COOK ISLANDS **NATURAL HERITAGE** TRUST

Report on the study of Culicoides "sandflies" on Ootu, Aitutaki and on Mitiaro.

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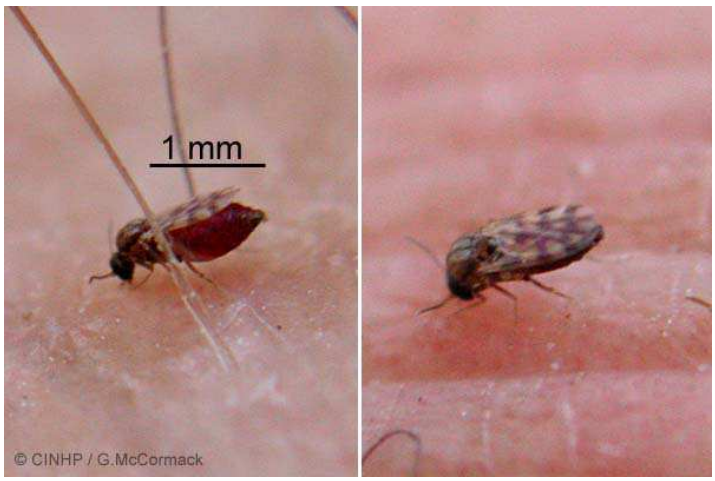
Executive summary

An international team of scientists undertook a field study on Aitutaki and Mitiaro of Belkin's Biting-midge, *Culicoides belkini*, locally known as "sandflies". The biting midge has been a serious nuisance to residents and visitors on Aitutaki since the early 1960s, and on Mitiaro since about 1980.

On Aitutaki the focus was on Ootu where it was found that the midges did not breed on ordinary sand beaches, but almost all bred at the water's edge in the Via Mokora, north of Aitutaki Village. Removing this breeding site by infilling, or suitable modification to remove the gradual water-land interface would dramatically reduce the number of midges and the level of biting. There is probably a breeding site on motu Ee to the south; midges from this location could easily fly to Akitua motu and probably also to Ootu.



On Mitiaro the team concluded that midges did not breed on the beaches nor within the village, and that the midges biting in the village were coming from the central swampland. With no reasonable possibility of disrupting the breeding site or of creating a barrier for the village, it was concluded that the control had to be around and within houses. Trapping within a recently closed house showed that midges were resting within the house.

It was concluded that the careful use of a residual pyrethroid insecticide might be effective if applied to the mosquito screens over windows, as well as to ceilings and upper walls. There could also be experimentation with light traps associated with insecticides, and with reducing outside lights which attract midges from afar. The insecticide recommended was Bifenthrin due to its long-lasting potency, and lack of repellence and irritability to insects.

It would also be useful to do some controlled experiments on the use of topical anti-itch remedies, such as *akari pi* and *akari* with lavender oil.

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Introduction

Belkin's Biting-midge *Culicoides belkini*, locally called a "sandfly", has been a pest on Aitutaki since 1964 (Duval, 1978) and Mitiaro since 1980 (pers. obs.)

The biting midge is much smaller than a mosquito but its bite is much more painful. It does not transmit any disease among people; however, the initially painless bite develops into a very itchy red welt. The intense itching usually lasts one to two days and scratching can easily lead to an infection.

This field study, the first since 1974, was organised by the Natural Heritage Trust with scientists from the United States (Lee Cohnstaedt of USDA), Australia (Glenn Bellis of AQUIS), New Zealand (Peter Maddison, retired Pacific entomologist) and the Cook Islands (Maja Poeschko of MoA and Gerald McCormack of NHT).

The team spent 10 days on Aitutaki (17-26 January) and 4 days on Mitiaro (26-30 January).

Aitutaki

On Aituaki the focus was on Ootu, where biting midges, also known as no-see-ums, are a serious nuisance to visitors and residents, especially during the summer months. They are particularly abundant 2-3 days after heavy rain when the humidity is high. The peak biting time is around dusk, although they continue biting throughout the night with a second peak around dawn. During the day they do not bite and the team was unable to locate their resting sites, although it was probably mainly under foliage.

Using emergence traps, sticky traps, and light traps in association with food dyes, it was shown that the vast majority of the midges biting on Ootu and motu Akitua came from the swamp Vai Mokora, 100m north of Aitutaki Village. They were mainly breeding within a metre of the edge of the water which rose and fell slightly in relation to the tide and rain fall.

The research discovered that this particular midge was unusual because newly hatched females laid eggs without a blood meal, although they required blood meals to lay subsequent batches.

There was insufficient time to determine how long the midges live. However, the literature reports that a close relative, Queensland's *Culicoides brevitarsis*, when fed on 10% sucrose had 50% adults alive two weeks after emergence, 25% alive after three weeks, a few survived 28 days and all dead by 35 days (Campbell & Kettle 1975). In general terms, we can expect Belkin's Biting-midge to survive about two weeks and lay 2-3 batches of eggs, the first without a blood meal and subsequent laying dependent upon the availability of blood meals.

We recorded marked females flying 350 metres from the swamp, and concluded that they can probably fly 1-2 kilometres in search of a blood meal before returning to the swamp to lay eggs.

We found no evidence that the midges breed on clean calcareous sandy beaches such as those bordering Ootu and Akitua, although they were breeding in the muddy intertidal zone opposite the entrance to the airport terminal and near the quarry of Viapeka.

The team found some evidence that they sometimes breed in landcrab (*Cardisoma carnifex*) holes. Research in French Polynesia (Duval 1976) concluded that landcrab holes were significant breeding sites when they flooded after heavy rain. Further research is required to determine the significance of crab holes as breeding sites.

For Ootu we concluded that infilling or modifying the swamp Vai Mokora to remove the breeding site would greatly reduce the biting problem. Killing the larvae in the pond is not an option because there is no suitable larvicide; the periodic application of a chemical mono-film does not kill them because, unlike mosquito larvae, they are completely aquatic; changing the salinity is not effective because the larvae can tolerate salinity from 2% to over 50% (seawater is 3.5%); and the use of an insecticide in the water would kill other aquatic life, such as dragonfly larvae, which are beneficial in eating midges and mosquitoes as adults. The most effective way to remove the larvae is to infill the pond or to modify it with a wall to make an abrupt transition between a central pond and a dry surround.

The midges biting on motu Akitua at the Aitutaki Lagoon Resort & Spa are mainly from the Via Mokora, although some probably fly north from motu Ee, which also has a breeding site.

The team did not have time to investigate the Culicoides situation on the west side of Araura, except for a brief visit to Eikura Turia's section south of the Pacific Resort. She reported periodic invasions on her beach, but not inland of the beach. There was no time to investigate the origin of these swarms, noting that there was no brackish breeding site in the immediate vicinity.

The midges biting on the coast further north near the old runway were probably breeding in the intertidal swamplands along the south side of the old runway. We trapped considerable numbers in the swamp opposite the road to the airport terminal and large numbers in an intertidal inlet near the quarry. The Viapeka-Vaitupa wetland is obviously a major breeding area and Amuri, at less than two kilometres away, is probably within flying distance for blood-seeking females. More research is required to understand the movement of these midges.

People reported that they mainly encountered the biting midges on beaches rather than inland. Apart from experiments showing that they do not breed on clean-sand sloping beaches, the team could not determine if midges were more common on beaches or if this is where people are more likely to relax in the evening when midges mainly bite. With biting experiments the team found that midges have a peak biting time around 7pm and continue at a lower rate throughout the night. Residents reported a second peak around dawn.

Mitiaro

With the background knowledge of the midge specialists and the information from Aitutaki, the team agreed with the residents that the midges were breeding in the large central swampland. The team found no likely breeding sites in the village. From the Aitutaki experiments it was concluded that they did not breed on the sloping clean-sand beaches of Mitiaro, although the popular beaches were where residents reported being commonly bitten. As on Aitutaki, it might be that people are on the beaches during the dusk biting peak.

The research focused around two houses near the inland swampland that had been recently evacuated by the families because of midges. The team found a strong peak of biting around 7pm and trapped 1,000 midges within one house that had its windows closed for two days. It was concluded that the midges were resting within the house.

Based particularly on the midge knowledge of Lee Cohnstaedt, who works on controlling midges that bite deer on American farms, it was suggested that the best way to reduce the biting problem within homes was to use a residual pesticide, especially Bifenthrin, which is long-lasting and has low levels of midge repellence and contact irritability. People should vacate their homes while the upper walls and ceilings are sprayed until damp (NOT wet!). The same insecticide could also be applied to mosquito screens on windows and used to soak curtains.

Lights attract midges; it was suggested that outside lights should be dim and downward pointing so they do not attract distant midges. The walls around outside lamps could have residual insecticide to kill resting midges.

There is a need to experiment with the use of residual insecticides, the positioning and colour of lights, and simple midge traps. Most residents are using *akari pi* on midge bites; there is a need to experiment with low cost repellent and anti-itch liquids.

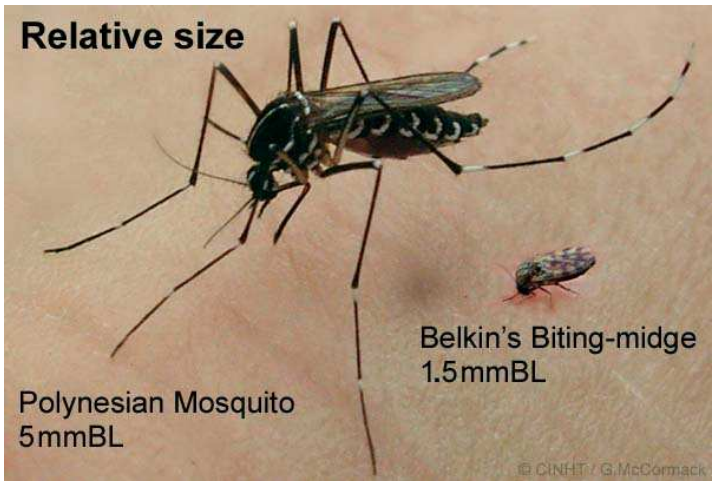
The Trust will follow-up on these options with Tata Vaeau of Public Health, Henry Wichman and Maja Poeschko. Mr Cohstaedt suggested that one of his midge researchers might be able to visit to do further experiments in early 2016 if we could cover in-country expenses.

The Trust has requested a project extension and this has been approved by NES (7th Feb).

Culicoides size and distribution

Belkin's Biting-midge is very small, about 1.5mm long, and biting-midges are widely known as no-see-ums, short for "no see them". In the Cook Islands they are known as "sandflies", although they are not closely related to the sandflies of New Zealand and elsewhere.

The composite image (right) shows the day-biting Polynesian Mosquito and Belkin's Biting-midge at the same scale. The midge is so small that it can easily pass through mosquito screens.



Belkin's biting midge is probably native from PNG to Samoa. It was first noted as a pest on Borabora in 1961; in the early '60s it appeared on Tahiti at Fa'a'a, other Society islands, various Tuamotu islands and on Aitutaki.

How it spread is unknown, but transportation of adults on aeroplanes was suspected, along with natural dispersal on favourable winds, or by boat for shorter distances.

It was recorded on Aitutaki in 1964, Manuae in 1969 and Mitiaro by 1980. Adults could have covered the short distances within the Cook Islands as stowaways on boats, or in the wind.

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Appendix: Notes on pyrethroid insecticides

Residual insecticides

Pyrethroid insecticides are in widespread use as fast knockdown and residual sprays and in mosquito coils.

The four pyrethroids commonly used as residual sprays are:

1) **Permethrin**: Permethrin is widely used in domestic and industrial settings. It is commonly used in domestic aerosols, to impregnate clothes and netting, and in passenger planes entering New Zealand and Australia (2007 MAF & AQIS). It has strong repellent properties due to its high volatility, and it degrades rapidly in direct sunlight.

2) **Deltamethrin**: Deltamethrin is widely used in domestic and industrial settings. It is commonly used to impregnate fabrics, and as a long lasting treatment for mosquito nets. It is not used on clothes because it irritates the skin of mammals. It also irritates insects which can prevent them landing long enough to be poisoned.

3) **Cyhalothrin**: Cyhalothrin is long lasting; it is not broken down by sunlight and not soluble in water, but it is degraded on contact with soil. It is not a contact irritant and is not a repellent due to low volatility. It is ideal for use in barrier fabrics. Lambda-cyhalothrin is a combination of several chemical orientations and is widely used.

4) **Bifenthrin**: Bifenthrin is the longest lasting of all pyrethroids; it is not broken down by sunlight, it has low solubility in water and it remains active in soil. It is neither a contact irritant nor vaporous repellent. It is ideal for use in barrier fabrics and to treat surfaces, and it works well in insecticidal sugar traps. It should not be used near aquatic systems as it is highly toxic to fish and other aquatic life, as are the other pyrethroid insecticides.

In general, pyrethroids are mixed with piperonyl butoxide (PBO) which increases their insecticidal properties by neutralising the insect enzymes that detoxify them.

Commercially available residual insecticides

All the following insecticides have NZ Food Safety approval Type B, which means they can be used in houses, shops, restaurants and factories, but should not be used in areas with exposed edible products or where there are packaging materials for edible products.

1) Recruit™ 100 SC (Active ingredient: 100 g/L bifenthrin)
Recruit is a general residual insecticide spray for indoor and outdoor use. Available from Key Industries.

2) Maxxthor 100 (Active ingredient: 100 g/L bifenthrin)
Maxxthor is a general-use residual insecticide spray registered for inside and outside use. Available from Ensystex NZ Ltd, Auckland.

3) Key Delta Aqua (25g/L Deltamethrin)
Key Delta Aqua is a knock down, residual and repellent insecticide for the control of ants, spiders, cockroaches, fleas, flies, and mosquitoes in domestic, industrial and public health areas. Available from Key Industries and used by the Cook Islands Ministry of Health (Tata Vaeau, pers. comm.).

4) Key Strike Out (200 g/L cypermethrin with zeta technology)
Strike Out is a residual insecticide for indoor and outdoor use. Available from Key Industries and used the Cook Islands Ministry of Health (Tata Vaeau, pers. comm.).

What are pyrethroid insecticides?

Pyrethrins are natural insecticidal chemicals extracted from the flowers of a Chrysanthemum, and the natural mixture of six Pyrethrins is known as Pyrethrum. Pyrethroids are synthetic or man-made

chemicals that have the insecticidal features of the Pyrethrins, but they are more potent and remain potent for a longer time. There are many different pyrethroids used as insecticides, and their names end with " thrin".

Almost all the household Raid, Mortein, PeaBeu, Budget and Ultrapel aerosols and coils sold in Rarotonga supermarkets and shops contain synthetic pyrethroids, such as: Tetramethrin, Permethrin, Allethrin, Cypermethrin, and Bioresmethrin. The one aerosol advertised as having natural Pyrethrins actually has 88% synthetic pyrethroids and only 12% natural Pyrethrins.

In addition to their domestic use, synthetic pyrethroids are used on all aircraft to New Zealand and Australia. The residual disinsection is 2% Permethrin every eight weeks to give a layer 0.2g/m^2 Permethrin on all internal surfaces. The alternative is aerosol spraying of the cabin with the passengers seated using 2% d-Phenothrin at 10g aerosol per 28m^3. Synthetic pyrethroids have been in use for over 30 years and account for 25% of the world insecticide market, and they are used against a wide variety of pest insects.

Synthetic Pyrethroids and the natural Pyrethrins are powerful neurotoxins to insects, fish and crustaceans, but are very mild toxins to mammals and birds. This means that when used in low concentrations they are lethal to insects but non-toxic to people and other mammals.