Alberta. Doctoral Thesis. Department of Entomology, University of Alberta.

6. HOCKING, B. 1959. Field Notes. Department of Entomology, University of Alberta.

7. KLASSEN, W. 1959. The Influence of the North Saskatchewan River Valley on the Dispersion of *Aedes*. M.Sc. Thesis. Department of Entomology, University of Alberta.

8. MCLINTOCK, J. Field Notes. 1950, 1951. Entomology Section, Research Station, Canada Agriculture, Saskatoon, Canada.

9. PUCAT, A. 1965. The Morphology and Function of the Mouthparts of Mosquito Larvae. Quaestiones Entomologicae 1(2):41–86; Field Notes.

10. PUCAT, A. 1964. Seven New Records of Mosquitoes in Alberta. Mosquito News 24(4): 419–421.

11. REMPEL, J. G. 1950. A Guide to the Mosquito Larvae of Western Canada. Canad. J. Res. D. 28:207–248.

12. REMPEL, J. G. 1953. The Mosquitoes of Saskatchewan. Canad. J. Zool. 31:433–509.

13. SHEMANCHUK, J. A. 1959. Mosquitoes in the Irrigated Areas of Southern Alberta and their Seasonal Changes in Abundance and Distribution. Canad. J. Zool. 37:899–912.

14. STRICKLAND, E. H. 1938. An Annotated List of the Diptera (Flies) of Alberta. Canad. J. Res. D. 16:175–219.

15. TWINN, C. R. 1949. Mosquitoes and Mosquito Control in Canada. Mosquito News 9:35–41.

16. WADA, Y. 1964. Field Notes. Department of Entomology, University of Alberta.

NOTES ON THE MOSQUITOES (CULICINAE) OF NORTHWESTERN NEBRASKA

WILLIAM F. RAPP, JR.[1] AND FRED C. HARMSTON[2]

Northwestern Nebraska, as considered here, comprises Dawes and Sioux Counties. Ecologically, this is the northern limit of the high plains area of the short grass prairie. Extending across the northern third of Dawes and Sioux Counties in a generally east-west direction is the Pine Ridge, a north-facing escarpment which rises prominently above the surrounding treeless prairie (Fig. 1). North of Pine Ridge, the unglaciated Missouri Plateau of short grass prairie and local badlands extends approximately 60 miles to the Black Hills in extreme southwestern South Dakota. Drainage from the northern slopes of Pine Ridge flows eastward into the headwaters of White River; the southern slopes drain eastward into headwater tributaries of the Niobrara River.

Pound and Clements (1900:83) state: "The Pine Ridge district is akin topographically and phytogeographically to the Black Hills of South Dakota." With its mature stands of ponderosa pine, and much of its flora and fauna showing affinities with western mountain ranges, the Pine Ridge is an ecological island separated from any other coniferous area by an extensive region of short grass prairie. Such birds as the Pinion Jay, Clark's Nutcracker, Western Tanager, and Pygmy Nuthatch are breeding birds of the area. The caddisfly, *Hesperophylax occidentalis* Banks, a common species of western mountain streams, is found in the streams of Pine Ridge. Several species of the dipterous family Dolichopodidae previously known only from the Wasatch Mountains in north-central Utah have recently been collected in small canyons which dissect the Pine Ridge, and quite likely reach the eastern limits of their distribution in the latter area.

Previous studies on the mosquitoes of Pine Ridge and surrounding areas of

[1] Entomologist, Nebraska State Department of Health, Division of Sanitation, Lincoln, Nebraska.

[2] Biologist, Disease Ecology Section, CDC, USPHS, Greeley, Colorado

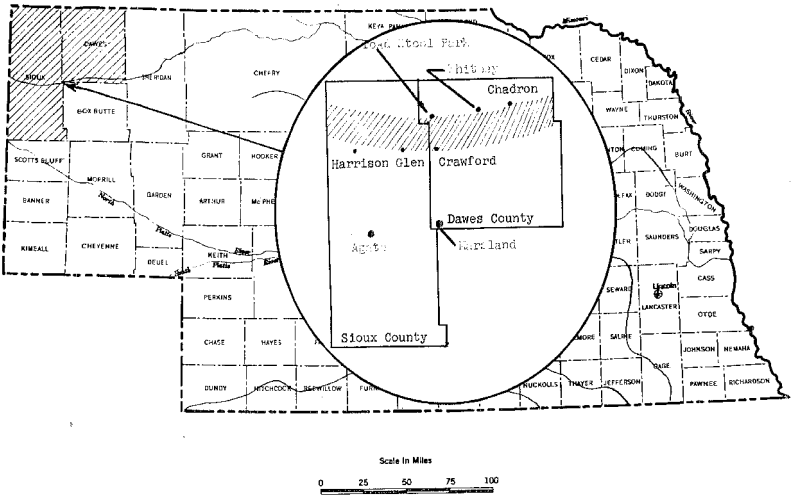

FIG. 1.—County map of Nebraska, with insert showing Sioux and Dawes counties in greater detail.

northwestern Nebraska have been made and reported by Olson and Keegan (1944), and Tate and Gates (1944). The mosquitoes reported by these investigators and those taken from 1957 and 1963 by the present writers are discussed in this report.

Studies in Pine Ridge have been conducted at Belmont, Crawford, Fort Robinson, Glen, and Monroe Canyon. In the prairie region within a 25-mile radius of Pine Ridge, studies have been made at Agate, Chadron, Harrison, Marsland, Toad Stool Park, and Whitney. Collection records are based on light trap operations at Chadron, Fort Robinson, Glen, and Whitney, and sweep net, biting catches, and larval sampling at all study sites.

Mosquito-producing habitats in the hilly, well-drained Pine Ridge area consist of a few spring-fed ponds and marshes and stream-bed pools in the small canyons which contain either a perennial stream or an intermittent flow in the spring and following summer rainstorms. Because of the paucity of breeding places in the Pine Ridge, mosquito populations seldom reach a nuisance level in the area. In the arid, non-irrigated prairie region of northwest Nebraska, mosquito populations generally are below the nuisance level except following heavy rains when flooding of undrained depressions on the open prairie and on floodplains of the White and Niobrara Rivers locally produce large numbers of *Aedes dorsalis*, *Aedes nigromaculis*, and *Aedes vexans*.

In contrast, excessive numbers of mosquitoes occur in the irrigated prairie district surrounding the town of Whitney. In the Whitney area, a prime example of excessive mosquito production resulting from faulty irrigation and drainage practices, residents are subjected to severe mosquito annoyance throughout the irrigation season due to the heavy production of *A. dorsalis*, *A. nigromaculis*, *A. vexans*, and *Culex tarsalis* in habitats associated with improper irrigation methods and inadequate drainage facilities.

A summary of the species and numbers of mosquitoes collected in light traps operated at Glen, in the Pine Ridge, and at Whitney, in the irrigated farming district 20 miles northeast of Glen, is presented in Table 1. The great difference in the populations of species comprising

TABLE 1.—Summary of mosquito light trap operations, Glen and Whitney, Nebraska

Species	Glen		Whitney	
	Number	Per cent	Number	Per cent
Aedes dorsalis	2	<1	2,908	11
flavescens			3	<1
increpitus	4	<1		
nigromaculis	3	<1	3,167	12
trivittatus	1	<1	112	<1
vexans	21	3	4,209	13
Anopheles earlei	5	<1		
Culex pipiens			2	<1
salinarius			4	<1
tarsalis	139	23	14,152	54
Psorophora confinnis			2	<1
signipennis			167	<1
Culiseta inornata	433	71	1,120	4
Total	608	100	25,846	100
Average No. per trap night	19		517	
No. trap nights	32		50	

the mosquito fauna of the two areas is evident from the light trap collections.

COMMENTS ON MOSQUITO SPECIES COLLECTED. To date, 19 species of mosquitoes have been reported from the Pine Ridge and adjacent short grass prairie regions of northwestern Nebraska. The writers are of the opinion that the occurrence of two of these species, *Culiseta melanura* and *Aedes fitchii*, are based on misidentifications. The species are as follows:

Genus *Aedes*

A. dorsalis (Meigen). In northwestern Nebraska, *A. dorsalis* is a species of the open prairie region. Only 2 specimens were taken in the light trap at Glen in the Pine Ridge on 32 nights of operation, whereas at Whitney in the irrigated short grass prairie 20 miles northwest of Glen, 2,908 were collected in 50 nights of operation.

A. fitchii (Felt and Young). Olson and Keegan report this species in their collections at Fort Robinson during May and June, but it has not been collected by the writers in northwestern Nebraska. Adult females of *fitchii* closely resemble those of *Aedes increpitus*, a species collected on several occasions by the writers in Pine Ridge. There is some possibility that the records of *fitchii* actually refer to *increpitus*.

A. flavescens (Muller). This species is an inhabitant of the open, treeless prairie region. Tate and Gates report the collection of three specimens in a light trap at Whitney.

A. increpitus Dyar. Four specimens were taken in the light trap at Glen during May and June in 1959, and one female was collected biting man in the same area in July 1959. This species also occurs at Crawford and has been collected by the senior author in the Black Hills, South Dakota. Northwestern Nebraska probably represents the eastern limit of the range of *increpitus*.

A. nigromaculis (Ludlow). This species is abundant in the irrigated Whitney area and large numbers have also been observed in the vicinity of Belmont, Crawford, Marsland, and Toad Stool Park. In the last-named area, *nigromaculis* breeds abundantly in akaline salt grass (*Distichlis*) meadows following heavy rains and constitutes a highly annoying pest. It is extremely rare in the hilly, wooded Pine Ridge area.

A. sticticus (Meigen). One female

taken while biting man at Chadron, July 28, 1959.

A. trivittatus (Coquillett). Only a few specimens of *trivittatus* were collected in the light trap at Whitney and a single specimen was taken in the trap at Glen. This species constituted an important pest locally in the vicinity of its breeding places along wooded streams and rivers in the open prairie and the lower foothills of the Pine Ridge.

A. vexans (Meigen). This species occurs throughout the Pine Ridge and short grass prairie areas where production is associated generally with floodwater pools along the streams and rivers and rain pools in both open and wooded situations. At Whitney, *vexans* is produced abundantly in habitats associated with irrigation and is the predominant pest species.

Genus *Anopheles*

A. earlei Vargas. This species was taken in small numbers in the light trap at Glen. The writers have observed *earlei* to be a common mosquito in the Black Hills, South Dakota, particularly in the vicinity of marsh habitats at Custer State Park. Apparently this species does not inhabit the treeless prairie region of western Nebraska.

Genus *Culex*

C. pipiens Linnaeus. This species is extremely rare in northwestern Nebraska. Only two specimens were taken in the light trap at Whitney. No larvae or adults were found in the surveys conducted by the writers.

C. salinarius Coquillett. Tate and Gates (1944) report four specimens collected in their light trap at Whitney. The writers found small numbers of larvae in spring-fed marshes in the vicinity of Glen.

C. tarsalis Coquillett. The larvae of *tarsalis* occur throughout northwestern Nebraska in a wide variety of semipermanent and permanent aquatic habitats in both open and sparsely-wooded situations. It is by far the most abundant species in the irrigated open prairie farming area at Whitney, and ranks next to *Culiseta inornata* in the hilly Pine Ridge.

Genus *Culiseta*

C. incidens (Thomson). One male of this species was taken in a light trap at Chadron.

C. inornata (Williston). This species is common during late season in both the Pine Ridge and prairie areas. In the former area, production occurs primarily in cool spring-fed marshes and ponds; flooded roadside ditches and marshy pastures associated with irrigation are the major breeding places in the open prairie. In 1960, *inornata* comprised 71 percent of the total mosquitoes taken in a light trap at Glen in the Pine Ridge, and represented 95 percent of the total catch during September and early October. *C. inornata* comprised 4 percent of the specimens collected in the trap at Whitney.

C. melanura (Coquillett). Olson and Keegan reported this species in light trap collections at Fort Robinson. Intensive collecting by the writers in northwestern Nebraska did not result in any specimens of *melanura*. Validity of the record cited above appears questionable.

M. perturbans (Walker). One specimen was taken in a biting collection in the vicinity of a cattail marsh near Glen in the Pine Ridge, July 27, 1959.

Genus *Psorophora*

P. confinnis (Lynch-Arribalzaga). Two specimens were taken in the light trap at Whitney.

P. discolor (Coquillett). Olson and Keegan reported this species from Fort Robinson.

P. signipennis (Coquillett). This is a species of the open prairie region. Specimens have been collected at Belmont, Chadron, Toad Stool Park, and Whitney but none has been taken in the wooded Pine Ridge area.

SUMMARY. The extreme northwestern corner of Nebraska, comprised of Dawes

and Sioux Counties, lies near the northern border of the vast high plains region of short grass prairie. Extending through these counties in a generally east-west direction is the Pine Ridge, a prominent topographical escarpment whose mature stands of ponderosa pine distinguish the area from any other region in the treeless short grass prairie.

Studies of the mosquito fauna of the Pine Ridge and the surrounding area of northwestern Nebraska have shown the species composition of the two areas to differ markedly. Results of the studies indicate that with respect to mosquitoes the Pine Ridge is an ecological island in the short grass prairie.

References Cited

OLSON, T. A., and KEEGAN, H. L. 1944. New mosquito distribution records from the Seventh Service Command Area. J. Econ. Ent. 37:847–848.

POUND, ROSCOE, and CLEMENTS, F. C. 1900. The phytogeography of Nebraska. Lincoln.

TATE, H. D., and GATES, D. B. 1944. The mosquitoes of Nebraska. U. of Nebr. Col. of Agriculture Expt. Sta. Res. Bul. 133.

CHANGES IN THE OVARIES OF CERTAIN BITING MIDGES (DIPTERA: CERATOPOGONIDAE) FOLLOWING COMPLETION OF THE GONOTROPHIC CYCLE

J. R. LINLEY

Sand Fly Research Unit, Ministry of Health, Montego Bay, Jamaica, W.I.[1]

INTRODUCTION. It has been known for a number of years that in certain mosquitoes, recognisable changes occur in the ovaries following the completion of each gonotrophic cycle. In particular, Russian workers have pioneered the study of changes in the ovarioles of *Anopheles* mosquitos, as a means for age determination. Russian literature on this subject has been reviewed by Gillies (1958), and a further account is given by Beklemishev *et al.* (1959) and also by Detinova (1962).

The Russian technique for age determination, by observing the condition of the ovaries, depends upon the fact that after oviposition, a small but distinct dilatation remains in the ovariole at the site recently occupied by the egg. Subsequent ovulations result in similar dilatations, so that after the completion of several gonotrophic cycles a string of dilatations may be seen in the portion of the ovariole between the currently developing follicle and the point of attachment of the ovariole to the calyx. Each dilatation is separated from its neighbours by a distinct connective stalk, while the first formed dilatation is separated from the calyx by the pedicel. Details of these structures have been given by a number of authors, and a recent description, employing the currently accepted terminology, is provided by Bertram (1962), so that further elaboration is unnecessary here.

It is the purpose of this paper to report and describe the formation of the first dilatation in the ovarioles of three species of biting midge, namely *Leptoconops bequaerti* Kieffer, *Culicoides barbosai* Wirth and Blanton and *C. furens* Poey. These species were studied in Jamaica, where their man-biting activity constitutes a considerable problem. It should be emphasized that only the formation of the first dilatation (following the first ovi-

[1] Now % Dept. of Entomology, London School of Hygiene and Tropical Medicine, Keppel St., London W.C.1