PARASITISM OF *COQUILLETTIDIA PERTURBANS* BY TWO WATER MITE SPECIES (ACARI: ARRENURIDAE) IN FLORIDA

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ABSTRACT. Female *Coquillettidia perturbans* collected in northern Florida were commonly parasitized by 2 species of water mites. Earlier in the year, mosquitoes were parasitized primarily by *Arrenurus danbyensis* and later in the year primarily by *Arrenurus delawarensis*. The number of mosquitoes simultaneously parasitized by both parasites is apparently greater than expected due to chance.

INTRODUCTION

Coquillettidia perturbans (Walker) is commonly parasitized by larval water mites, which attach to the cervical region of newly emerged adults (Jalil and Mitchell 1972, Smith and McIver 1984, Allan 1979,[3] Mullen 1974[4]). Two species of the water mite genus *Arrenurus* (subgenus *Truncaturus*) have been recorded from *Cq. perturbans*: *Arrenurus danbyensis* Mullen and *Arrenurus delawarensis* Mullen. Although *A. danbyensis* is widespread and common (Mullen 1976, Smith and McIver 1984), *A. delawarensis* is known only from 2 larvae collected on *Cq. perturbans* in Delaware City, Delaware, USA (Mullen 1976). In this study, we describe the sequential parasitism of adult female *Cq. perturbans* by *A. danbyensis* and *A. delawarensis*, both of which are abundant parasites of this mosquito in Florida.

MATERIALS AND METHODS

Female *Cq. perturbans* were collected during 1987 and 1988 at 3 locations in northern Florida with CO_2-baited CDC traps. Two locations were sampled 5.6 km apart on Paynes Prairie State Preserve, a marshy flatland in Gainesville, Florida, and a third was sampled at a public boat-launching facility next to Orange Lake in Cross Creek, Florida. Traps were set out at approximately 2–3 week intervals and were gathered the day after being set-up. In 1987, identification of mite species and analysis of mite numbers began with the samples of July 24 and ended with the samples of October 29, when the last parasitized hosts were captured during that year. (Shortly after the last parasitized hosts were collected, *Cq. perturbans* were no longer observed in the traps.) In 1988, mite identification and analysis began with the first samples containing parasitized *Cq. perturbans*, March 30 for Cross Creek and April 19 for Paynes Prairie, and continued until July 12.

Captured mosquitoes were frozen, and parasitized and unparasitized individuals were separated. Mites removed from each parasitized mosquito were placed on a separate slide in a drop of Hoyer's mounting medium, and the slide was dried for 24 h at 65°C. The mites were then counted and identified with a phase-contrast microscope using descriptions and diagrams in Mullen (1976).

Data recorded from each sample were the number of unparasitized and parasitized female *Cq. perturbans* and the number and identity of mites from each parasitized individual. These data yielded the proportion of hosts parasitized, i.e., prevalence (total number of parasitized hosts divided by total number of hosts) and the average number of mites per host, i.e., abundance (total number of mites divided by total number of hosts) (Margolis et al. 1982, Smith 1988). The data were further analyzed with a chi-square test applied to a 2×2 contingency table to determine whether the 2 mite species were more or less likely to be found on the same host individuals than due to chance.

RESULTS

Parasitic mites were observed on the cervical region of mosquitoes collected from late March to late October. At all 3 sampling locations, parasitism of *Cq. perturbans* followed the same general pattern: *A. danbyensis* appeared on the host earlier in the year and *A. delawarensis* later (Figs. 1–3). The prevalence and abundance of *A. danbyensis* were higher than those of *A. delawarensis* from March through May. Then the values of *A. delawarensis* were higher than those of *A. danbyensis* from June through October,

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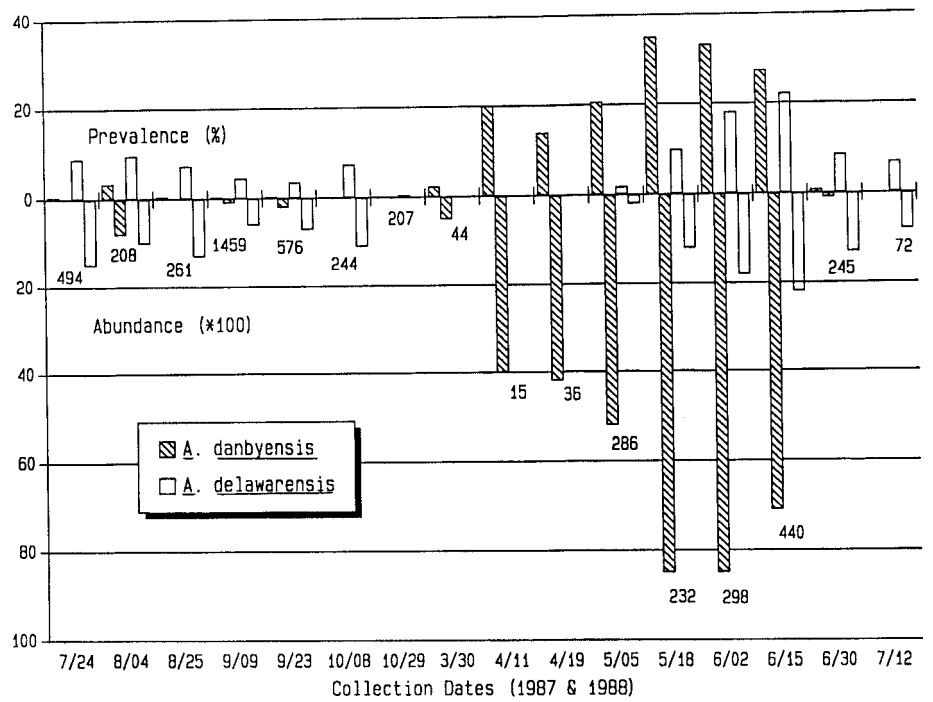

Fig. 1. Prevalence (expressed as a percentage) and abundance (multiplied by 100) of *Arrenurus danbyensis* (cross-hatched bars) and *Arrenurus delawarensis* (white bars) from Cross Creek samples. Total numbers of *Coquillettidia perturbans* collected on each sampling date are listed below the bars.

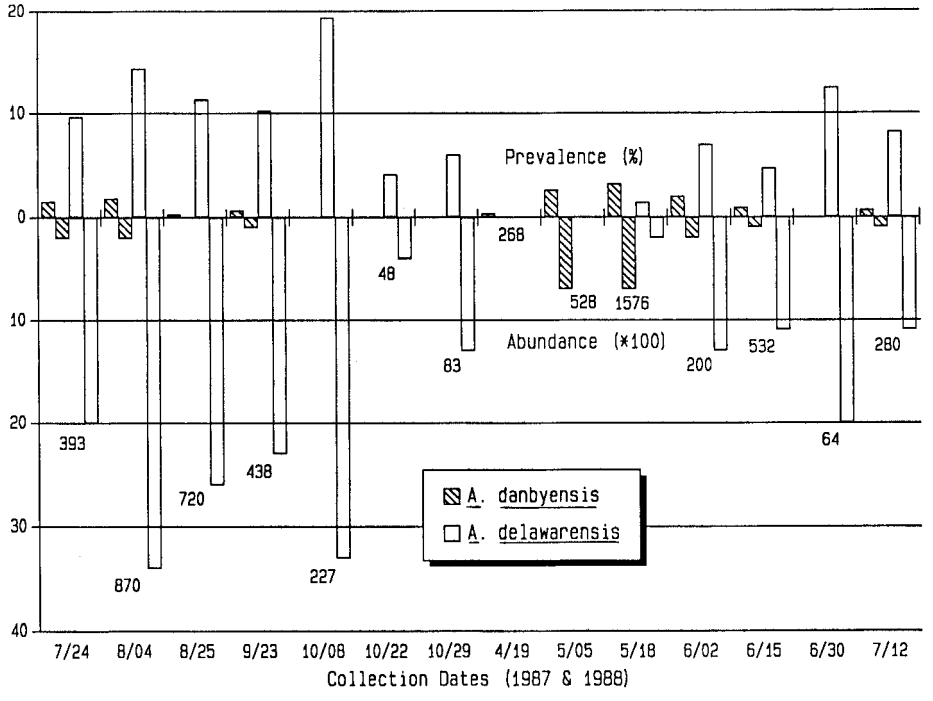

Fig. 2. Prevalence (expressed as a percentage) and abundance (multiplied by 100) of *Arrenurus danbyensis* (cross-hatched bars) and *Arrenurus delawarensis* (white bars) from Paynes Prairie (site 1) samples. Total numbers of *Coquillettidia perturbans* collected on each sampling date are listed below the bars.

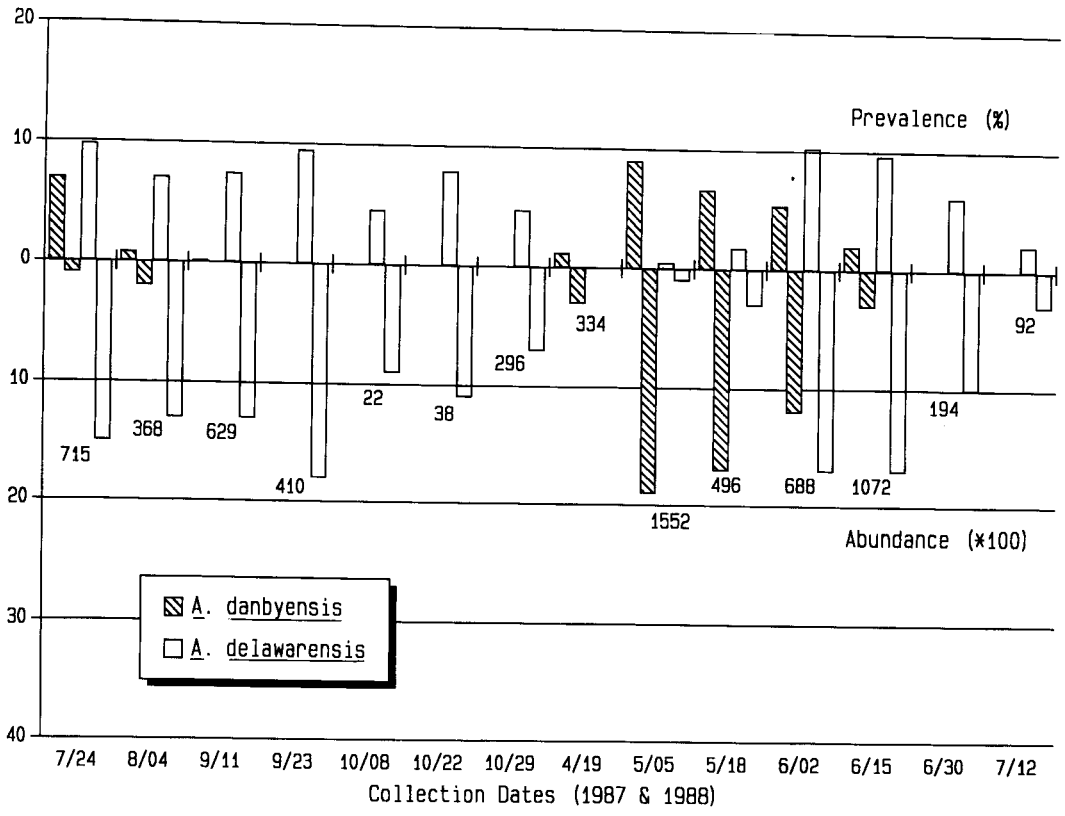

Fig. 3. Prevalence (expressed as a percentage) and abundance (multiplied by 100) of *Arrenurus danbyensis* (cross-hatched bars) and *Arrenurus delawarensis* (white bars) from Paynes Prairie (site 2) samples. Total numbers of *Coquillettidia perturbans* collected on each sampling date are listed below the bars.

Table 1. Chi-square tests of association between *Arrenurus danbyensis* (*A. da.*) and *Arrenurus delawarensis* (*A. de.*) on *Coquillettidia perturbans*. "All" includes all samples with both mites present. Sample abbreviations are CC, Cross Creek; PP1, Paynes Prairie, site 1; PP2, Paynes Prairie, site 2. The May 18, 1988—PP1 sample has a continuity correction because an expected value used to calculate χ^2 was less than 1.

Sample	Number of hosts				χ^2	P
	A. da. alone	*A. de.* alone	Both species	Neither species		
All	544	916	164	13,404	284.36	<0.001
May 18, 1988—CC	69	11	12	140	3.35	0.067
June 2, 1988—CC	67	22	32	177	20.15	<0.001
June 15, 1988—CC	73	50	47	270	28.16	<0.001
Aug. 4, 1987—PP1	6	115	10	739	30.67	<0.001
May 18, 1988—PP1	44	16	7	1,509	46.68	<0.001
June 2, 1988—PP2	26	60	11	591	15.91	<0.001
June 15, 1988—PP2	11	93	11	957	41.75	<0.001

after which mites were no longer found on the host.

Applying a chi-square test to the pool of all samples including both mite species or to individual samples with each mite species found on at least 10 host individuals showed that the 2 species were not randomly associated on the host. Instead, they occurred on the same host individuals more often than expected (Table 1), i.e., the largest contribution to the significant

chi-square values was from the higher than expected number of mosquitoes harboring both mite species.

DISCUSSION

Parasitized female *Cq. perturbans* are observed throughout most of this mosquito's long host-seeking period in northern Florida. Unlike North American populations of *Cq. perturbans* studied at higher latitudes, Florida populations are commonly exploited by 2 mite species. Although habitat and attachment site are the same in both mite species, timing of parasitism is different. Earlier in the year, the mosquito is parasitized primarily by *A. danbyensis* and later, primarily by *A. delawarensis*, a species found for the first time to be an abundant parasite of this mosquito. The ranges in prevalence (0–34.91%) and abundance (0–0.85) of *A. danbyensis* (Figs. 1–3) are similar to those observed by Smith and McIver (1984), who noted that this mite's prevalence rarely exceeded 30% and abundance rarely exceeded 1.00 on host-seeking *Cq. perturbans* in Ontario, Canada.

The number of hosts simultaneously parasitized by both mite species is apparently greater than expected due to chance. The causes of this possible positive association are unknown, but may be related to similar microhabitats or to similar host-selection mechanisms of the 2 mite species.

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