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CULICOIDES MELLEUS (COQ.) (DIPTERA: CERATOPOGONIDAE): SEASONAL ABUNDANCE AND EMERGENCE FROM SANDY INTERTIDAL HABITATS[1]

D. L. KLINE AND R. C. AXTELL[2]

Department of Entomology, North Carolina State University, Raleigh, NC 27607

ABSTRACT. The seasonal abundance of adult sand flies, *Culicoides melleus* (Coquillett), was studied during portions of 1972 and 1973 using a light trap, emergence traps and sticky cylinder traps at sandy tidal creek sites in the central coast region of North Carolina. *C. melleus* was effectively captured by all 3 methods and was found continuously present from early April through mid-October, being most abundant from late spring through early summer. Five additional species of *Culicoides* were collected, but *C. furens* (Poey) was the only other abundant species.

Larval distribution was determined by emergence traps. Only *C. melleus* and *C. furens* were found breeding in the intertidal sandy areas. *C. melleus* was the dominant species in both areas with the greatest number of *C. melleus* recovered from non-vegetated areas, and the greatest number of *C. furens* from vegetated areas.

INTRODUCTION

Culicoides furens (Poey), *C. hollensis* (Melander and Brues), and *C. melleus* (Coquillett) are common blood sucking sand flies (or gnats) attacking people and livestock in the Atlantic and Gulf Coast regions of the United States. Various authors have mentioned tidal salt marshes as breeding habitats for *C. furens* and *C. hollensis,* and intertidal areas of sandy beaches where wave action is minimal as breeding habitats for *C. melleus* (Goulding et al. 1953, Jamnback and Wall 1958, Jamnback et al. 1958, Khalaf 1969, Kline et al. 1975, Linley and Adams 1972, Wall and Doane 1960).

This paper reports data on the seasonal occurrence of the adults and on the distribution of the larvae of *C. melleus* in a coastal marsh (with a substrate of coarse sand) in North Carolina.

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[2] Graduate Research Assistant, and Professor, respectively.

METHODS AND MATERIALS

The study area was a tidal creek, known as Hoop Hole Creek, located adjacent to Atlantic Beach, on the sound side of Bogue Banks, Carteret County, North Carolina. The narrow (2–10m) margins of the tidal creek consisted of two subhabitats: (1) vegetated sandy areas dominated by tall form (>1.2 m) *Spartina alterniflora* Loisel. (smooth cordgrass) and (2) non-vegetated sandy areas (Figure 1). Both of these subhabitats were flooded twice daily by the high tides. These subhabitats were surrounded by a bank (ca. 30° incline). The study site was adjacent to areas of *Spartina patens* (Ait.) Muhl. (salt meadow grass), *Juncus roemerianus* Scheele (black needle rush), a *S. alterniflora* marsh with silt substrate, and areas of high marsh shrubs and hardwoods.

Culicoides adults were sampled during portions of 1972 and 1973 by means of a light trap, conical emergence traps, and sticky cylinder traps. A New Jersey light trap equipped with an automatic timer and modified by replacing the regular screen of the delivery cone with 40-mesh brass screening was operated ca. 1 mile from the study site. The trap was functional from 1800–0630 hrs EST in spring and fall and from 2000–0630 hrs in the summer. Collections were removed at least 3 times a week and usually daily.

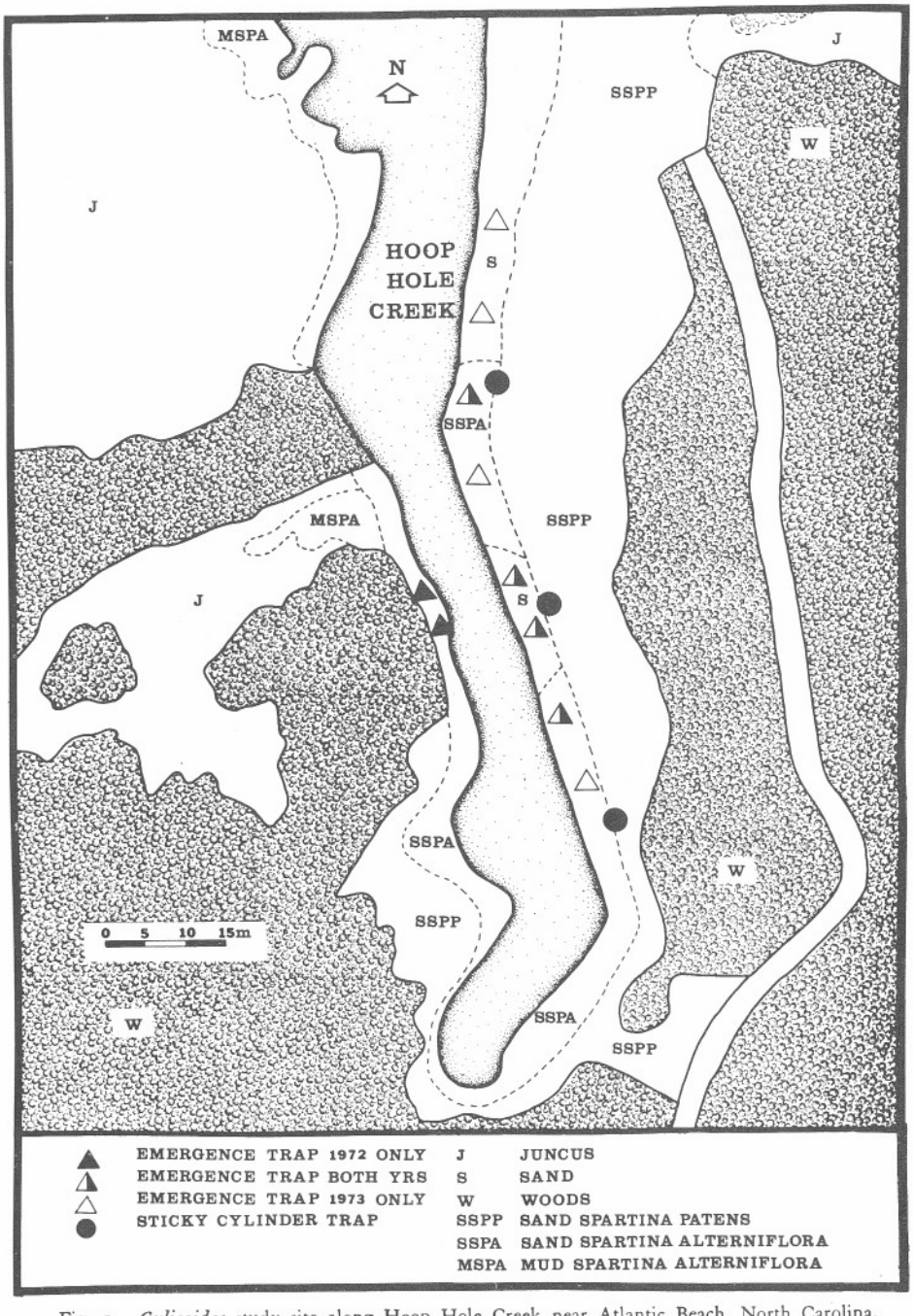

Fig. 1. *Culicoides* study site along Hoop Hole Creek near Atlantic Beach, North Carolina.

The number of *Culicoides* in a collection was estimated in a manner similar to that described by Jamnback and Watthews (1963) except that the collections were processed through a series of screens in a dry state rather than washed through in 80% ethyl alcohol. The average daily catch was calculated from the combined data for 1 week.

The conical metal emergence traps (63 cm diam. at the base and 48 cm high) were similar to those described by Davies (1966) and Linley et al. (1970). The newly emerged adult *Culicoides* were trapped on sticky Bird Tanglefoot® coated thinly on a sheet of cellulose acetate inside an inverted glass jar attached to the apex of the cone. The inside lip and bottom of the jar were also coated. In 1972, 4 were located in sandy vegetated (*S. alterniflora*) subhabitat, and 2 in the sandy areas which were free of vegetation. All traps were placed just below high tide level since Linley and Adams (1972) found the greatest number of pupae of *C. melleus* at this level. In 1973, 4 traps were placed in each subhabitat. At each site, the trap was checked and moved twice weekly to minimize a bias due to possible attraction of larvae beneath the trap from the surrounding areas as suggested by Davies (1966). Collecting jars were changed twice weekly in 1972 and once weekly in 1973. Specimens were removed with Varsol and preserved in 70% ethyl alcohol for subsequent identification.

The sticky cylinder traps were similar to those used by Kettle (1951). Sections (30 cm high x 10 cm diam.) of black plastic sewer pipe were held 1.8 m above the ground on wood posts. *Culicoides* were trapped on sheets of cellulose acetate which were thinly coated with Bird Tanglefoot® and wrapped around the outside of the pipe. The acetate sheets were changed once a week. Specimens were removed with Varsol and preserved in 70% ethyl alcohol for subsequent identification. Three traps were located ca. 30 m apart along the east bank of the tidal creek.

RESULTS

SEASONAL PATTERNS. In 1972, *C. melleus* was present in light trap collections from mid-April to near the end of October; the population was rarely below 1 gnat/trap night (only in late May and early October) (Figure 2). There were 2–3 peaks with definite peak occurrences from the last week in April through the first week in May and again in late September (largest); a possible peak occurred in early June. In 1973 the seasonal incidence was similar; the only exceptions were the earlier appearance of the gnats in light trap collections by about 2 weeks, the population level never dropped below 1 gnat/trap night, and the largest peak occurred in late April. With the exception of a very large peak in late April, peaks were hard to define. A possible second peak occurred in late May, after which the population level remained at ca. 100 gnats/trap night for all but a few weeks for the remainder of the season.

Gnats were collected in emergence traps from the first week of April through the first week of September in 1972. There were 3 progressively smaller peaks of abundance: (1) the last week of April through the first week in May, (2) the first week in July, and (3) mid-August. In 1973 the gnats first appeared in the emergence traps in mid-March and were continuously captured through the second week in October. There were 6–7 possible peaks: (1) mid-April, (2) late May, (3) early June, (4) late June (largest), (5) the last 3 weeks in July (questionable), (6) early August, and (7) early September.

Sticky cylinder traps were used only in 1973. Gnats were captured on them from early April through the first week in October. According to our data there were 6–7 peaks of abundance: (1) late April, (2) early May, (3) early June, (4) the last week in June through the first week in July (largest), (5) mid-August, (6) the first week in September, and (7) the last

week in September. Peaks 1 and 2, and peaks 5 and 6 may represent different broods.

EFFECTIVENESS OF METHODS. All three methods appeared to effectively capture large numbers of both sexes of *C. melleus* (Table 1). The lowest percentage of males was found in light trap collections, and the highest percentage in sticky trap collections. In addition to *C. melleus,* these sampling methods collected other species. The greatest diversity was obtained in light trap catches. *C. furens* was the second most abundant species in the light trap, but a small number of *C. hollensis, C. niger* Root and Hoffman and *C. stellifer* (Coquillett) were also obtained. *C. furens* was the only other species re-

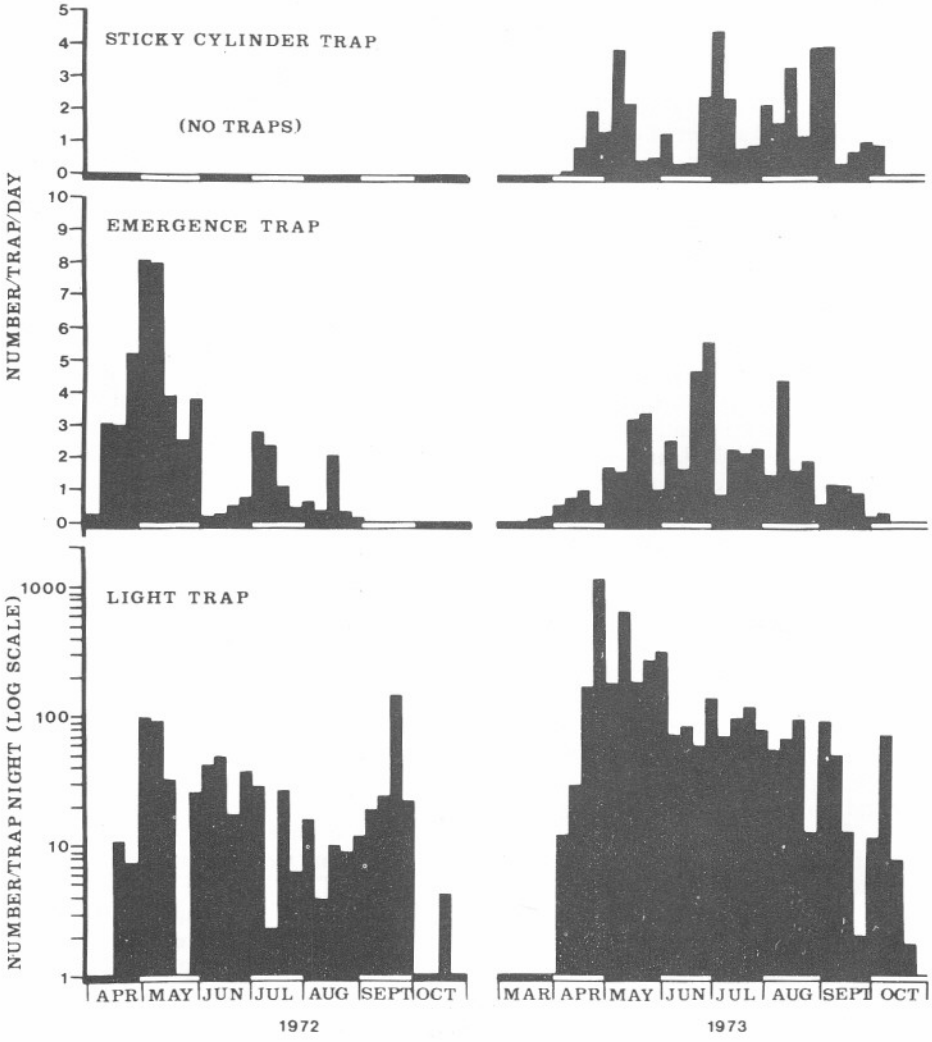

Fig. 2. Seasonal abundance of *Culicoides melleus* as monitored by 3 methods.

Table 1. Number and percentage (in parentheses) of each sex of *Culicoides melleus* captured by 3 trapping methods (LT=light trap; ET= emergence trap; SCT=sticky cylinder trap) for portions of 1972 and 1973.

	1972			1973		
Method	♂	♀	Tot.	♂	♀	Tot.
LT	1221 (26.5)	3386 (73.5)	4607	11227 (39.5)	17174 (60.5)	28401
ET	921 (45.3)	1111 (54.7)	2032	1318 (47.7)	1446 (52.3)	2764
SCT	....	....	....	515 (54.0)	438 (46.0)	953

covered in the emergence traps. *C. furens, C. hollensis,* and *C. obsoletus* (Meigen) were captured on the sticky cylinder traps.

LARVAL DISTRIBUTION. *C. melleus* was the dominant (ca. 79% both years) but not the only species recovered in the emergence traps. Some *C. furens* (ca. 21% both years) were also recovered. Greater than 50% (56.1 and 51.3% for 1972 and 1973, respectively) of the gnats from the vegetated areas, and greater than 90% (97.9 and 91.9% for 1972 and 1973, respectively) of the gnats from the non-vegetated areas were *C. melleus.* The majority (68–79%) of the *C. melleus* were recovered from the non-vegetated areas (Table 2). Nearly all of the small numbers of *C. furens* were recovered from vegetated areas. No gnats were recovered from a "control" trap (a trap placed on a sheet of plywood with the rim raised 2.5 cm above the plywood by small blocks) which was maintained in the non-vegetated areas; this demonstrated that the traps were collecting only adults emerging from the soil beneath the traps and not adults entering from the outside.

Table 2. Numbers and percentages (in parentheses) of *Culicoides melleus* and *C. furens* in conical emergence traps in vegetated (*Spartina alterniflora* Loisel.) and unvegetated sandy areas.

	Mean no./trap/week			
Species	Vegetation		No vegetation	
C. melleus				
1972	8.7	(31.5)	18.9	(68.5)
1973	6.0	(20.8)	22.8	(79.2)
C. furens				
1972	6.8	(94.4)	0.4	(5.6)
1973	5.7	(74.0)	2.0	(26.0)

DISCUSSION AND CONCLUSIONS

SEASONAL PATTERNS. In general, *C. melleus* adults were present from early April to about mid-October. The number and occurrence of peak populations varied from year to year. Overall, *C. melleus* tended to be more abundant in late spring and early summer than in late summer and early fall. In 1972, the period of peak abundance obtained by the emergence traps was especially skewed to late spring-early summer. In 1973, the gnats appeared to emerge more evenly throughout the season but were still slightly skewed to late spring-early summer.

Our results, when compared to data collected in other regions, show that the seasonal incidence of *C. melleus* is a function of latitude: shorter in the more northern latitudes and longer in the more southern latitudes within the United States. Lewis (1959) reported that *C. melleus* was not present until late June and declined by mid-September in Connecticut. In New York there is apparently only 1 generation per year with the peak in mid-summer (Jamnback et al. 1958). Similar findings were reported by Wall and Doane (1960) in Massachusetts. Henry (1973) reported that *C. melleus* was present from as early as March to as late as October in South

Carolina, and Beck (1958) collected this species every month of the year in Florida, but found it most abundant from March to May.

EFFECTIVENESS OF METHODS. Since the light trap was not operated at the same site as the emergence and sticky cylinder traps, no direct comparisons of the 3 methods can be made. Some general observations of the light trap catches, however, can be made. Large numbers of *C. melleus* were attracted to the light trap; the proportion of males in these collections was very high in comparison to light trap catches of *C. hollensis* and *C. furens* (Kline 1975). The light trap, with the exception of very large peaks, does not appear to accurately monitor detailed seasonal population fluctuations.

Emergence and sticky cylinder trap collections for 1973 are comparable. Both of these methods provided detailed information on seasonal fluctuations. Data from both methods revealed an equal number of nearly synchronous, and relatively the same size peaks. These methods differ somewhat in the proportion of each sex of *C. melleus* caught; a few more females than males (52 vs 48%) were recovered in the emergence traps while the opposite (46 vs 54%) was true for sticky traps. Also, *C. melleus* appeared in emergence trap catches a few weeks earlier than in the sticky trap catches.

Another difference was in the proportion of *C. melleus* and *C. furens* caught. More *C. melleus* (79 vs 21%) were recovered from the emergence traps, but less were caught on the sticky traps (34 vs 66%). This difference was probably due to the emergence traps recovering only those adults which emerge from the sandy habitats while the sticky traps in addition probably attracted adults emerging from the adjacent *S. alterniflora* and *Juncus* habitats with mud substrate.

LARVAL DISTRIBUTION. Our results show that *C. melleus* prefers non-vegetated to vegetated sandy areas, and *C. furens* prefers the opposite. Whether this was due to actual preference, to interspecific competition, or some other factor was not investigated. Similar areas of intertidal sand protected from violent wave action have frequently been reported as breeding habitats of *C. melleus* (Goulding et al. 1953, Jamnback and Wall 1958, Jamnback et al. 1958, Wall and Doane 1960, Linley and Adams 1972), but only Wall and Doane (1960) mentioned that larvae were found beneath stands of *S. alterniflora* growing in intertidal sand. There are no other reports, to our knowledge, of overlapping breeding of *C. melleus* and *C. furens*. Usually *C. furens* is associated with tidal marshes and mangrove swamps even though this species has been found breeding in sand (Hair et al. 1966, Linley and Davies 1971).

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