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Risk Manage-ment

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Risk Management Planning for a Future Screw-worm Fly Incursion. Are they Adequate?

Lecture given at the Australian National University 8 December 2005

Abstract

Following the Screw-worm Fly Emergency Preparedness Conference held in Canberra in 2001 numerous recommendations were made. They included enhancing surveillance, undertaking essential research to improve the potential of the sterile insect technology (SIT), updating the bio-economic model for a possible screw-worm fly incursion and resolving the management and coordination of the screw-worm fly preparedness strategy.

It is now four years since this seminal meeting and an appraisal of some of the key recommendations and their implementation is considered timely.

Introduction

I do not know whether anyone here needs reminding that screw-worm fly (SWF) is one of the most horrific insect pests known to man and the greatest and closest entomological threat facing Australia's livestock industries. Its impact on human health would also be significant. Larvae of SWF invade living flesh and excavate muscle tissue by ripping open the capillaries with their mouth hooks, thereby causing deep lesions and blood loss.

Such physical damage can result in disfigurement in humans, loss of condition, maiming and ultimately death in host animals.

The cost to Australia of a screw-worm fly incursion is now estimated at about $1 billion per annum (Kwabena Anaman, personal communication and Anaman et al. 1993).

An historical perspective

Twenty years ago, Australia had the capacity to respond to a SWF incursion by the Old World screw-worm fly, *Chrysomya bezziana* (OWS), through the deployment of the sterile insect technique (SIT).

A fly factory in Papua New Guinea based at a disused PNG Government dairy farm at Laloki some 25km from Port Moresby and close to Jackson's International Airport, had the capacity to rear at least 50 million sterile flies per week. Such sterile fly production would have provided a meaningful response if SWF had been detected in Australia. At that time, an Australian Bureau of Animal Health review (Anon 1979a) noted that such a number would be adequate if the fly was detected reasonably soon after entry.

This view was endorsed by the chief staff veterinarian from the highly successful US-based program for the eradication of New World screw-worm fly, *Cochliomyia hominivorax*, (NWS) from the USA and Central America (Anon 1979b).

In the event of an incursion being detected in Australia, funding for a major expansion of the facility would no doubt have resulted in an even greater capacity for rearing flies for deployment over infested areas.

However, the support for a response capability and a resolve to maintain or upgrade this capacity began to change in the late 1980s to one of "risk assessment". The change was from "preparing for disaster to one of managing the disaster when it occurs" (Paxton 1992).

Despite general agreement during the 1980s that Laloki had significant capacity to mount a SIRM response, there was an almost complete about-turn in policy by 1990 and the Minister for Agriculture was advised that the Laloki facility no longer had a role to play and that a SIT response was abandoned as a "grossly optimistic notion" (see Paxton 1992).

This view was dominated by a pessimistic assessment of early detection of SWF in Australia. There were also important considerations relating to the tenancy of Laloki and the challenging and turbulent environment for staff in PNG at this time.

Savings from the closure would be used for other preparedness programs and would be augmented by an almost 70 per cent increase to $650,000 per annum, even though the annual cost of maintaining Laloki as a response facility was only about $290,000 – a modest insurance premium by the standards of the day.

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Torres Strait: 170km between SWF endemic PNG and Cape York in Australia but only 40km of open water between islands

The new agenda did not include any response capability – the new initiative being a "research laboratory" in a country somewhere.

In December 1991 the PNG facility was closed down and the fly culture that had provided so much over the preceding 18 years was destroyed. The policy of closure did not meet with universal support from the veterinary and entomological professions.

At the time, a former Director of the Australian Bureau of Animal Health, Dr Bill Gee, expressed his view to the press that such a closure was suicidal for Australia's livestock industries. As described by David Paxton, a veterinarian and sometime Trade Commissioner in the Middle East, "the PNG facility was opened to counter a hypothetical risk and was closed on the hypothesis that the first hypothesis lacked weight" (Paxton 1992).

Subsequently, a culture of OWS was established at the Institut Haiwan, Malaysia, in 1994 while a new mass-rearing facility with a targeted capacity of 10 million flies per week was being designed and construction begun.

The contract for the Malaysian facility was valued at AUD$3.6 million but the end-cost exceeded $6 million and it was never satisfactorily completed, although production trials began in late 1999 (Wilde 2001).

Despite valiant attempts to develop highly computerized rearing methods for OWS, the mass rearing exercise in Malaysia was clearly a frustrating and disappointing exercise (see Mahon 2002 and Wilde 2002).

The facility did however produce sufficient sterile flies for a major SIT trial in 2000 (Mahon 2002a) although it has not been meaningfully used for the past four years, its capacity scaled down to 6 million flies per week (Anon 2003) and by 2005 was, apparently, largely unserviceable.

Risk

The risk of a screw-worm fly incursion into Australia ('in the next 10 years') has been rated by Animal Health Australia as "low to very low" based on surveillance results and epidemiological findings over the past 20 years (Anon 2003). But the situation remains dynamic, especially with major increases in live animal exports. For example, exports of live cattle from northern ports have increased from about 80 thousand head in 1988 to 955 thousand in 2002 (a 12-fold increase).

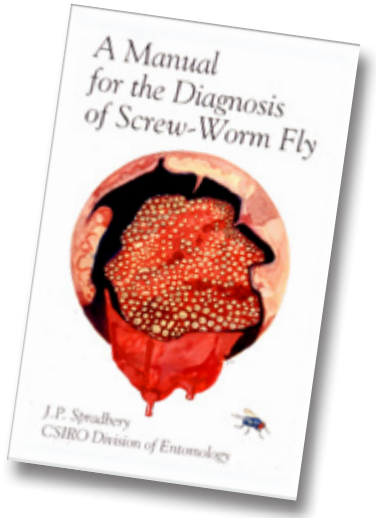
These livestock ships are like giant, mobile SWF traps with OWS recorded flying onto such vessels even before they dock in Middle East ports (Rajapaksa and Spradbery 1989).

Despite the official appraisal that the risk is low, recent events that have appeared in our national press during 2005 alone are disquieting – human OWS cases in Chiang Mai, Bangkok (*Canberra Times* 4 May) and Hong Kong (*Courier Mail* 7 October) and the reports of "thousands of foreign fishing vessels ... encroaching ever closer to the mainland, with reports of some crews carrying animals and camping ashore" (*Weekend Australian* 1 October) and with animals aboard such vessels, including cats, a dog with a litter of pups and a monkey! (*The Australian* 22 October).

Refugee boats were not even mentioned. The Leader of the Opposition, Mr Kim Beasley, reminded the electorate of these imminent dangers on 27 November (*Canberra Times* 2005).

Surveillance

The first line of defence against a screw-worm fly incursion is public and professional awareness and early detection. One difficulty with maintaining a high level of awareness of a potential pest is a lack of scares or near-misses – when nothing happens, complacency inevitably sets in.



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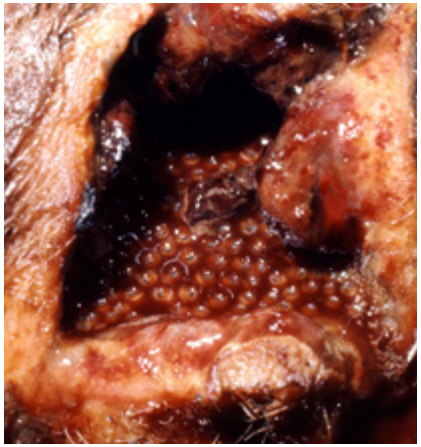
Human case of screw-worm myiasis, Lae, PNG



Screw-worm myiasis on cattle in PNG

The deployment by the Northern Australia Quarantine Strategy (NAQS) of dedicated screw-worm fly traps and the pro-active use of sentinel herds in northern Australia help maintain awareness, as does the distribution of maggot collection kits to a range of stake-holders including the medical profession (Lee 2002).

The design of the current SWF trap and improved selectivity of lures has enhanced surveillance and further progress is anticipated (see Urech et al 2010*). A series of new SWF brochures has recently (2009*) been developed for distribution, to complement other awareness initiatives.

Diagnosis

Early detection is all well and good, but it must be complemented by fast, fool-proof diagnosis. There is an updated *Manual for the Diagnosis of Screw-worm Fly* (Spradbery 2002) and reference collections of adult and immature stages at all diagnostic laboratories in northern Australia. Despite this resource, occasional specimens prove challenging and end up at the bench of specialists at CSIRO and elsewhere.

Just prior to the SWF Preparedness Conference of 2001, a mis-diagnosed fly trapped on the Torres Strait island of Boigu caused a major screw-worm alert (Lee 2002).

Such alerts are good for raising public awareness, and provide some excuse for taxonomic error! The identity of a male OWS is unequivocal based on the facets of the compound eye while the short length of the ovipositor in the female declares it's unequivocal OWS screw-worm fly status compared with look-alikes (see Spradbery 2002, p44). Nevertheless, the specialist should always evaluate the entire suite of characters before making a final identification.

Because of the mis-diagnosis of 2001, a new method for the identification of OWS by DNA analysis was developed at CSIRO (Mahon *et al*. 2003) and most suspect flies are now apparently subjected to the new test (J. Lee, personal communication) although many still reach my laboratory. A very recent development is the detection of OWS in bulk fly catches using real-time polymerase chain reaction (PCR) (Jarrett *et al.* 2010*).

** Recent revisions (2010)*

Response capability

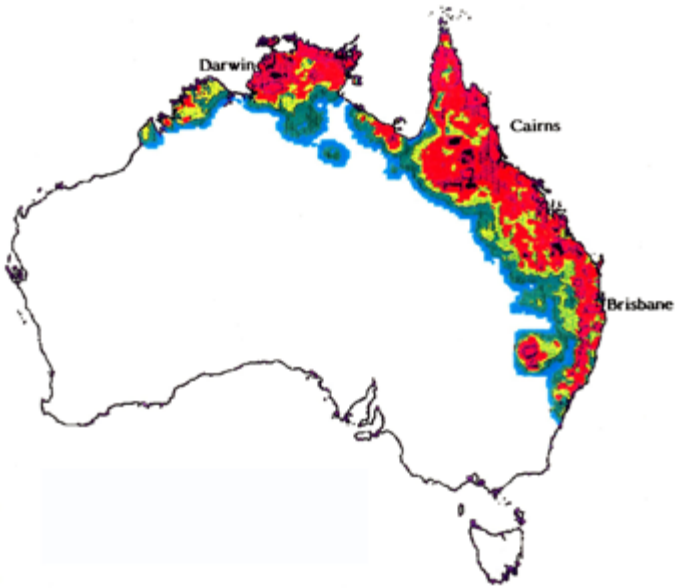
Australia's SIT trials and the Competitiveness Question

There have been two major SIT trials on OWS carried out by Australia, the first was in PNG in 1982 (Spradbery et al. 1989) and the second in Malaysia nearly twenty years later, in 2000 (Mahon 2002).

Releases of chilled sterile flies from aircraft were made for 8 weeks in PNG and 14 weeks in Malaysia with resulting maximum sterility recorded in the wild population of 33% and 62% respectively.

The mean dose rate (number of sterile flies [approximately half males] released per km2 per week) was 460 in PNG and 880 in Malaysia but, during the final months of the Malaysian trial and in the area being monitored for sterility 5,560 and then 16,720 flies were released per km2 per week – a 6 to 20-fold increase in dose rate! Prior to the major dose increase during the final 3 weeks of the Malaysian trial, sterility was 36-41%.

The area infested by SWF after 10 years following a hypothetical incursion in Brisbane that was not eradicated (from Anaman et al. 1993).



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Fat-tailed seep grazing in the Iraqi desert (1998)

Below – Head of Old Worm Screw-worm fly larva with prominent mouth hooks.

Clearly, SIT works with OWS – mass-reared larval flies subsequently sterilized by exposure to gamma rays as 5-day pupae and released into the field as adults, can mate with wild females (which subsequently lay sterile egg masses).

Fundamental to the success or effectiveness of SIT is the competitiveness of the mass-reared males in competing with native males for females in the field.

What contributes to male competitiveness is probably a complex mix of degree of laboratory adaptation and genotype, the rearing regime with its myriad variables, the impacts of storage, handling and release from aircraft – one sometimes wonders how such entities survive at all! I believe that "competitiveness" can be most easily and primarily described in terms of "quality control" in which the major parameter above all else is the size specification.

A factory producing 1 inch screws would have its product rejected by Quality Control if it produced 3/4 inch screws. It must be emphasized however that rearing insects, especially in very large numbers, is much harder than manufacturing screws.

Before developing a so-called new, more competitive strain (Mahon 2002b), the efficacy of a robust mass-reared fly should be assessed.

When using a meat-based diet, the artificially reared flies in PNG were 78% of the wild type (based on weight of 5-day old puparia) but they were only 60% (range, 53-67%) of wild type when using a semi-synthetic liquid diet (Spradbery 1990, and unpublished data).

In Malaysia, mass-reared puparia were 56% (range, 50-62%) of the wild type (Mahon 2002a, Mahon & Leopold 2002).

The success of SIRM, as well as the design and capacity of a mass rearing facility, depends very heavily on competitiveness or quality of the reared insect.

Size (as the major indicator of quality above all else) is of the utmost importance – a small, puny male irrespective of its genotypic heritage will not perform well – it will always be a "dud stud". Size does indeed count.

SIRM Preparedness – where are we now?

The prevailing official philosophy on screw-worm preparedness and response in the event of a SWF incursion include plans to build a large rearing facility at an Australian location after the invasion is confirmed, a process that could take up to two years or more to complete. The proponents for such a policy note that it would take about that time to get a culture of SWF sufficiently well trained for mass production. The identification of a possible Australian site for a SWF production facility (if required) in Australia was "imminent" in 2005.

But there is another way. As a strong believer that we should have our own SWF culture for research as well as have the capacity for an immediate SIRM response initiative, why not use one of the redundant Offshore Detention Centres? These centres had cost the Australian taxpayer $220 million by 2005 and the one on Manus Island, PNG, was costing $700,000 per month in maintenance costs.

What a splendid place for a secure mass-rearing facility – with a potentially beneficial function that would surely meet with the enthusiastic approval of the majority of Australians.

Failing that, if Australia does become the target of a screw-worm fly incursion, we may well have to appeal to the Government of Iraq (and allied UN Agencies) for supplies of sterile OWS flies from their Middle East Eradication program to combat the invasion. Let me explain…

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Guarding the cows in Baghdad (1998)

The FAO delegation visiting the Iraq Veterinary HQ, Baghdad (1998)

The Iraq connection

In 1996, OWS was discovered in Iraq – apparently for the first time in the country's recorded history. The number of cases and distribution increased dramatically with nearly 60,000 cases in livestock and humans recorded by early 1998 – just two years after the initial outbreak.

At the time of the epidemic, Iraq was in the grip of UN sanctions with its veterinary services effectively destroyed – there were no vehicles or fuel, no electricity to the clinics and, with no power – no vaccines or other veterinary medicines requiring refrigeration. The morale of the service had reached a very low ebb. In June 1998 I led a UN (FAO) Mission to Iraq and neighbouring countries to assess the extent of the outbreak and prepare a regional response plan (Spradbery & El-Dessouky 1998).

By the time of our visit, Iraqi scientists had established an OWS culture and a new, screw-worm dedicated facility was under construction with a vigorous research program underway.

Among the AUD$90,000 recommendations for research and development projects resulting from our UN mission, was a field trial in Iraq to evaluate SIT during September-October that year (1998), using sterile flies from the Australian SWF facility in Malaysia. I was under the impression that mass rearing had progressed well since the program began 4 years earlier.

At a subsequent meeting with representatives of the Department of Agriculture and CSIRO Entomology on my return to Canberra, it transpired that the Malaysian plant could not supply sufficient sterile flies for such a trial and the initiative was abandoned.

What a pity that such an international exercise could not be pursued and that sterile SE Asian flies were not used against a Middle Eastern population of OWS – we could all have learnt much from that experiment.

Later, with the looming threat of a pre-emptive strike against Iraq, I wrote to John Howard, the Prime Minister in early January 2003 *(see next page)* protesting the proposed misadventure. My plea clearly had minimal impact and the coalition of the willing invaded Iraq on 20 March 2003 in an operation codenamed "Iraqi Freedom" resulting in around 100,000 or more of its civilians killed, the National Museum looted and the screw-worm fly facility destroyed.

Today (2005), with UN (IAEA) support, there is a new screw worm culture established in Baghdad and field monitoring and surveys have recommenced in areas where this is possible, while 5 Iraqi staff will receive training at the Mexican and Panama NWS screw-worm fly facilities in Central America.

Currently, planning for the eradication of screw-worm fly from the Middle East is underway with support from FAO, IAEA and the Arab Organisation for Agricultural Development (AOAD).

A mobile, modular factory with 50 million sterile flies per week capacity is under review (Spradbery *et al.* 2006).

Such a facility could be assembled on board a dumb barge (such barges have a working area in excess of the total site requirements for the old PNG SWF facility).

The point in describing the Iraq disaster and recent developments is to underline that, in the event of a future SWF incursion into Australia (and with no other OWS cultures available to us), we may well have to appeal to the government of Iraq for help in mounting an eradication campaign using sterile flies from the Baghdad facility.

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Mr John Howard, The Prime Minister of Australia
House of Parliament – CANBERRA ACT 2601

2 January 2003

Dear Mr Howard,

I wish to add my personal voice to the millions of my fellow Australians who are totally opposed to Australia's involvement in a war against Iraq.

The arguments against such a military adventure are so compelling that I am absolutely amazed that you and your government can entertain such a prospect of war. Apart from the political and economic consequences does not the certainty of enormous loss of civilian life in Iraq and beyond worry you? Does not the inevitability of Australia being branded an enemy of Islam for decades to come concern you? Does not the thought that Australia would become a prime target for extremist groups hell bent on wreaking vengeance keep you awake at night?

If I thought a war to unseat Saddam Hussein would bring benefits exceeding the losses of such a campaign, then there might be some justification. But I simply cannot see what would be gained - apart from US control over its oil supplies.

In 1998 I headed a United Nations (Food & Agriculture Organisation) mission to Iraq. The people I met and worked with, despite their privations, lack of resources and justified bitterness against the UN-imposed sanctions were the most generous of all peoples I have met in more than thirty countries in which I have worked over the past four decades. It is these individuals who are at grave risk if a war against Iraq is launched.

I wish it to be known that I, my family and most of my colleagues and friends are totally opposed to a war against Iraq and that Australian involvement is totally unjustified (even under a UN Security Council umbrella) – it is not even in our area of influence or interest (although we do have significant economic ties with Iraq and most other Middle East countries with regard to our agricultural exports, which would be severely compromised if Australia engages in such a war).

Would it not be infinitely better for Australia to take an individual stance and act in a benign manner in the region, such as pushing for an equitable peace settlement in the Israeli/Palestinian conflict and a diplomatic solution to the Iraq problem? Think of the long-term good that approach would generate! (Look at what Norway has achieved in Africa?) Shouldn't Australia be seen as an independent voice for peace? I am sure Australia would generate more goodwiil and have greater influence as a small country by pushing towards peace than by following aggressive US or UK policies in the Middle East.

I trust sanity will prevail and that the recent calls for PEACE by world leaders, including yourself and President Bush, are truly and energetically pursued.

Yours sincerely, Philip Spradbery

cc: Mr Simon Crean, Leader of the Opposition

Summary

If we accept the party line – that the risk of SWF invasion is "low to very low" and that there be no response capability until after the event, then progress in preparedness for SWF is going reasonably well according to the reports I have seen. Surveillance (Lee 2002), diagnosis (Spradbery 2002, Mahon *et al*. 2003, Urech *et al*. 2010) and chemical means of control (James *et al*. 2005) are particularly well covered.

However, if you disagree with that philosophy, as I do, then we are in a fairly woeful position should SWF gain access to this country. This applies particularly to the lack of a viable screw-worm fly culture and the retaining of expertise, plus broadening the present skills base.

Today there are less than half a dozen people in Australia with hands-on SWF expertise, most of whom are either retired or considered too old to be useful as expert consultants. The United Nations agencies such as FAO and IAEA do not recruit experts beyond the age of 70 years, irrespective of the uniqueness of their experience (Udo Feldmann, IAEA, personal communication).

There is absolutely no need to develop a new OWS strain until rearing procedures result in a quality product, say around 60% or more of wild type in size.

Quality is paramount (refer to Professor Yosiaki Ito and his team and the Melon fly eradication experience in Okinawa).

We seemed to be re-inventing the wheel regarding SWF rearing with an obsession for highly sophisticated, computerized rearing methods that do not appear to work too well.

The USDA experience in the US, Mexico and Panama have set the standards although there is always room for improvements (see Rearing of Old World Screw-worm fly in PNG, Spradbery 1990).

But I still maintain my criticism of the official response philosophy and the lack of an accessible OWS screw-worm culture for research and development.

Australia should maintain and develop its screw-worm fly operational skills and have the capacity to provide a prompt initial SIT response in the event of a screw worm invasion.

We should be preparing for the worst, not hoping for the best.

Acknowledgments

I am indebted to Dr David Paxton for access to his 1992 Thesis, *"Screw-worm fly eradication policy in a changing environment"*.

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