MOSQUITOES CAPTURED IN A BOVINE-BAITED TRAP IN A WYOMING PASTURE SUBJECT TO RIVER AND IRRIGATION FLOODING[1]

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ABSTRACT. *Aedes melanimon* Dyar and *A. dorsalis* (Meigen) comprised 79% of all mosquitoes collected from a bovine-baited trap situated in a flood irrigated area near Laramie, Wyoming between 16 June and 10 August in 1971. Other species that were numerous, though not as abundant as *A. melanimon* or *A. dorsalis* were *A. idahoensis* (Theobald), *A. campestris* Dyar and Knab, *A. flavescens* (Müller), *A. fitchii* (Felt and Young), and *Culiseta inornata* (Williston). Small numbers of *Culex tarsalis* Coquillett were collected.

Populations of most species increased until early July, then they decreased. *A. flavescens, A. fitchii,* and *Culex tarsalis* appeared later in the season than did the other species. *Culiseta inornata* demonstrated an early but lesser peak in June due to overwintering females, then another peak in early July.

Maximum adult activity of most species occurred during the morning and evening hours. Most species fed in presumably significant numbers during the daylight hours as well. *A. idahoensis* and *A. fitchii* demonstrated no strong periodicity.

Percent blood engorgement of adult mosquitoes varied considerably from day to day. A lower percentage of engorgement was observed in those mosquitoes attracted into the trap in the evening, possibly because of the suppressive effect of cold nighttime temperatures on subsequent adult activity.

INTRODUCTION. The importance of mosquitoes as pests of cattle in the Rocky Mountain states of the USA is unknown. Investigators in coastal areas of the USA have found that mosquitoes are a significant detriment to production of cattle (Granett and Hansens 1956 and 1957, Hoffman and McDuffie 1963, MacCreary 1938, Sanders et al. 1968, and Steelman et al. 1972 and 1973). Based on the numerous requests for advice on mosquito control from individuals associated with the cattle industry in Wyoming, it would seem that mosquitoes, particularly those that require flood water, have a considerable impact on the cattle industry in certain areas of the state. The following study was conducted to determine: 1) which mosquito species should be considered important pests based on numbers of adult females attracted to cattle; 2) the seasonal abundance of those mosquitoes; 3) approximate time of day when the mosquitoes were attracted to cattle; and 4) the percentage of female mosquitoes attracted to a caged bovine that actually fed.

METHODS AND MATERIALS. The experiment was conducted in 1971 at the University of Wyoming Range and Pasture Experiment Station, which is located about 3 mi southwest of Laramie at an elevation of 7,165 ft. In 1971, total rainfall at the station was 10.18 in, and the annual average temperature was 40.0° F (U.S. Dept. of Commerce 1971). The Experiment Station occupies 492.5 acres of the Laramie Plains, which is an area subjected to extensive flood irrigation, plus annual spring flooding of the Laramie River. As a result of current flood irrigation practices on the Laramie Plains, there are meadows, alkali depressions, and vegetation-choked ditches in which water may stand for several weeks at a time. The flood plain of the Laramie River contains numerous oxbows that are flooded annually.

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Forage crops, produced in the flood irrigated fields of the Laramie Plains, are mostly introduced grasses and a few legumes. The pasture rangeland of the area was described by Porter (1962). The dominant vegetation consists of blue grama (*Bouteloua gracilis*), several species of bluegrass (*Poa*), prairie junegrass (*Koeleria cristata*), needleandthread (*Stipa comata*), several species of wheatgrass (*Agropyron*), a low species of spoonleaf milkvetch, (*Astragalus spatulatus*), and a dwarf species of rabbit brush (*Chrysothamnus* sp.). Alkali depressions in the area, which are flooded by irrigation waste-water and flood water, contain extensive stands of greasewood (*Sarcobatus vermiculatus*), saltbush (*Atriplex* spp.) and inland saltgrass (*Distichlis stricta*).

The bovine-baited trap described by Roberts (1965) was used to trap mosquitoes. The bait animal was a 250 lb, 4 month old, Hereford heifer. The trap was located adjacent to the flood plain of the Laramie River, ca. 20 ft from the water's edge at time of maximum flooding. Flooding of the river, as well as flood irrigation, began ca. 1 month prior to establishment of the trap.

Mosquito collections were made on 16 different dates: 16, 18, 23, 29, and 31 June; 1, 7, 9, 13, 16, 20, 22, 27, and 29 July; and 3 and 10 Aug. Each of the collection dates was further divided into 4 collecting periods, the first of which began at 8:30 p.m. in the evening prior to the collection date. The collection periods were 8:30 p.m. to 5:30 a.m., 5:30 a.m. to 9:00 a.m., 9:00 a.m. to 5:30 p.m. and 5:30 p.m. to 8:30 p.m., MDT. The respective lengths of these 4 collection periods were 9, 3.5, 8 and 3.5 hr.

At the end of each collection period all visible mosquitoes were removed from inside the trap by means of a vacuum cleaner powered by a portable generator. A 24 x 24 mesh nylon screen was inserted in the extension tube of the vacuum cleaner to retain the insects. The louvered openings of the trap were closed during collection to prevent entrance of mosquitoes attracted to the collector.

The number of mosquitoes in each collection was determined by counting every mosquito or by weighing the collection and estimating the number from the weight of a 100-mosquito subsample. Species identity and percent that had taken a blood meal were determined from subsamples of 75 and 100 individuals, respectively. Total samples of fewer than 175 were divided proportionally. To confirm whether mosquitoes had fed on blood, specimens were individually squashed on white blotter paper.

RESULTS AND DISCUSSION. Eight species of mosquitoes were collected in this study (Table 1). Additional species have been reported in the area in the past (Owen 1951), and it is possible that these were present but not attracted to the trap. Several investigators, including Easton et al. (1968) Olson et al. (1968), Roberts (1965) and Service (1964) have demonstrated that animal-baited traps do not necessarily attract all mosquito species in an area.

Table 1. Total number of adult female mosquitoes collected from a bovine baited trap on sixteen collection days from June 16 to August 10, 1971, Laramie, Wyoming.

Mosquito species	Number trapped[1]	Percent of total
Aedes melanimon	71,440	44.34
Aedes dorsalis	56,388	35.06
Culiseta inornata	9,643	5.97
Aedes flavescens	8,684	5.39
Aedes idahoensis	6,761	4.20
Aedes campestris	5,457	3.39
Aedes fitchii	2,644	1.64
Culex tarsalis	10	0.01
TOTAL	161,127	100.00

[1] The collection includes those mosquitoes that entered the trap between 8:30 pm, the preceding day, until 8:30 pm on the "collection" day.

Aedes melanimon and *A. dorsalis,* which were almost equally abundant, together accounted for 79.4% of the total mosquito collection (Table 1). Tempelis

et al. (1967) reported that these species frequently feed on cattle and that, in their studies, 61 and 92% respectively, of female *Aedes dorsalis* and *Aedes melanimon* were engorged with bovine blood.

Culiseta inornata plus the *Aedes* species *flavescens, idahoensis, campestris* and *fitchii,* although less numerous than *A. dorsalis* and *A. melanimon,* appeared to be sufficiently abundant to be considered pests of cattle. Seventy-nine percent of the *C. inornata* collected in Colorado by Tempelis et al. (1967) were engorged with bovine blood. *C. inornata* has been reported by several authors to prefer the blood of larger mammals such as cattle and horses to that of man (Owen and Gerhardt 1957, Reeves and Hammon 1944, Mail 1934). Relatively cool midsummer temperatures, such as those that are found at higher elevations, have been reported by Harmston and Lawson (1967) to be favorable to survival of *C. inornata.* Carpenter and LaCasse (1974) reported that *A. flavescens* prefers cattle to man. Owen and Gerhardt (1957) reported that although *A. flavescens* is attracted to livestock in Wyoming, the species usually does not occur in large numbers. These authors also stated that *A. idahoensis, A. campestris* and *A. fitchii* are species that can at times rival *A. dorsalis* in numbers, and *A. idahoensis* and *A. fitchii* are reportedly attracted to livestock in Wyoming. In Colorado, Tempelis et al. (1967) found that 28% of blood-engorged *Culex tarsalis* had fed on cattle. Based on our collection size this species would appear to be unimportant as a pest of cattle on the Laramie Plains.

Any "trap effect" on size or species composition of the collections is unknown. Swarms of male mosquitoes, which on occasion were observed near the trap may have affected activity of the females.

The abundance of adult female mosquitoes of the 8 species trapped on each of 15 collection dates is illustrated in Fig. 1. The large fluctuations in numbers of mosquitoes between collection dates are expected due to numerous biotic and abiotic factors that control mosquito abundance and activity.

Most species, i.e., *A. dorsalis, A. melanimon, A. campestris, A. idahoensis* and *Culiseta inornata,* were active and were caught in our trap on June 16, the first collection date. *A. flavescens* appeared in the trap on June 19. Larvae of this species were reported by Rees (1943) to mature relatively slowly. *A. fitchii,* which did not appear until July 7, was reported by Mail (1934) as a species that can hatch late in the year. Owen and Gerhardt (1957) reported that *A. fitchii* eggs will hatch later than those of other *Aedes* species in the same ponds. *Culex tarsalis* did not appear in the trap until July 29. *C. tarsalis* adults might have been active earlier in the summer, but possibly were not found in the trap at this time because this species is primarily ornithophilic, and the maximum adult population is generally reached during August or September (Carpenter and LaCasse 1974).

A. dorsalis, A. melanimon and *A. flavescens* numbers increased from low numbers to a maximum on July 7, then they declined to lower numbers until the end of the experiment on August 10. A similar trend in population densities was noted with *Aedes idahoensis* and *Aedes campestris,* however, these species reached maximum numbers on June 29 and July 16, respectively.

A. dorsalis and *A. melanimon* have been reported capable of producing more than one generation per year by numerous authors including Carpenter and LaCasse (1974). Large numbers of mosquitoes might result from production of additional generations of mosquitoes during the experiment. Owen (1951), however, in a discussion of the mosquito problem in Wyoming, stated that "A second brood of species like *Aedes dorsalis* is seldom of importance." *A. idahoensis, A. campestris, A. flavescens* and *A. fitchii* have all been reported to have but one generation per year by one or more of the following authors: Mail (1934), Carpenter and LaCasse (1974), Harmston and Lawson

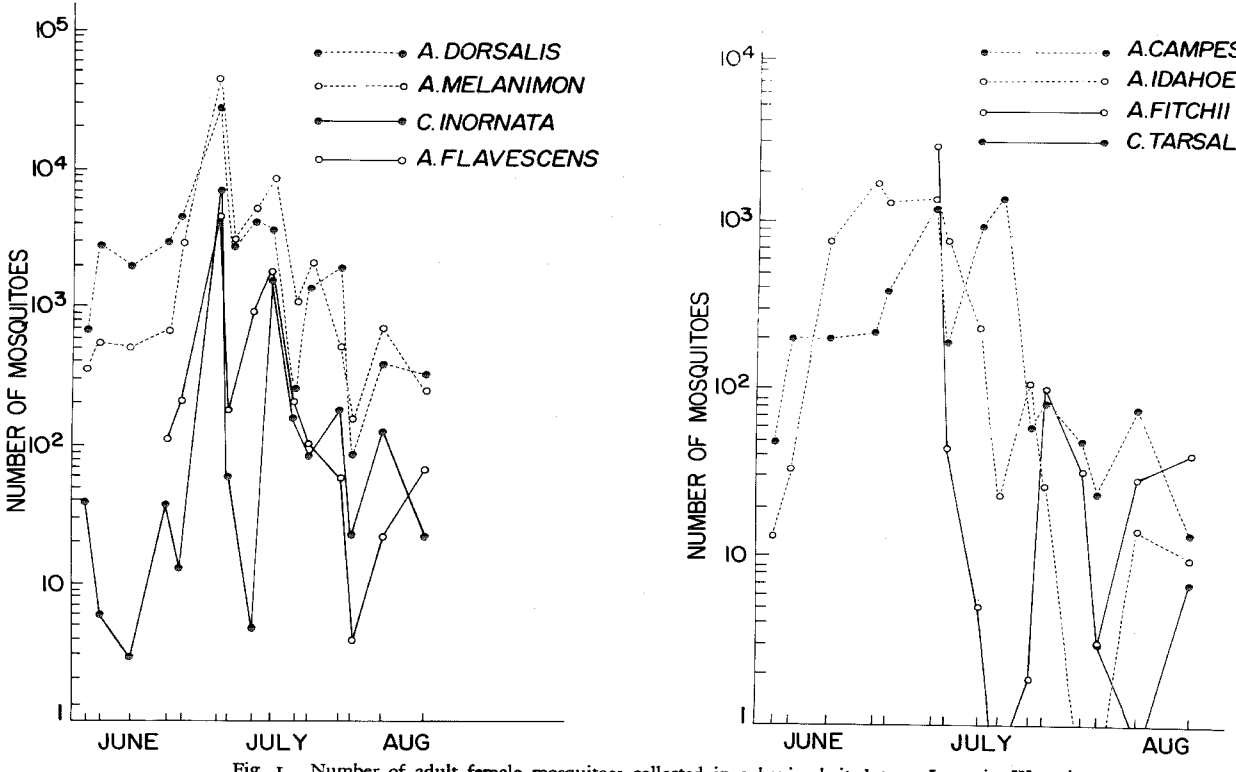

Fig. 1. Number of adult female mosquitoes collected in a bovine-baited trap, Laramie, Wyoming, 1971. Collection dates: 16, 18, 23, & 29 June; 1, 7, 9, 13, 16, 20, 22, 27, & 29 July; 3 and 10 Aug.

(1967), and Owen and Gerhardt (1957). These species appeared to persist in the collections over relatively long periods of time, e.g., *A. idahoensis* and *A. campestris* 55 days, *A. flavescens* 45 days, and *A. fitchii* 34 days. Adult females of *A. campestris* and *A. flavescens* have been reported as surviving as adult females for long periods of time by Rees (1943) and Carpenter and LaCasse (1974), respectively. In addition to longevity of the females, the presence of these single brood species over extended periods could also be due to delayed hatching, possibly due to delayed flooding, or the specimens collected later in the season might have migrated from a distant source. A possible flight range of 10 miles for *A. campestris* was suggested by Rees (1943).

It seems likely that the *C. inornata* females that were collected on June 16 had overwintered. After this collection, numbers dropped until late June, they then climbed in early July to a peak of over 7,000 individuals on July 7. On July 13, numbers of *C. inornata* dropped sharply while most other species increased in numbers from the preceding collection date (July 9). The temperature on July 13, which was the hottest day of the summer (max temp=90° F), may have been responsible for the reduced *C. inornata* activity.

Complete sets of data, which included 4 collections during periods of differing light intensity over 24 hr, were obtained on 11 of the collection dates. Those dates were: 18, 27 and 29 June; 1, 9, 20, 22 and 27 July; and 3, 10 and 13 Aug. A summary of these data is presented in Table 2. Only a few general statements can be made regarding the mosquito activity based on these data because sampling was too infrequent to determine hourly activity, and a few extremely large collections would tend to bias the results.

Although most of the species collected in this study could be captured at any time of day, most exhibited some periodicity. *Aedes melanimon, A. dorsalis* and *A. campestris* were captured less frequently during the daylight hours (9:00 a.m.–5:00 p.m.) than during any other time period. However, the numbers collected during the daylight hours might be considered quite large, particularly numbers of *A. dorsalis*. We would confirm the statement of Carpenter and LaCasse (1974) that "*A. dorsalis* is especially active toward evening." Harmston and Lawson (1967) stated that *A. melanimon* is most aggressive at dusk. Miura and Reed (1970) in the Central Valley of California found the daily flight cycle of *A. melanimon* to be crepuscular with bimodal peaks at twilight periods. Ac-

Table 2. Number of adult female mosquitoes collected from a bovine baited trap during four different periods of the day,[1] Laramie, Wyoming, 1971.

	Time Period							
	(8:30 p.m. 5:30 a.m.)		(5:30 a.m. 9:00 a.m.)		(9:00 a.m. 5:00 p.m.)		(5:00 p.m. 8:30 a.m.)	
Species	total	no./hr	total	no./hr	total	no./hr	total	no./hr
A. melanimon	6,847	69	3,236	84	829	9	1,815	47
A. dorsalis	10,064	102	4,226	110	1,235	14	4,638	121
A. idahoensis	905	9	1,852	48	1,887	21	300	8
A. campestris	773	8	350	9	151	2	291	8
A. flavescens	646	7	171	4	129	2	36	1
C. inornata	624	6	116	3	3	<1	0	0
A. fitchii	95	1	82	2	7	<1	49	1
C. tarsalis	7	<1	0	0	0	0	0	0
TOTAL	20,024	202	1,051	261	4,238	48	7,172	185

[1] Total number of mosquitoes collected on 16, 18, 23 and 29 June; 1, 9, 20, 22 and 27 July; and 3 and 10 Aug.

cording to Carpenter and LaCasse (1974), *A. campestris* is especially active in the evening and early morning hours. In our study all 3 species were aggressive during the evening as well as early morning hours.

Most activity of *Aedes flavescens* and *Culiseta inornata* occurred during the evening immediately following sunset. *A. flavescens* was active, but to a lesser degree, during the early morning and daytime hours. *A. flavescens* has been reported to be a day and early evening feeder (Owen and Gerhardt 1957 and Carpenter and LaCasse 1974), and *C. inornata* a dusk and early evening feeder (Harmston and Lawson 1967). In our study, early morning activity was observed more frequently than was early evening activity, and relatively little activity was detected in the evening.

Carpenter and LaCasse (1974) stated that *A. idahoensis* females bite persistently during the day. Our results would confirm this observation. Slightly less activity of *A. fitchii* was observed during the daylight hours (9:00 a.m.–5:00 p.m.); otherwise there was little apparent difference due to time of day. Freeborn (1926) stated that the adults of *A. fitchii* bite persistently both during the day and in the evening.

Various investigators, including Blackmore and Dow (1958), Dow et al. (1957) and Easton et al. (1968) have reported less than 100% engorgement of female mosquitoes collected from animal-baited traps. Blackmore and Dow (1958) in a study of the feeding preference of *Culex tarsalis* on various bird species found a relatively constant percent of engorgement for individual host animals. In our study, based on χ^2 analysis ($p=.05$), the ratio of engorged to unengorged mosquitoes varied significantly from day to day.

The percentages of collected mosquitoes that were blood-engorged varied considerably between those mosquitoes that were collected during periods of darkness and those that were collected during periods of daylight. The highest percentages of engorgement, 74 and 80%, occurred among collections made during the 5:30 a.m. to 9:00 a.m. and 9:00 a.m. to 5:00 p.m. time periods, respectively. A much lower percent engorgement was observed during the 5:00 p.m. to 8:30 p.m. (56%) and 8:30 p.m. to 5:30 a.m. (55%) time periods.

We suspect that mosquitoes attracted into the trap in the evening had a limited amount of time available to obtain a bloodmeal. Adult activity ceased due to cold nighttime temperature and did not begin again until the warmer hours of the morning.

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EDITORIAL NOTE

With partial financial support of the AMCA, it was my privilege to attend the 1975 meeting of the Council of Biology Editors in Gainesville in May. The accomplishment for which the Council is best known is production of the *CBE Style Manual*. If you have not seen the latest edition, I suggest that you take the trouble to locate a copy. You will find that it differs greatly from the old manual with the blue cover. The CBE may be considered an offspring of the American Institute of Biological Sciences. The *Style Manual* has been influential in standardizing various practices and in the overall improvement of biological journals.

Editors become affiliated with the Council to learn how other editors conduct their operations and to pick up ideas which may be used to modify procedures with the goal of greater efficiency in mind. The program at the Gainesville meeting involved the following subjects: (1) Editors and the Reviewing System, (2) Standardization of Style, (3) How is Your Journal meeting Inflation? (4) A Reconsideration of Manuscript Editing, and (5) Editorial Processing Centers.

In future Editorial Notes I plan to present very briefly some of the ideas gleaned at the CBE meeting or from CBE publications. In the meantime my message is that *Mosquito News* is quite respectable. There were at the meeting representatives of "large" journals—both in circulation and number of pages—sponsored by organizations which are wealthy by any standard. Other organizations are smaller and poorer than AMCA. After rubbing shoulders with editors from different strata, I feel that we are doing very well, and I can see no reason for making any drastic changes in our methods of operation.—W. E. Bickley