SEASONAL ABUNDANCE AND PARITY OF COMMON *CULICOIDES* COLLECTED IN BLACKLIGHT TRAPS IN VIRGINIA PASTURES

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ABSTRACT. In a blacklight trap survey of *Culicoides* occurring in pastures selected from 3 of the 5 physiographic provinces of Virginia, the 5 most common species collected were *C. biguttatus, C. obsoletus, C. stellifer, C. variipennis* and *C. venustus. Culicoides biguttatus* was univoltine with a possible second emergence occurring in the coastal plain province. The other 4 species were multivoltine. *Culicoides variipennis* had the highest mean seasonal parous rates, being 73–83% during 1978 and 53–80% during 1979. The parous rate of *C. biguttatus* averaged 55% and *C. obsoletus* 8–45% during 1978 and 8–31% during 1979. Similar parous rates were observed in *C. stellifer* collected in 1978 (19–34%) and 1979 (4–30%).

INTRODUCTION

The *Culicoides* of Virginia and their geographical distribution have been summarized by Battle and Turner (1971), but studies on their seasonal occurrence and abundance have been limited primarily to those species inhabiting the forested regions of western Virginia (Murray 1957, Messersmith 1966, Tanner and Turner 1975). Other studies on species known to be present in Virginia have been summarized by Blanton and Wirth (1979).

Since there is a lack of knowledge of the species present in other areas of the state and because *Culicoides* are important vectors of several livestock diseases (Kettle 1965), a study of these midges was conducted in 3 of the 5 major physiographic provinces of Virginia. The purpose of this study was to relate seasonal abundance and gonotrophic age to vector potential of these midges.

MATERIALS AND METHODS

STUDY SITES. Sites were selected in 3 of the 5 physiographic provinces of Virginia. They were: Ridge and Valley Province (RVP), Piedmont Plateau (PP) and Coastal Plain (CP) (excluding the tidewater area) (Hoffman 1969). Forest types for each province were oak-hickory, oak-hickory with secondary pine and southeastern evergreen, respectively. In this study, we assumed that the RVP trap site was typical of the livestock raising areas of the other 2 physiographic provinces in western Virginia (Blue Ridge and Appalachian Plateaus).

The RVP site was located on the Virginia Polytechnic Institute and State University farm (37° 12′N, 80° 26′W) at an elevation of 677 m. The trap site was located between the Beef and Sheep Centers on county route 314 in a pasture with 2 small oak-hickory woodlots approximately 20 m² each. The nearest woodlot was 60 m from the trap site. Two small first order streams as well as one impounded and polluted first order stream were located 500 m from the trap site. One 2.43 hectare pond was located 750 m from the trap site and the entire area was well drained.

At the PP site, in Campbell Co., 2 sites were used in 1978 and one in 1979 both located near county route 663. The elevation of site 1 (37° 12′N, 78° 51′W), (used both years) and site 2 (37°, 16′N, 79° 01′W) was 244 m. The site 1 trap was located in a pasture near (33 m) a 40 m² oak-hickory woodlot. Six impounded first order streams ranging from 0.8–4 hectares were located within 500 m of the trap site. Site 2 was located 1 km west of site 1. Site 2 contained less pasture than site 1 and had a continuous mixture of oak-hickory woods throughout. In addition, 2 first order streams were located about 150 m from this site. Both sites were well drained.

The CP trap site was located in Isle of Wight Co. (36° 48′N, 76° 41′W) at an elevation of 11 m off state route 360, 6.6 km west of Suffolk. Traps were placed in a pasture in which the nearest mixed deciduous woodlot was approximately 250 m from the trap site. Two large brackish lakes were situated 500 m north and south of the trap site. In addition, twelve 0.4–1.2 hectare ponds were located within 330 m of the site. Drainage was poor.

TRAP TYPE. A New Jersey light trap modified with a 4.7 cm circular fluorescent blacklight (Concession Supply Co., 3916 Secor Rd., Toledo, OH 43613) was used. A 14 mesh plastic screening shield was placed around the opening to inhibit the collection of large insects. This blacklight trap was operated weekly at all sites

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from 30 min pre-sunset to 90 min post-sunset (designated "sunset"). At the CP site, an additional blacklight trap was operated from 90 min post-sunset to approximately 70 min post-sunrise (designated "rest of night"). Additional blacklight traps were operated rest of night occasionally at the other 2 sites. When the 2 trap times were combined, the trapping period was designated "all night." Collections were made in 236.6 ml Mason jars filled to ⅔ capacity with 80% ethyl alcohol. At least 200 midges were identified from each catch using the separation and identification method similar to Jamnback and Watthews (1963). Each sample was placed in a white enamelled tray containing aliquot divisions. From one aliquot, 200 *Culicoides* were randomly removed and identified to species.

Parity for all species except *C. variipennis* (Coquillett) and *C. venustus* Hoffman was determined by the pigmentation method described by Dyce (1969). For parity determination of *C. variipennis*, the method of Potter and Akey (1978) was used, showing that the abdominal tergites of *C. variipennis* change from a nulliparous condition of a dark trilobed pattern to a completely dark appearance when parous. However, neither of the above methods could be used for *C. venustus*, because information on pigmentation changes in this species is lacking. Percent parity was calculated as follows: % parity = no. parous ♀♀ ÷ no. parous ♀♀ + no. nulliparous ♀♀ × 100.

Data for the species collected in blacklight traps were examined in 2 ways: (1) the results were presented in numbers per trap catch so comparisons between sites and species could be made and (2) to examine trends in population abundance, weekly collections were transformed to Log (N+1). This was done to prevent errors in interpretation of high catches on certain nights (Williams 1937). Climatological data were obtained from the nearest National weather station (RVP in Blacksburg, PP in Appomattox and CP at Lake Kilby).

RESULTS AND DISCUSSION

Table 1 shows the five "most common" species plus total of all species collected and the average catch by site in 1978 and 1979. Numbers and gonotrophic age by site for the other 25 species collected are listed elsewhere.[2] These latter species were collected in low numbers (≤450) and could not be analyzed further.

Culicoides biguttatus (Coquillett) was abundant at the CP site in 1978, and at the PP site in 1979 but abundant at the RVP site in both years (Table 1). The preferred larval habitats of this species include lake margins, pools, stream edges, poorly drained mud, sand and decaying leaf matter (Hair et al. 1966, Blanton and Wirth 1979). These habitats were not in abundance at the RVP site.

Figure 1 shows the seasonal abundance of *C. biguttatus* as collected at the PP site (sunset) and at the CP site (all night). This species occurred from early May to mid-July. These results were similar to those previously reported in Virginia by Murray (1957) and Messersmith (1966) and in Connecticut by Lewis (1959). At the CP site, parous rates remained above 55% from early June until July. There was no decrease in percent parity with a concurrent increase in numbers except perhaps on June 15 and July 10, 1978 and July 1, 1979. This suggested that fluctuations in numbers were mainly due to trap catch variability and not to emerging nulliparous females. If discrete emergences did occur, then percent parity would probably drop when the population numbers suddenly increased. Also, if emergences overlapped, the percent parous rates would fluctuate like those for *C. stellifer* (Coquillett) (Fig. 3) and *C. variipennis* (Fig. 4) without a consistent increase in parous rate. Because of the generally high parous rates, *C. biguttatus* is considered to be univoltine in Virginia with a possible minor emergence in early summer at the CP site. A univoltine phenology and similar trend in parous rates for *C. biguttatus* has also been suggested by Schmidtmann et al. (1980) in New York State.

The largest number of *C. obsoletus* (Meigen) adults were collected at the RVP site in 1978 and at the PP site in 1979 (Table 1). The larval habitats of this species are moist terrestrial habitats such as straw-manure, corn composting stalks, and moist leaf litter (Murray 1957, Jamnback and Wirth 1963). These habitats were more abundant at the warmer CP site, but the range of this species does not appear to extend further south than Tennessee (Jamnback and Wirth 1963), suggesting an affinity for more northern type climates. It is also absent from Florida (Blanton and Wirth 1979). Therefore, small numbers would be expected at the CP site. This species occurred from May through part of September (Fig. 2) and its temporal distribution is similar to observations made in New York (Jamnback 1965).

Unfortunately the total number of nongravid females collected was small due to the high number of total gravid *C. obsoletus* females col-

[2] Zimmerman, R. H. 1981. Seasonal abundance and host preference of *Culicoides* in Virginia: with emphasis on the ecology of *Culicoides variipennis* (Diptera: Ceratopogonidae). Ph.D. dissertation, Virginia Polytechnic Institute, Blacksburg, VA 189 p.

Table 1. Average number of five most common *Culicoides* collected per trap time in blacklight traps during 1978 and 1979 in three physiographic provinces in Virginia.

	Physiographic provinces*					
	1978			1979		
Species	CP (12)**	PP (15)	RVP (11)	CP (18)	PP (12)	RVP (9)
C. biguttatus	10.33	2.13	0.18	9.33	17.33	2.78
C. obsoletus	1.83	7.67	16.27	0.08	18.25	5.55
C. stellifer	116.58	58.47	8.18	108.22	121.67	8.33
C. variipennis	43.25	1.40	0.18	105.22	6.33	8.11
C. venustus	13.33	3.33	1.27	5.61	4.25	0.67
All species	189.08	76.67	31.55	232.17	180.17	65.33

* CP = Coastal Plain; PP = Piedmont Plateau; RVP = Ridge and Valley.
** Number of trap times.

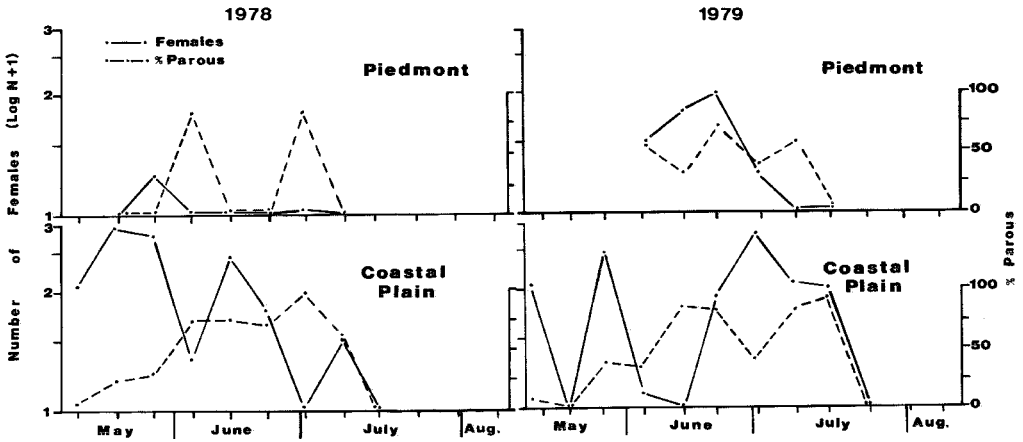

Fig. 1. Seasonal abundance and % parous rates of *Culicoides biguttatus* collected in blacklight traps weekly on the Piedmont Plateau at 30 min pre-sunset to 90 min post-sunset and on the Coastal Plain at 30 min pre-sunset to 60 min post-sunrise in 1978 and 1979.

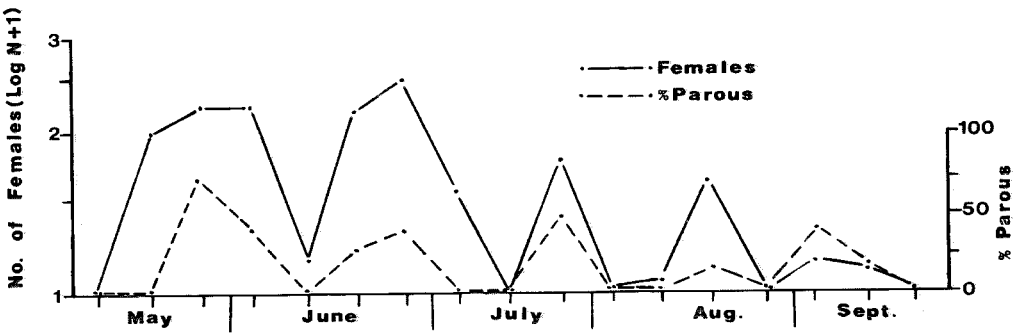

Fig. 2. Seasonal abundance and % parous rates of *Culicoides obsoletus* collected in blacklight traps weekly in the Ridge and Valley Province at 30 min pre-sunset to 60 min post-sunrise in 1978.

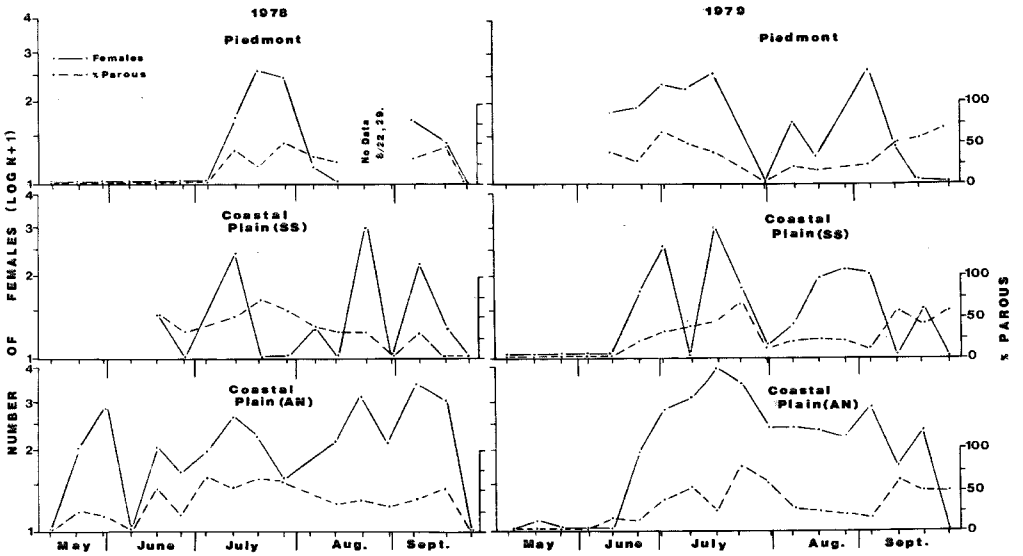

Fig. 3. Seasonal abundance and % parous rates of *Culicoides stellifer* collected in blacklight traps weekly on the Piedmont Plateau at 30 min pre-sunset, to 90 min post-sunset, and on the Coastal Plain at 30 min pre-sunset to 90 min post-sunset (SS) and at 30 min pre-sunset to 60 min post-sunrise (AN) in 1978 and 1979.

lected (n = 660, 62%). This made analysis of phenology difficult. But, during 1978 a blacklight trap was operated weekly at the RVP site "all night" for an 11 wk/period. A total of 558 female *C. obsoletus* were collected, of which 328 were gravid. Only 230 females remained from which seasonal phenology could be ascertained. Figure 2 shows the number of females collected and their parous rates during this trap time. These numbers and parous rates fluctuated concurrently over time. Therefore, peak numbers were not due to emerging females.

In order to assess the phenology of *C. obsoletus* the seasonal percent parous rates of females collected at all sites were examined. The percent parous rates for 1978 ranged from 8–41 and in 1979 from 8–31. This suggests that adults of this species are continuously emerging in low numbers throughout the season. The possibility of continuous emergence is supported by the findings from New York State where *C. obsoletus* was observed to emerge continuously and was considered to be multivoltine (Jamnback 1965, Schmidtmann et al. 1980). Lewis (1959) concluded that there were only two generations per year in Connecticut with three definite population peaks.

Culicoides stellifer was generally the most abundant species collected in the blacklight traps in both years at all sites (Table 1). The large number of *C. stellifer* collected at the CP and the PP sites suggested that the traps were located in close proximity to the preferred larval habitat, which are diverse freshwater soil types including ponds, streams and poorly drained areas of mud and leaf litter (Murray 1957, Hair et al. 1966). The PP site was located near several impounded and wooded streams. The area surrounding the CP site was poorly drained with frequent standing water. On the other hand, the RVP site had good drainage with few freshwater habitats, hence fewer larval habitats.

Culicoides stellifer was collected from May until at least mid-September. Virginia data are in agreement with studies by Pickard and Snow (1955) in Tennessee and from other studies (Blanton and Wirth 1979). In Connecticut, Lewis (1959) observed a single high population peak followed by a low constant population for a month. Figure 3 shows the seasonal abundance and percent parous rates of this species at the PP site (sunset) and the CP site (all night) for 1978 and 1979. Continuous fluctuations in total number of females collected were observed as well as low fluctuating percent parous rates. Mean seasonal percent parous rates in Virginia ranged from 19–34 in 1978 and from 4–30 in 1979. These results indicated that *C. stellifer* was

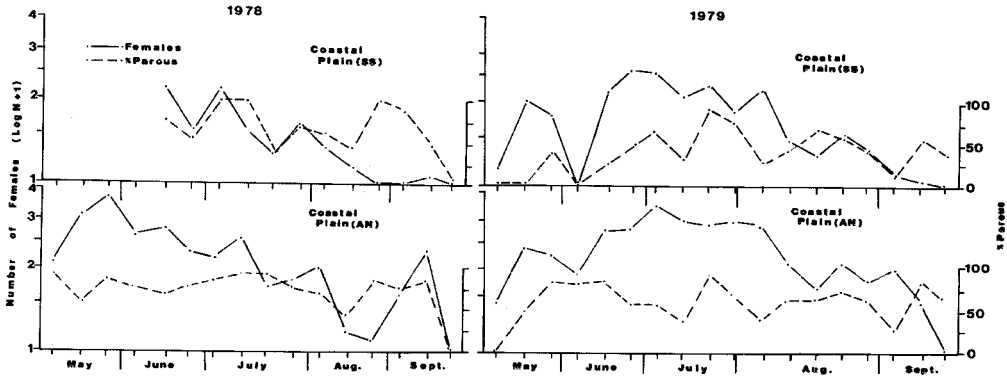

Fig. 4. Seasonal abundance and parous rates of *Culicoides variipennis* collected in blacklight traps weekly on the Coastal Plain at 30 min pre-sunset to 90 min post-sunset (SS) and at 30 min pre-sunset to 60 min post-sunrise (AN) in 1978 and 1979.

multivoltine in Virginia. They also suggested that a species collected in large numbers but having small percent parity would result in small numbers of adult survivors. During 1979, adult female *C. stellifer* were collected alive and brought into the laboratory, but the adults did not survive over two days.

Culicoides variipennis was the second most abundant species collected in the blacklight traps at the CP site in both years, but at the PP site and at the RVP site it was the third and fourth most abundant species, respectively (Table 1). These rankings can again be attributed to the light trap being located near the preferred larval habitat of this species which were diverse fresh, salt and alkaline waters plus streams and ponds polluted with livestock excrement (Jones 1961, Hair et al. 1966, Blanton and Wirth 1979). The CP site was not well drained and wherever pasture depressions and hoofprints occurred there was a potential mixing of livestock excrement with standing water. Its high larval abundance in organic polluted areas accounted for the large numbers of adults collected at the site. At the PP sites and RVP site the pastures were well drained and did not result in as much mixing of manure and water.

This species was collected from May until mid-September and has been recorded in Colorado from March to November (Barnard and Jones 1980). The seasonal occurrence and parity results from the CP site indicated that this species is multivoltine and long-lived in Virginia (Fig. 4). The results from the other sites were not presented, because the numbers caught were too small to be meaningful. The total number of females collected per trap time fluctuated over time and percent parous rates usually decreased as numbers increased. The fluctuations in the number of females collected were similar to *C. stellifer*, but parous rates of *C. variipennis* were consistently higher. Mean seasonal percent parous rates were 73–83 in 1978 and 53–80 in 1979. These high parous rates persisted throughout the season and were seldom recorded below 30%, suggesting that *C. variipennis* is a long-lived, continuously emerging species. However, recent studies in New York by Mullens and Schmidtmann (1982) showed that determination of parity using the tergite pattern is less reliable than the abdominal pigment method. Thus it is possible that parous rates of Virginia *C. variipennis* may in actuality be lower than reported here. Contrasted to *C. stellifer*, *C. variipennis* adults survived in our laboratory up to 14 days. Jones (1967) observed female survivorship up to 44 days in his laboratory.

The largest number of *Culicoides venustus* was collected at the CP site and the smallest number was collected at the RVP site (Table 1). This species breeds in wet pastures, muddy hoofprints of livestock, stream edges and swamps (Jamnback 1965, Hair et al. 1966, Blanton and Wirth 1979); habitats that were most prevalent at the CP site.

Figure 5 shows the seasonal occurrence and abundance of this species collected ("all night") at the CP site in 1978 and 1979. *C. venustus* occurred from May to mid-September and these collections agreed with the results of Murray (1957) and Messersmith (1966). Because parity for this species could not be determined, it was difficult to assess the longevity or voltinism of this species accurately. This midge persisted throughout the season in Virginia and

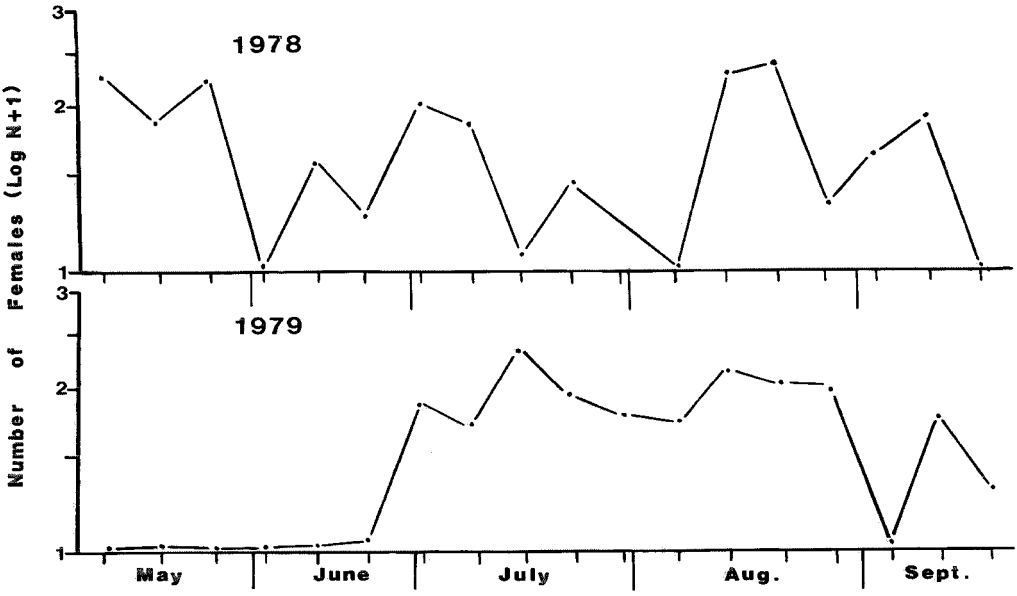

Fig. 5. Seasonal abundance of *Culicoides venustus* collected in blacklight traps weekly on the Coastal Plain (30 min pre-sunset to 60 min post-sunrise in 1978 and 1979.

also in Tennessee (Snow et al. 1957), New York (Jamnback 1965), Missouri (Childers and Wingo 1968) and Florida (Blanton and Wirth 1979). Therefore, it is probably multivoltine. Its survivorship and potential bi-(or multi)-parity cannot be determined until further studies are undertaken.

CONCLUSIONS

We conclude that trap site as well as geographic region influenced the number of *Culicoides* collected in blacklight traps. The largest overall number of *Culicoides* were collected on the coastal plain, and *C. variipennis* was the second most predominant species taken there. Seasonal percent parous rates of this species were high, which indicated greater survival. This would thus be another reason that *C. variipennis* was considered to be one of the principal midge species for continued studies as a disease vector in Virginia. This does not rule out the possibility that one or more of the other common *Culicoides* collected in this study are potential disease vectors. Further epidemiological studies should be undertaken, especially on the abundant multivoltine species *C. stellifer*.

ACKNOWLEDGMENTS

This research was supported by a cooperative agreement No. 12–16–5–1037 from USDA, Animal and Plant Health Inspection Service. We have greatly benefited from the excellent technical assistance of S. J. Barker and D. Koren.

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