BLUETONGUE VECTOR STUDIES

Vector Surveillance Program, California: 1978-1981.

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I. OBJECTIVES

The objectives of the vector surveillance program were:

1. To identify Culicoides developmental sites and determine common characteristics of these sites,

2. To develop standard methods for quantitative sampling of Culicoides in developmental sites,

3. To determine the seasonal distribution of adult Culicoides spp. in endemic areas of BTV occurrence,

4. To collect adult Culicoides spp. and other biting arthropods for virus isolation tests at U. C. Davis.

5. To collect immature stages of Culicoides from different larval sites for shipment to Denver, Colorado for BTV transmission studies by the Arthropod-Borne Animal Disease Laboratory, (ABADL), ARS/USDA

II. CULICOIDES DEVELOPMENTAL SITES

1. The initial investigation of Culicoides larval developmental sites began with the identification of those sites and the species present. Sites sampled included: creek, river and lake margins, irrigated pastures, irrigation canals and ponds, water trough overflow, industrial waste ponds, poultry ranch waste water systems, cattle feedlots, dairy waste-water lagoons, and sewage treatment ponds. Culicoides spp. were reared from gnat collections at most of these sites. Culicoides variipennis (C.v.) was the predominant species with the occassional presence of C. crespuscularis.

By far the most productive C.v. larval sites were dairy waste-water lagoons and associated runoff from these sources. Sewage treatment ponds were also very conducive to C.v. development although larval densities at the sites were much less than those found in dairy lagoons.

2. As a result of this larval site study, a statewide survey of dairy lagoons was undertaken to determine the prevalence of C.v.. One hundred-sixteen

(116) dairies in 16 counties in the central, southern and coastal areas were investigated between May and June of 1980. Fifty-two percent (52%) of these ponds were positive for C.v. with 50% of these having moderate to dense larval populations. Reinvestigation of these dairies between August and September showed that C.v. positive lagoons decreased to 40%. This reduction in the gnat population was attributed, in part, to the fluctuation in water level in these lagoons due to crop irrigation.

The highest percentage of C.v. positive ponds were found in the Riverside (90%) and Fresno (74%) milk-shed areas.

3. Characteristics of both gnat positive and negative lagoons were examined. Soil composition, water analysis (NH_3, pH, electro-conductivity and redox potential), percent vegetation, percent solids and the degree of slope of lagoon margins were recorded. Of these, vegetation, solids, and slope were shown to have the most influence on the presence of C.v. populations in these lagoons. Although lack of vegetation and some degree of solids are important in the establishment of C.v. populations, the slope of the lagoon margins proved to have a high inverse association with C.v. production.

In addition, later investigations indicated that fluctuations of water level in lagoons can reduce or prevent establishment of C.v. populations as effectively as steep sided construction of these water impoundment facilities

4. Besides physical control of C.v. in these dairy lagoons, a preliminary chemical trial was conducted using Chlorpyrifos (40.7% EC and 15% granular formulations) applied to the soil-water interface of lagoon margins at dosage rates of 1.14 and 0.57 Kg/Ha. Results showed 99 to 100% reduction in gnat emergence for both formulations and dosage rates after 24 days posttreatment.

5. Due to the necessity of determining more accurate C.v. larval densities in the soil-water interface of these various developmental sites, numerous quantitative sampling devices were designed and tested. Initially, qualitative samples were taken using a trowel. From this a Kellen dredge was tested but the sample was too large for accurate larval determinations. Smaller sampling devices, such as metal scoops and cores (6 and 10 cc), were designed and found to be more accurate and efficient while also providing more time to take a greater number of samples.

As a final result, a modified core sampler was designed to permit sampling of both horizontal and vertical larval distribution. The sampler could determine presence of larvae to a depth of 30cm at 1cm intervals. Using a salt floatation method the sampler was very effective at measuring population densities and changes at various developmental sites.

6. In cooperation with the USDA/ABADL 27 larval collections from 1978 to 1981 were sent to Denver for rearing of adults and subsequent vector BTV competency studies. These collections represented 20 larval sites from 14 counties. Overall results from the California shipments showed a definite variation in the virus infection rate (IR) among the C.v. groups tested. Tests by USDA/ABADL have determined IR for: all 4 virus serotypes for C.v. collected in Imperial and Stanislaus areas, for serotypes 10,11, and 13 in C.v. from the Butte area, and serotypes 10 and 11 in C.v. taken in the Sonoma area. Variations from high IR to refractive status in these C.v. populations provide more insight into the role certain C.v. ecotypes have in transmitting Bluetongue in areas of California.

III. ADULT CULICOIDES POPULATION STUDIES

1. Adult gnats were collected for BTV isolations as well as for population studies. To accomplish this, a large m^2 vehicle net was designed to capture large numbers of gnats as well as other haematophagus diptera. In addition, CDC light traps were modified to operate with dry ice or with CO_2 tanks and regulators for routine collections.

2. The results from repetitive sampling determined the seasonal distribution of C.v. in three study areas (Butte, Sonoma, Stanislaus Counties). In general, adult populations were present between April and October with peak adult densities occurring between August and September. In Butte and Sonoma Counties, C.v. populations in each of the four years declined sharply after October while during the winter of 1979-1980 the Stanislaus County population continued through February and finally decreased to zero in March.

C.v. was always the predominant gnat species at every site where adult gnats were collected. Other species in the northern region included C. crepuscularis, C. cavaticus, C. freeborni, C. (Selfia) spp. and C. stellifer, while in the southern areas C. calexicanus, C. mohave, and

C. saltonensis were captured.

Additional information showed that maximum C.v. flight activity occurred immediately following dusk with another but smaller peak of activity prior to sunrise. This activity was found to change over the course of the season. With cooler temperatures and decreasing photoperiod peak flight activity changed to early afternoon even under full sunlight.

3. Additional studies involved height preference experiments in desert vs. pasture environments. During May and July of 1980, a transect of CDC light traps was established in a straight line extending 2.4km from a pasture into the Lower Sonoran desert in Imperial County. Three traps, set at high (1.5m), medium (1.0m), and low (0.5m) positions within a 3m circle were located in the pasture as well as a similar number of traps set at 1.6 and 2.4km distant into the desert. Traps were checked and emptied every hour for 24 hours. Four species of Culicoides were collected: C.v., C. mohave, C. saltonensis and C. calexicanus. Results from both trials demonstrated significantly greater captures of all species at the 0.5m height.

In addition, there were significantly greater numbers of gnats collected in the desert areas compared to those taken in the pasture. This suggested that the direction of gnat flight was from the desert to the cultivated pasture. This hypothesis was somewhat substantiated by the discovery of a dense C.v. larval population in a municipal sewage pond at a nearby desert community. Developmental sites for the other three species were not found despite extensive inspections made within a 1-mile radius around the study area.

Gnat preference for the 0.5m light trap was hypothesized to be a possible adaptation to searching and feeding on desert rodents and hares. This hypothesis was tested by a series of similar transects conducted in a multiple crop area (orchards, row crops and pasture) in the San Joaquin Valley. Results from these transects again demonstrated significantly greater C.v. (the only species present) collections at the 0.5m height. The results from additional studies have showed that the metered release of compressed CO_2 was significantly more effective at attracting C.v. than from CO_2 as emitted by dry ice.

These studies have given important direction into the efficient methodology of collecting and evaluating Culicoides populations.

4. During the course of the vector surveillance program 678 insect pools representing 17,329 haematophagus diptera were sent to U. C. Davis pathology laboratory for BT virus isolation and serotyping. A breakdown of these pools is given in the following table.

Year	Species	# Pools	# Specimens	BTV(Serotype)
1978	C.v.	14	87	1(11)
	C. crepuscularis(Cc)	1	2	
1979	C.v.	183	1,663	2(11); 1(13)
	C. tarsalis(C.T.)	34	4	
	C.c.	13	3	
	Simuliidae	2	5	
1980	C.v.	12	556	
	C.t.	2	205	
	C.pipiens(Cp)	1	8	
	Culicoides spp.	1	?	
1981	C.v.	345	13,629	17(11); 1(13);2(17)
	mosquito spp.	19	256	
	C. t.	8	167	
	A. nigromaculus	8	136	
	Stomoxys calcitrans	6	52	
	Simulium spp.	5	208	
	C. p.	5	75	
	C. brookmani	4	197	
	C. freeborni	4	60	
	Culicoides spp.	3	140	
	C. hieroglyphicus	2	95	
	Leptoconop spp.	2	10	
	Melophagus ovinus	1	16	
	C. peus	1	10	
	C. c.	1	9	
	C. baueri	1	6	
TOTAL:		678	17,329	24*

* The 24 viral isolates were from C.v. collected in the following six counties: Sonoma (1), Butte (3), Fresno (2), Riverside (3), Kern (5), Stanislaus (10).

5. A preliminary study was initiated to determine the effects of 0.25% Coopertox solution (46% toxaphene, 1.6% lindane) on adult C.v.. Approximately 30 female C.v. were placed in each of 3 plastic cages fitted to the shorn side of three dip-treated and 1 control sheep. After a 15 minute exposure gnats were removed and held in the laboratory to record mortality. Mortality ranged between 65 and 89% after 1 day posttreatment. By 13 days posttreatment gnat mortality decreased from 26 to 37%. Results throughout the trial were variable and were not tested for statistical analysis.

6. Another study was initiated to determine the preferred feeding sites of C.v. on sheep. Fluorescent dusts were applied to the ears, muzzle, lower abdomen and legs of a yearling Suffolk ram confined inside a 4x4x2m organdy lined cage. Several hundred gnats were then released into the cage and collected every 24 hours to check for the presence of fluorescent dust.

Results indicated that the leg area of the animal may be a perferred feeding site for this ecotype of C.v.. Retesting with other C.v. ecotypes have not been as successful and demonstrate the need for more research in Culicoides behavior.

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