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SURVEY OF CONTAINER-BREEDING MOSQUITOES FROM THE FLORIDA KEYS, MONROE COUNTY, FLORIDA

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ABSTRACT. A survey of container-breeding mosquitoes was conducted on urban islands (Big Coppitt Key, Rockland Key, Key West, and Stock Island) and rural islands (Big Pine Key, Cudjoe Key, Little Torch Key, No Name Key, Ramrod Key, Saddlebunch Keys, Sugarloaf Key, and Summerland Key) within the Florida Keys. Five mosquito species were collected: *Aedes aegypti, Culex nigripalpus, Cx. quinquefasciatus, Cx. salinarius,* and *Ochlerotatus taeniorhynchus.* Plastic buckets, trash cans, and discarded plastic containers most commonly were found to be mosquito breeding sites. Many containers were used by more than 1 mosquito species. More containers holding water were found in the rural areas than in the urban areas. The percentage of wet containers with mosquitoes did not differ between the rural and urban areas.

KEY WORDS Containers, Florida Keys, *Aedes, Culex, Ochlerotatus*

INTRODUCTION

Since 1998, the Florida Keys Mosquito Control District has been implementing increased larval surveillance and public education efforts to increase efficacy of mosquito control programs. Review of daily surveillance reports indicated that a significant problem with container-breeding mosquitoes existed in the lower Florida Keys (as described by Pritchard et al. 1949). Container-breeding mosquitoes serve as vectors of a number of human pathogens, possibly including West Nile virus (Harrison et al. 2000). Because of the proximity of these islands to the Caribbean, the high number of tourists and illegal immigrants passing through the area, and the introduction of West Nile virus into the United States, a survey of container-breeding mosquitoes was conducted to determine what species were present and what containers were being used as larval habitats.

MATERIALS AND METHODS

The study was conducted in 2 phases. The 1st phase determined the species of mosquitoes breeding in containers in the urban parts of Monroe County. Collections from Big Coppitt Key, Stock Island, and Key West were analyzed. Inspectors collected larvae from all breeding containers that they encountered, recording date, island, and type of container for all samples. Kendall's tau statistic (SPSS, Inc. 1997) was calculated to determine if differences existed among the oviposition sites of the most commonly collected mosquito species. Collections from Big Coppitt Key began on February 24, 2000; collections from Stock Island began on April 4, 2000; and collections from Key West began on July 14, 2000; all collections were made until July 31, 2000.

During the 2nd phase, inspectors counted the numbers of containers during their daily rounds. Each day they recorded total number of containers examined, number of wet containers (those holding water), and number of breeding containers (those with mosquito larvae present). This phase of the study also determined if differences existed between urban and rural parts of the Florida Keys. The U.S. Census Bureau considers all islands from Big Coppitt Key to Key West to be urban. Collections were made on Big Coppitt Key, Key West, Rockland Key, and Stock Island. The rest of the Keys are classified as rural (U.S. Department of Commerce 2001). Collections were made from Big Pine Key, Cudjoe Key, Little Torch Key, No Name Key, Ramrod Key, Saddlebunch Keys, Sugarloaf Key, and Summerland Key. Differences between urban and rural islands were detected by using the log-likelihood ratio (G-test) for contingency tables (Wilks 1935). Analyses were conducted according to Zar (1984). Larval identifications were verified with the aid of the keys of Darsie and Morris (1998), except where recent changes in taxonomy dictate otherwise (Reinert 2000). Narrow-mouthed containers were ignored because they usually do not produce enough larvae to warrant attention (Focks et al. 1981).

RESULTS

Phase 1

Six hundred twenty-nine collections were made, 168 from Big Coppitt Key, 288 from Stock Island, and 173 from Key West. These collections are summarized in Table 1. Five mosquito species were encountered during this study: *Aedes aegypti* (L.), *Culex nigripalpus* Theobald, *Cx. quinquefasciatus* Say, *Cx. salinarius* Coquillett, and *Ochlerotatus taeniorhynchus* (Wiedemann). Many containers had infestations of more than 1 species of mosquito. Multiple

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Table 1. Containers harboring mosquito larvae in urban Monroe County, Florida (percentages may not equal 100 because of rounding).[1]

Species	Big Coppitt Key		Stock Island		Key West		Totals per species	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Aedes aegypti	88	52.4	169	58.7	80	46.2	337	53.6
Culex nigripalpus	4	2.4	3	1.0	6	3.5	13	2.1
Cx. quinquefasciatus	73	43.5	114	39.6	87	50.3	274	43.6
Cx. salinarius	1	0.6	0		0		1	0.2
Ochlerotatus taeniorhynchus	2	1.2	2	0.7	0		4	0.6
Totals per island	168		288		173		629	

[1] Values given are number and percentage of containers with mosquito larvae.

infestations were more common on Stock Island than on Big Coppitt Key and Key West (Table 2). On all islands, *Ae. aegypti* and *Cx. quinquefasciatus* occupied the greatest proportion of containers.

The containers used for oviposition by mosquitoes varied by species and island. On Big Coppitt Key, no differences in container use were found between *Ae. aegypti* and *Cx. quinquefasciatus* (τ = 1.0). Both species used plastic buckets as the most common larval habitat, followed by trash cans and unspecified plastic containers. On Stock Island, both species used plastic buckets most commonly, and unspecified plastic containers were 4th in order of use. *Aedes aegypti* used tires 2nd and plastic trash cans 3rd, whereas *Cx. quinquefasciatus* reversed that order (τ = 0.667). On Key West, no correlation was found among oviposition sites, except that *Cx. quinquefasciatus* utilized trash receptacles most commonly, and *Ae. aegypti* divided its primary oviposition sites between trash receptacles and unspecified plastic containers (τ = 0).

Phase 2

In June and July 2000, 2,055 containers were examined in the urban area and 2,599 were examined in the rural area of the Florida Keys (Table 3). More containers held water in the rural area than in the urban area (G = 258.344; $P < 0.001$). When all containers (wet or dry) were considered, those in the rural area had mosquito larvae more often than did those in the urban area (G = 56.27; $P < 0.001$). However, when only wet containers were considered, those in the rural area held mosquitoes no more often than did those in the urban area (G = 0.296; $P > 0.5$).

DISCUSSION

Note that not all containers contained mosquitoes. In our study, more containers were dry than were wet. Not all wet containers are used by mosquitoes (Chambers et al. 1986). The study most comparable to Key West in terms of climate and geography probably is that of Marquetti et al. (1999) conducted in Havana, Cuba. In their study, *Cx. quinquefasciatus* was the most common container-breeding mosquito. *Aedes aegypti, Cx. nigripalpus,* and *Oc. taeniorhynchus* also were collected, along with 5 other species not detected in the present study. *Ochlerotatus mediovittatus* (Coquillett) is present in Cuba but not in Florida (García and Gutsevich 1969, Fuentes et al. 1993). *Ochlerotatus scapularis* (Rondani) also occurs in Cuba, but has not been collected in Florida since the mid-1940s (Darsie and Morris 1998). Two other species, *Anopheles albimanus* Wiedemann and *Mansonia titillans* Walker, occur in Florida but are not normally found in containers and were not detected during this study. Finally, Marquetti et al. (1999) reported collecting *Psorophora confinnis* Lynch-Arribalzaga. This species complex occurs in the western United States, but not in Florida (Darsie and Ward 1981).

Collections of *Oc. taeniorhynchus* from containers were reported by Marquetti et al. (1999) in Havana. We found very few containers that were positive for *Oc. taeniorhynchus*; only 4 collections were made, 2 of those dual infestations with *Cx. quinquefasciatus*. The proximity of both study sites (Florida and Cuba) to marine environments provides opportunities for containers to retain salt water, which probably accounts for the occurrence of

Table 2. Number of containers with infestations of multiple mosquito species in urban Monroe County, Florida.

	Big Coppitt Key	Stock Island	Key West
Aedes aegypti and *Culex nigripalpus*	1	0	2
Ae. aegypti and *Cx. quinquefasciatus*	21	146	33
Cx. nigripalpus and *Cx. quinquefasciatus*	3	2	4
Ochlerotatus taeniorhynchus and *Cx. quinquefasciatus*	0	2	0
Cx. quinquefasciatus and *Cx. salinarius*	1	0	0
Ae. aegypti, Cx. quinquefasciatus, and *Cx. nigripalpus*	0	1	1

Table 3. Container analysis from rural and urban parts of the Florida Keys.

Statistic	Rural	Urban
Total containers examined	2,599	2,055
Number of wet containers (%)	1,304 (50.2)	558 (27.1)
Containers with mosquito larvae	369	151
Percent of wet containers with larvae	28.3	27.1
Percent of total containers with larvae	14.2	7.3

Oc. taeniorhynchus in containers. However, no salinity tests were done at breeding sites.

Chambers et al. (1986) studied container-breeding mosquitoes in East Baton Rouge Parish, LA, and detected *Ae. aegypti, Cx. quinquefasciatus, Cx. salinarius* Coquillett, and *Ochlerotatus triseriatus* (Say). *Ochlerotatus triseriatus* was most commonly collected in their study, with *Cx. quinquefasciatus* the 2nd most common speices. Nineteen percent of their collections were dual infestations. A large percentage of our collections (34.5%) were dual or triple infestations (Table 2). The most common association was between *Ae. aegypti* and *Cx. quinquefasciatus,* similar to what was found in Havana (Aguilera et al. 2000).

We did not collect *Aedes albopictus* (Skuse) during this survey. Although *Ae. albopictus* has invaded every county in Florida (O'Meara et al. 1995), it has not become established in the Florida Keys. The spread of this species in the United States has been related to movement of old tires and proximity to interstate highways (Moore and Mitchell 1997). Most if not all of the movement of scrap tires through the Florida Keys likely is outward, from the Keys to other parts of the state, rather than inward. Only time will tell whether this species will become established here.

Inspection of containers is a useful indicator of mosquito numbers, but inspection can be subjective, dependent on the judgment of the inspector (Tinker 1967). The variety of containers used as larval habitats by mosquitoes in the Florida Keys is impressive. A list of containers discovered during this study is too long to include in this paper, but some of the breeding sites were unusual, to say the least. We noticed a real need for education and sanitation among a few members of the public. Some yards were little more than private dumps, with buckets, boats, and old appliances all retaining water and supporting mosquito development. We have no explanation for the difference in number of containers holding water between rural and urban islands. One possibility is rural residents may be less likely to complain about mosquito numbers, or to complain to code enforcement officers about accumulation of containers. Our results reinforce the need for inspectors to use their imagination and instinct to investigate any container that can possibly hold water, and for education programs to alert the public to the benefits of domestic cleanliness.

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