DIEL HOST-SEEKING ACTIVITY OF *CHRYSOPS CELATUS* (DIPTERA: TABANIDAE) IN NORTHWEST FLORIDA

J. E. CILEK AND E. T. SCHREIBER
John A. Mulrennan, Sr. Arthropod Research Laboratory, Florida A & M University
4000 Frankford Avenue, Panama City, FL

ABSTRACT

Diel host-seeking activity of adult *Chrysops celatus* Pechuman was studied in northwestern Florida during June 1993 and 1994. Primary peak activity occurred at 0645 h (CST) with a secondary peak at 1945 h. Host-seeking behavior was correlated with relative humidity but not temperature and light intensity. No host-seeking activity was observed at darkness. In all studies, the majority of flies initially marked and released were not recaptured in the area. Anthrone assays from *C. celatus* collected adjacent to the immediate study area revealed that approximately 96% had fed on fructose, while parity assays indicated about 92% of host-seeking adults were nulliparous.

Key Words: Chrysopinae, annoyance, behavior, population ecology

RESUMEN

Fue estudiada la actividad de búsqueda de hospedante en adultos de *Chrysops celatus* Pechuman en Florida noroccidental durante Junio de 1993 y 1994. La actividad primanria pico ocurrió a las 0645 h (hora estándard central) con un pico secundario a las 1945 h. La búsqueda del hospedante estuvo correlacionada con la humedad relativa pero no con la temperatura y la intensidad de luz. No fue observada actividad de búsqueda en la obscuridad. En todos los estudios, la mayoría de las moscas inicialmente marcadas y liberadas no fueron recapturadas en el area. Ensayos con anthrone en *C. celatus* colectados junto al area de estudio revelaron que aproximadamente el 96% se había alimentado con fructosa, mientras que ensayos ovoparidad indicaon que alrededor del 92% de los adultos buscando hospedante fueron nulíparos.

Many species of horse flies and deer flies (Diptera: Tabanidae) can be serious economic and nuisance pests in various portions of the U.S. (Harwood & James 1979). In northwest Florida the deer fly, *Chrysops celatus* Pechuman, can be abundant enough in residential and recreational areas to be considered a serious biting pest of humans. This species has been reported to occur during March through November with peak seasonal abundance from mid-May through June in Florida (Jones & Anthony 1964). The bite of *Chrysops* spp. can be painful and has been reported to cause severe reactions in some individuals (Mease 1943). Larval control using insecticides has proven to be difficult because of developmental site patchiness and environmental concern for the impact insecticides might impose on nontarget organisms in wetland habitats where most *Chrysops* species develop (Jones & Anthony 1964). Additionally, the use of insecticides for area-wide adult tabanid control has met with limited success (Anderson 1985).

The purpose of this study was to determine the diel host-seeking activity of adult *C. celatus* so periods for maximum exposure to control procedures against pestiferous populations could be identified. Additionally, we wanted to be able to recommend periods during the day when persons engaged in outdoor recreation or work-related activities could avoid these pests.

Materials and Methods

The study was conducted on June 11, 12, 1993 and June 3, 6, 8, 11, 12, 1994 in Walton County near Grayton Beach, Florida, USA. Sampling commenced during these two weeks because it is the usual period that seasonal peak abundance for adult *C. celatus* has been observed previously in north Florida (unpublished observation). 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 *C. celatus* 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 inner and outer 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 1 h before sunrise and ending 1 h after sunset. In addition, collections were taken 1/2 h before sunrise and after sunset to include crepuscular periods. Sunrise occurred at about 0545 and sunset at about 1945 hours CST. Each day contained 19 collection intervals in each of the four transects.

Flies captured at each transect were recorded, identified and released. To prevent biases in sampling previously collected flies, a small dot of brightly colored 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 flies were released after marking near their collection site. Marked flies recaptured were recorded as such and not included in final data to determine total abundance at each time interval.

Air temperature, relative humidity, wind speed and direction were recorded during each collection period. During 1994, light intensity (lux) was also recorded in each transect using a handheld light meter (capable of recording <1 to 107,589 lux obtained from A. W. Sperry Instruments, Inc., Hauppauge, NY,). Each light measurement was a mean of these transect readings with the photocell pointed towards the sky, perpendicular to the ground. Percent cloud cover was estimated subjectively and generally did not exceed 10%. On 6 June 1994, it rained from 0400 through 1500 hours with 100% cloud cover during the majority of that day.

In 1994, additional aerial net samples of *C. celatus* 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 at 0°C until gonotrophic dissection and fructose assays were performed. Dissections and fructose assays were performed within one week 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 during the same time fructose assays were conducted and placed in a drop of 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 of road and forest 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 & Rohlf 1981).

Step-wise regressions were performed separately 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 & Rohlf 1981). Relative humidity and light intensity data were log transformed prior to regression analyses.

RESULTS

A total of 521 *C. celatus* host-seeking females were collected during this study. The earliest collection of *C. celatus* occurred during the crepuscular period one half hour before sunrise (0530) with a primary peak at 0645 (Fig. 1). A second peak of lesser abundance occurred at 1945 hour. In between peak periods, flies were generally present in lower numbers. No fly activity was observed during darkness.

Chrysops celatus was found to be present and actively biting during diurnal rain episodes on 6 June. On that day, peak activity of host-seeking flies shifted two hours later in the morning (0845) and five hours earlier (1445) in the afternoon compared with non-rain dates and minimal cloud cover. Relative humidity on that date ranged from 99 to 100%, while temperature ranged from 21 to 22°C.

No significant location effects were observed for either year when total fly abundance per location was compared between collections from dirt road transects and forest canopy transects (1993-F=3.22, d.f.=75, P=0.08; 1994-F=0.96, d.f.=151, P=0.33).

Of the total *C. celatus* marked during 1993 and 1994, 4.8% (n=25) were recaptured. The overall majority of *C. celatus* (95.8%, i.e., 181 out of 189) collected near sample transects had fed on a fructose source, while 92.1% (i.e., 174 out of 189) from these collections were nulliparous. Most nullipars (95.4%, i.e., 166 out of 174) were also positive in the anthrone test for a fructose meal. One individual fly collected at 0545 hour contained blood in its diverticulum.

Hourly temperature and humidity cycles appeared to coincide with peak periodicity of host-seeking activity of *C. celatus* (Fig. 1). When all three environmental parameters: relative humidity, temperature and light intensity, were regressed against total number of flies, the total model explained approximately 45% of the variation in diel biting activity ($Y=-13.40+3.46X_1-0.05X_2-0.03X_3$, P=0.0001). Relative humidity explained 93.3% of the variation in the above model (P=0.03). Light intensity (P=0.42) was not a significant contributing factor nor was temperature (P=0.56). Similar trends were observed with biting data from the rain date collection, however in this case, relative humidity was not significant (P=0.09). Wind speed during studies from both years did not exceed 1.6 km/h and analysis of this parameter's effect on biting activity was not conducted.

Discussion

No previous reports on diel host-seeking periodicity of *C. celatus* exist. However, the biphasic behavior pattern of this species was similar to that reported for *C. atlanticus* Pechuman in Connecticut (Anderson 1973) and New Jersey (Thorpe & Hansens 1978), *C. flavidus* Weidemann (Roberts 1974) in Mississippi, and *C. dimidata* Wulp and *C. silacea* Austen in British Cameroons (Duke 1959). In each instance, one peak feeding period was identified shortly after sunrise and a second peak two hours before sunset with host-seeking activity terminating at darkness.

Temperature and humidity have been reported to influence host-seeking activity of a variety of tabanids (Corbet 1964, Dale & Axtell 1975, Alverson & Noblet 1977, Strickman & Hagan 1986). *Chrysops celatus* showed a statistically significant association with hourly humidity levels but not temperature.

We found no significant statistical association of *C. celatus* host-seeking behavior with relative light intensity (P=0.78), even though light intensity has been reported to influence the flight activity for other *Chrysops* spp. (Roberts 1974, Dale & Axtell 1975). However, host-seeking activity of *C. celatus* was prolonged the morning of 6 June 1994 (rain date) by two hours and appeared five hours earlier in the afternoon when 100% cloud cover prevailed. These shifts are in agreement with reports by Fair-

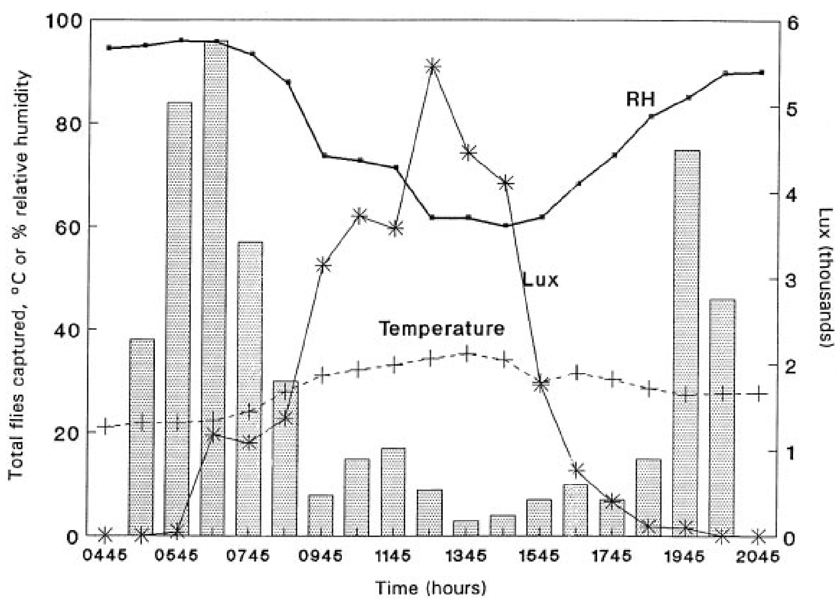

Fig. 1. Diel host-seeking activity of *Chrysops celatus* and associated environmental parameters. Total flies captured per time period (▯), mean % relative humidity (--), mean temperature °C (-+-), and mean light intensity (lux -*-) from 0445 hour to 2045 hours (CST) during June 1993 and 1994, Grayton Beach, Walton Co., Florida.

child & Weems (1973) and Alverson & Noblet (1977) that cloudy days often obscure activity peaks by prolonging host-seeking compared with sunny days.

On average, 4.8% (25 of 521) *C. celatus* initially marked were recaptured. We believe that the low recapture rate was not due to “panic flights” away from the sampling area. Rather, the majority of *C. celatus* may have flown out of the area, after release, to resume seeking a suitable host rather than remain in the immediate area for another to appear. A study in Louisiana, by Foil (1983), reported that 65% of marked *Chrysops* spp. (i.e., 134 out of 206) were recaptured on the same tethered horse after being interrupted from completing a blood meal, marked in a similar fashion, and released 0.31 m away.

It was not unusual that the majority of *C. celatus* collected had obtained a fructose meal, for carbohydrates have been reported as important dietary components for tabanids (Magnarelli et al. 1979, Magnarelli 1981) presumably to restore depleted energy reserves during flight. Magnarelli et al. (1979) also reported that female *C. atlanticus* and *C. fuliginosus* Wiedemann fed on similar reducing sugars throughout the day. However, ground searches in our immediate area for possible fructose sources for *C. celatus* revealed only sporadic blossoms of a few eastern redbud (*Cercis canadensis* L.) and magnolia. We acknowledge that *C. celatus* adults may have fed on other sources (such as cryptic extrafloral nectaries, especially in the upper canopy) at this, and other locations, before flying into our sampling area.

The importance of identifying diel host-seeking activity is crucial if one is to narrowly target time intervals for control of adult *C. celatus*. Insecticide applications applied during early morning hours may partially reduce the population but because of the apparent high mobility of these pests, new individuals probably would enter an area soon after spraying. Although the use of traps may be considered (e.g., Snoddy 1970, Cilek 1993, French & Hagin 1995), an alternative solution, and more prudent economical or environmentally sensitive strategy than using insecticides, would be to avoid areas where this pestiferous tabanid is abundant during early morning and late afternoon hours.

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