Distribution and Abundance of *Aedes (Finlaya) japonicus japonicus* (Theobald) in Five Districts on the Island of Hawaii

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Abstract. Subsequent to the detection of *Aedes* (*Finlaya*) *japonicus japonicus* (Theobald) on the island of Hawaii, a survey was conducted over the span of twelve months from June 2005 until June 2006, to determine its distribution and abundance on the island. *Ae. j. japonicus* was the third most abundant species encountered employing gravid traps and the fourth most abundant using New Jersey light traps in the districts surveyed. In addition, gravid mosquito traps which used a bait of infused leaf detritus were more effective at catching *Ae. j. japonicus* than New Jersey light traps.

Key words: *Aedes japonicus japonicus*, Hawaii, gravid traps, New Jersey light traps

Introduction

Since the arrival of Europeans to the Hawaiian Islands in the late 1700s, there has been a rapid increase in the flow of alien arthropod species into the islands. Hawaii was without mosquitoes until 1826 when *Culex quinquefasciatus* was accidentally introduced (Hardy 1960). *Aedes aegypti* was first noticed in 1892 and closely followed by *Aedes albopictus* in 1986 (Hardy 1960). There were no further mosquito introductions until 1962, when *Aedes vexans nocturnus* was found on the island of Oahu (Joyce and Nakagawa 1963). This introduction was followed by the discovery of *Wyeomyia mitchellii* on the island of Oahu in 1981 (Shroyer 1981). There were also intentional introductions of several species of *Toxorhynchites* in the 1950s for the biological control of *Ae. albopictus* (Bonnet and Hu 1951, Nakagawa 1963). These introductions brought the number of mosquito species in the islands to seven (Nishida 2002) until the recent discovery of a population of *Aedes* (*Finlaya*) *japonicus japonicus* (Theobald) on the island of Hawaii in June of 2004 (Larish and Savage 2005). The presence of *Ae. j. japonicus* on Hawaii heralds the first establishment of a new mosquito species in the Hawaii Islands in over two decades. To date, routine New Jersey light trap surveillance by the Vector Control Branch of the Hawaii Department of Health, has not detected *Ae. j. japonicus* on any of the other major islands of the Hawaiian chain.

Ae. j. japonicus is native to Japan, Korea, Taiwan, eastern China and Russia (Tanaka et al. 1979). It was first reported in the United States in August and September of 1998 from light traps in New York and New Jersey (Peyton et al. 1999) and during West Nile virus surveillance work in Connecticut (Andreadis et al. 2001), Ohio and Pennsylvania (Fonseca et al. 2001) and in Maryland, Massachusetts and Virginia (Sardelis and Turell 2001). This was followed by its most recent appearance in King County in Washington State (Roppo et al. 2004, Washington State Dept. of Health 2002). *Ae. j. japonicus* has also been found in Quebec and Ontario, Canada (Thielman and Hunter 2006), France (Schaffner et al. 2003) and it was intercepted in New Zealand in shipments of used tires from Japan (Laird et al. 1994). Its rapid spread outside of its native range has been attributed to international commerce in used tires (Schaffner et al. 2003) and the Standardbred horse race circuit within the continental United States (Fonseca et al. 2001).

After its detection in Hawaii in June of 2004, a limited gravid trap and light trap survey reveled that *Ae. j. japonicus* occurred at a number of locations near existing New Jersey light trap locations on the island (Larish and Savage 2005). The purpose of this study was to determine whether *Ae. j. japonicus* occurred on the east side of Hawaii.

Materials and Methods

From June 2005 through June 2006, eight CDC portable gravid mosquito traps (John W. Hock Company, Gainsville, FL), were used to sample adult mosquitoes. Traps were baited with a 4–5-day-old infusion of guava (*Psidium guajava*) leaves and tap water (46 g dry leaves in 3.8 liters of water). This attractant was designed to mimic the common larval habitat of *Ae. j. japonicus* in Hawaii. Once a week, gravid traps were set in a new geographic location, usually on private property close to a residence. At each location, four to eight traps were set within the same neighborhood or in an approximate one mile radius of each other. Sites were sampled for one to three nights. Trapping continued for 44 weeks and was only suspended in times of extremely rainy weather. Each trap location was recorded using a GPS receiver (E-Trex Legend) and the coordinates were mapped using ARCView® software (ArcView 9.1, ESRI, Redlands, CA).

Congruent to the gravid trap survey, mosquito collections from twenty-one New Jersey light traps maintained by the Vector Control Branch, permanently located in four districts on the eastern side of Hawaii were tabulated from June 2005 through June 2006 for 357 nights. Light traps automatically turned on from 6 p.m. until 6 a.m. daily, and mosquitoes were collected from the repository jar weekly.

Results and Discussion

The gravid trap survey covered a total of 232 mostly residential sites for a total of 352 trap nights in five districts stretching from Volcano Village in the district of Puna to the Kamuela Airport in the district of South Kohala (Fig. 1). The trap locations ranged in elevation from sea level to over 1,220 meters. Five mosquito species were caught in portable gravid traps, however, *Ae. albopictus* and *Culex quinquefasciatus* were 10 to 100 times more abundant than *Ae. j. japonicus*, *Ae. aegypti*, and *Wyeomyia mitchellii*. Out of a total of 1102 mosquitoes caught, *Ae. albopictus* constituted 50.9% of those mosquitoes, 42.9% were *Cx. quinquefasciatus*, 4.7% were *Ae. j. japonicus*, 1.0% were *Ae. aegypti*, and 0.5% were *Wy. Mitchellii*. Since not every trap site yielded mosquitoes, these numbers are more meaningful if they are interpreted in terms of the relative abundance of each species of mosquito caught at those sites where mosquitoes were present. Table 1 show that out of the 232 sites surveyed, 175 sites were positive sites, 29 or 16.7% had a population of *Ae. j. japonicus*. This data clearly revealed that *Ae. j. japonicus* was the third most abundant species at all of the sites surveyed.

Only nine out of twenty-one New Jersey light traps showed a presence of *Ae. j. japonicus*, so only data from those nine traps was compared with the gravid trap results. Five mosquito species were caught by the New Jersey light traps; *Ae. j. japonicus, Cx. quinquefasciatus, Ae. albopictus, Ae. aegypti* and *Ae. vexans nocturnus*. *Cx. quinquefasciatus* was the most abundant species and averaged 78% of the total sample of adult mosquitoes over a twelve-month period. The next most abundant species was *Ae. vexans nocturnus* with an average of 17% of the catch. Next was *Ae. albopictus* with only 3.2% and then *Ae. j. japonicus* with 1.6% of the total sample of adult mosquitoes.

Figure 1. *Aedes j. japonicus* sites in Hawaii. Dot: gravid trap location; star: *Aedes j. japonicus* found.

In Table 1, the mean number of adult mosquitoes per trap night surveyed was compared between gravid traps and New Jersey light traps. The district of Puna had two light traps, South Hilo had four, North Hilo had two, South Kohala had one trap, and Hamakua district had no light traps. It was found that in the four districts with both types of traps, the portable gravid traps caught 0.132 to 2.227 adult *Ae. albopictus* and 0.026 to 0.096 adult *Ae. j. japonicus* per trap night while the light traps caught 0.0 to 0.027 adult *Ae. albopictus* and 0.007 to 0.014 adult *Ae. j. japonicus*. This indicated that gravid traps were capable of catching 80 to 230 times more *Ae. albopictus* and 2 to 13 times more *Ae. j. japonicus* per trap night. These results agree with other researchers who have found gravid traps a much better means of *Ae. j. japonicus* surveillance than light traps (Andreadis et al. 2001, Scott et al. 2001b, Falco et al. 2002). The gravid traps were also able to detect two other species of mosquitoes: *Ae. aegypti* and *Wy. Mitchellii*. However, New Jersey light traps were clearly more effective at catching *Ae. vexans nocturnus*, as this species was never attracted to the gravid traps. The gravid traps caught more *Cx. quinquefasciatus* per trap night than New Jersey light traps in three out of the four districts even though the attractant was leaf infusion rather than the hay infusion usually used to catch *Cx. quinquefasciatus*.

On the east side of Hawaii, *Ae. j. japonicus* was the fourth most common mosquito caught using New Jersey light traps and the third most common species using portable gravid traps. In addition, *Ae. j. japonicus* was found in all five districts surveyed. This survey was initiated only twelve months since its first detection in June of 2004, but already *Ae. j. japonicus* was widespread in areas close to human habitation. In the Hamakua District, the area of its highest abundance, the Vector Control Branch of the Hawaii Department of Health does not maintain a surveillance New Jersey light trap. Therefore, *Ae. j. japonicus* could have evaded detection for a number of years before its discovery in 2004.

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Table 1. Total and mean adult mosquitoes sampled using portable gravid traps and New Jersey light traps in five districts of Hawaii.

District	Trap type	*Culex*		*Ae. albopictus*		*Ae. japonicus*		*Ae. vexans*		Other species	
		No.	Mean	No.,	Mean	No.,	Mean	No.,	Mean	No.	Mean
Puna	Gravid	122	1.061	176	1.530	11	0.096	0		10	0.087
	Light	173	0.242	10	0.014	5	0.007	41	0.057	0	
South Hilo	Gravid	284	2.928	216	2.227	7	0.072	0		0	
	Light	576	0.403	39	0.027	11	0.008	262	0.184	0	
North Hilo	Gravid	3	0.094	31	0.969	2	0.063	0		5	0.156
	Light	538	0.074	3	0.004	6	0.008	0		0	
Hamakua	Gravid	51	0.699	134	0.1.836	29	0.397	0		0	
South Kohala	Gravid	15	0.395	5	0.132	1	0.026	0		0	
	Light	23	0.064	0	0.0	5	0.014	1	0.003	0	

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