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20. ABSTRACT

Population dynamics and control studies on *Culicoides* biting midges were continued at Parris Island, South Carolina, and Yankeetown, Florida.

Adult seasonal patterns were monitored at both sites. Four species were abundant enough to be considered pests, *C. hollensis* and *C. melleus* at Parris Island, *C. furens* at both sites, and *C. mississippiensis* at Yankeetown. *C. furens* was abundant during the summer, *C. melleus* in early spring through summer, and *C. hollensis* and *C. mississippiensis* in the spring and fall. At Yankeetown peak diurnal activity for *C. furens* was 2000-0600 EST and for *C. mississippiensis* 1600-2300 EST.

Studies on immature populations were conducted at both sites. At Parris Island the most productive breeding areas were under large logs in the marsh proper or areas shaded by oak trees. At Yankeetown during a 10 wk study, *Dishtichlis* vegetated areas were most productive. No large difference was detected between the larval densities from the gridded marsh area (also studied in 1981) and the surrounding marsh areas.

In chemical control studies, evaluations of permethrin and NRDC-161 as window screen treatments were continued. Aerial ULV tests using 1.0 oz Dibrom 14®/acre resulted in a significant reduction of natural populations of adult *Culicoides* at Parris Island. Deet- and DPM-treated netting provided an effective barrier against adult *Culicoides* for 2 and 5 days post-treatment, respectively.

SUMMARY

Population dynamics and control studies on *Culicoides* biting midges (sand flies) were continued at Parris Island, South Carolina and Yankeetown, Florida.

At Parris Island seasonal patterns of *Culicoides* adults were monitored by modified New Jersey light traps. Three species (*C. furens* (Poey), *C. hollensis* (Melander and Brues), and *C. melleus* (Coquillett)) are considered major pests. *C. furens* was abundant in October (1981) and from April through September (1982) with large peaks in June, July, August and late September. *C. hollensis* was most abundant during October through mid-November, and again in the spring from March through mid-May. *C. melleus* peaked several times during early spring through the summer months with the largest peak in late April-early May.

At Yankeetown 2 modified Koch-type interval suction traps were used to monitor seasonal and diurnal activity patterns. *C. mississippiensis* Hoffman was most abundant during the months of October through November, and March through April. The population level of this species was lower than in FY81. This species was active throughout the day with peak activity between 1600 and 2300 EST. *C. furens* was abundant in October and May through September with peak diurnal activity between 2000 and 0600.

Studies on immature populations were conducted at both sites. At Parris Island three areas (under large logs (fallen trees)) in the marsh proper, the marsh-upland interface shaded by water oak trees, and the margins of 3rd Bn Pond (also shaded by water oak trees) were consistently productive throughout the sampling period. Panne areas and areas vegetated with sparse *Salicornia* were least productive. At Yankeetown larval densities were compared between FY81's gridded marsh area and other marsh areas in the vicinty of Yankeetown for 10 wks during June through August. Overall densities (ca. 9 larvae/ sample) were similar in the gridded and surrounding areas. In a comparison of larval abundance based on vegetation cover, *Distichlis spicata* areas were the most productive, followed in decreasing order by *Spartina patens*, *Juncus roemerianus*, *Spartina alterniflora* and margins of ponds.

The evaluations of two synthetic pyrethroids, permethrin and NRDC-161 (Dacamethrin ®) as window screen treatments were continued from FY81; greater than 90% mortality and observed with *C. mississippiensis* for 7 days posttreatment.

Field experiments were conducted to evaluate the effectiveness of ultra-low-volume aerial applications of naled (Dibrom 14 ®) against natural populations of *Culicoides* spp at Parris Island. Two applications of undiluted Dibrom-14 were made on 2 consecutive

days at a rate of 1.0 oz/acre each. This resulted in ca. 99% reduction, based on natural population assessment made with baited CDC-type and unbaited New Jersey light traps. These results indicate that conventional aerial application methods can be used for control of biting midges, when the applications are made with sufficient dose levels and frequency.

Studies were conducted on the feasibility of repellent treated barrier netting for area protection. DEET-and DPM-treated netting provided >95% protection for 2 and 5 days posttreatment respectively.

An effective prototype portable DC interval suction trap was built and field-tested.

I. INTRODUCTION

This report summarizes research activities on *Culicoides* biting midges (sandflies) conducted at Parris Island, South Carolina, and Yankeetown, Florida during FY82. Population studies were conducted to complement previous years' studies. In the chemical control studies emphasis was on refining our aerial spray techniques.

II. POPULATION DYNAMICS AND BIOLOGICAL STUDIES

Seasonal and Diurnal Patterns of Adult Activity Periods

Seasonal population studies of adult *Culicoides* were continued at Parris, Island, South Carolina, and Yankeetown, Florida. New Jersey light traps, modified by replacing the standard delivery cone with 40-mesh brass screening, were used at Parris Island. Modified Koch-type interval suction traps were used at Yankeetown. These latter traps provided data on diurnal as well as seasonal patterns.

As in previous years, four New Jersey light traps were operated nightly at Parris Island. Samples were retrieved from the field at least twice weekly (3- and 4-day intervals). Based on past years' trap catches, the traps were not operated from early December through mid-March. Trap catch results for the period October 1, 1981 through October 4, 1982 are listed in Table 1. Three species *C. furens*, *C. hollensis* and *C. melleus* are considered major pest species at this location. Seasonal patterns of these major species were similar to those obtained in FY81.

C. furens was abundant during October (1981) and from April through September. Several large peaks occurred in June, July, August and in late September. *C. hollensis* was abundant during October through mid-November, and then again from March through mid-May. Thereafter, *C. hollensis* was virtually absent from light trap collections until mid-September. *C. melleus* was abundant in some traps until mid-November, and was very abundant as soon as the traps were placed in operation in mid-March. This species reached its spring peak in late April, early May and remained at a high level throughout the summer months. *C. melleus* was much more abundant in FY82 than FY81.

At Yankeetown, two modified Koch-type interval suction traps were operated ca. 4 days each week from October through December and from March through September. Based on trap collections from previous years, the traps were not operated during January and February because of low adult activity during this time period. Trap collections were made hourly during the entire 24 hr. period of each day. Tables 2-4 summarize, respectively, the data for the 3 most common species, *C. mississippiensis*, *C. furens* and *C. barbosai*. Seasonally, *C. mississippiensis* was most abundant during the months October through November and March through April. The spring population was lower than we expected based on our prior years' collections. There was some activity throughout the entire 24 hr. period for *C. mississippiensis* , but the greatest activity was between 1600-1900 EST in the fall (largest peak between 1700-1800), and between 16000-2300 EST in the spring. *C. furens* was most abundant in October and May through September. Its greatest peak occurred in September. This species was most active between 2000 and 0600.

During the rest of the day there was very little activity. Very few *C. barbosai* were caught in our traps during FY82. Based on these limited trap catches, *C. barbosai's* seasonal patterns were very similar to those of *C. furens*. Diurnal activity for *C. barbosai* was greatest between 1800 and 2200. Seventeen other species were collected in low numbers during the year (Table 5).

Studies of Immature Populations

In FY81 the emphasis at Parris Island was to identify all possible breeding sites. Twenty-one different types of habitats were identified. In FY82 several of these sites were selected to study seasonal changes in larvae density (Table 6). Throughout the year the three most productive areas were marsh areas located under logs (fallen trees) on Horse Island, under water oak trees at the end of the runway on Page Field and, along the margins of 3rd Bn Pond under water oak trees. The least productive were panne areas and areas vegetated with sparse *Salicornia*.

At Yankeetown our goal was to compare larval densities obtained from our grid area to surrounding marsh areas in the vicinity of Yankeetown. During this study we noticed that marsh lands bordering the Gulf of Mexico in the vicinity of Yankeetown are stratified with respect to their distance from the Gulf. Aerial photographs and ground measurements indicated that there are distinct differences in the numbers of islands, tidal creeks, ponds, soil structure and types of vegetation within the various zones. Basic features used to distinguish these zones are shown in Table 7. Transects were established throughout the Yankeetown marshes. Samples were taken ca. every 15 min. Larval densities from similar vegetation types in the 2 zones were compared with each other and with larval densities from similar samples taken from the gridded area, which is typical of zone I.

The data for this study are summarized in Table 8. Not obvious from Table 8 are results of the comparison of overall larval density (larvae/sample) between the 3 zones. These overall densities were similar: grid (9.87), zone 1 (9.00), and zone 2 (9.22). In the comparison of vegetation associations, *Distichlis spicata* areas were the most productive (11.39) followed closely by *Spartina patens* (11.13), then by *Juncus roemerianus* dominated areas (9.56), by *Spartina alterniflora* (8.16), and lastly by margins of ponds (4.76) (found only in zone 2).

Results from substrate sampling for the past few years indicated that the areas covered with *Distichlis* were the most productive and the *Spartina alterniflora* vegetated areas were the least productive during the summer months. These data (Table 8) tend to confirm this observation. We believe that the major reason for this occurrence is the seasonal tidal dynamics. During the summer months the tides are consistently higher (ca. 0.3 m above mean low water) than during the winter months. These areas will be resampled during the low tide cycle (January through March).

III. CHEMICAL CONTROL STUDIES

Evaluation of Treated Window Screens

Additional laboratory tests were conducted with insecticide-treated window screens against *C. mississippiensis* at Yankeetown. Both aluminum and galvanized screens were treated with NRDC-161 (Decamethrin®) and permethrin. NRDC-161 at 0.125% (wt/volume) technical material in acetone gave ca. 90% mortality for 50 days posttreatment on the galvanized screens and 15 days on the aluminum screens. Greater than 90% mortality was achieved for only 7 days posttreatment on both aluminum and galvanized screens treated with 0.25% technical permethrin in acetone. These latter data were disappointing in that last year's tests with permethrin at 0.25% gave ca. 100% control for almost six months. Further tests with permethrin are needed to clarify this discrepancy.

Aerial ULV Tests

Applications of undiluted Dibrom-14® at the rate of 1.0 oz./acre each were applied on 2 consecutive days (April 21-22, 1982) over the entire Marine Corps Recruit Depot at Parris Island, SC. These applications were timed to coincide with the first spring population peak of biting midges and suitable weather for aerial applications.

Applications were made with U.S. Air Force UC-123K aircraft equipped with Tee Jet® nozzles on wing booms. The applications were made from an altitude of 150-250 ft at an airspeed of 140 knots using 1,000 ft swaths. Each application was made in the late afternoon starting ca. 1800 h EST and finishing before dark.

The effectiveness of the applications was measured by a combination of natural population survey and caged insect bioassay. The natural population survey consisted of CO_2-baited CDC-type and unbaited New Jersey (NJ) light traps. A check area was located at Sam's Point, SC, ca. 10 mi. northeast of Parris Island. The CDC traps were placed ca. 4 ft above the ground on metal stakes. The CO_2 gas was supplied from 20 lb pressurized cylinders at a flow rate of 200 cc/min and metered by a floating ball flowmeter, pressure regulator, and needle valve on each trap. The CDC traps were powered by 6 volt Gel-Cell® batteries that were changed and recharged daily. The NJ traps were located where 120 volt AC power sources were available. Both CDC and NJ traps were operated continuously (day and night) to provide suction trap action during daylight hours since the peak activity period for one of the predominate biting midge species, *C. hollensis* (Melander and Brues), included some early morning and late evening daylight hours. Specimens from all traps were collected daily between 1600 and 1700 h.

The composition of *Culicoides* spp. consisted of 3 species (based on trap collections the day before treatment): 80.6% *C. hollensis*, 12.4% *C. melleus* and 7.0% *C. furens*.

Caged insects were not available during the first application, but both caged mosquitoes and biting midges were used during the second application. *Aedes taeniorhynchus* females reared in the laboratory at Gainesville, FL were placed in cages (25/cage) and transported to Parris Island on the day of treatment. The mosquitoes were transferred to clean holding cages ca. 30 min after exposure and held for 12 hr before recording mortality. The biting midges used in cages were field-collected from Parris Island on the day of application using a modified CDC trap baited with CO_2 and then aspirated into cages (ca. 25/cage). The biting midge cages were constructed of 1/2 pint cylindrical paper cartons with 40 ga brass screen wire on the top and bottom. Cages of both insects were placed on wooden stakes ca. 4 ft above the ground. Cages each of mosquitoes (30) and biting midges (30) were placed along roadways of the island at ca. 0.2 mi intervals. A limited number (4-6) of cages of both insects were also placed in the check areas to monitor natural mortality in the cages. Mortality in the cages of mosquitoes and biting midges in the check areas was very low (less than 8%)

and therefore no corrections were made for mortality in the treated area.

The survey trap collections indicated a very significant reduction in the natural population of both *Culicoides* spp., and mosquitoes following the 2 applications of 1.0 oz/acre of undiluted Dibrom-14. Trap collections in the check area (Sam's Point) were consistently lower than those on Parris Island but remained stable throughout the test period. The reduction in the numbers collected in traps in the treated area on the day following the first application (before the second spray) was 63%. However, this value does not represent the full impact of the first application since many of the specimens in the posttreatment trap collections were collected during and immediately after the spray application. This is particularly true for *Culicoides* spp. since they appeared to show an increased biting activity as a result of the chemical application during both spray applications; however, the increased activity was of short duration (ca. 5 min) before the effects of the insecticide apparently eliminated all *Culicoides* spp. biting. The overall impact of both sprays was clearly shown by a reduction in trap collections on the day following the second application which was greater than 99%. This level of suppression was maintained for more than 3 days following the last treatment.

Further evidence of the effectiveness of the sprays was indicated by the high mortality of caged insects in the treated area, which averaged 96% for mosquitoes and 95% for *Culiocides* spp. Only insects in cages placed at the northern end of the spray area (which was the windward side for this application) had significantly less than 100% mortality. The upwind swath offset was probably insufficient to give good spray coverage in this area. However, this was not detrimental to the overall effectiveness of the application. The kill of the caged insects, combined with the natural population suppression indicates that good penetration of vegetation was obtained with the higher dose applied in this test (1 oz/acre/treatment).

These experiments show that conventional aerial applications of insecticides can be effectively used to control *Culiocoides* spp., in non-isolated coastal areas when the applications are made with sufficient dose levels and frequency. Additional field tests are needed to further define the effect of chemical dilution and application interval on overall efficiency and duration of control. Further field studies will also provide additional information concerning optimum weather conditions for aerial applications of insecticides.

IV. PERSONAL PROTECTION

Studies were initiated on repellent-treated polyester-cotton netting barriers to determine if a large area can be protected from *Culicoides* spp. attacks by this method. An area 12 m X 12 m was enclosed by a 2 m high net barrier. In different tests two different chemicals were used to treat the netting, DEET (diethyltoluamide) and DPM (disopenthlmalate), at the rate of 0.25 gram chemical/gram of net. DEET- and DPM-treated netting barrier provided >95% protection for 2 and 5 days posttreatment, respectively. The influence of environmental conditions on treatment effectiveness was studied.

Further studies using indalone will be conducted in FY83.

V. MISCELLANEOUS

An effective prototype of a portable DC interval suction trap was built and field-tested. Data collected in this type of trap will assist us in determining the correct time and environmental conditions required to achieve the optimum level of control.

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Table 1. Avg. no. (per trap/night) of *Culicoides* spp. collected sy 4 locations at Parris Island, South Carolina.

Trapping Dates		Horse Island			Elliott Beach			Rifle Range			" Gardens		
		f	h	me	f	h	me	f	h	me	f	h	me
1981 Oct	01-07	5.6	5.7	8.1	219.3	37.0	12.3	1.4	1.4	0.6	5.0	7.3	0.0
	08-14	3.4	63.0	12.1	7.1	25.0	5.0	0.3	2.7	0.3	0.5	3.3	0.0
	15-21	9.6	61.9	7.9	58.1	23.0	1.6	1.3	8.4	0.0	5.0	40.9	0.7
	22-28	2.7	30.9	0.3	160.3	49.4	1.3	1.4	9.7	0.1	0.3	3.4	0.0
Oct/Nov	29-05	2.4	39.8	19.4	992.5	1901.0	434.4	0.6	18.9	3.9	0.0	16.8	1.0
	06-12	0.1	1.9	2.6	144.6	220.6	31.1	0.4	3.0	0.0	0.0	2.1	0.0
	13-19	0.0	1.7	0.4	1.3	3.9	0.3	0.0	0.0	0.0	0.0	0.0	0.0
	20-26	0.1	3.0	0.0	2.6	4.0	0.9	0.0	0.0	0.0	0.0	0.1	0.0
Nov/Dec	27-03	0.0	2.9	0.0	6.6	7.3	1.0	0.0	0.0	0.0	0.0	0.0	0.0
1982 Mar	16-22	0.0	1.3	0.0	0.0	6365.0	1504.4	0.0	774.0	153.6	0.0	310.4	6.4
	23-29	0.0	1.2	0.0	0.1	703.6	51.6	0.0	73.7	14.3	0.0	33.2	6.2
Mar/Apr	30-05	1.6	199.9	15.3	387.1	5535.9	883.1	19.3	453.4	93.7	17.3	1005.0	14.1
	06-12	0.0	72.9	2.3	21.6	1535.1	10.6	0.3	56.0	0.0	1.0	6832.1	0.1
	13-19	27.9	711.9	370.3	461.4	7852.0	1725.0	87.9	990.7	836.4	212.1	3936.9	700.4
	20-26	25.1	391.2	166.4	342.7	7352.0	1566.4	44.1	729.4	121.3	161.7	1949.4	57.6
Apr/May	27-03	9.7	18.9	17.6	204.3	298.6	117.3	57.4	92.1	34.1	67.1	247.9	4.7
	04-10	10.4	13.1	46.7	3234.6	551.7	2584.7	417.6	157.3	387.3	112.4	678.3	170.0
	11-17	97.7	19.4	168.6	1614.7	481.7	666.4	529.9	197.3	227.9	657.0	275.0	42.9
	18-24	94.7	21.7	63.3	2687.7	269.6	186.3	706.4	115.1	40.0	570.0	101.1	16.1
	25-31	3.7	0.3	2.7	538.7	8.4	29.0	60.6	2.3	2.0	26.7	1.0	0.6

Number of *Culiocoides*[a/] at indicated location

f = *furens*

h = *hollensis*

me = *melleus*

Table 1.--continued. Avg. no. (per trap/night) of *Culicoides* spp. collected at 4 locations at Parris Island, South Carolina.

Trapping Dates		Horse Island			Elliott Beach			Rifle Range			Gardens		
		f	h	me	f	h	me	f	h	me	f	h	me
1982 June	01-07	56.0	0.6	23.7	3187.0	4.7	107.0	32.9	0.3	5.1	10.1	0.0	1.6
	08-14	37.1	0.6	47.6	734.7	1.4	68.9	32.3	0.1	22.7	9.4	0.0	1.6
	15-21	14.4	0.0	14.3	341.9	0.0	102.3	9.9	0.0	34.7	4.6	0.1	2.0
	22-28	3.6	0.0	5.4	148.4	0.0	5.6	36.3	0.0	5.1	1.7	0.1	0.0
Jun/Jul	29-06	87.6	0.0	23.6	2260.3	1.3	338.9	390.9	0.1	138.4	13.9	0.0	6.1
	07-12	3.0	0.0	0.3	735.3	0.0	24.3	196.8	0.0	13.3	0.7	0.0	0.0
	13-19	43.4	0.0	14.7	5466.1	0.0	152.5	1393.6	0.0	138.1	5.1	0.0	0.7
	20-26	42.9	0.0	3.7	410.9	0.0	48.1	140.6	0.0	32.6	2.7	0.0	0.0
Jul/Aug	27-02	102.1	0.0	23.1	2208.1	0.0	163.3	143.7	0.0	45.7	1.1	0.0	0.0
	03-09	175.6	0.0	10.6	276.8	0.0	12.7	81.6	0.0	6.0	2.4	0.0	0.0
	10-16	15.9	0.0	8.1	172.3	0.0	18.1	128.7	0.0	10.3	1.7	0.0	0.0
	17-23	19.1	0.0	1.1	46.9	0.0	1.0	21.4	0.0	1.0	0.3	0.0	0.0
	24-30	31.4	0.4	37.3	14.6	0.0	6.7	14.4	0.0	8.9	0.4	0.0	0.7
Aug/Sep	31-07	46.7	0.0	51.7	141.4	1.9	8.9	14.3	0.6	4.0	0.5	0.0	0.0
	08-13	6.0	0.0	2.5	168.7	0.2	2.2	17.7	0.7	0.0	0.5	0.2	0.0
	14-20	27.4	14.3	1.3	85.9	44.1	2.7	14.1	7.4	1.0	0.6	0.0	0.0
	21-27	29.7	5.7	8.2	13.6	6.3	1.9	3.3	2.9	1.6	1.1	0.1	0.1
Sep/Oct	28-04	168.3	58.0	34.4	5068.6	675.7	238.4	89.3	22.3	24.9	1.4	0.1	0.0

Table 2

Diel relative abundance patterns of adult female *Culicoides mississippiensis* Hoffman at Yankeetown, FL, summarized by hour and month fo the 1-year period October 1981 to September 1982. Two alernating 12-hour interval suction traps (40W incandescent light plus 100-200 ml CO_2 per min.) were run continuously for selected 3- and 4-day periods within each recorded month.

HOUR (Est)	MONTH OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	1-YR TOTAL BY HOUR
0000-0100	111 (17)	161 (14)	12 (7)			107 (28)	43 (21)	50 (15)	23 (17)	2 (13)	2 (12)	7 (16)	101
0100-0200	90 (17)	103 (14)	30 (7)			132 (27)	54 (21)	60 (15)	16 (17)	2 (13)	1 (12)	11 (16)	97
0200-0300	104 (17)	93 (14)	34 (7)			109 (27)	74 (21)	102 (15)	18 (17)	1 (13)	<1 (12)	8 (16)	96
0300-0400	139 (17)	61 (14)	21 (7)			92 (27)	52 (21)	73 (15)	14 (17)	2 (13)	<1 (12)	5 (16)	86
0400-0500	159 (17)	40 (14)	16 (7)			63 (27)	43 (21)	51 (15)	13 (17)	1 (13)	<1 (12)	8 (16)	74
0500-0600	239 (16)	29 (14)	14 (7)			45 (27)	38 (21)	15 (15)	9 (17)	<1 (13)	<1 (12)	7 (16)	80
0600-0700	193 (17)	87 (14)	23 (7)			54 (27)	22 (21)	7 (14)	5 (17)	<1 (13)	0 (12)	1 (16)	81
0700-0800	55 (17)	76 (13)	8 (7)			77 (27)	20 (21)	5 (14)	1 (17)	<1 (13)	<1 (12)	2 (16)	57
0800-0900	81 (17)	68 (14)	15 (7)			45 (27)	14 (21)	4 (14)	<1 (17)	<1 (13)	<1 (12)	1 (16)	49
0900-1000	62 (17)	69 (14)	9 (7)			41 (27)	7 (21)	3 (14)	1 (17)	<1 (13)	0 (12)	0 (16)	42
1000-1100	60 (15)	80 (14)	54 (7)			61 (26)	8 (21)	4 (14)	1 (17)	1 (13)	<1 (13)	0 (16)	50
1100-1200	47 (16)	139 (15)	38 (7)			119 (30)	34 (21)	19 (14)	1 (18)	0 (12)	<1 (14)	<1 (16)	87
1200-1300	33 (16)	157 (15)	40 (7)			96 (30)	20 (21)	1 (15)	<1 (18)	<1 (12)	0 (14)	0 (16)	75
1300-1400	19 (16)	447 (15)	40 (7)			82 (30)	18 (21)	2 (15)	<1 (18)	0 (12)	0 (14)	<1 (16)	120
1400-1500	25 (16)	212 (15)	40 (7)			85 (30)	21 (21)	2 (15)	<1 (18)	0 (12)	<1 (14)	<1 (16)	80
1500-1600	35 (16)	391 (15)	61 (7)			131 (30)	30 (21)	3 (15)	<1 (18)	0 (12)	0 (14)	0 (16)	134
1600-1700	69 (16)	803 (15)	110 (7)			161 (30)	52 (21)	3 (14)	<1 (18)	0 (12)	0 (11)	0 (16)	233
1700-1800	220 (16)	2150 (15)	127 (7)			215 (30)	67 (21)	7 (15)	2 (18)	<1 (12)	0 (14)	<1 (16)	532
1800-1900	418 (16)	860 (15)	92 (7)			274 (30)	80 (21)	8 (15)	<1 (18)	0 (12)	0 (14)	6 (16)	359
1900-2000	225 (16)	263 (15)	36 (7)			375 (30)	103 (21)	15 (15)	3 (18)	<1 (12)	3 (14)	16 (16)	256
2000-2100	353 (16)	193 (15)	25 (7)			222 (30)	106 (21)	53 (15)	24 (18)	5 (12)	3 (14)	11 (12)	213

Table 2.--continued.

HOUR (Est)	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	1-YR TOTAL BY HOUR
2100-2200	244	201	33			238	95	91	20	11	3	6	196
	(16)	(15)	(7)			(30)	(21)	(15)	(18)	(12)	(14)	(16)	
2200-2300	150	360	57			246	93	83	29	9	3	6	208
	(17)	(15)	(7)			(29)	(21)	(15)	(17)	(12)	(14)	(16)	
2300-2400	107	241	28			142	52	37	20	2	3	8	127
	(17)	(13)	(7)			(28)	(21)	(15)	(17)	(12)	(13)	(16)	
AVG/DAY FOR EACH MONTH	3238	7487	964			3278	1146	707	204	36	21	103	

Table 3

Diel relative abundance of adult female *Culicoides furens* (Poey) at Yankeetown, FL summarized by hour and month for the 1-year period October 1981 to September 1982. Two alternating 12-hour interval suction traps (40W incandescent light plus 100-200 ml $CO_2 \cdot min^{-1}$) were run continuously for selected 3- and 4-day periods within each recorded month.

	MONTH												1-YR TOTAL
HOUR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	BY HOU
0000-1000	55 (17)	<1 (14)	0 (7)			1 (28)	20 (21)	29 (15)	174 (17)	107 (13)	58 (12)	442 (16)	150
0100-0200	32 (17)	<1 (14)	0 (7)			1 (27)	24 (21)	50 (15)	75 (17)	92 (13)	48 (12)	645 (16)	163
0200-0300	47 (17)	<1 (14)	0 (7)			2 (27)	23 (21)	39 (15)	64 (17)	80 (13)	48 (12)	439 (16)	123
0300-0400	62 (17)	<1 (14)	0 (7)			1 (27)	21 (21)	24 (15)	45 (17)	87 (13)	76 (12)	356 (16)	110
0400-0500	84 (17)	<1 (14)	0 (7)			<1 (27)	26 (21)	20 (15)	28 (17)	90 (13)	71 (12)	601 (16)	154
0500-0600	81 (16)	<1 (14)	0 (7)			2 (27)	9 (21)	5 (15)	25 (17)	30 (13)	32 (12)	275 (16)	78
0600-0700	21 (17)	<1 (14)	0 (7)			<1 (27)	3 (21)	3 (14)	16 (17)	10 (13)	6 (12)	42 (16)	17
0700-0800	4 (17)	0 (13)	0 (7)			<1 (27)	<1 (21)	2 (14)	5 (17)	10 (13)	4 (12)	65 (16)	16
0800-0900	4 (17)	0 (14)	0 (7)			<1 (27)	<1 (21)	2 (14)	3 (17)	6 (13)	2 (12)	20 (16)	6
0900-1000	3 (17)	0 (14)	0 (7)			<1 (27)	<1 (21)	<1 (14)	2 (17)	7 (13)	1 (12)	<1 (16)	2
1000-1100	4 (15)	0 (14)	0 (7)			<1 (26)	1 (21)	1 (14)	2 (17)	5 (13)	1 (13)	<1 (16)	2
1100-1200	2 (16)	<1 (15)	0 (7)			<1 (30)	1 (21)	30 (14)	1 (18)	3 (12)	1 (14)	<1 (16)	6
1200-1300	1 (16)	<1 (15)	0 (7)			<1 (30)	<1 (21)	3 (15)	<1 (18)	<1 (12)	<1 (14)	<1 (16)	<1
1300-1400	<1 (16)	<1 (15)	0 (7)			<1 (30)	<1 (21)	<1 (15)	<1 (18)	<1 (12)	<1 (14)	0 (16)	<1
1400-1500	<1 (16)	<1 (15)	0 (7)			<1 (30)	<1 (21)	<1 (15)	<1 (18)	<1 (12)	<1 (14)	<1 (16)	<1
1500-1600	2 (16)	0 (15)	0 (7)			<1 (30)	<1 (21)	<1 (14)	<1 (18)	<1 (12)	<1 (14)	<1 (16)	<1
1600-1700	1 (16)	<1 (15)	0 (7)			<1 (30)	<1 (21)	<1 (15)	<1 (18)	<1 (12)	<1 (14)	<1 (16)	<1
1700-1800	3 (16)	<1 (15)	0 (7)			<1 (30)	<1 (21)	<1 (15)	13 (18)	<1 (12)	<1 (14)	<1 (16)	3
1800-1900	17 (16)	<1 (15)	(0) (17)			<1 (30)	1 (21)	2 (15)	4 (18)	1 (12)	<1 (14)	1 (16)	4
1900-2000	31 (16)	<1 (15)	0 (7)			10 (30)	8 (21)	5 (15)	2 (18)	9 (12)	23 (14)	108 (16)	31

TABLE 3.--continued.

	MONTH												
HOUR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	1-Yr TOTAL BY HOUR
2000-2100	49	<1	0			3	23	61	22	122	55	147	73
	(16)	(15)	(7)			(30)	(21)	(15)	(18)	(12)	(14)	(16)	
2100-2200	34	<1				4	24	143	22	226	77	211	113
	(16)	(15)	0			(30)	(21)	(15)	(18)	(12)	(14)	(16)	
2200-2300	30	<1	(7)			2	28	127	39	234	67	347	136
	(17)	(15)	0			(30)	(21)	(15)	(17)	(12)	(14)	(16)	
2300-2400	25	1	(7)			1	28	49	63	148	57	288	104
	(17)	(13)	0			(30)	(21)	(15)	(17)	(12)	(13)	(16)	
AVG/DAY FOR EACH MONTH	593	4	0			27	243	606	595	1263	616	3989	

Table 4

Diel relative abundance of adult female *Culicoides barbosai* W. & B. at Yankeetown, FL, summarized by hour and my month for the 1-year period October 1981 to September 1982. Two alternating 12-hour interval suction traps (40W incandescent light plus 100-200 ml $CO_2 \cdot min^{-1}$) were run continuously for selected 3- and 4-day periods within each recorded month.

	MONTH												1-YR TOTAL
HOUR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	BY HC
0000-0100	7 (17)	<1 (14)	0 (7)			<1 (28)	<1 (21)	<1 (15)	<1 (17)	<1 (13)	1 (12)	<1 (16)	4
0100-0200	7 (17)	0 (14)	0 (7)			<1 (27)	<1 (21)	<1 (15)	1 (17)	1 (13)	<1 (12)	2 (16)	4
0200-0300	7 (17)	<1 (14)	0 (7)			<1 (27)	<1 (21)	<1 (15)	<1 (17)	<1 (13)	<1 (12)	1 (16)	4
0300-0400	9 (17)	<1 (14)	0 (7)			<1 (27)	<1 (21)	<1 (15)	<1 (17)	<1 (13)	<1 (12)	1 (16)	5
0400-0500	9 (17)	<1 (14)	0 (7)			<1 (27)	<1 (21)	<1 (15)	<1 (17)	<1 (13)	<1 (12)	<1 (16)	5
0500-0600	14 (16)	<1 (14)	0 (7)			<1 (27)	<1 (21)	<1 (15)	1 (17)	<1 (13)	3 (12)	5 (16)	9
0600-0700	12 (17)	2 (14)	0 (7)			<1 (27)	<1 (21)	<1 (14)	1 (17)	<1 (13)	4 (12)	1 (16)	8
0700-0800	7 (17)	<1 (13)	0 (7)			1 (27)	<1 (21)	<1 (14)	<1 (17)	<1 (13)	<1 (12)	1 (16)	4
0800-0900	4 (17)	<1 (14)	0 (7)			<1 (27)	<1 (21)	0 (14)	<1 (17)	<1 (13)	0 (12)	<1 (16)	3
0900-1000	3 (17)	<1 (14)	0 (7)			<1 (27)	<1 (21)	0 (14)	<1 (17)	<1 (13)	0 (12)	<1 (16)	1
1000-1100	4 (15)	<1 (14)	0 (7)			<1 (26)	<1 (21)	<1 (14)	<1 (17)	<1 (13)	<1 (13)	<1 (16)	2
1100-1200	<1 (16)	<1 (15)	0 (7)			<1 (30)	<1 (21)	<1 (14)	<1 (18)	<1 (12)	0 (14)	<1 (16)	<1
1200-1300	<1 (16)	1 (15)	0 (7)			<1 (30)	<1 (21)	0 (15)	<1 (18)	<1 (12)	0 (14)	0 (16)	<1
1300-1400	<1 (16)	<1 (15)	0 (7)			<1 (30)	<1 (21)	<1 (15)	<1 (18)	<1 (12)	0 (14)	0 (16)	<1
1400-1500	<1 (16)	0 (15)	0 (7)			<1 (30)	<1 (21)	<1 (15)	<1 (18)	<1 (12)	0 (14)	0 (16)	<1
1500-1600	<1 (16)	<1 (15)	<1 (7)			<1 (30)	0 (21)	<1 (15)	0 (18)	0 (12)	0 (14)	<1 (16)	<1
1600-1700	1 (16)	<1 (15)	0 (7)			<1 (30)	<1 (21)	<1 (14)	<1 (18)	0 (12)	0 (14)	<1 (16)	<1
1700-1800	11 (16)	3 (15)	<1 (7)			<1 (30)	<1 (21)	<1 (15)	<1 (18)	<1 (12)	0 (14)	<1 (16)	6
1800-1900	46 (16)	2 (15)	0 (7)			<1 (30)	<1 (21)	<1 (15)	<1 (18)	<1 (12)	<1 (14)	9 (16)	28
1900-2000	42 (16)	<1 (15)	0 (7)			1 (30)	1 (21)	1 (15)	2 (18)	<1 (12)	3 (14)	10 (16)	26

Table 4.--continued.

HOUR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	1-YR TOTAL BY HOUR
						M O N T H							
2000-2100	42	<1	0			<1	<1	2	5	3	2	5	24
	(16)	(15)	(7)			(30)	(21)	(15)	(18)	(12)	(14)	(16)	
2100-2200	42	<1	0			<1	2	1	3	3	2	3	23
	(16)	(15)	(7)			(30)	(21)	(15)	(18)	(12)	(14)	(16)	
2200-2300	13	<1	0			1	1	1	2	2	3	3	8
	(17)	(15)	(7)			(29)	(21)	(15)	(17)	(12)	(14)	(16)	
2300-2400	7	<1	0			<1	<1	<1	<1	2	<1	2	5
	(17)	(13)	(7)			(28)	(21)	(15)	(17)	(12)	(13)	(16)	
AVG/DAY FOR EACH MONTH	288	12	1			11	14	10	21	17	28	51	

Table 5.--Minor *Culicoides* spp, caught in Koch-suction traps at Yankeetown, FL

OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
125	7	0			49	101	27	63	160	141	65	*C. arboricola* Root & Hoffman
21	6	0			2	11	20	6	3	2	5	*C. n. sp.* 109 near baueri 1/
3	3	0			0	4	2	2	0	13	5	*C. bermudensis* Williams
1	0	0			1	3	0	0	0	0	0	*C. biguttatus* (Coquillett)
4	2	1			0	0	2	0	0	1	3	*C. crepuscularis* Malloch
18	0	0			0	0	8	394	163	110	28	*C. floridensis* Beck
27	11	0			5	28	32	16	13	15	44	*C. haematopotus* Malloch 2/
2	0	0			0	0	3	2	2	5	3	*C. hinmani* Khalaf
3	1	1			0	0	0	0	0	16	15	*C. insignis* Lutz
1	1	0			0	2	2	6	0	5	3	*C. loughnani* Edwards
31	1	0			31	14	5	32	1	3	3	*C. melleus* (Coquillett)
1	0	0			0	0	0	0	0	0	0	*C. nanus* Root & Hoffman
0	0	0			0	0	2	1	0	0	0	*C. niger* Root & Hoffman
9	0	0			5	8	7	4	16	15	8	*C. ousairani* Khalaf
1	0	0			0	0	1	1	2	5	3	*C. paraensis* (Goeldi)
1	2	0			1	0	5	0	0	1	3	*S. n. sp. spinosus*
13	3	0			0	1	3	0	0	0	3	*C. stellifer* (Coquillett)
261	37	2			94	172	119	527	360	332	191	

1/ Previously reported incorrectly as *C. baueri*.

2/ Some specimens previously misidentified as *C. edeni* W & B.

Table 6.--Seasonal density changes in *Culicoides* larvae recovered from substrate samples taken from different salt marsh habitats at Parris Island Marine Depot, South Carolina during 1982.

		Mean Number Larvae Recovered per Sample; Number of Samples in ( )									
Location	Habitat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Σ
Tidal Flats Across From Trailer Park Zone I	Panne	N.S.	N.S.	N.S.	N.S.	N.S.	0.0 (4)	0.0 (10)	0.0 (5)	N.S.	0.0 (19)
Zone II	*Sparse Salicornia* sandy	N.S.	N.S.	N.S.	N.S.	N.S.	1.3 (4)	0.9 (20)	0.0 (5)	N.S.	0.8 (29)
Zone III	Mixed *Salicornia* short *Spartina*	N.S.	N.S.	N.S.	N.S.	N.S.	0.3 (4)	1.3 (15)	0.8 (10)	2.0 (5)	1.1 (34)
Zone IV	Mixed short and medium *Spartina* with firm sandy/ muddy substate	N.S.	N.S.	N.S.	N.S.	N.S.	0.0 (4)	4.8 (25)	3.7 (15)	0.3 (10)	3.3 (54)
Zone V	Mixed medium and tall *Spartina* with *firm* sandy/ muddy substrate	N.S.	N.S.	N.S.	N.S.	N.S.	0.3 (4)	4.7 (15)	9.5 (15)	0.6 (5)	5.6 (39)

Table 6.--continued.

Location	Habitat	Mean Number Larvae Recovered per Sample; Number of Samples in ( )									
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Σ
Zone VI	Tall *Spartina* with soft mud substrate	N.S.	N.S.	N.S.	N.S.	N.S.	1.5 (4)	2.7 (15)	1.6 (5)	2.8 (5)	2.4 (29)
Zone VII	Edge of Causeway Pond Trailer Park; *Borrichia*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	18.2 (5)	0.0 (5)	N.S.	9.1 (10)
Scout Island Past Culvert 3-4 m. from tree line	Short *Spartina* with some flotsam	8.9 (20)	7.7 (15)	4.5 (20)	N.S.	3.6 (5)	18.4 (10)	0.9 (10)	4.9 (10)	26.8 (10)	9.1 (100)
Depression Area	Tall, thick *Salicornia*	N.S.	N.S.	N.S.	N.S.	0.0 (5)	3.4 (10)	9.3 (10)	9.5 (10)	4.7 (10)	5.9 (45)
Horse Island Skeet Range by old log	Short/med. *Spartina* Sandy/organic soil	24.2 (25)	15.6 (25)	19.1 (10)	N.S.	5.6 (20)	21.3 (10)	15.8 (10)	16.3 (10)	20.8 (10)	17.0 (120)
Under oak trees	No vegetation except for a few clumps of short/med. *Spartina* leaf litter	6.2 (20)	14.1 (15)	9.3 (10)	N.S.	3.9 (20)	12.9 (10)	8.9 (10)	4.5 (10)	11.0 (10)	8.4 (105)

Table 6.--continued.

Location	Habitat	Mean Number Larvae Recovered per Sample; Number of Samples in ( ) Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Σ
Page Field Runway Under Oak Tees	Little vegetation (clumps of short/ med. *Spartina*) $\bar{c}$ dead leaves	28.2 (20)	18.5 (20)	9.0 (10)	N.S.	30.5 (10)	50.9 (10)	37.2 (10)	26.5 (10)	17.4 (10)	26.5 (100
Marsh area between creek bank and upland edge	Med./tall *Spartina*	5.7 (25)	8.6 (20)	0.7 (10)	N.S.	0.0 (10)	11.7 (15)	2.7 (15)	4.7 (10)	7.4 (10)	5.7 (115
General's Landing Whale Creek	Med. *Spartina*	3.1 (25)	3.7 (15)	3.5 (10)	N.S.	0.9 (12)	3.9 (10)	1.2 (10)	8.8 (10)	10.5 (10)	5.7 (115
Ballast Creek Zone I	*Borrichia frutescens*/ *Salicornia*/ med. *Spartina*	N.S.	N.S.	N.S.	N.S.	N.S.	9.1 (15)	14.3 (35)	6.9 (40)	4.3 (10)	9.6 (100
Zone II	Panne	N.S.	N.S.	N.S.	N.S.	N.S.	0.1 (10)	0.0 (5)	N.S.	N.S.	0.1 (15)
Zone III	Down Center of depressed with *Spartina* cover	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	14.4 (10)	7.6 (20)	8.0 (10)	9.4 (40)

Table 6.--Continued.

Location	Habitat	Mean Number Larvae Recovered per Sample; Number of Samples in ( )									
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Σ
Elliott Beach Road Runoff Ditch	Mixture of short *Spartina*, *Distichlis*, *and* *Salicornia*	4.9 (30)	7.4 (15)	1.9 (10)	N.S.	0.1 (20)	6.6 (10)	3.6 (25)	25.8 (10)	21.3 (10)	6.9 (130)
Scout Island Pond	Margin of pond vegetation with short/med. *Spartina*	N.S.	4.9 (20)	5.2 (10)	N.S.	1.0 (5)	8.6 (10)	6.2 (10)	4.7 (10)	8.8 (10)	5.8 (75)
3rd Bn Pond under oak tree next to public works	Sandy soil covered with short/ medium *Spartina*	N.S	9.2 (5)	2.2 (5)	N.S	12.2 (5)	32.8 (10)	13.7 (10)	34.2 (10)	17.3 (10)	19.9 (55)
Borrow Pit Area across from Trailer Park (Tidal Pond)	Margin of pond covered with short *Spartina* and some *Distichlis*	N.S.	5.2 (20)	2.1 (10)	N.S	1.3 (15)	6.1 (10)	2.5 (10)	2.4 (20)	3.0 (10)	3.2 (95)
		11.5 (165)	9.8 (170)	5.8 (105)	N.S.	4.8 (127)	12.0 (164)	7.3 (285)	8.7 (240)	10.6 (155)	8.9 (1411)

Table 7.--Characteristics of Gulf marsh zones found adjacent to Withalacoochee Bay Yankeetown, Levy Co., Florida.

Zone	Distance (KM) Zone Extends Inland From Outward Gulf Is.	Mean KM^2 (1) of						Confirmation of
				Tidal Creeks of Width				
		Islands	Ponds	<1M	1-8M	8-16M	>16M	Islands
I	2.4	51.1	0.0	122.2	55.3	28.5	16.8	Generally smaller with exposed limestone banks on sides subject to tial currents.
II	2.4-3.4	18.1	30.7	58.6	7.0	1.4	0.0	Generally larger and with gentle sloping banks surrounded by marsh on all sides

Table 7.--continued.

Tidal Creeks	Marsh	Marsh	Island	Ponds	Marsh	Islands
Generally wider and with vertical cut banks & sand bottoms	.32	.12-.52	1.39	--	*Disticilis spicata* *Juncus roemerianus* *Spartina alteriflora*	Pine, oak, cabbage palm, ceder, wiregrass, broomgrass, palmetto, gal-berry, holly, Christmas berry, poison ivy, salt-grass (patens), opuntia
Small bore creeks with silty sloping banks and mud bottoms	.69	.52-.86	1.50	.76	*Salicornia* *Distichlis spicata* *Juncus roemerianus* *Spartina patens* sea lavender salt marsh aster	same as above

1. Mean numbers figured from 5 randomly selected aerial photographs of marsh areas representative of zones I and II. Each photograph with approximate area of .20 KM^2.

2. Elevation figured to the nearest 0.01 ft. (.3 CM) projected from USGS Benchmark TT13T (Elevation +5.80 ft. (1.77M) above MSL (mean sea level)).

Table 8. *Culicoides* spp larval densities within various plant associations in different ecological zones at Yankeetown, Florida during June through August 1982.

Zone	Dominant Vegetation	Number Samples	Number Positive Samples	Total Number Larvae	Average Number Larvae Samples
Grid	*Juncus roemerianus*	152	138	1556	10.24
1	*Juncus roemerianus*	106	104	940	8.87
2	*Juncus roemerianus*	156	134	1460	9.36
		414	376	3956	9.56
Grid	*Distichlis spicata*	36	33	333	9.25
1	*Distichlis spicata*	106	98	1117	10.54
2	*Distichlis spicata*	34	33	554	16.29
		176	164	20[illegible]4	11.39
Grid	*Spartina alterniflora*	71	60	648	9.13
1	*Spartina alterniflora*	106	91	805	7.59
2	*Spartina alterniflora*	2	2	8	4.00
		179	153	1461	8.16
Grid	*Spartina patens*	2	1	38	19.00
2		21	18	218	10.38
		23	19	256	11.13
2	Margins of Ponds	62	46	295	4.76
		854	758	7972	9.33