Diel Host-Seeking Activity of Adult *Diachlorus ferrugatus* (F.) (Diptera: Tabanidae) in Northwestern Florida[1]

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Abstract Host-seeking activity of adult *Diachlorus ferrugatus* (F.) was studied in northwest Florida during its peak abundance period in June 1993 and 1994. Primary peak activity occurred at sunset (1945h Central Standard Time) with a minor secondary peak at 1145h. Temperature explained the major portion of variation in host-seeking behavior with relative humidity and light intensity as statistically non-significant factors. No host-seeking activity was observed at darkness. Mark-recapture studies indicated that the majority of individuals did not remain in the area after initial capture but were transitory. Anthrone assays from *D. ferrugatus* collected adjacent to the immediate study area revealed that about 72% had fed on fructose, while parity assays indicated 96.9% of host-seeking adults were nulliparous.

Key Words Tabanidae, behavior, population ecology, deerflies.

Host-seeking adult deer flies (Diptera: Tabanidae) can be abundant enough to be considered as serious economic and nuisance pests in various regions of the U.S. (Harwood and James 1979). In northwestern Florida, *Diachlorus ferrugatus* (F.) can often become a serious biting pest in residential and recreational areas from mid-May through June (Jones and Anthony 1964, Fairchild and Weems 1973). The bite of this species has been reported to be painful and can cause severe localized reactions in some individuals (Fairchild and Weems 1973). Larval control using insecticides or habitat modification is not an option because of regulatory issues associated with such activities in wetland habitats where this species develops (Jones and Anthony 1964). Adulticides for area-wide control of tabanids has met with limited success (Anderson 1985).

The purpose of this study was to characterize diel host-seeking activity of adult *D. ferrugatus* and identify peak time periods for maximum exposure to control procedures, if warranted and feasible, to reduce pestiferous populations. Additionally, we wanted to recommend what time of day persons could avoid these pests when engaged in outdoor recreation or work-related activities.

Materials and Methods

This study was conducted on 11 and 12 June 1993 and 3, 8, 11 and 12 June 1994 in Walton Co. near Grayton Beach, FL. Sampling commenced during these 2 wks

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because it was the seasonal peak for *D. ferrugatus* as reported by Jones and Anthony (1964) and Fairchild and Weems (1973). The 16-ha study area, located adjacent to a black needlerush (*Juncus roemerianus* Scheele) marsh on Choctawhatchee Bay, was once a commercial pine bottomland forest containing slash pine (*Pinus elliotii* Ex. Chapm.). This forest also contained a mixture of magnolia (*Magnolia grandiflora* L.) and live oak (*Quercus virginiana* Mill.).

Host-seeking *D. ferrugatus* were collected using a 32-cm diam aerial insect net. Four staked 30 m by 4 m wide transects were used: 2 near the edge of a forest along a dirt road and 2 through the forest canopy. Transects were separated by at least 50 m. Each sample consisted of continually making figure-eight sweeps in front of and behind the head, shoulders, and legs while walking slowly along each transect for 1.5 min. Two persons simultaneously sampled one canopy and one road transect. Sampling was conducted so that no one person consecutively sampled the same pair of transects at any given interval. Collections in each transect were conducted hourly, starting at 1 h before sunrise and ending 1 h after sunset. Additionally, collections were taken 1/2 hour before sunrise and after sunset to include crepuscular periods. Sunrise occurred at about 0545 h and sunset at about 1945 hours Central Standard Time (CST). Each day contained 19 collection intervals from each of the four transects.

Flies captured at each transect were recorded, identified and released. To prevent bias in sampling previously collected flies, a small dot of brightly colored water-based acrylic paint was placed on the dorsum of the thorax of each fly the first time it was captured. A different color was used for each time period and day. All individuals were released after marking near their collection site. Marked flies recaptured were recorded as such and not included in final data to determine mean abundance at each time interval.

Air temperature, relative humidity, wind speed and direction were recorded at each collection period. During 1994, light intensity (lux) also was measured in each transect using a handheld light meter (A. W. Sperry Instruments, Inc., Hauppauge, NY). Each light measurement was a mean from each transect location (i.e., road vs forest canopy) with the photocell pointed towards the sky, perpendicular to the ground. Percent cloud cover was estimated subjectively and generally did not exceed 10%.

In 1994, additional aerial net samples of *D. ferrugatus* were taken at least 50 m from the main sampling transects during the same time periods for determination of parity and fructose feeding. All flies collected for this purpose were placed on dry ice immediately after capture and kept frozen until gonotrophic dissection and fructose assays were performed. Dissections and fructose assays were performed within 1 wk of collections. Thoraces were excised and assayed for presence or absence of a fructose meal using the methods of Van Handel (1972). Results were recorded at 1 h. Abdomens were excised at the same time as fructose assays were conducted and placed in a drop of physiological saline solution on a slide to determine parity. Parity was based on presence or absence of tracheal dilations at the base of ovarioles (Detinova 1962). Females were classified as parous (had oviposited) or nulliparous (not oviposited).

Data from collections from road and canopy transects were subjected to ANOVA (PROC GLM, SAS Institute 1990). Fly collections were transformed via $\sqrt{x + 1}$ prior to statistical analyses. A Student-Newman-Keuls test was used to determine differences ($P < 0.05$) in total fly abundance between transects (Sokal and Rohlf 1981). Step-wise regressions were performed on 1994 mean light intensity (lux) data and on pooled

data means for 1993 and 1994 using relative humidity and temperature as independent variables (Sokal and Rohlf 1981) with PROC REG/MAXR option (SAS Institute 1990). Relative humidity and light intensity were $\log_{10}$ transformed prior to regression analyses.

Results

A total of 255 *D. ferrugatus* host-seeking females was collected during the study. The earliest collection occurred at 0645 h (CST), 1 h after sunrise, peaked slightly during 1145 h with a major peak at 1945 h (Fig. 1). In between these two activity peaks females were generally present in low numbers. No fly activity occurred during darkness. No significant transect location effects were observed when total fly abundance per location was compared between collections along the dirt road and those in forest canopy (1993: $F = 0.02$, df = 75, P = 0.88; 1994: $F = 0.01$, df = 151, $P = 0.91$).

The majority of *D. ferrugatus* (96.9%, n = 131) were nulliparous. Of these, 71.7% had fed on a fructose source. Two flies captured at 1045 h were observed to have blood in their diverticula.

Only one host-seeking fly was recaptured during the study (1993) in transects. This fly had been recaptured on three occasions (25h, 27h and 37h) after being marked. Another fly also was recaptured in a New Jersey mosquito light trap about 0.8 km from the study area after being marked the preceding day. No marked flies were recaptured during 1994.

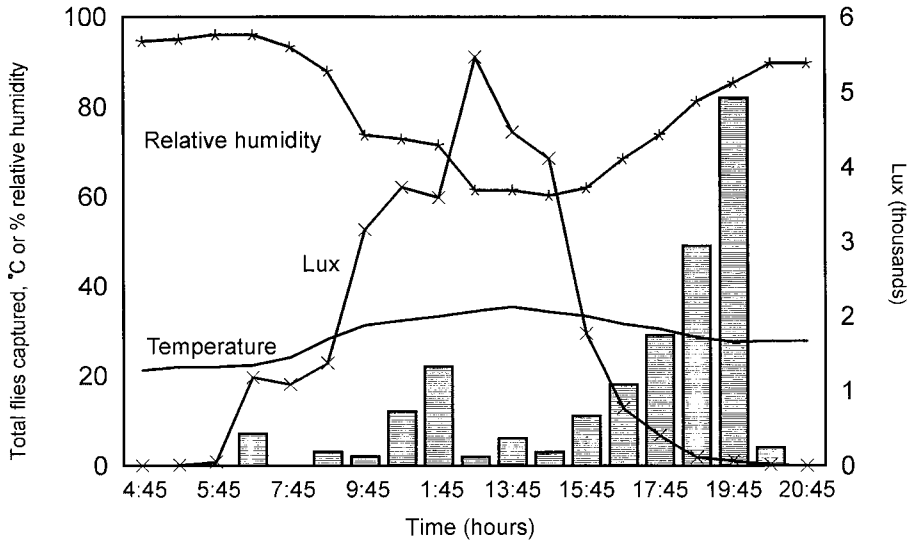

Fig. 1. Diel host-seeking activity of *Diachlorus ferrugatus* and associated environmental parameters. Total flies captured per time period (▤), mean % relative humidity (*), mean temperature (--), and mean light intensity (lux -+-) from 0445 h to 2045 h (CST) during June 1993 and 1994, Grayton Beach, Walton Co., FL.

After relative humidity, temperature and light intensity were regressed against total number of flies, the total model explained approximately 43% of variation in diel host-seeking activity ($Y = 41.34 - 1.46X_1 + 0.006X_2 - 10.16X_3$, $P = 0.003$). Temperature explained 97.7% of variation in the above model ($P = 0.003$) while relative humidity ($P = 0.56$) and light intensity ($P = 0.96$) were not significant contributory factors. Wind speed during studies from both years did not exceed 1.6 km/h and analysis of this parameter was not conducted.

Discussion

In northwestern Florida, adult *D. ferrugatus* primary host-seeking activity occurred during sunset with a slight late morning secondary peak. Once this species was active, about 1 h after sunrise, activity generally continued until dusk and ceased during darkness.

Temperature, humidity and light level have been reported to influence host-seeking activity of a variety of tabanids (Corbet 1964, Dale and Axtell 1975, Alverson and Noblet 1977, Strickman and Hagan 1986). However, in our study, only temperature showed a statistically significant association with regard to this behavior for *D. ferrugatus.*

We observed that attack zone and feeding behavior of *D. ferrugatus* was markedly different from congeneric tabanids (namely *Chrysops*) found within our study site. *Chrysops* spp. generally attacked the head and upper body region, whereas *D. ferrugatus* did not exhibit a strict preference although it often frequented lower extremities more often than upper extremities. Fairchild and Weems (1973) and McKeever and French (1997) also reported similar differences between these two genera. Furthermore, we observed that *D. ferrugatus,* after landing, appeared to move methodically and unobtrusively before it selected a suitable site to feed. However, a noticeable shift in host-seeking persistence occurred relative to time of day. From dawn through mid-afternoon, this fly was rather docile (compared with *Chrysops* persistent circling of a person's head) and could often be easily repelled by brushing it away when attempting to land. However, from 1745h-to dark, *D. ferrugatus* could not be easily repelled or dislodged once it landed in order to obtain a blood meal.

The majority of *D. ferrugatus* collected had obtained a fructose meal. This result was not unusual because carbohydrates have been reported to be important dietary components for tabanids (Magnarelli et al. 1979, Magnarelli 1981). Ground searches in the immediate sample area revealed sporadic blossoms of a few eastern redbud (*Cercis canadensis* L.), magnolia, and sparsely isolated stands of meadow beauty (*Rhexia virginica* L.). It was also possible that these flies may have fed on cryptic extrafloral nectaries, especially in the upper canopy.

We noted that the majority (96%) of *D. ferrugatus* did not remain in the study area after being marked. We also observed no distention or darkness of the abdomen in the majority of individuals marked that may have indicated a recent blood meal. Therefore, we suggest the majority of these tabanids continued to move out of the area, after release, to resume seeking a suitable host rather than remain in the area waiting for one to appear. We believe the reluctance of these flies to remain in the area after marking was not due to "panic flights" outside the recapture area (Foil 1983, Cilek and Schreiber 1996). Also, we did not observe any large flying insects (e.g., odonates and asilids) during the study that would have indicated possible predation on marked tabanids.

Given the constraints of area-wide control for larval or adult tabanid reduction when using insecticides, it may be prudent to investigate the feasibility of localized non-chemical control methods where pestiferous populations of *D. ferrugatus* occur. For example, Cilek (1993) developed the use of adhesive-coated black beach balls as decoy-traps for this species. These traps have proved to be highly attractive to these flies and have been used with great success in reducing perceived annoyance in northern Florida residential areas for a number of years (Cilek, unpubl. data). In areas where insecticides or traps are not useful (as well as persons who experience severe allergic reactions after being bitten), it may be prudent to simply avoid areas where this species is abundant during late morning and/or afternoon hours.

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