

***MACLURA POMIFERA* (RAF.) SCHNEID.: A NEW HOST RECORD FOR *BACTROCERA TRYONI* (FROGGATT) (DIPTERA: TEPHRITIDAE) and *DELIA PLATURA* (MEIGEN) (DIPTERA: ANTHOMYIIDAE)**

Olivia L. Reynolds¹, T. Osborne² and A. Finlay³

¹ *Graham Centre for Agricultural Innovation (New South Wales Department of Industry and Charles Sturt University), Private Bag 4008, Narellan, NSW 2567, Australia.*

² *New South Wales Department of Industry, Private Bag 4008, Narellan, NSW 2567, Australia.*

³ *Pikes Creek Orchard, 3895 Texas Rd, Stanthorpe Qld 4380, Australia.*

Summary

Three dipteran flies, *Bactrocera tryoni* (Froggatt), *Delia platura* (Meigen) and an unidentified species, family Muscidae, have been reared from fruit collected from Osage orange, *Maclura pomifera* (Raf.) Schneid. in Stanthorpe, Queensland, Australia. This is the first record of *B. tryoni* and *D. platura* recorded in *M. pomifera* fruit and has management implications for this tree species, particularly in and surrounding horticultural production areas.

Keywords: Queensland fruit fly, Seedcorn maggot, biosecurity, Osage orange, horticulture, pupae, adult flies

INTRODUCTION

The Queensland fruit fly, *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae) is Australia's most significant biosecurity threat to horticulture, infesting nearly all commercial fruit crops (White and Elson-Harris 1992) and fruiting vegetables (Hancock et al. 2000). This polyphagous pest has been recorded on over 240 host species from 48 families (Hancock et al. 2000) including 60 wild hosts from 25 families (Drew 1989, Hancock et al. 2000). The Australian native is endemic throughout much of its range in south-eastern Australia (Drew, 1989; Mathuthantri 2010) and also occurs in some South Pacific Island nations including New Caledonia and French Polynesia (Drew et al. 1978) and the Torres Strait Islands (Hancock et al. 2000). The adult fly is 6-8mm in length (NSWDPI 2012) orange to brown, with distinctive yellow markings (White and Elson-Harris 1992), and can be morphologically distinguished from related species using a taxonomic key (Drew, 1989). Banana-shaped eggs (<1mm length) are laid into the flesh of mature and ripe fruit where they hatch and the creamy-white to pale yellow larvae feed on fruit pulp and associated bacteria until they reach approximately 8-11mm in length, before they leave the fruit, burrow into the soil and pupate. Adults emerge from the soil, before locating food, shelter and a mate (White and Elson-Harris 1992). The females are capable of mating within a week to 10 days after eclosion and can produce several hundred eggs during their lifetime.

The seedcorn maggot (also known as the onion maggot or bean seed fly), *Delia platura* (Meigen) (Diptera: Anthomyiidae) is, as its common name suggests, a reported pest of germinating corn and soybeans ((Funderburk et al. 1983, Gessell 2000). It

also attacks other species such as cabbage, cucumber, green beans, melon, turnips, lettuce, onion, seed potatoes and other cruciferous vegetables (Kessing and Mau 1991). It is often considered a secondary pest as it is associated with plants that have been damaged by insects or disease (Brooks 1951). *Delia platura* is a native of Europe but now occurs on all continents except Antarctica (Griffiths 1991). In Australia, *D. platura* has been verified from all states and territories, except the Northern Territory (http://www.ces.csiro.au/aicn/system/c_1114.htm; accessed 22 June 2015). The grey-brown adult flies are 5-6mm long with three stripes down their scutum. The white, elongated (0.16 cm length) eggs are deposited in clusters among plant debris and/or on seeds or around plant stems near the soil surface (Bennet et al. 2011). Most studies report that the greyish/yellow larvae, which grow to about 0.50-0.63 cm long (Kessing and Mau 1991), complete their entire development within the soil by burrowing into seeds or feeding on cotyledons emerging from seeds (Bennett et al. 2011). Larvae pupate in the soil before adults emerge (Gesell 2000). Unlike *B. tryoni* that overwinter as adults (CAB International 2015), *D. platura* survives the winter in the pupal stage in soil, and adults emerge in early spring (Higley and Pedigo 1984). The flies mate within two to three days after emerging, and each female lays an average 270 eggs (Bennett et al. 2011).

The Osage orange, *Maclura pomifera* belongs to the Moraceae (Order: Rosales), the mulberry family. This family includes some important temperate and tropical fruit species, particularly across parts of Asia, the Pacific and the Middle East. Some of these species are also reported hosts of *B. tryoni*, including *Artocarpus heterophyllus* (Lamk (1979)) (jakfruit)

and *Morus nigra* (L.) (mulberry) and also species from the *Ficus* genus including *F. carica* (L.) (edible fig) and *F. macrophylla* Desf. Ex Pers. (Moreton Bay fig). Several genera in the mulberry family are valuable sources of timber (<http://www.britannica.com/plant/Moraceae>; accessed 22 June 2015), with *M. pomifera* a favoured timber by wood turners in Australia. The plant is dioecious, i.e. there are separate male and female plants (Burton 1990). *Maclura pomifera* is native to Oklahoma, Texas and Arkansas in the USA (Little 1979), and has been planted in greater numbers than almost any other tree species in North America. Branches may bear short, stout spines which led directly to the invention of barbed wire. Although the fruit of *M. pomifera* is not considered edible, the seeds may be eaten by humans (<http://www.eattheweeds.com/maclura-pomifera-the-edible-inedible-2/>; accessed 22 June 2015). In New South Wales, Australia *M. pomifera* is considered an environmental weed.

MATERIALS AND METHODS

Five Osage Orange fruit, *Maclura pomifera*, were collected by Andrew Finlay, on the 15 February 2015 from two separate trees located within 300m, at Pikes Creek Orchard, 3895 Texas Rd, Stanthorpe Qld 4380 (28°40'40.45"S 151°34'46.08"E and 28°40'30.8"S 151°34'40.6"E).

The fruit was packaged and sent to the Elizabeth Macarthur Agricultural Institute (EMAI), New South Wales (NSW) where it was received on 18 February 2015. Whole fruit were placed individually over moistened vermiculite (4:1; vermiculite: water), in enclosed clear buckets with mesh-covered ventilation

holes in a controlled environment room at 26°C ± 1°C, 65%RH ± 10%RH and 14:10 hour light: dark cycle. Fruit was held above the vermiculite on a container covered with fine mesh, allowing the passage of juice into the container but excluding larvae entering the container. Emerged adult flies were identified by the Agricultural Scientific Collections of NSW Department of Primary Industries, Orange, NSW. Voucher specimens of the flies reported were deposited in the Collections Unit.

On 15 April 2015, a cue-lure baited Lynfield trap was placed in a single *M. pomifera* tree (the last fruit had fallen from the tree several weeks prior to trapping commenced) located at EMAI (S30°06'51.2", E150°43' 50.5") and checked weekly for six consecutive weeks.

RESULTS

New host record for *Bactrocera tryoni* and *Delia platura*

On the 3 March 2015, *D. platura* and another unidentified dipteran (Muscidae) commenced adult eclosion from three of the five fruit containers. Three days later adult *B. tryoni* were observed (Table 1). *Bactrocera tryoni* only emerged from fruit from which either *D. platura* or the unidentified muscid sp. had emerged, however the anthomyiid and muscid species were not found to occur together in the same fruit (Table 1). Flies only emerged from fruit which had blackened areas (Fig. 1). Adult male *B. tryoni* were trapped in the Lynfield trap located in a single *M. pomifera* tree for two consecutive weeks, before trap catches fell to zero (Table 2).

Table 1. The total number of dipteran flies recorded from five whole Osage orange, *Maclura pomifera* fruit collected from two trees located near Stanthorpe, Queensland and a note on whether the fruit was damaged (blackened).

Whole fruit	<i>Bactrocera tryoni</i> (Diptera: Tephritidae) adults	<i>Delia platura</i> (Diptera: Anthomyiidae) adults	Unknown sp. (Diptera: Muscidae) adults	Fruit blackened (Yes/No)
1	31	0	54	Yes
2	0	0	0	No
3	8	0	11	Yes
4	0	0	0	No
5	1	23	0	Yes
Total	40	23	65	

Fig. 1. Osage orange, *Maclura pomifera*, leaves and fruit; the latter showing a blackened area caused by the secretion of the milky fruit juice drying after bruising. Image taken by A. Finlay.



Table 2. The total number of *Bactrocera tryoni* trapped in a cue-lure baited Lynfield trap located in a fruiting *Maclura pomifera* tree at Elizabeth Macarthur Agricultural Institute, New South Wales over a six week period.

Date	<i>Bactrocera tryoni</i>	
	Male	Female
22/04/2015	5	0
29/04/2015	4	0
6/05/2015	0	0
13/05/2015	0	0
20/05/2015	0	0
27/05/2015	0	0

DISCUSSION

Bactrocera tryoni has an extensive host range and distribution, including records on related species of *M. pomifera*, including ten species of Moraceae (Hancock et al., 2000). However, this finding is of importance, as *M. pomifera* is distributed throughout much of eastern Australia, and is therefore likely to act as a successive, or at least, an occasional host, facilitating the spread of this major insect pest. The fruit of *M. pomifera* is unlike that of the fleshy fruits which *B. tryoni* typically infests, and is more similar to fruit of *Clivia miniata* (Lindley) Regel reported as a larval host of *B. tryoni* by May & Drew (2003). Evidence of male *B. tryoni* trapped in a *M. pomifera* tree in NSW, together with infested fruit in Queensland, suggests the possibility that there is some level of *B. tryoni* activity linked with this tree species.

Delia platura is sometimes considered a secondary pest, attacking plant tissue that is diseased through bacterial or fungal infestation (Bailey 2007). The larvae are typically found underground and therefore not thought to be susceptible to much predation, with few reported natural enemies (Reid, 1940). This first report of the larvae of *D. platura* found feeding in the fruit of *M. pomifera* may have management implications. Although *O. platura* is not considered a major pest this crop is widely grown in the Americas, and could be an alternate host for this pest in other countries where it is grown and *O. platura* occurs.

The three *M. pomifera* fruit which were recorded as infested with dipterans in this study were all observed to have blackened areas. When bruised, the fruit exudes a bitter milky juice which will blacken the fruit on drying (Burton 1990). Further studies are required to determine whether the fruit was infested with a single species, diseased or damaged before other species were able to oviposit or whether one, or all, species were able to oviposit regardless of prior infestation. Further, it is unclear if populations of *B. tryoni* could be sustained by this host in the absence of other, more favourable hosts.

The implications for management of *M. pomifera*, particularly in and surrounding horticultural production areas are important, given its newly recorded larval host status of *B. tryoni*, and to a lesser extent, *D. platura*.

ACKNOWLEDGEMENTS

Antonita Jukiel is thanked for project support. Ania Deutscher is thanked for reviewing an earlier draft of the manuscript. This project has been funded by Horticulture Innovation Australia using the summerfruit industry levy with co-investment from Traprock Group and NSW Department of Primary Industries and funds from the Australian Government.

REFERENCES

- Bailey, P. (ed.) (2007). Pests of Field Crops and Pastures. CSIRO Publishing, Collingwood, Victoria, Australia.
- Bennett, K.V.W., Burkness, E.C. and Hutchison, W.D. (2011). Seed corn maggot. Vegetable IPM Resource for the Midwest. University of Minnesota.
- Brooks, A.R. (1951). Identification of the root maggots (Diptera: Anthomyiidae) attacking cruciferous garden crops in Canada, with notes on biology and control. *Canadian Entomologist* **83**: 109-120.
- Burton, J.D. (1990). *Machura pomifera* (Ref.) Schneid. In: Silvics of North America. Vol. 2: Hardwoods. Washington, DC, USDA Forest Service, pp. 843-852.
- CAB International. (2015). *Bactrocera tryoni* (Froggatt). In: Invasive Species Compendium. Wallingford, UK. (<http://www.cabi.org/isc/datasheet/17693>). Accessed 24 June 2015.
- Drew, R.A.I. (1989). The tropical fruit flies (Diptera: Tephritidae: Dacinae) of the Australasian and Oceanian regions. *Memoirs of the Queensland Museum*, **26**: 1-521.
- Drew R.A.I., Hooper, G.H.S. and Bateman, M.A. (1978). Economic Fruit Flies of the South Pacific Region. Queensland Department of Primary Industries, Brisbane, Australia.
- Funderburk, J.E., Pedigo, L.P., Berry, E.C. (1983). Seedcorn maggot (Diptera: Anthomyiidae) emergence in conventional and reduced-tillage soybean systems in Iowa. *Journal of Economic Entomology*. **76**: 131-134.
- Gesell, S. (2000). Seed corn maggot as a pest of field corn. Entomological Notes. Department of Entomology, Pennsylvania State University, Pennsylvania, USA.
- Griffiths, G.C.D. (1991). Flies of the Nearctic region. Volume VIII, Part 2, Number 7. Cyclorrhapha II (Schizophora: Calyptrata) Anthomyiidae. E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), Stuttgart, Germany.
- Hancock, D.L., Hamacek, E.L., Lloyd, A.C. and Elson-Harris, M.M. (2000). The distribution and host plants of fruit flies (Diptera: Tephritidae) in Australia. Department of Primary Industries, Queensland. Information Series Q199067; iii + 75 pp.
- Higley, L. G. and Pedigo, L.P. (1984). Seedcorn maggot (Diptera: Anthomyiidae) population, biology and aestivation in Central Iowa. *Environmental Entomology*. **13**:1436-1442.
- Kessing, J.L.M. and Mau, R.F.L. (1991). Seed corn maggot, *Delia platura* (Meigen). Crop Knowledge Master. Department of Entomology, Honolulu, Hawaii. (16 June 2013).
- Little, Elbert L., Jr. (1979). Checklist of United States Trees (Native and Naturalized). Agriculture Handbook. U.S. Department of Agriculture, Washington, DC.
- May, R. and Drew, R.A.I. (2003). The genus *Clivia* Lindley (Amaryllidaceae), an unusual new host plant record for the Queensland fruit fly *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae) and a new fruit fly distribution record in Queensland. *Australian Entomologist*. **30**(4): 177-178.

- Muthuthantri, S., Maelzer, D., Zalucki, M.P. and Clarke, A.R. (2010). The seasonal phenology of *Bactrocera tryoni* (Froggatt) (Diptera: Tephritidae) in Queensland. *Australian Journal of Entomology*. **49**(3): 221-233.
- New South Wales Department of Primary Industries. (2012). Factsheet: Queensland Fruit Fly (QFF). Orange, New South Wales, Australia.
- Reid, W. J. (1940). Biology of the Seed-Corn Maggot in the Coastal Plain of the South Atlantic States. Technical Bulletin No. 723. United States Department of Agriculture, Washington, DC.
- White, I.M. and Elson-Harris, M.M. (1992). Fruit Flies of Economic Significance: Their identification and Binomics. CAB International, Wallingford, UK.