Australian Distribution of 17 Species of Fruit Flies (Diptera: Tephritidae) Caught in Cue Lure Traps in February 1994

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ABSTRACT We report the first widespread survey of tephritid fruit flies attempted in a single time period. 1,471 cue lure traps caught 17 species, and extensions to previously recorded geographical ranges were detected for seven of them: *Bactrocera tryoni*, *B. neohumeralis*, *B. frauenfeldi*, *B. aeroginosa*, *Dacus absonifascies*, *D. aequalis* and *D. newmani*. The traps also unexpectedly caught several *B. cacuminata* and also both males and females of *Dirioxa pornia* and *Ceratitis capitata*. The geographical variation in the relative abundance of *B. tryoni* and *B. neohumeralis* in the region of their co-occurrence was in substantial agreement with earlier estimates. The regional variation in abundance of *B. tryoni* in the eastern states was in accordance with the predictions of a published bioclimatic model. Furthermore, the spread of this species (expected from the model) to several locations in the Northern Territory is recorded here for the first time.

Introduction

Ideally, a comprehensive survey of Australian tephritids would involve a nationwide grid of traps and a corresponding sampling of host fruit. In 1994, we had the opportunity to obtain data from an Australia-wide set of cue lure traps whose primary purpose was to obtain specimens of the Queensland fruit fly, *Bactrocera tryoni* (Froggatt), for a study of geographic variation in variable DNA sequences.

To date, the only widespread survey of Australian species using a single set of traps has been reported by May (1963) who used McPhail (invaginated) traps baited with orange extract and ammonium carbonate throughout the state of Queensland. Such traps (and also protein hydrolysate traps) have the advantage of catching all species of fruit flies (as well as many other insects), but are very inefficient when compared with traps using "male lures". The majority of Australian fruit flies respond strongly to one or other (but not both) of the male attractants cue lure and methyl eugenol (Drew and Hooper 1981; Drew *et al.* 1982; Drew 1989). Thus our most recent knowledge of geographical distributions is based mainly on the catching of flies with traps using different lures, usually at different times in different places. The most complete picture, assembled from a variety of sources, is given by Drew (1989) in a review of the taxonomy, distribution, host fruit and male lure specificity of fruit flies in the Australian and Oceanic regions.

Materials and methods

1,471 members of the CSIRO's Double Helix Club collected flies during February 1994. The distribution of sampling points, therefore, corresponded to the distribution of collectors, but nevertheless covered all significant centres of human habitation, including many rural and isolated districts (Table 1, Fig. 1). Exceptions included Tasmania (where no fruit flies were expected to occur) and the areas covered by detection grids in South Australia and the NSW part of the "Fruit Fly Exclusion Zone" (an area approximately 1,000 km × 800 km covering fruit growing regions around the border of NSW with Victoria and South Australia). In the areas covered by detection grids, the relevant authorities undertook to send us any flies that were caught on their grids during our census period (none were returned).

In late January, participating members were sent a kit which contained instructions for constructing and installing a modified "Bateman trap" (Drew *et al.* 1982) out of a plastic (PET) soft drink bottle (2-L capacity). The kit also contained an experiment sheet and a loaded bait wick secured in a fine fly-wire mesh. The wick was a short length of dental roll initially charged with approximately 2 mL cue lure/malathion solution (8 mL cue lure to 1 mL 118% w:v malathion). For despatch in the kit, the wick was sealed in a plastic vial that was also to be used for the return of the catch. Flies caught were preserved in methylated spirits, drained, and returned in the vial with a cotton wool ball soaked in methylated spirits.

Collectors were asked to trap flies for 2 weeks from 5 February. They were advised to remove and preserve flies daily in order to avoid ant predation and to reduce deterioration of the DNA in the flies. Safety instructions regarding the "bait" were also given.

On receipt, the flies in each sample were classified and counted before transfer to 100% ethanol for storage at −70 °C. Each fly and the Excel data base of the results are kept at the Fruit Fly Research Centre.

Identification was done by R. Osborne using the

keys of Drew (1989) and White and Elson-Harris (1992). R. A. I. Drew reviewed all faded specimens and all flies returned from the Northern Territory.

Results

1,471 samples were returned, comprising a total of 17,301 flies from 17 species (Table 2). Since trap distribution, construction and placement were not under our control, we cannot comment on unexpected absences from all or part of the survey. We can, however, comment on the unexpected positive catches, on the frequency of catches of *B. tryoni* and *B. neohumeralis*, and on apparent extensions to previously reported distributions.

Apparent extensions to previously reported distributions. Seven species appeared to have slight to large extensions of ranges from those reviewed by Drew (1989).

Bactrocera frauenfeldi (Schiner) was trapped within its expected range at Thursday Island (Torres Strait) and Weipa (Cape York), but 61 flies were also trapped at Cairns which is about 600 km from Weipa.

Dacus aequalis Coquillett, known to be associated with coastal rainforests in Queensland, northern and mid NSW, was also trapped in Sydney, NSW south coast, Canberra and also in central Queensland at Longreach, approximately 700 km from the nearest previously recorded rainforest observation (Fig. 2). The only previously non-coastal record was for one specimen at Wilcannia in western NSW.

Dacus absonifacies (May), known previously to be common in southeastern Queensland, was caught in five traps in the Sydney region, and two in Canberra giving an extension to the known range of about 800 km (see Fig. 2).

Dacus newmani (Perkins) was trapped in many semi-arid regions as expected, but was also caught in the wet tropics at Cairns.

Bactrocera aeroginosa (Drew and Hancock) was trapped at Townsville, whereas its previously reported most southerly record was for Innisfail which is 200 km to the north.

Bactrocera neohumeralis (Hardy), normally a coastal species from Queensland and the far north of NSW was also unexpectedly trapped at Emerald and Clermont in Queensland (approximately 250 km from the coast).

Bactrocera tryoni had a distribution and abundance in the eastern states as expected (see later). However, its distribution in the Northern Territory confirms earlier unpublished reports of its spread in the northern part of that region (Fig. 3). Catches in other than Darwin and Alice Springs have never been reported before. In this survey catches were made in Darwin, Batchelor, Katherine, east Arnhem Land and Alice Springs.

Unexpected responses to cue lure traps. *Dirioxa pornia* (Walker) was trapped in Sydney (NSW), Cairns (Queensland) and Como (Western Australia). The specimens were predominantly female, so they may have been attracted to the odour of decomposing flies as they are commonly attracted to traps using protein hydrolysate as a lure.

Table 1. Numbers of cue lure traps per region.

Region		Number of traps
THE NORTH WEST		
1	Arnhem Land	4
2	Darwin Region	19
3	Ord and Victoria River	0
4	The Kimberleys	1
5	North West Shoulder	4
THE SOUTH WEST		
The Plateau		
6	Salt Lakes and Gold Fields	5
7	Wheat Belt	2
8	Plateau Margins	6
The Coastal Margins		
9	Perth Region	92
10	Coastal Fringe	0
11	The Nullarbor	0
CENTRAL AUSTRALIA		
12	Isa Highlands	0
13	Barkly Tableland	0
14	Channel Country	1
15	Horseshoe of Salt Lakes	0
16	Flinders Ranges	0
17	The Centre	4
18	The Deserts	0
THE NORTH EAST		
West of the Divide		
19	Cape York Peninsula	6
20	Gulf Country	0
21	Mid West Queensland	8
Eastern Basins and Ranges		
22	North East Highlands	7
23	Northern Sugar Coast	33
24	Burdekin Basin	36
25	Midland Sugar Coast	14
26	Fitzroy Basin	22
27	Burnett and Mary Basins	21
28	Brisbane and Moreton Regions	229
THE SOUTH COAST		
The Coastal Belt		
29	North Coast of NSW	38
30	Hunter Valley	67
31	Sydney Region	353
32	South Coast of NSW	12
33	Gippsland	36
34	Melbourne Region	115
35	Western District	22
36	South East of South Australia	0
37	Adelaide and the Hills	0
38	Northern and Western Coast	0
MOUNTAINS and TABLELAND		
39	New England	58
40	Central Uplands	24
41	Southern Tablelands	107
42	Australian Alps	16
43	Central Victorian Hills	45
44	Tasmania	0
SLOPES and PLAINS		
45	Darling Downs	29
46	North Darling Lowlands	7
47	North West Slopes	18
48	Lower Darling Basin	1
49	Murray Basin Slopes	0
50	Riverina Plains	0
51	Murray Plains in Victoria	5
52	Lower Murray Basin	4
	Total traps	1,471

Bactrocera cacuminata (Hering) was trapped in Canberra, Sydney, Cairns and Brisbane. This species is strongly attracted to methyl eugenol and is not known to be attracted to cue lure. Traps catching *B. cacuminata* also caught other species, known to respond to cue lure.

Ceratitis capitata (Wiedemann) of both sexes was trapped at three locations (Perth, Bunbury, and Mount Tom Price) within its expected range. Twenty-seven males and 17 females were caught. There are unpublished reports of immature females being attracted to cue lure, but there are no reports for males. None of the specific male lures for this species (Trimedlure and its relatives) have ever been used or kept in our laboratory, so contamination cannot be the explanation. The traps were made by the volunteers from soft drink bottles, so residual fruit-like odours may have been present with some attractancy for this species, as well as the two preceding species.

The ratio of *B. tryoni* to *B. neohumeralis*. *B. neohumeralis* has a coastal distribution in Queensland and northern NSW. Its range is therefore entirely included within part of the range of *B. tryoni*. Fig. 3 (giving the catch per trap per week) illustrates how the proportion of the two species changed within the area of sympatry in

Table 2. Numbers of each species trapped during survey.

Species	Number
Bactrocera tryoni (Froggatt)*	14,778
B. frauenfeldi (Schiner)*	1,074
B. neohumeralis (Hardy)*	685
B. cacuminata (Hering)	294
B. bryoniae (Tryon)	106
Dacus newmani (Perkins)*	98
B. strigifinis (Walker)	71
B. alyxiae (May)	52
Ceratitis capitata (Wiedemann)	44
Dacus aequalis Coquillett*	27
B. aeroginosa (Drew and Hancock)*	18
B. chorista (May)	17
B. manskii (Perkins and May)	17
Dacus absonifascies (May)*	10
B. jarvisi (Tryon)	7
Dirioxa pornia (Walker)	6
Dacus bellulus Drew and Hancock	1

*extension to previously recorded distributions noted.

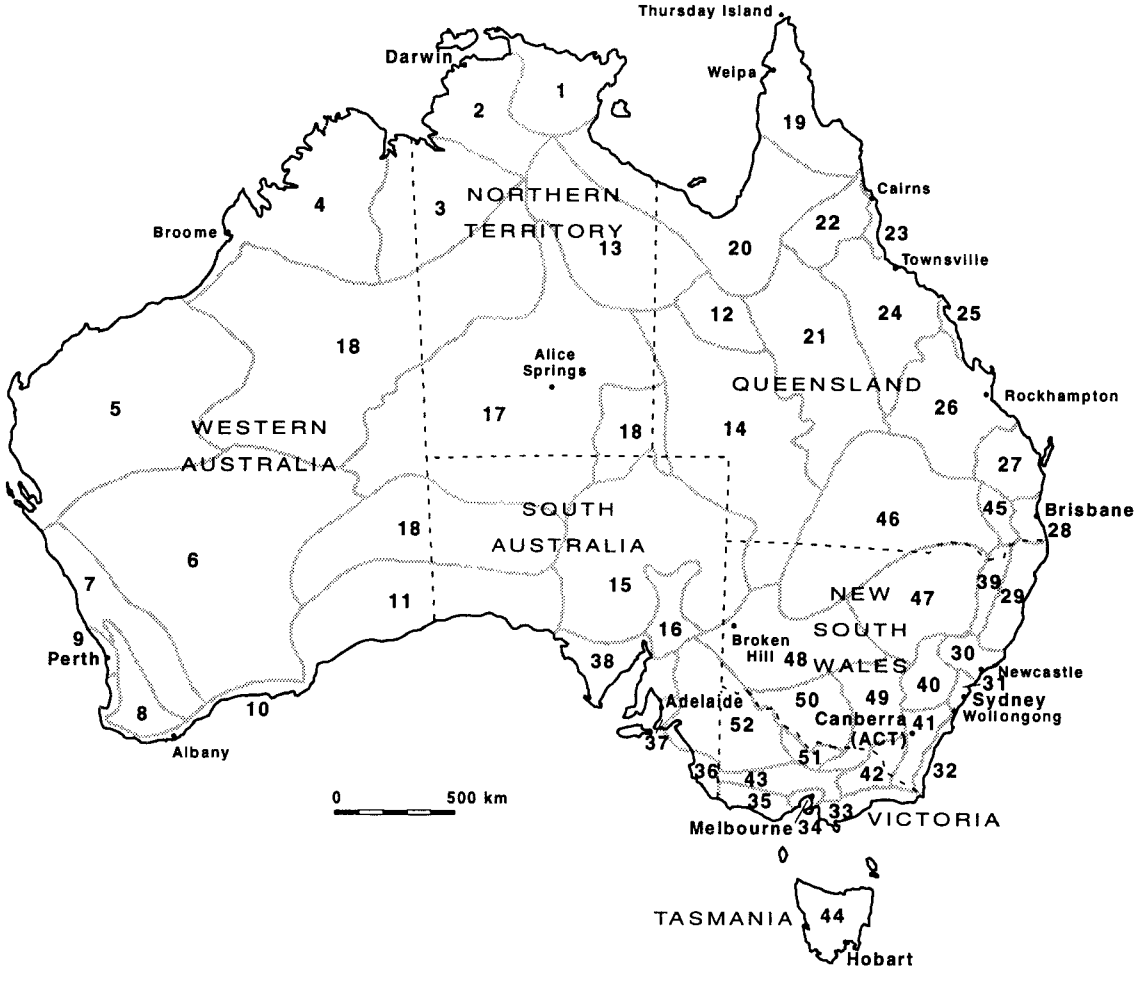

Fig. 1. Key to agricultural regions used in the survey (after Learmonth and Learmonth, 1971).

February 1994. The pattern is substantially the same as that recorded by May (1963) using yearly trapping rates pertaining to ammoniacal traps.

Geographic variation of *B. tryoni* trapping rates throughout its range. Fig. 3 also reveals the pattern of variation in trapping rates, and therefore relative abundance (Fletcher 1974) of *B. tryoni* throughout its range. This is substantially in agreement with the predictions of the bioclimatic model of Meats (1981).

Discussion

Range extensions. Minor extensions to the recorded ranges of *B. neohumeralis*, *B. aeroginosa* and *D. newmani* may have been due to the fact that ranges are likely to be at their maximum in late summer. However, the major extension of 600 km of *B. frauenfeldi* from Weipa to Cairns was probably due to inadvertent transport of infested fruit. The major extension of the reported range of *D. absonifacies* from southeastern Queensland to Sydney and Canberra should not be too surprising. It has been trapped among citrus both in Brisbane and nearby elevated regions with a colder climate. It has not been reported as being bred out of citrus, however, although it is rare for

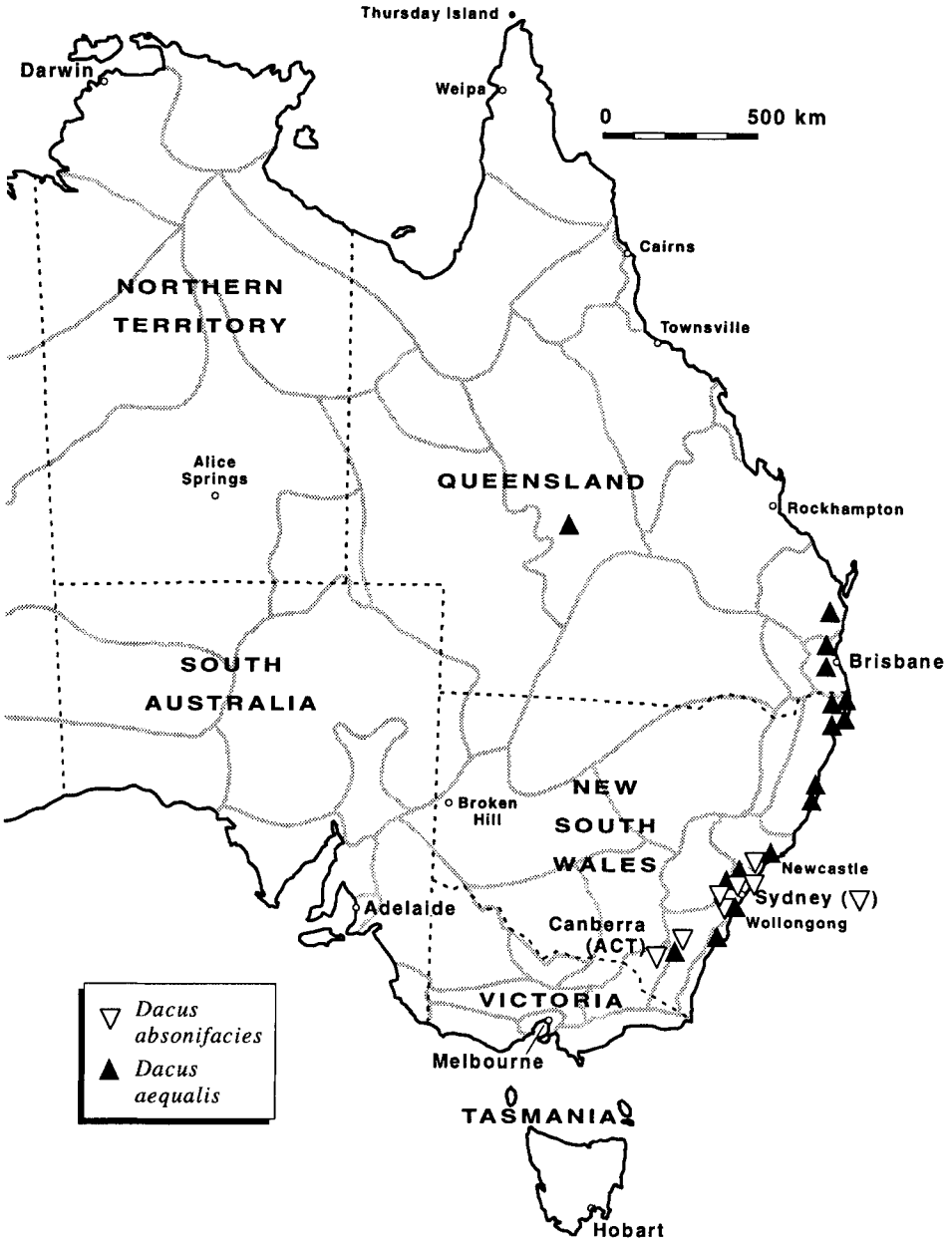

Fig. 2. Distribution of catches of *Dacus absonifacies* and *D. aequalis*.

anyone to attempt to breed fruit flies out of this type of fruit as the exercise generally produces very few specimens of any kind. The trapping of *D. aequalis* in non-rainforest areas (at Sydney, Canberra and Longreach) reinforces conclusions from the previous non-rainforest find at Wilcannia (NSW) that the bioclimatic potential of this species may not be as restricted as earlier supposed. Further understanding of both *D. absonifacies* and *D. aequalis* requires information on host fruit that is lacking at present.

Queensland fruit fly in the Northern Territory. *B. tryoni* has obviously spread beyond Darwin and Alice Springs, hence there is a distinct possibility that *B. tryoni* will spread along the northern coastline into Western Australia.

We emphasise that great care was taken to avoid confusing *B. tryoni* with its sibling species *B. aquilonis* May. None of the latter was found in our collections, although the significance of this cannot be assessed in view of the relatively small sampling numbers in this region. It is possible that the two species hybridise to produce a *B. tryoni*-like form. Molecular techniques may prove

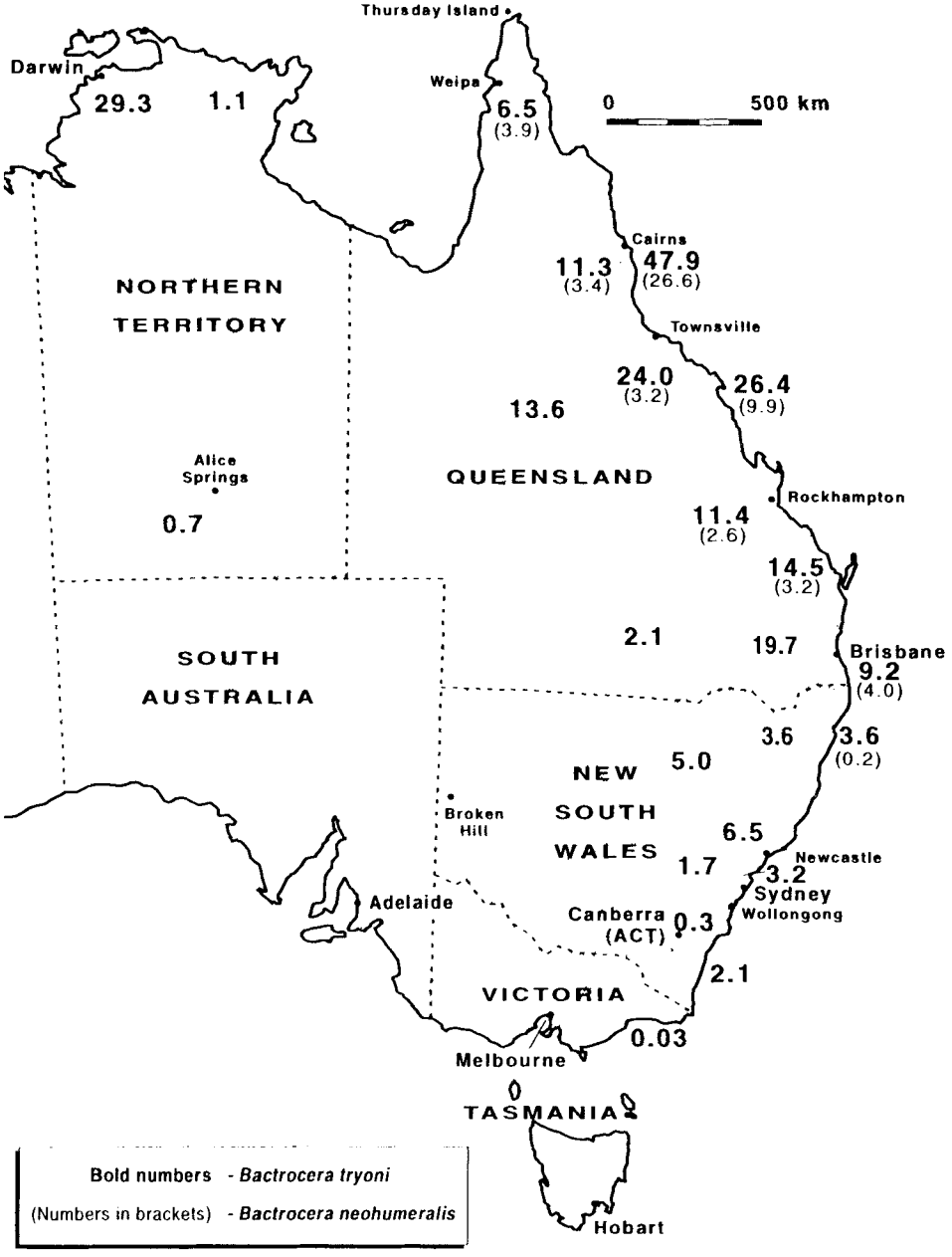

Fig. 3. Catches of *Bactrocera tryoni* (bold type) and *B. neohumeralis* (numbers in brackets) by region. The numbers refer to trapping rates (catches per trap per week).

successful in differentiating between various possibilities.

Bioclimatic potential of the Queensland fruit fly. The variation of trapping rates with region was in accordance with that expected from the bioclimatic model of Meats (1981). It is of interest to note that the dry pocket around Townsville (not distinct on the map) was indeed associated with reduced trapping rates (rates were higher both to the north and south) and that an increase in abundance is not apparent for Victoria despite the abolition of interstate quarantine precautions since 1981.

Acknowledgments

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