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HYDROGEN ION CONCENTRATION (pH) AS RELATED TO THE OCCURRENCE AND ABUNDANCE OF TREE-HOLE DWELLING *CULICOIDES* SPP., (DIPTERA: CERATOPOGONIDAE) IN NORTHERN FLORIDA[1]

WILLIAM W. SMITH AND JAMES H. VARNELL, JR.
University of Florida, Gainesville

INTRODUCTION. The species of *Culicoides* which complete their immature stages in tree-holes or stump-holes constitute an important part of the pestiferous insect fauna in wooded areas where rainfall supplies sufficient moisture. Although most species presumably feed on birds by choice, *C. paraensis* (Goeldi) and *C. hinmani* Khalaf (*borenqueni* of authors) avidly bite man during daylight hours in Tennessee forests (Snow, 1955) and *C. guttipennis* (Coquillett) also feeds on man during the crepuscular hours. We have been bitten diurnally by specimens of *C. arboricola* Root and Hoffman which escaped in the laboratory. Wirth and Hubert's report of *C. snowi* Wirth and Jones biting man is the only host record known by the authors for this species. *C. debilipalpis* Lutz, *C. ousairani* Khalaf and *C. villosipennis* Root and Hoffman recorded from northern Florida are believed to be feeders on birds primarily as blood-engorged specimens were trapped in chicken houses (Messersmith, 1965).

The biting habits of *C. nanus* Root and Hoffman, probably the most abundant tree-hole species in northern Florida, are unknown. This species was rarely captured in light traps and chicken houses, and no blood-engorged specimens were encountered. Antennal sensory pits on segments 3 through 14 (Varnell, 1967) indicate it may feed on birds, based on Jamnback's suggestion (1965) that species with pits on most antennal segments prefer to feed on birds rather than on large mammals. One specimen of *C. pusillus* Lutz was taken from a tree-hole sample in this study. Its biting habits are unknown and it may not be a true tree-hole species. *C. ousairani* was also reared from two samples obtained after this study had been concluded.

No species has been incriminated as a disease vector, but the tendencies of certain species to bite both birds and humans indicate the possible transmission of commonly shared viral diseases by some tree-hole *Culicoides*.

METHODS AND MATERIALS. Collections of tree-hole and stump-hole debris and water samples were made in Alachua County, Florida from September, 1964 through September, 1966, examinations of samples continuing until January, 1967.

[1] This research supported in part by NIH Grant No. GM 12322-03 Florida Agricultural Experiment Stations Journal Series No. 2709.

Studies of selected positive samples from these collections constitute the data reported below.

Four hammock areas in Alachua County were routinely sampled at monthly intervals and additional samples were obtained from seven other areas throughout the county in August and September, 1966. A 50-ml. cooking baster was used to extract some of the water and bottom debris from wet tree-and stump-holes. Distilled water was added to samples scooped with a spoon from dry tree- or stump-holes. All samples were placed in 1-pint Mason jars with the disc of the two-piece lid replaced by a disc of organdy supported by a plastic screen disc. The material's volume varied from one-fourth to three-fourths of a pint according to the amount of water and debris present in the hole sampled. Samples were stored in the laboratory at 72 to 74° F. for 3 to 6 months, or until adult *Culicoides* ceased to emerge. Each was examined weekly and all adults were identified, counted and recorded according to sex.

The pH of the selected samples was determined initially in the field with a portable Beckman Model N meter and subsequently checked weekly in the laboratory. The pH did not change appreciably (± 0.2) in the jars from the original field determinations if water of approximately the same pH was added when necessary to prevent desiccation. Consequently, samples taken during the latter part of the study received only one pH determination when brought in from the field, after which water of near that pH was added as needed during the weekly inspections.

RESULTS AND DISCUSSION. There was little relationship between pH and tree species having tree- or stump-holes. In sweet gum (*Liquidamber styraciflua* L.) and magnolia (*Magnolia grandiflora* L.) tree-holes, the pH ranged from 6.3 to 9.4. In the oaks *Quercus virginiana* Mill., *Q. nigra* L., and *Q. imbricaria* Mich., the range was wider, 4.1 to 9.1, the lowest value having been obtained from a live oak tree-hole; pH values above 9.0 occurred in magnolias and water oaks only.

Table 1 summarizes the occurrence of each species as related to pH.

A chi square test of dependency between species abundance and pH was applied to the original data from which Table 1 was derived, *C. snowi* and *C. villosipennis* being excluded because of insufficient information on their abundance. A very significant chi square ($\chi^2 = 4456$; $.005 = 66.77$) indicated a very high degree of dependency but the factors involved are unknown. Successful completion of development at a particular pH range is more reasonably assumed than female choice for oviposition of tree-holes with a specific pH range.

The six most abundant species emerged as adults from samples within the entire pH range encountered (4.1–9.4). How-

TABLE 1. Numbers of *Culicoides* that emerged from tree- or stump-hole samples within certain pH ranges, Alachua County, Florida: Sept. 1964–Dec. 1966.

No. Samples	pH Range	*Culicoides* Species													
		nanus		*arboricola*		*debilipalpis*		*paraensis*		*guttipennis*		*hinmani*		*snowi*		*villosipennis*	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
2	4.1–5.7	0–2		22–19		29–22		1–0		0–3		0–0		0–0		0–0	
11	5.8–6.7	4–5		434–395		124–233		7–12		34–43		32–41		0–0		0–3	
15	6.8–7.7	3–9		165–150		16–26		4–5		50–40		4–14		0–0		0–0	
12	7.8–8.7	47–57		174–188		16–6		35–46		21–26		6–9		9–2		0–0	
10	8.8–9.4	626–1248		15–9		2–4		94–117		0–0		41–53		3–16		0–0	
Sex Totals		680–1321		810–761		187–291		141–180		105–112		83–117		12–18		0–3	
Totals		2,001		1,571		478		321		217		200		30		3	

ever, *C. nanus, C. paraensis* and *C. hinmani* emerged in greater numbers from samples with a pH range above 8.7. Greater numbers of *C. arboricola, C. guttipennis,* and *C. debilipalpis* were obtained from samples having pH's less than 8.7.

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AEHA CARTRIDGE-TYPE ASPIRATORS

WILLIAM W. BARNES, LTC, MSC AND J. WANLESS SOUTHWICK, 2LT, MSC
U. S. Army Environmental Hygiene Agency, Edgewood Arsenal, Maryland

Collecting adult mosquitoes for virus isolations, malaria studies and insecticidal resistance determinations has long been accomplished by many different types of aspirators, depending largely upon the particular investigator and under what conditions he might be collecting. The two designs discussed herein resulted from a requirement for a small, lightweight, unbreakable aspirator to be used by U. S. Forces in South East Asia while conducting epidemiological investigations of mosquito-borne diseases. The aspirators which evolved have been field-tested upon many species of mosquitoes while making landing rate and diurnal resting place collections and have demonstrated their efficiency and adaptability to all who have used them.

The majority of mouth-operated aspirators in common use consist of a straight glass or plastic tube to which a flexible rubber or plastic tube mouthpiece is attached. A retaining screen is affixed between the rigid tube and the flexible mouthpiece to trap the mosquitoes. The small diameter of most such aspirators damage specimens as they are aspirated, particularly when several specimens accumulate during a collection. Such damaged mosquitoes tend to yield invalid results when used in insecticidal resistance tests using the WHO test kits.

The cartridge-type aspirators offer a rapid, easy method to collect adult mosquitoes, blackflies and other biting Diptera without undue damage to specimens. Specimens may be collected for virus pool isolations, oocyst or sporozoite counts and routine identifications with a minimum amount of handling. The cartridges may be used for a number of purposes, i.e., collecting eggs from gravid females, holding cages for malaria studies and for insecticide resistance determinations. WHO test papers may be cut to fit any size cartridge desired and mosquitoes are readily aspirated directly into the lined vials, exposed for one hour and held in clean vials for 24-hour mortality counts. Results obtained in small vials are comparable to those obtained using standard