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HOST STATUS OF LITCHI AND RAMBUTAN TO THE WEST INDIAN FRUIT FLY (DIPTERA: TEPHRITIDAE)

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ABSTRACT

Fruit of litchi, *Litchi chinensis*, and rambutan, *Nephelium lappaceum*, were collected from the field in 2006 and 2007 and monitored for the emergence of West Indian fruit flies, *Anastrepha obliqua*. Fruit clusters of rambutan and litchi, with a piece of the peel removed to allow access to ovipositing females, were also placed in cages and exposed to 12-d-old post-eclosion male and female West Indian fruit flies for 48 h. These exposed fruit were then monitored for the emergence of *A. obliqua*. Mango fruit were simultaneously exposed to male and female *A. obliqua* in separate cages and monitored for the emergence of *A. obliqua*. Fruit fly traps baited with putrescine and ammonium acetate were placed in orchards of litchi and rambutan, as well as an adjacent orchard of carambola, *Averrhoa carambola*, to demonstrate the presence of fruit flies while litchi and rambutan were fruiting. Although we collected 3732 ripe litchi fruit (40.34 kg) and 5534 ripe rambutan fruit (166.60 kg), none of these yielded tephritid larvae. Litchi and rambutan fruit exposed to adult fruit flies in cages did not yield tephritid larvae, though similarly exposed mangoes did. We conclude that litchi and rambutan have an undetectably low probability of being infested by *A. obliqua* in Puerto Rico.

Key Words: *Anastrepha obliqua*, *Litchi chinensis*, *Nephelium lappaceum*, quarantine

RESUMEN

Frutas de litchi, *Litchi chinensis*, y rambután, *Nephelium lappaceum*, fueron colectadas en el campo en 2006 y 2007 y se monitorearon para detectar la presencia de la mosca de la fruta de la Indias Occidentales, *Anastrepha obliqua*. Frutas de rambután y litchi con un pedazo de la cáscara removida para permitir oviposición, fueron colocadas en jaulas y expuestas por 48 horas a machos y hembras de esta mosca. Las frutas fueron monitoreadas para detectar la emergencia de *A. obliqua*. Trampas para la mosca de la fruta con carnada a base de putrecina y acetato de amonio fueron colocadas en huertos de litchi y rambután y en huertos cercanos de carambola, *Averrhoa carambola*, para demostrar la presencia de la mosca de la fruta mientras los árboles experimentales estaban en fruto. Se colectaron 3732 (40.34kg) frutas de litchi maduras y 5534 (166.60 kg) de rambután pero en ninguna se observó la presencia de larvas *Tephritidae*. Frutas de litchi y rambután expuestas en una jaula a adultos de la mosca de la fruta tampoco mostraron emergencia de larva *Tephritidae* aunque frutas de mango sí. Se concluye, que frutas de litchi y rambután tienen una baja probabilidad de ser infectadas por *A. obliqua* en Puerto Rico.

Translation provided by the authors.

Litchi, *Litchi chinensis* Sonn., and rambutan, *Nephelium lappaceum* L., both in the Sapindaceae family, are valuable fruits native to southern China and Malaysia, respectively (Morton 1987). Although currently cultivated on a small scale on the island of Puerto Rico, growers have expressed an interest in expanding their market to include the North American mainland. Currently, Puerto Rico is home to 2 economically important tephritid fruit flies, *Anastrepha obliqua* Marquart and *A. suspensa* (Loew) (Diptera: Tephritidae) (Martorell 1976). *Anastrepha obliqua* is only occasionally reported from California and Texas, but otherwise is not found within the continental U.S. (Epsky et al. 2003). As a result, there are understandable fears that the importation of some fruit, such as litchi and rambutan, from Puerto Rico to mainland North America may facilitate the establishment of *A. obliqua* there. A search of a host plant database for Tephritidae (Norrbom 2004) found no reports of *L. chinensis* or *N. lappaceum* as hosts of *A. obliqua* as of Aug 2007. In light of the difficulties regulatory agencies face in determining the relative threat of importing exotic pests, particularly fruit flies in the family Tephritidae, guidelines have been published that outline methods thought to be sufficient in establishing that threat for a particular fruit species (Cowley et al. 1992).

Our objective was to observe the incidence of infestation in field-collected fruits, and in fruit exposed to *A. obliqua* females in no-choice laboratory tests. In addition, adult fly populations were monitored by trapping in orchards of litchi and rambutan, and in adjacent orchards of other spe-

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cies of fruit trees. We used the principles outlined in Cowley et al. (1992) as guidelines for our investigation. Identical methods have been used to demonstrate the non-host status of litchi and longan (*Dimocarpus longan* (Lour.): Sapindaceae) and mamey sapote (*Pouteria* sapota (Jacq.) H.E. Moore & Stearn: Sapotaceae) to *A. suspensa* and *A. obliqua*, respectively (Gould et al. 1999; Gould & Hallman 2001; Jenkins & Goenaga 2007).

Materials and Methods

Between May 2006 and Aug 2007 mature litchi fruits (Brewster, Bosworth-3, Groff, Mauritius, Kaimana, and Salathiel varieties) were harvested from an orchard in Adjuntas, PR, and mature rambutan fruits (Benjai, Gulu Batu, Jitlee, R-134, R-156, R-162, R-167, and Rongren varieties) were harvested from an orchard in Corozal, PR. Harvested fruit were counted, weighed, placed on a wire mesh over vermiculite in a screen-covered plastic bin, and were stored at 25-27°C in an environment of approximately 60% RH (never less than 50% RH). The vermiculite was monitored weekly for fruit fly larvae or pupae. These were collected and placed in a plastic Petri-dish with a small amount of moistened vermiculite and stored at 25°C in an environmental chamber (12:12 D:L) (White & Elson-Harris 1992). The Petri-dishes were monitored daily for the emergence of adults.

In the summer of 2006, collapsible nylon cages (60 × 60 × 60 cm) (Bioquip, Rancho Dominguez, CA) were filled with clusters of ripe litchi with one half of the peel removed from each fruit to expose the fleshy pulp. Twenty female and 20 male *Anastrepha obliqua* individuals, reared from mango, *Mangifera indica* L. and/or fruit of *Spondias mombin* L. (Anacardiaceae), were placed into each cage 12-d post-eclosion. As simultaneous positive controls, nylon cages were filled with mango fruit that had been covered with brown paper bags (Lawson pollination bags, No. 400) 2 weeks prior to prevent field infestation by *A. obliqua*. Twenty female and 20 male *A. obliqua* adults, 12 d old, were placed into each cage. All cages were held in a greenhouse (mean temperature 24.8°C, RH 74%) and contained a single seedling of *Manilkara zapota* van Royen (Sapotaceae) to provide a suitable microclimate for the flies. Prior to placement in cages, flies were given slivers of carambola, *Averrhoa carambola* L. (Oxalidaceae), to provide carbohydrates and water. Mangoes that had been bagged but not subsequently exposed to ovipositing *A. obliqua* were monitored for the emergence of fruit flies to ensure that the paper bags prevented infestation. After 48 h of exposure, all fruit in all cages were harvested and monitored as described above for the emergence of adult *A. obliqua*. All fruit were monitored for 3 weeks post-harvest and then discarded. Each laboratory exposure was replicated 3 times for each fruit variety and for the control exposures with mangoes. This experiment was repeated with fruits of rambutan in the summer of 2007.

In addition, 5 plastic Multilure traps® (A Better World, Inc., Fresno, CA) baited with ammonia acetate and putrescine (Suterra, Bend, OR) were placed in each litchi and rambutan orchard and monitored weekly for fruit flies. Five traps also were placed in a carambola orchard near the rambutan orchard and monitored weekly.

Results

A total of 3732 litchi fruit weighing 40.34 kg were collected from Adjuntas, PR, none of which yielded tephritid pupae (Table 1). Similarly, 5534 rambutan fruits were collected, weighing a total

Table 1. Collections of litchi by date and variety.

Variety	Dates collected	Number of fruit	g of fruit	Total fruit per variety	Total g per variety
Brewster	27-Jun-2006	534	4986	1064	12110
	13-Jun-2006	234	2567		
	31-May-2006	216	3510		
	29-May-2007	80	1047		
Bosworth 3	23-May-2006	150	2120	705	6761
	26-May-2006	305	2828		
	29-May-2007	250	1813		
Groff	20-Jun-2006	171	1853	722	7534
	1-Aug-2006	251	3818		
	21-Jun-2007	300	1863		
Mauritius	31-May-2006	333	4008	583	7493
	29-May-2007	250	3485		
Kaimana	18-Jul-2006	147	1520	347	3785
	29-May-2007	200	2265		
Salathiel	11-Jul-2006	111	1015	311	2660
	29-May-2007	200	1645		
Total		3732	40343		

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TABLE 2. COLLECTIONS OF RAMBUTAN BY DATE AND VARIETY.

Variety	Dates collected	Number of fruit	g of fruit	Total fruit per variety	Total g per variety
Benjai	19-Jul-2006	127	3831	654	19830
	22-Aug-2007	367	11103		
	29-Aug-2007	160	4896		
Gulu Batu	28-Jun-2006	235	7134	692	20899
	19-Jul-2006	275	8289		
	29-Aug-2007	182	5476		
Jitlee	4-May-2006	284	8507	906	27149
	13-Sep-2006	286	8453		
	22-Aug-2007	336	10189		
R-134	17-May-2006	183	5324	706	20961
	22-Aug-2007	308	9228		
	29-Aug-2007	215	6409		
R-156	4-May-2006	249	7419	688	20633
	22-Aug-2007	240	7252		
	29-Aug-2007	199	5962		
R-162	17-May-2006	130	3906	682	20451
	22-Aug-2007	245	7329		
	29-Aug-2007	307	9216		
R-167	19-Jul-2006	219	6591	540	16273
	22-Aug-2007	132	3961		
	29-Aug-2007	189	5721		
Rongren	19-Jul-2006	267	8003	666	20401
	9-Aug-2006	296	9433		
	29-Aug-2007	103	2965		
Total		5534	166597		

of 166.60 kg, none of which yielded tephritid pupae (Table 2). Litchi and rambutan fruit exposed to *A. obliqua* adults in laboratory studies yielded no tephritid larvae, while mango fruit similarly exposed yielded pupae (Tables 3 and 4, respectively). Mangoes that had been bagged prior to use but that were not exposed to *A. obliqua* females did not yield any tephritid pupae.

Multilure traps baited with putrescine and ammonium acetate yielded *A. obliqua* and *A. suspensa* females simultaneous to fruit collection, indicating that these flies were active in the area when fruit were harvested. The number of *A. obliqua* trapped in the rambutan orchard was always 0, whereas a nearby carambola orchard the number fluctuated between 0 and 25 *A. obliqua* adults per trap per d.

TABLE 3 FLY PUPAE RECOVERED FROM LITCHI FRUIT EXPOSED TO 20 MALE AND 20 FEMALE *ANASTREPHA OBLIQUA* (12-D POST-ECLOSION) FOR 48 H.

			Tephritid pupae recovered			
Date	Variety	Fruit/rep	Rep 1	Rep 2	Rep 3	Mean ± SEM
13-Jun-2006	Brewster	200	0	0	0	0.0 ±0.0
13-Jun-2006	Mango	10	16	0	2	6.0 ± 6.2
26-May-2006	Bosworth 3	189	0	0	0	0.0 ± 0.0
26-May-2006	Mango	10	18	11	10	13.0 ± 3.1
1-Aug-2006	Groff	234	0	0	0	0.0 ± 0.0
1-Aug-2006	Mango	10	0	15	19	11.3 ± 7.1
31-May-2006	Mauritius	200	0	0	0	0.0 ± 0.0
31-May-2006	Mango	10	16	14	21	3.6 ± 2.5
18-Jul-2006	Kaimana	212	0	0	0	0.0 ± 0.0
18-Jul-2006	Mango	10	11	8	5	8.0 ± 2.1
11-Jul-2006	Salathiel	125	0	0	0	0.0 ± 0.0
11-Jul-2006	Mango	10	12	9	7	9.3 ± 1.8

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TABLE 4. FLY PUPAE RECOVERED FROM RAMBUTAN FRUIT EXPOSED TO 20 MALE AND 20 FEMALE *ANASTREPHA OBLIQUA* (12-D POST EMERGENCE) FOR 48 H.

Date	Variety	Fruit/rep	Tephritid pupae recovered			
			Rep 1	Rep 2	Rep 3	Mean + SEM
29-Aug-2007	Benjai	50	0	0	0	0
	Mango	5	8	3	6	5.66 + 1.8
29-Aug-2007	Gulu Batu	50	0	0	0	0
	Mango	5	2	6	4	4.00 + 1.4
22-Aug-2007	Jitlee	50	0	0	0	0
	Mango	5	5	8	3	5.33 + 1.8
22-Aug-2007	R-134	50	0	0	0	0
	Mango	5	5	6	8	6.33 + 1.1
22-Aug-2007	R-156	50	0	0	0	0
	Mango	5	4	4	3	3.67 + 0.4
22-Aug-2007	R-162	50	0	0	0	0
	Mango	5	5	7	7	6.33 + 0.8
22-Aug-2007	R-167	50	0	0	0	0
	Mango	5	4	8	3	5.00 + 1.9
29-Aug-2007	Rongren	50	0	0	0	0
	Mango	5	2	4	3	3.00 + 0.7

The number of *A. obliqua* adults captured in the litchi orchard ranged from 0 to 4.3 flies per trap per d while these fruits were being harvested.

DISCUSSION

It is impossible to prove that a fruit is never a host to a species of insect, only that a fruit is used by a species of insect. However, our data show that the likelihood of infestation of the varieties of litchi or rambutan that we assayed by *A. obliqua* is very small. We conclude that these fruit varieties are extremely unlikely to contain *A. obliqua* and therefore represent minimal threat of transporting this pest when exported.

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Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. We thank Elkin Vargas for his excellent field and labwork.

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