Fruit Fly Pests of Northwestern Australia

By

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Declaration

The research presented in this thesis is the result of my own investigation. All work by other researchers is properly acknowledged.

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Contents

Abbreviations

A$	Australian dollars
AS	Alice Springs
bp	base pairs
cm	centimetres
CI	confidence interval
c/some	chromosome
°C	degrees centigrade
df	degrees of freedom
DNA	deoxyribonucleic acid
dNTPs	deoxyribonucleoside triphosphates
EDTA	ethylenediaminetetra-acetate
EtBr	ethidium bromide
FFEZ	Fruit Fly Exclusion Zone
FFRC	Fruit Fly Research Centre
km	kilometres
KUN	Kununurra
m	metres
ms^{-1}	metres per second
$MgCl_2$	magnesium chloride
min	minutes
ml	millilitre
mm	millimetres
mM	millimolar
$MQ.H_2O$	milli-Q filtered distilled water
µl	microlitre
µM	micromolar
msat	microsatellite locus
mtDNA	mitochondrial DNA
NSW	New South Wales
NT	Northern Territory
NW	Northwestern Australia
P	P-value
PCR	Polymerase Chain Reaction
QLD	Queensland
SA	South Australia
sec	seconds
SIT	Sterile Insect Technique
TBE	tris-borate-EDTA
TT	Ti Tree
V	voltage
VIC	Victoria
w:v	weight to volume
WA	Western Australia

Summary

Until recently, Northwestern Australia was thought to be relatively free of serious fruit fly pests. Although a noxious strain, present in Darwin since 1985, was widely believed to be an infestation of the Queensland fruit fly, *Bactrocera tryoni*, from the East coast, the fruit flies present outside this area were believed to be the benign endemic species, *B. aquilonis.* However, during the year 2000, infestations of fruit flies were discovered on major commercial crops in both Western Australia and the Northern Territory. It was not known whether these outbreaks were due to an invasion of the major pest species, *Bactrocera tryoni*, a change in the behaviour of *B. aquilonis*, or a hybridisation event between the two species. Finding the source of these outbreaks has been complicated by the fact that, since *B. tryoni* and *B. aquilonis* are virtually indistinguishable morphologically, it was not known which species are present in the region. Traditionally any *tryoni* complex fly caught in the Northwest was called *B. aquilonis* based solely on location.

In order to get a good population profile of the region, an extensive trapping program was set up to include flies from urban areas, commercial crops and natural areas where the benign strain is thought to remain. Tests of genetic differentiation and clustering analyses revealed a high degree of homogeneity in the Northwest samples, suggesting that just one species is present in the region. The Northwest samples were genetically differentiated from the Queensland samples but only to a small degree (F_{ST} =0.0153). MtDNA sequencing results also showed a small degree of differentiation between these regions. A morphological study of wing shape indicated that there are some minor identifiable morphological differences between East coast and Northwest laboratory reared flies. This difference was greater than that seen between *B. jarvisi* populations across the same geographic range. The results suggest that the flies caught in the Northwest are a separate population of *B. tryoni*.

Soon after pest flies were discovered in Darwin, a population became established in Alice Springs. This population had a low genetic diversity

compared with Queensland and Darwin populations, and showed evidence of being heavily founded. In 2000, an outbreak was discovered in the nearby town of Ti Tree. Due to the geographic and genetic similarity of these populations, Alice Springs was determined to be the source of the Ti Tree outbreak. To investigate the founding of these populations, a program was developed to estimate the propagule size. Using a simulation method seven different statistics were tested for estimating the propagule size of an outbreak population. For outbreaks originating from populations with high genetic diversity, the number of alleles was a good estimator of propagule size. When, however, the genetic diversity of the source population was already reduced, allele frequency measures, particularly the likelihood of obtaining the outbreak population from the source population, gave more accurate estimates. Applying this information to the Alice Springs samples, it was estimated that just five flies were needed to found the major population in and around Alice Springs. For Ti Tree, the propagule size was estimated to be 27 flies (minimum 10).

In 2000, a much larger outbreak occurred in the developing horticultural region of Kununurra in northern Western Australia. An important question for the management of the problem is whether there is an established fly population or the flies are reinvading each year. This population was found to have a large amount of gene flow from the Northern Territory. Within the Kununurra samples, one group of flies was genetically differentiated from all the other samples. This group came from a small geographic area on the periphery of Kununurra and appeared to be the result of an invasion into this area at the time when the population was building up following the dry season.

A further threat to the Northwest horticultural regions comes from *B. jarvisi*. A recent increase in the host range of this species has lead to speculation that it may become a greater pest in Northwestern Australia. At the present time, protocols for the population monitoring and disinfestation of this species are not in place. Here it is shown that *B. jarvisi* eggs are more heat tolerant than *B. tryoni* eggs and that monitoring of *B. jarvisi* populations is possible using cue lure traps placed according to fruiting time and location of their favoured host, *Planchonia careya*