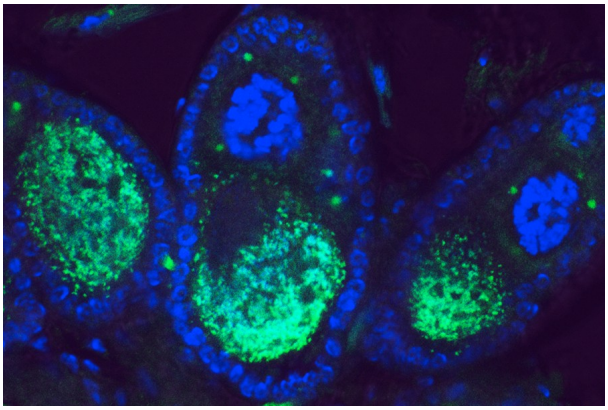
By identifying and comparing the sequences of more than 400 receptors in the genomes of two fruit

flies and three mosquito species, they identified a single gene for a receptor with an unknown function within the species distribution they expected.
By targeting the gene encoding the receptor, the authors found that disabling its expression inhibited the mosquitoes' ability to produce eggs after a blood meal.
"This receptor fills a major gap in our understanding of the regulation of mosquito reproduction," Strand said. "Going forward, we are well positioned to better characterize the steps leading to egg production and potentially identify points at which we can disrupt reproduction and control mosquito populations."

DID YOU KNOW?

Virus-blocking Wolbachia may make dengue history
A team of researchers is plotting the elimination of dengue
Science Translational Medicine
Washington Apr 9, 2015
Cameron Simmons from the University of Melbourne said that the discovery could lead to improved strategies to reduce the incidence of dengue.
Simmons noted that they did a "real world" experiment and allowed mosquitoes infected with Wolbachia and uninfected mosquitoes to feed on the blood of Vietnamese dengue patients, adding that their team then measured how efficiently Wolbachia blocked dengue virus infection of the mosquito body and saliva, which in turn steps stops them spreading the virus between humans.
Researchers developed a mathematical model of dengue virus transmission and used the experimental results as a basis to predict how well Wolbachia would reduce the intensity of dengue transmission under a variety of scenarios.
They found that Wolbachia could eliminate dengue transmission in locations where the intensity of transmission is low or moderate and in high transmission settings, Wolbachia would also cause a significant reduction in transmission.
The findings are important because they provide realistic measures of the ability of Wolbachia to block transmission of the dengue virus and provide precise projections of its impact on dengue infections, added Simmons.
Wolbachia has been recently introduced into Cairns and Townsville and the results of this study suggest future dengue outbreaks in these cities should be much less severe than in the past.
Simmons said that the results will enable policy makers in dengue-affected countries to make informed decisions on Wolbachia when allocating scarce resources to dengue control.

PICTURE OF THE MONTH



Wolbachia bacteria (in green) infect the ovaries of a malaria-transmitting mosquito IMAGE: ZHIYONG XI / MICHIGAN STATE UNIVERSITY

NEW ZEALAND BIOSECURE

MOSQUITO WORLD-DISCUSSION

PERSONALIZED MEDICINE' IS FATAL FOR MOSQUITOES

Health and Medicine, Purdue University
April 7, 2015 by Natalie van Hoose

A new class of chemical insecticides may provide a safer, more selective way to control the mosquitoes that transmit key infectious diseases such as dengue, yellow fever, and elephantiasis.

Known as dopamine receptor (DAR) antagonists, the chemicals beat out the neurotransmitter dopamine to lock into protein receptors that span the mosquito cell membrane. Disrupting the mechanics of dopamine—which plays important roles in cell signalling, movement, development, and complex behaviors—eventually leads to the insect's death.

Researchers used the mosquito genome to pinpoint chemicals that will be more selective than current insecticides, which bind readily to molecules in humans and non-target insects, says Catherine Hill, professor of entomology at Purdue University. "These are sophisticated designer drugs. They're like personalized medicine for mosquitoes—but in this case, the medicine is lethal."

The findings show that DAR antagonists have high potency for both the larval and adult stages of the *Aedes aegypti* mosquito—which transmits yellow fever, dengue, and chikungunya.

A companion study, published in PLOS Neglected Tropical Diseases, shows their potency against *Culex quinquefasciatus*, the vector of West Nile virus and the disfiguring disease elephantiasis.

Overuse of antibiotics and insecticides has led to a "double whammy"—the rise of drug-resistant strains of infectious diseases and the emergence of mosquitoes that can withstand conventional pesticides, Hill says.

"There's an urgent need for new insecticides. We are seeing a resurgence of infectious diseases that for the last 50 years we had the luxury of controlling with antibiotics and modern medicine. These diseases are increasingly going to become a problem for people everywhere."

The DAR antagonists were designed to disrupt molecules that are crucial to mosquito survival. The chemicals are structurally distinct from existing insecticides and target a different biochemical path in the mosquito. The insecticides could be cost-effective compared with current products and would have low environmental impact because of their selectivity, Hill says.

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The researchers are also taking steps to minimize the risk that the insecticides could bind with human dopamine receptors, says coauthor Val Watts, professor of medicinal chemistry and molecular pharmacology. "Many of the compounds we've identified are selective for mosquito receptors versus human receptors—some at a more than one hundredfold," he says. "Also, some of these compounds are already used as treatments for diseases such as schizophrenia and depression. They are safely handled by physicians and pharmacists every day."

The tougher challenge may be ensuring the insecticides do not affect beneficial insects such as honey bees. While the researchers have identified chemicals that are highly selective for mosquito receptors, they are also exploring the possibility of heightening insecticide specificity by using allosteric modulators, molecules that act like dimmer switches, dialing up or down the cell's response to dopamine. Similar protein receptors exist in the African malaria mosquito, the sand fly, and the tsetse fly, suggesting that DAR antagonists could help control these disease-transmitting insects as well.