# OBSERVATIONS ON LARVAL HABITATS AND THE WINTER BIONOMICS OF SOME COMMON SPECIES OF *CULICOIDES* (DIPTERA:CERATOPOGONIDAE) IN THE CENTRAL COLUMBIA BASIN[1]

WAYNE A. ROWLEY[2]

Washington State University, Pullman, Washington

INTRODUCTION. During a study of the occurrence and bionomics of *Culicoides* Latreille in the central Columbia Basin of Washington, marked differences were observed in the occurrence and relative abundance of *Culicoides* in different larval habitats. The study area, which included the Columbia National Wildlife Refuge north of Othello, Washington together with portions of Adams and Grant counties, abounds with highly alkaline semiaquatic areas suitable for larval development of some species of *Culicoides*.

This report represents an attempt to categorize and characterize various types of larval habitats of the most common species in this area.

COLLECTION OF LARVAE AND PUPAE. The occurrence of *Culicoides* larvae in suspected habitats was determined by methods similar to those described by Jones (1961). A sample of surface mud and water was placed in a white enamel tray, flooded with water and stirred until all of the mud was well mixed and covered with water. Flooding caused larvae to swim at or near the surface of the water in an eel-like manner. Third and fourth instars were removed by aspiration or by being scooped onto a fine mesh wire screen. When flooded with water, pupae floated to the surface and the same recovery procedures were used. In areas where these procedures failed to reveal the presence of *Culicoides* mud samples were taken to a field laboratory and held for possible adult emergence.

Tarpaulin traps used by Harwood (1962) for collecting overwintering mosquitoes were also employed to evaluate the *Culicoides* fauna in particular habitats. These traps were made of 2-pound coffee cans, with a screen entrance cone in the bottom and a screen cover, mounted on a tripod with 1½-foot legs and surrounded by a 10 by 10 foot piece of canvas tarpaulin. Traps were placed over suspected or known breeding sites, and the edges of the tarpaulin were weighted down. Adult *Culicoides* emerging in the area covered by the trap would proceed towards the light, enter the can and thereby be trapped. Harwood (1962) reported that the problem of spiders spinning webs in the mouth of the trap could be eliminated by coating the under surface of the tripod base and legs with motor oil. This procedure was used to prevent capture of *Culicoides* by spiders.

To determine the overwintering stages of *Culicoides,* mud and water samples were taken periodically during the winter from areas which had contained abundant larvae the previous summer. Overwintering larvae were placed in white enamel trays and maintained at 75° F. Trays were examined daily for pupation.

An experiment was performed to determine the effect, if any, of freezing on overwintering larvae. Two hundred fourth instars of *C. variipennis* were subjected to a temperature of 28° F. for 6 weeks. After this period the temperature was re-

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[2] Present address. U. S. Army Biological Laboratories, Fort Detrick, Frederick, Maryland.

stored to 75° F. and the larvae were examined daily for pupation.

DESCRIPTION OF LARVAL HABITATS. *Culicoides* were collected or reared from hundreds of individual habitats, each of which had certain unique features; however, because of important similarities it was possible to categorize them into four representative types. Table 1 shows some differences in the four "types" of larval habitats which occur in the central Columbia Basin. Habitats were grouped according to the type of soil, the species occupying the habitat and their abundance in that type of habitat.

*Fresh Water Seepage Ponds.* This type of habitat (Fig. 1) was common in the area below O'Sullivan Dam. Sandy soil with a slight crust of alkali surrounded such seepage ponds. Although the water from these seepage ponds was fresh, the soil was definitely saline (Lyon *et al.*, 1958). Shore line vegetation was primarily salt tolerant grass (*Distichlis stricta* Rybd.). Also common were Russian thistle (*Salsola kali* L.) and cheat grass (*Bromus tectorum* L.). Large amounts of algae and duckweed (*Lemna minor* L.) formed mats on the surface of the water during late summer. *Culicoides wisconsinensis* Jones was the most common species found in these seepage ponds. *Culicoides variipennis* was abundant, and an occasional specimen of *C. crepuscularis* Malloch and *C. haematopotus* Malloch was recovered.

*Mud Flats Along Crab Creek.* Lower Crab Creek originates at O'Sullivan Dam and flows southwesterly towards the Columbia River. Cheat grass and salt tolerant grass were the primary types of vegetation. *Culicoides* larvae and pupae were found in many places along the creek where exposed mud banks had been formed by erosion and underground springs (Fig. 2). The presence of livestock manure and other forms of organic matter appeared to enhance the suitability of these areas as *Culicoides* breeding sites. Larvae of *C. variipennis* were generally abundant in these mud flats.

*Culicoides wisconsinensis* also occurred in these areas although the recovery ratio of *C. variipennis* to *C. wisconsinensis* was several hundred to one. *Culicoides crepuscularis* and *C. haematopotus* were reared and recovered as adults from mud

TABLE 1.—Species composition, abundance, and some chemical variations in four representative types of *Culicoides* larval habitats found in the central Columbia Basin. Abundance was determined in a manner similar to that described by Jones (1961).

| Type of Habitat | Soil Type | Approximate pH | Meq Na/100 Grams Soil | Species Present and Abundance |
|---|---|---|---|---|
| Fresh-water Seepage Ponds | Saline | 8.5 | <1.0 | *wisconsinensis*[a] *variipennis*[a] *crepuscularis*[c] *haematopotus*[c] |
| Mud Flats on Crab Creek | Slightly Saline | 8.0 | <1.0 | *variipennis*[a] *wisconsinensis*[b] *crepuscularis*[c] *haematopotus*[c] |
| Alkaline Potholes | Alkaline | 10.0 | >12.0 | *variipennis*[d] |
| Drainage Ditches | Neutral | 7.5 | <2.0 | *crepuscularis*[b] *variipennis*[c] |

[a] Abundant, 75–100 were collected in 1 hour.
[b] Common, 50–75 were collected in 1 hour.
[c] Uncommon, less than 25 were collected in 1 hour or pupae were not collected, but adults were recovered from these areas.
[d] Extremely abundant, several thousand pupae and larvae were collected in 1 hour.

samples but were never taken in larval or pupal samples. The inability to collect these species from specific areas does not necessarily prove that they do not occur there. It was likely that their presence was obscured by the overwhelming predominance of *C. variipennis.*

*Alkaline Potholes and Permanent Water Ponds.* Basalt outcroppings and fairly constant water levels characterized the alkaline potholes. Large mud flats when present contained tremendous populations of *C. variipennis* larvae. Extremely sparse salt tolerant grass constituted the only shore line vegetation. A thick crust of alkali surrounded potholes and ponds and was generally pock-marked with livestock hoofprints (Fig. 3). As would be expected, the alkalinity of this type of habitat was extremely high as was the pH. *Culicoides variipennis* was the only species recovered here. More specifically, only the subspecies *C. variipennis occidentalis* Wirth and Jones occurred in this type of habitat. Thousands of pupae and larvae of this subspecies could be collected from a single tablespoon of surface mud at the water's edge. The majority of semi-aquatic habitats suitable for *Culicoides* larvae in this region were of this highly alkaline type.

*Drainage Ditches and Fresh-Water Springs.* Habitats of the non-saline or non-alkaline type were not common in the central Columbia Basin, but they occurred often enough to be of significance as a primary type of larval habitat. The pH of the mud was considerably below that of the other habitat types. Drainage ditches and fresh-water springs were characterized by having grassy banks with limited exposed mud suitable for larval development (Fig. 4). The dominant species in areas of this type was *C. crepus-*

FIG. 1.—Fresh-water seepage pond. This was the second most common type of larval habitat in the study area and the primary breeding site for *C. wisconsinensis.*

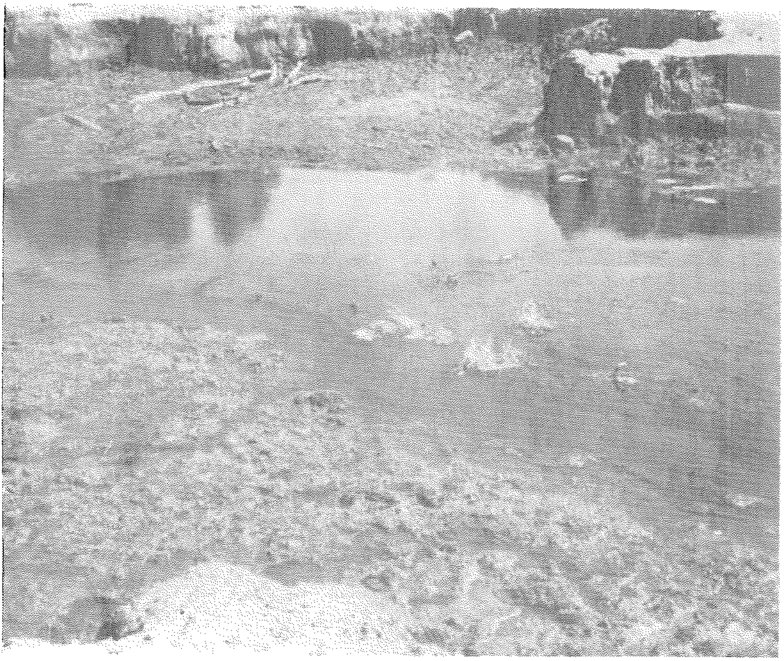

FIG. 2.—Mud flat on Crab Creek. Underground springs and erosion of creek banks created breeding sites for *C. variipennis* and *C. wisconsinensis*.

*cularis*. The average recovery ratio was 25 *C. crepuscularis* to 1 *C. variipennis*. These were the only breeding sites examined in which *C. variipennis* was not common. Therefore, it appeared that the near neutral pH of the soil was probably less favorable to the larval development of *C. variipennis*. Since the non-alkaline habitats were not "saturated" with *C. variipennis*, populations of *C. crepuscularis* existed and more importantly they could be detected.

WINTER BIONOMICS. *Culicoides* in the Columbia Basin overwintered as larvae. After the middle of September only larvae were found in areas which had been abundant with pupae in August and early September.

Figure 5 shows the number of days required for the onset of pupation of *C. variipennis occidentalis* larvae collected at different times of the year and maintained at 75° F. after being taken into the laboratory. Larvae collected during early fall and late spring pupated in three days, whereas those taken during the coldest part of the winter required two weeks and larvae collected in late fall or early spring required 1 week for pupation to begin. Larvae collected on April 12 began pupating in 2 days. This date preceded the appearance of adults in the field by only 2 weeks.

During the winter *C. variipennis occidentalis* larvae were found several feet from the muddy shore line of the alkaline potholes. Larvae were active and congregated in and around clumps of algae much as they did during the daylight hours of the summer. During the coldest part of the winter their activity appeared somewhat reduced. When taken into the laboratory, overwintering larvae congregated around and fed on algae which coated aquatic vegetation and debris taken from their natural habitat. During December and January field collections had to be taken from under a thin sheet of ice. Larvae taken at this time were also active and feeding on algae. The larvae of *C. wisconsinensis* and *C. crepuscularis* were collected from seepage ponds but these species were always found in mud banks.

Two hundred larvae of *C. variipennis occidentalis* were collected on November 9 and placed in a mud and water preparation that was frozen for 6 weeks. During this period some of the larvae were observed on the surface and in small holes in the ice. After 6 weeks the mixture was gradually warmed to 75° F. The first pupae appeared 15 days after removal from the cold. This was almost identical to the time required for the onset of pupation in larvae collected during the coldest part of the winter. In the 10-day period after pupation began, 124 of the 200 larvae had pupated; no larvae remained in the tray. At least 62 percent of the larvae were able to survive being frozen in a tray of ice and mud for 6 weeks. Winters in the Columbia Basin are generally mild for that latitude. Periods of below freezing temperatures are not uncommon, but the microenvironment of *Culicoides* larvae is rarely, if ever, as severe as that tested in the laboratory. During the period of this investigation ice formed on the water only occasionally in December and January, and this was but a thin sheet. Obviously the larvae of *Culicoides* are well adapted to survive normal winters in central Washington.

DISCUSSION. *Culicoides variipennis* was the only species found in most of the larval sites examined. Other species may have been present in some of these sites, but their presence could have been obscured by the high density of *C. variipennis* in the saline and alkaline regions. *C. wisconsinensis* was abundant in several seepage holes (Fig. 1). This species was

FIG. 3.—Highly alkaline pothole. Tremendous populations of *C. variipennis occidentalis* lived in exposed mud flats.

FIG. 4.—Drainage ditch from fresh-water spring. This near neutral type of habitat was the primary breeding site of *C. crepuscularis.*

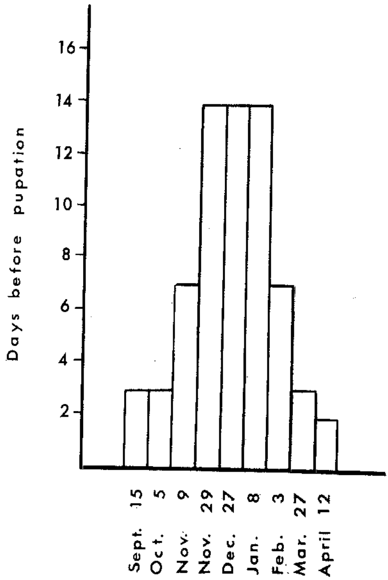


FIG. 5.—Number of days exposure to 75° F before pupation of *Culicoides variipennis occidentalis* collected at different times of the year, Othello, Washington, 1963–1964.

also found in limited numbers in mud flats along Crab Creek, but it always occurred in association with *C. variipennis, C. crepuscularis,* and *C. haematopotus.*

Adults of two species, *C. jamesi* Fox and *C. denningi* Foote and Pratt, were collected in considerable numbers with light traps in the study area. Whenever high numbers of either species were taken in light traps, extensive sampling of conceivable larval habitats was undertaken in the immediate area. In Colorado and Utah, Jones (1961) found *C. jamesi* breeding in slight numbers in fresh-, salt-, and alkaline-water habitats. Neither *C. jamesi* nor *C. denningi* was taken in immature samples, reared from mud samples, or collected in tarpaulin traps placed over breeding sites.

Most soils in the central Columbia Basin were either alkaline or saline, and where the proper conditions existed were quite conducive to the larval development of *C. variipennis.* Jones (1961) surveyed the larval breeding sites of 29 species of North American *Culicoides* and concluded that the presence of only a single species in a habitat was rare. Only *C. variipennis* was found in the majority of suitable habitats investigated in this area and it was found in every habitat where any *Culicoides* occurred. *Culicoides variipennis* was extremely abundant in highly alkaline habitats, yet it prevailed in areas where the alkalinity was not pronounced. In areas such as drainage ditches where the soil was not alkaline or saline, *C. variipennis* was present but not abundant.

The subspecific problem of *C. variipennis* in central Washington is extremely complex and one which merits a comprehensive investigation. Bacon (1953) collected *C. variipennis occidentalis* in copious numbers from the potholes area near O'Sullivan Dam. He also took specimens of *C. variipennis sonorensis* Wirth and Jones in light traps from Rocky Ford

Creek and Lower Crab Creek. Thus two subspecies of *C. variipennis* occurred in the same geographical area, apparently sharing the same ecological niche as adults. Wirth and Jones (1957) studied Bacon's material and concluded that differences in the salinity of the two types of larval habitats probably serve for the ecological separation of the two subspecies. Crab Creek flows near many alkaline potholes and seepage areas thus creating two extremely different types of habitat with regard to soil alkalinity and pH within yards of one another. Therefore, it seems probable that the two subspecies could exist for a period of time in the same area without intergradation completely obscuring the identity of either or both.

Adult specimens examined from the area showed considerable variation in many of the characters used by Wirth and Jones (1957) to separate the subspecies of *C. variipennis*. Wirth (1964) examined a series of slides from an alkaline pothole (pH 9.9) and determined all to be *C. variipennis occidentalis*. Many specimens taken from the non-alkaline areas were determined by this author to be *sonorensis*, but the majority showed variation between *sonorensis* and *occidentalis.*

Wirth has suggested that there are an infinite number of populations of *sonorensis* and *occidentalis* and their intergrades plus some intergrades with *C. variipennis variipennis* in contact areas in the Western United States, and particularly in the State of Washington.

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## DEMONSTRATION OF EQUIPMENT AT ANNUAL MEETING IN NEW ORLEANS

There will be an Open House at all four local Mosquito Control Districts on Monday, Tudesday and Wednesday until noon. During this time the commercial firms can have their equipment at any one (or all) of the Districts for the members to see. All of the Districts are within 7 miles of the hotel. There will be a desk in the registration area and members can sign up to go to the Districts at any time during the 2½ days. Transportation will be furnished. The paper reading sessions will be set up with similar papers grouped so that visitors to the Districts can arrange not to miss papers of special interest.