NOTES ON THE BIOLOGY AND SEASONAL ABUNDANCE OF THE LARVAL STAGES OF *CULEX TARSALIS* COQUILLETT IN IRRIGATED AREAS OF SCOTTS BLUFF COUNTY, NEBRASKA (DIPTERA: CULICIDAE)

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INTRODUCTION. *Culex tarsalis* Coquillett appears to be the most important mosquito species concerned in the epidemiology of the virus encephalitides in western United States. It is also one of the most common species found in the irrigated areas of this region. In order to understand more clearly the relationship between irrigation and *C. tarsalis* production, studies were initiated during the 1953 season on the larval ecology of this species at Mitchell, Scotts Bluff County, Nebr. These studies were primarily concerned with evaluating the relative importance of the various habitats in which *C. tarsalis* larvae were found. In addition, observations were made on its seasonal occurrence, relative abundance, rates of development, and larval associations.

Because of its vector role in the transmission of encephalitis, *C. tarsalis* has been the subject of intensive studies in recent years. Jenkins (1950) has summarized much of this information and points out that there are still many important gaps in our knowledge of the biology of this species. The present work was undertaken to supply information on the biology of the immature stages in the field.

METHODS. Forty-seven aquatic habitats, all that could be found within a 1-mile radius of Mitchell, Nebr., were studied. These habitats, classified on the basis of gross ecological characteristics, included representative types of all aquatic situations occurring in Scotts Bluff County and were typical of extensive areas of the North Platte Valley. Stations were established for each habitat and routine inspections were made once each week. Larval populations were sampled by dipping each station thoroughly with a pint-size white enamel dipper. The number of dips taken depended on the size of the station. At each inspection, water areas and mosquito breeding areas were estimated; also the source of the water was determined. This information along with the average number of larvae or pupae per dip was recorded.

In order to compare the mosquito productiveness of the various habitats a "Production Index" was used. The Production Index is based upon the larval density in relation to the amount of breeding area; and equals the average number of the fourth-instar larvae and pupae per dip, times the number of square feet in the breeding area.

For studies on larval growth rates, individual egg rafts of *C. tarsalis* were isolated in rearing containers in permanent seepage areas. The containers were galvanized iron cylinders, 20 inches in diameter and 12 inches deep. They were screened on top to prevent contamination with additional ova after the initial isolation of a single egg raft. The lower end was buried in the bottom mud along the shallow margins of permanent seepage areas (Fig. 1). Observations of each isolation were made daily and the date of hatching, date fourth instar was reached, date of pupation, and date of adult emergence were recorded.

RESULTS. In the study area there was a total production index value of 20.9 million for all species of mosquitoes. Of

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FIG. 1. Rearing containers used in isolating egg rafts of *Culex tarsalis* for studies on larval growth rates under field conditions.

this total 12.1 million or 58 percent were for *C. tarsalis*. The production of this species in the various habitats was approximately as follows: permanent or semipermanent seepage areas, 9.8 million; temporary surface pools, 2.3 million; roadside borrow pits and weed clogged ditches, only 0.001 million.

A total of 18,684 fourth-instar larvae and pupae of *C. tarsalis* was collected from various habitats. This species was found most commonly in association with *Culiseta inornata*, and occasionally with *Culex restuans, Culex pipiens, Culex salinarius, Culex territans, Anopheles walkeri,* and *Uranotaenia sapphirina* in permanent or semipermanent water areas. It was also found associated with *Aedes dorsalis, Aedes vexans,* and *Aedes nigromaculis* in temporary water areas.

First-instar *C. tarsalis* larvae were collected from a permanent seep near Mitchell, Nebr., on May 7, and the first fourth-instar from the same seep on May 25. A gradual increase in *C. tarsalis* larval populations took place in all types of habitats during June, and a seasonal peak in production occurred during the week ending July 11 (Fig. 2). Large numbers of larvae continued to develop until the middle of August, after which a gradual decline in larval populations took place. The last fourth-instar larvae and pupae were collected on October 29. These results are similar to those obtained in studies made in Utah where Rees (1943) found that the larvae of *C. tarsalis* usually appeared first in late May and that they were frequently found until early November.

The egg rafts of *C. tarsalis,* collected in the field, were found to contain from 143 to 331 eggs, and averaged 244. Brennan and Harwood (1953) in laboratory studies found an average of 230 eggs per raft; while Brookman (1950) found that in California egg rafts most frequently contained between 100 and 149 eggs. The rafts were common during June, July, and August resting on the water of larval

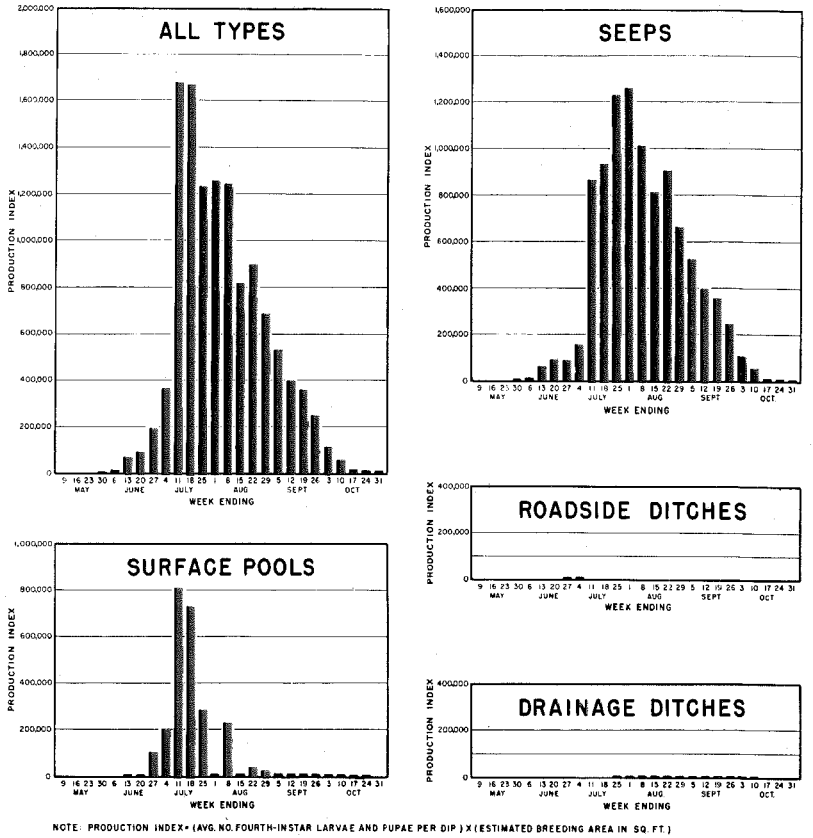
habitats. In the field, egg rafts from which larvae had emerged were separated at sight from unhatched ones by the fuzzy appearance given them by the open hatching caps.

Hatching generally occurred 1 to 3 days after the egg raft was isolated. The number of days required to complete development in permanent seeps at different dates varied throughout the season, temperatures being an important influence. The period from hatching to adult emergence in permanent seepage areas ranged from 14 days at average air temperatures of 78.5° F. to 31 days at 63.4° F. Husbands and Rosay (1953) found that in irrigated pastures in California *C. tarsalis* could complete development in 9 to 10 days following irrigation. Individual rafts included eggs of both sexes. This was demonstrated by rearing of both sexes from isolated rafts. Several generations

Figure 2

WEEKLY PRODUCTION INDEXES OF *CULEX TARSALIS* ACCORDING TO TYPE OF BREEDING PLACE

MITCHELL, NEBRASKA, 1953



NOTE: PRODUCTION INDEX = (AVG. NO. FOURTH-INSTAR LARVAE AND PUPAE PER DIP) X (ESTIMATED BREEDING AREA IN SQ. FT.)

are capable of developing in a single season in Scotts Bluff County.

Most of the larval habitats in which *C. tarsalis* was found were man-made. The greatest production of this species occurred in seepage areas associated with irrigation. Beds of *Chara,* an aquatic plant, were frequently present in places where high production of *C. tarsalis* occurred. In Scotts Bluff County this observation was made so frequently that *Chara* might be considered as an indicator of high *C. tarsalis* production in permanent and semipermanent seeps. Large numbers of larvae also developed in temporary surface pools in irrigated pastures and hay meadows.

DISCUSSION. Because of its abundance and the frequency with which it attacks humans, *C. tarsalis* may be considered a pestiferous species in the North Platte Valley (Anon., 1953). Knowledge of its bionomics is important from the standpoint of pest mosquito control as well as possible encephalitis transmission. In this region extensive seepage areas form early in the summer soon after irrigation begins. These seeps permit continual development of *C. tarsalis* throughout the season. Extensive salt grass pastures and hay meadows are irrigated 3 or 4 times during the summer. Because of irregular topography, the fields are irrigated by wild flooding and when enough water is applied to cover the high spots, excessive ponding occurs in the low places. Water often stands in the depressions for several weeks, thereby permitting *C. tarsalis* to complete its aquatic stage.

Prevention and control of *C. tarsalis* in the North Platte Valley must take into account both the seepage areas and the irrigated pastures. Because of the extensiveness of these habitats, temporary control by means of chemicals would be difficult and costly. Emphasis should be given to permanent corrective work directed toward elimination of man-made habitats associated with irrigation. Measures to prevent seepage from canals and laterals should be utilized where needed and drains should be provided for the removal of surface water.

SUMMARY. 1. From May through October (1953), larvae and pupae of *Culex tarsalis* occurring in various habitats in Scotts Bluff County, Nebr., were studied. The breeding habitats which produced the greatest numbers of larvae were permanent or semipermanent seepage areas and surface pools.

2. The greater portion of *C. tarsalis* breeding habitats in Scotts Bluff County were found to be man-made and related directly to irrigation. Permanent control of *C. tarsalis* in the area studied will involve the elimination of seepage areas and residual pools on irrigated pastures.

3. In these studies the first fourth-instar larvae appeared on May 25. A seasonal peak in larval population occurred during the week ending July 11. The last fourth-instar larvae and pupae were collected on October 29.

4. In permanent or semipermanent seepage areas *C. tarsalis* was found in association most commonly with *Culiseta inornata,* and in temporary water areas with *Aedes dorsalis, A. vexans,* and *A. nigromaculis.*

5. *C. tarsalis* egg rafts were found to contain from 143 to 331 eggs, average 244. Hatching generally occurred in 1 to 3 days, and the period from hatching to adult emergence ranged from 14 to 31 days.

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