MOSQUITOES OF NORTH DAKOTA[1]

By

Richard L. Post[2] and J. A. Munro[3]

Economic Importance

Mosquitoes affect man's welfare both as nuisances and as disease carriers. As nuisances they inflict loss in various ways. They attack livestock and fowl and when present in large numbers are a serious drain on the vitality of their hosts. They cause loss in milk production and in weight of cattle. Mosquitoes are a nuisance to workers in gardens and fields and sometimes become so abundant as to cause stoppage of outdoor work. In some sections they restrict the vacation season with subsequent loss of patronage to resort establishments and are responsible for reductions in the value of real estate.

Several important diseases of man are transmitted by mosquitoes. *Anopheles* mosquitoes are the sole vectors of malaria in human beings. Four species of these mosquitoes are recorded from North Dakota but they have not become abundant enough to be of concern.

Various strains of encephalitis are known to be transmitted by mosquitoes. *Culex pipiens, C. tarsalis* and *Culiseta inornata* have been found to be naturally infected with Western strain of encephalitis. This disease has been transmitted under controlled laboratory conditions by mosquitoes belonging to the genera *Aedes, Culex,* and *Culiseta. Culex pipiens* and *C. tarsalis* have been found infected by nature by the St. Louis encephalitis and species belonging to the genera *Aedes, Culex* and *Culiseta* can transmit the disease experimentally.

Aedes vexans and *A. dorsalis,* the two species which comprise about 75% of North Dakota mosquito population have been incriminated as carriers of encephalitis under laboratory conditions and *Culex tarsalis* our third most abundant species with a relative abundance of approximately 8% has been found infected in nature by both the St. Louis and Western types of encephalitis. Munro and Telford (1943) report that during the 1941 outbreak, when encephalitis reached an all time high in the United States and Canada, 1,101 people and 2,552 horses contracted the disease in North Dakota with mortality rate of 12.6 percent (139 deaths) and 21 percent (549 deaths) respectively. Practically all cases were the Western type of encephalitis.

Several other human diseases such as yellow fever, filariasis and dengue are transmitted by certain species of mosquitoes which occur in North Dakota. However these diseases are so far removed geographically that they are not considered a threat to North Dakota at the present time. Service men returning from areas in the Pacific

[1]Progress report on Purnell Project No. 119. "An Investigation on the Biology and Control of Mosquitoes".
[2]Associate Entomologist.
[3]Entomologist.

and Oriental regions who have contracted these diseases could be a source from which our mosquitoes might become infected. These diseases could then be transmitted to other persons residing in the same locality.

Bird malaria is a disease caused by protozoa of the genus *Plasmodium* and is transmitted by mosquitoes. The genera *Aedes, Anopheles, Culex* and *Culiseta* have been found to be infected with this organism with *Culex quinqefasciatus* and *C. pipiens* considered to be the most important vectors.

Life History

The eggs of mosquitoes are laid singly on or near water or are glued together in boat shaped rafts and float upon the water. The species which lay their eggs out of water belong to two groups with respect to hatching. The first group are those that hatch as soon as the eggs are flooded and whose life history is completed rapidly. Several generations are produced in a summer as the pools dry and flood with the alternating dry and rainy periods. In the absence of water these eggs are capable of remaining viable for months and even years. Species belonging to this type are called intermittent breeders and include our most common species of *Aedes* and *Psorophora*. The second group are those in which only one generation is developed each year and are called annual breeders. The eggs must be subjected to winter freezing before hatching. *Aedes canadensis* and *A. excrucians* are examples of this type.

Mosquito larvae live only in water and their food consists of small aquatic organisms or particles of organic matter which are swept into the mouth by the action of the mouth brushes. Air is obtained at the surface of the water, except in the genus *Mansonia*, by means of a breathing tube or plate.

The pupa or "tumbler" is lighter than water and floats except when disturbed. It does not feed in this stage. Air tubes are situated on the thorax.

The food of the adult female mosquito includes nectar of flowers, fruit juices, and animal blood. Only the female mosquito bites animals and sucks blood.

A typical mosquito life history is illustrated in Figure 1.

Control

Mosquito abundance depends upon local rainfall which provides breeding places for the larvae. Prevailing winds blow the adults into mosquito-free areas. The most effective means to combat such drifting in of mosquitoes is the application of larvacides and residual sprays as may be necessary. The control of mosquitoes has been published in previous issues of the Bimonthly Bulletin (See References) and can be summarized as follows:

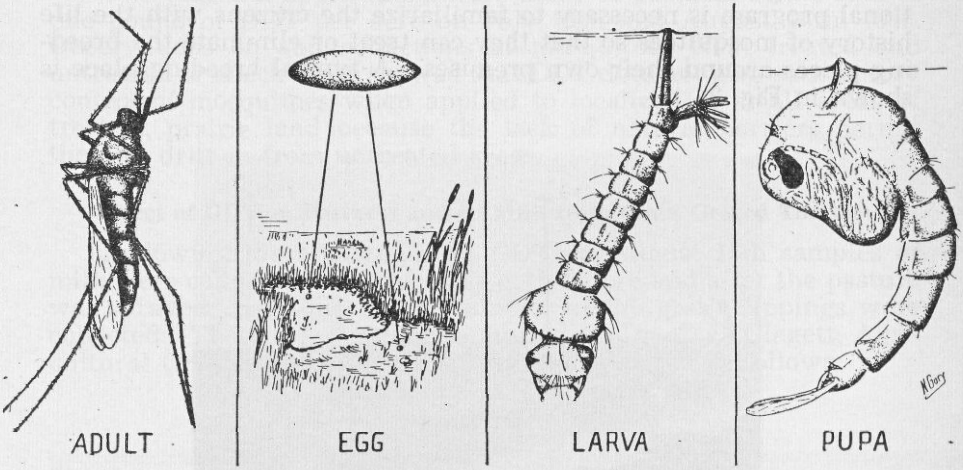

Fig. 1—Typical Mosquito Life History

Mosquitoes are troublesome because of their attacks on man and livestock. Their annoyance to cattle reduces milk production. They are also responsible for loss of weight to livestock. The predominating species, Aedes vexans and A. dorsalis, are capable of transmitting encephalitis, a disease which at times has caused serious illness and loss of life in North Dakota.

Eggs are laid on or near water. The larvae or "wrigglers" feed on small plants or animals and are most abundant in polluted water. They breathe by means of a respiratory tube near the tip of the body. The pupae or "tumblers" breathe through two trumpet-like tubes on the thorax. Under summer conditions the life cycle may be completed in ten days.

In cooperation with the City Health Department of Fargo all ponds within Fargo and one mile radius were systematically treated in the spring and summer of 1945 and again in 1946. The same procedure was followed by the adjoining city of Moorhead, Minnesota. Freedom from mosquitoes within the treated areas continued until the third week of June in 1945 when warm winds from the south prevailed for several days causing an influx of these pests. About the second day of this wind activity, the mosquitoes became as abundant throughout the Fargo-Moorhead area as they had been in the outside untreated areas. The problem of mosquitoes being blown in from untreated areas emphasizes the importance of extending the area of treatment. How far it should be extended will probably vary with the terrain and the usual velocity of the prevailing winds. In any event, the mosquitoes which drift in may be destroyed by applications of residual sprays. To afford adequate protection of a community a mosquito control program must be planned well in advance with a spring and an early summer survey of breeding areas. Pools or sloughs where mosquito larvae abound should be drained or treated with larvacides. Either a light application of DDT (½ lb. per acre of water), used crank case oil, or a

number 2 grade of fuel oil are satisfactory as larvacides. An educational program is necessary to familiarize the citizens with the life history of mosquitoes so that they can treat or eliminate the breeding places around their own premises. A typical breeding place is shown in Fig. 2.

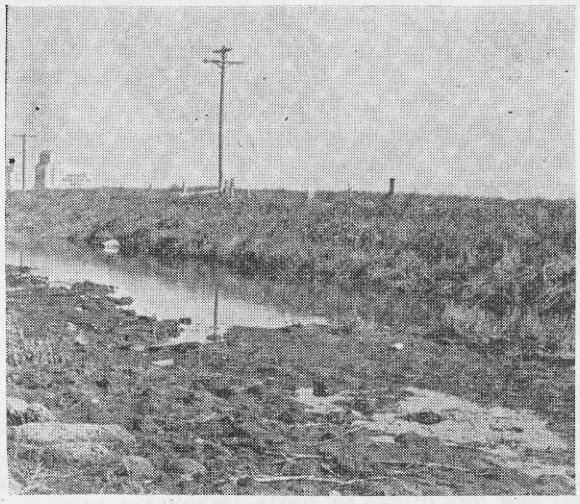

Figure 2—A breeding place for mosquitoes
This roadside pool, composed largely of seepage from a nearby stockyard, contained more than 3,000 mosquito larvae per square foot of water. A light application of fuel oil sprayed on the surface, gave complete control.

Applications of several residual insecticides in the parks of Fargo and Grand Forks during 1947 demonstrated that mosquitoes can be effectively controlled in restricted areas such as golf courses and picnic areas. Most park departments have sprayers which can be used for this purpose. However, the effectiveness of small capacity sprayers over picnic areas was demonstrated. Excellent results were obtained with .25 percent concentrations for one week. All residual sprays such as DDT, DDD, Chlordane and Benzene hexachloride reduced the number of mosquitoes from ten to fourteen days, after which they again became annoying. Of these insecticides DDT was outstanding.

At larger public outdoor gatherings, such as ball games and conventions, a preliminary spraying of the area and shrubbery gave spectacular control results in mosquito infested localities. The extra revenue obtained by attendance at golf courses, swimming pools, and ball parks should more than offset the cost of spray applications.

A control program in which the area of treatment is extended to eliminate the breeding areas in surrounding territory supplemented by weekly sprayings in recreational areas will effectively reduce local mosquito populations.

Two seasonal applications were made to pastures at the rate of one pound of DDT per acre on July 14th and August 16th, 1948. Observations on and collections of mosquitoes from treated and untreated or check areas showed that DDT does not give satisfactory control of mosquitoes when applied to localized or small areas of treeless, prairie land because the lack of natural barriers permit them to drift in from untreated areas.

Effect of DDT on Pastures and on Milk from Cows Grazed Thereon

Following the application of DDT on August 16th samples of milk were collected from the cows both before and after the pasture was sprayed; also square yard samples of the grass clippings were collected. These samples were analyzed by Dr. C. O. Clagett, Agricultural Chemist, NDAC. His report is tabulated as follows:

DDT Content of Milk Samples

Sample Date		DDT Content
8-16-48	night*	none
17	morning	none
17	night	none
18	morning	none
18	night	trace
19	morning	none
19	night	0.1 ppm
20	morning	0.7 ppm
20	night	0.7 ppm
21	morning	0.4 ppm
21	night	0.5 ppm
22	morning	0.4 ppm

*Before cows turned on pasture.

DDT Content of Grass Clippings

Sample 1	West end of pasture	4.1 mg. sq. yd.
Sample 2	Center of pasture	1.8 mg. sq. yd.**
Sample 3	East end of pasture	.2 mg. sq. yd.**
Weight of Grass:-	**Fresh Wt.**	**Dry Wt.**
Sample 1	50 g.	21.8 g.
Sample 2	36 g.	13.7 g.
Sample 3	48 g.	20.1 g.

**From this analysis it would appear that samples 2 and 3 had been taken from areas poorly covered.

From the milk analyses it would appear that 60 hours are required for the DDT consumed to be excreted in the milk. Whether the small quantity of DDT (.1 to .7 ppm) in the milk, following treatments of pasture, would be objectionable or result in making the dairy products injurious as food is questionable. Further investigations of a nutritional aspect should yield the answer.

Seasonal Appearance and Distribution

There are now 31 species representing 8 genera of mosquitoes known to occur in North Dakota. The species are listed alphabetically. **The locality of capture followed by date and month (in Roman numerals) and the year with the collectors initials in parenthesis accompanies each species.** The key to the collectors initials is at the end of the list of species. Prior to 1947 most of the mosquito determinations were made by Dr. W. C. Reeves of the Hooper Foundation and Dr. Alan Stone of the Division of Insect Identification, USDA Bureau of Entomology and Plant Quarantine. Dr. Stone determined the mosquitoes collected in 1947. During 1948, approximately three thousand mosquitoes were collected at Valley City by M. A. Leraas, Head, Department of Biology, Valley City State Teachers College and Graduate Student in Agricultural Entomology at NDAC. These mosquitoes were collected by mechanical traps in cooperation with Dr. Brennan of the U. S. Public Health Service. An additional five hundred specimens were collected throughout the state by staff members and students. Dr. James M. Brennan, Division of Infectious Diseases, U. S. Public Health Service, Rocky Mountain Laboratory, Hamilton, Montana, determined the mosquitoes collected during 1948.

Aedes campestris Dyar & Knab

Buxton 6 V 39 (JAM & HO); Cavalier 3 VIII 48 (DBN); Devils Lake 17 VII 21 (HGD); Fargo 13 to 16 VIII 48 (JRA); Grafton 5 V 39 (JAM & HO); Hankinson 27 VII 48 (JAM & WDN); Mandan 17 VII to 7 VIII 38 (JS); Milnor 17 V 39 (DD); Minot 7 VIII 48 (RBK); New Rockford 19 V39 (JAM & SS); Niles Siding 16 VII 21 (HGD); Northwood 23 VII 48 (RLP & KSE); Ramsey Co. 17 VI 42 (JAM); St. Thomas 17 VI 48 (RLP & WJC); Valley City 10 VII to 8 VIII 48 (MAL).

The larvae occur early in ground pools, often charged with mineral matter. The males swarm after sunset close in the tops of small pine trees. The females bite by day or night whenever one invades their haunts.

Aedes canadensis (Theobald)

Valley City 22 VII 48 (MAL).

The larvae develop in ground puddles, woods-pools and ditches. The larvae will appear several times a season following successive fillings of pools by rains but there is probably only one annual generation as all the eggs would not hatch at the first filling of the pool. The adults are persistent biters and attack low, near the ground.

Aedes dorsalis (Meigen)

Butte 28 VIII 48 (JRA & NM); Casselton 5 VII 41 (JAM & HST); Cass Co. 3 VI to 29 IX 42 (HST); Cavalier 11 VII 42 (HST); 3 VIII 48 (DBN); Fargo 2 to 21 V 40, 21 VI 41 (HST), 3 to 19 VI 42 (HST), 5 VII 41 (JAM & HST), 6 to 16 VII 48 (JRA), 3 to 8 VIII 38 (JAM); Grand Forks 12 VIII 48 (DBN), 15 X 41 (HST); Hankinson 27 VII 48 (JAM & WDN); Jamestown 16 VIII 41 (JAM & HST); LaMoure Co. 20 V 39; Litchville 10 VIII 41 (WJ & JAM); Mandan 17 VII to 16 VIII 38 (JTS); Milnor 1940; Minot 17 VII 38 (TS), 1 VIII 48 (RBK); Minto 9 VI 39 (SS); New Rockford 1940; Northwood 23 VII 48 (RLP & KSE); Oberon 19 V 39 (JAM); Towner Co. 18 V 39 (JAM); Traill Co. 17 VI 41 (HST); Valley City 20 VI to 21 VIII 48 (MAL), 21 IX 37 (JTS); Walsh Co. 1 X 42 (HST); Ward Co. 19 VI 42 (JAM).

The larvae develop in early ground puddles. The females are persistent biters and are especially abundant after sunset. The males swarm after sunset over prominent objects on the prairie.

Aedes excrucians (Walker)

Mandan no date; Towner Co. 11 V 39 (JAM & HCO); Valley City 12 VIII 48 (MAL).

The larvae develop in early spring water, woods pools, and marshes. There is one annual generation but the adults last most of the summer, flying in the woods. It does not enter houses. It is holarctic in distribution and in North America is restricted to the northern coniferous forest belt and areas a short distance southward.

Aedes fitchii (Felt & Young)

Christine 10 V 39 (SS); Jamestown 19 V 39 (JAM & SS).

This species is common on the prairies where some cover exists but is less closely addicted to forests than *A. excrucians*. The larvae develop in early spring water, often with *A. excrucians*. The adults fly until late in the season, not entering houses.

Aedes flavescens (Müller)

Benson Co. 18 IX 42 (JAM); Butte 28 VIII 48 (JRA); Cass Co. 14 VII 42 (HST); Casselton 5 VII 41 (JAM & HST); Clyde 28 VIII 48 (JRA); Devils Lake 19 VII 21 (HGD); Edgeley 20 V 39 (JAM & SS); Fargo 6 V 39 (JAM & HO), 10 VI to 4 VII (RCP LJP & RLP), 13 to 16 VII 48 (JRA), 17 X 41 (HST); Golden Valley 10 VIII 41 (HST); Grandin 25 VI 48 (RLP DBN & HCH); LaMoure Co. 1940; Jamestown 19 V 39 (JAM & SS); Levant 17 VI 48 (RLP & WJC); Minot 6 to 21 VI 48 (RBK); Ramsey Co. 17 VI 42 (JAM); St. Thomas 17 VI 48 (RLP & WJC); Towner Co. 18 V 39 (JAM & HCO); Valley City 14 VI to 24 VII 48 (MAL); Verona 20 V 39 (JAM & SS); Ward Co. 19 VI 42 (JAM).

The larvae develop in the larger ground pools in early spring. The adults are not abundant but are occasionally met with on prairies and open woodlands. This species also occurs in Alaska, Asia and Europe. It is recorded as a vicious pest of horses and cattle in Denmark, though man is not exempt.

Aedes idahoensis (Theobald)

Dickey Co. 15 IX 42 (JAM); Fargo 2 VI 41 (HST); Grand Forks Co. 20 IX 41 (IIST); Mandan 17 VII 38 (JTS); Minot 17 VII 38 (TS); Ramsey Co. 17 VI 42 (JAM); Valley City 9 VII 48 (MAL).

The larvae develop in early spring pools. The adults inhabit open country, avoiding timber.

Aedes intrudens Dyar

Valley City 20 VII 48 (MAL).

The larvae develop in early ground pools with a floor of rotten leaves and is one of the especially early species. The species is appropriately named as it is the most troublesome of forest mosquitoes from its habit of entering houses. No other forest species behaves in this manner. It will attack during the day.

Aedes nigromaculis (Ludlow)

Argusville 15 VIII 41 (WJ); Casselton 5 VII 41 (JAM & HST); Cavalier 3 VIII 48 (DBN); Devils Lake 20 VII (HGD); Dickey Co. 15 IX 42 (JAM); Fargo 21 VI 41 (HST), 5 to 8 VII 41 (JAM & HST), 13 to 16 VII 48 (JRA), 17 X 41 (HST); Golden Valley Co. 10 VIII 41 (HST); Grand Forks 12 VIII 48 (DBN), 21 VII 48 (HGD); Grand Forks Co. 15 X 41 (HST); Mandan 17 VII 38 (JTS); Valley City 10 VII to 9 VIII 48 (MAL).

The larvae develop in early ground pools in dry country which at times may be strongly alkaline. In the presence of irrigation several generations, or hatchings, may occur in the season and become abundant. The females are severe biters and bite readily during the day. They are strong fliers and have been taken several miles from their breeding places.

Aedes punctor (Kirby)

Fargo 12 VI 22 (HGD)

The larvae are found during the early spring months in pools with a floor of decaying leaves. The adults are severe biters, and can be found until frost in the northern woods, although there is but a single annual generation. The species is widely distributed throughout Canada, the northern United States, Europe and northern Asia.

Aedes riparius Dyar & Knab

Fargo 12 & 13 VI 22 (HGD), 30 VII 48 (LJP RCP & RLP); Golden Valley Co. 10 VIII 41 (HST).

It breeds in early spring pools in the prairie, particularly those near or in small wooded areas.

Aedes spenceri (Theobald)

Alice 9 IX 41 (WJ); Argusville 15 VIII 41 (WJ); Butte 28 VIII 48 (JRA); Cass Co. 11 V 41 (HST), 9 to 20 IX 42 (JAM & HST); Casselton 5 VII 41 (JAM & HST); Cavalier 3 VIII 48 (DBN); Devils Lake 20 VII 21 (HGD); Dickey Co. 15 IX 42 (HST); Eastern N. Dak. Summer 1939 (Ent. Staff); Fargo 2 VI to 5 VII 41 (HST); 27 VI 21 (HGD), 13 to 16 VII 48 (JRA), 17 X 41 (HST); Grand Forks Co. 20 IX to 15 X 41 (HST); Knox 16 VII 21 (HGD); Minot 27 VII to 7 VIII 48 (RBK); Norwich 16 VII 21 (HGD); Rugby 16 VII 21 (HGD); Traill Co. 20 IX 41 (HST); Tunbridge 16 VII 21 (HGD); Valley City 2 to 10 VIII 48 (MAL); Walsh Co. 15 IX to 1 X 41 (HST).

The larvae develop in early spring pools. The adults inhabit open prairie, avoiding timber and are day biting mosquitoes.

Aedes sticticus (Meigen)

Fargo 2 VIII 47 (RLP).

The species breeds in flood pools. At times individuals of the species appear in swarms and the females are ferocious biters during the evening and also during the day in cloudy or shaded situations. Emergence of the adults occurs once a year in early spring.

Aedes triseriatus (Say)

Fargo 2 VIII 47 (RLP).

The larvae live in the water in holes in tree trunks. The females are severe biters, and though never abundant, are often troublesome in dry woods.

Aedes trivittatus (Coquillett)

Bismarck 4 VIII 39 (SS); Bottineau 31 VII 48 (JRA & NFM); Mandan 17 VII to 7 VIII 38 (JTS); Minot 17 VII 38 (TS) Sanish 27 VII 23 (OAS); Valley City 7 to 12 VII (MAL).

The larvae live in ground pools, particularly in river valleys where the pools are filled by flood waters. They also occur sparingly in irrigation waters. The adults frequent the bushes and trees along the river bottoms and will bite severely persons going to such places, even in the daytime.

Aedes vexans (Meigen)

Cass Co. 3 VI 42 to 20 VII 42 (JAM & HST); Casselton 5 VII 41 (JAM & HST); Clyde 2 to 4 VIII 48 (NFM); Devils Lake 20 VII 21 (HGD); Fargo 30 V 22 (LRW), 31 V to 19 VI 42 (HST), 2 VI to 8 VIII 41 (JAM & HST); 18 VI 42 (HST), 2 VI to 30 VIII 47 (LJP RCP & RLP), 3 VII 44 (JAM), 4 VII to 11 IX 48 (LJP RCP & RLP), 6 to 16 VII 48 (JRA), 1 IX 48 (JAM), Glenburn 29 VII 48 (NFM & JRA); Grafton 5 V 39 (JAM & HO); Grand Forks 4 VIII 47 (RLP), 12 VIII 48 (DBN); Hankinson 27 VII 48 (JAM & WDN), 21 IX 37 (JAM); Jamestown 16 VIII 41 (JAM & HST); Lake Metigoshe 1 VIII 48 (JRA & NFM); Leonard 23 VI 41 (JAM); Mandan 23 VII to 16 VIII 38 (JTS); Minot 23 VI to 13 VIII 48 (RBK), 17 VII 38 (TS); Northwood 23 VII 48 (RLP & KSE); Pyramid Park 1 VIII 39 (SS); Saint Thomas 17 VI 48 (RLP & WJC); Sanish 27 VII 23 (OAS); Sheldon 23 VII 48 (NFM); Valley City 14 VI to 21 VIII (MAL), 21 IX 37 (JAM).

The larvae hatch in early ground pools, but occur later in the season whenever the pools are filled by rain. The females are severe biters in woods and thickets. It is North Dakota's most common mosquito and is especially abundant after the summer rains, when it emerges in clouds from many types of rain pools and the flooded edges of marshes.

Carpenter et al (1946) states that "*Aedes vexans* has been shown through laboratory experiments to transmit both the eastern and western varieties of equine encephalitis. Feemster and Getting (1941) state that it is not unlikely that the species may prove to be the most important natural vectors of this disease. The virus of St. Louis encephalitis has also been successfully transmitted by *Aedes vexans* in the laboratory.

Anopheles occidentalis Dyar & Knab

(*Anopheles maculipennis* Meigen)

Fargo 13 VIII 20 (OAS), 27 VIII 43 (JAM); Harwood Slough, Fargo 15 VII 48 (WS & EL), Rugby 1941 (CBP); Towner 1941 (CBP); Traill Co. 24 IX 41 (HST); Valley City 10 VII to 21 VIII 48 (MAL).

The larvae are surface feeders in water puddles, especially permanent waters connected with rivers. A dangerous malaria carrier.

Anopheles punctipennis (Say)

Traill Co. 20 IX 41 (HST); Valley City 28 VII to 21 VIII 48 (MAL).

The larvae are surface feeders in all sorts of water puddles, often in small temporary rain puddles, but also in permanent waters. This species is not an important carrier of malaria under natural conditions, although the species readily becomes infected under experimental conditions.

Anopheles quadrimaculatus Say

Valley City 1941 (CBP), determined by T. H. G. Aitken.

Philip (1943) reported that the farthest previous northwest record of this important malarial vector was eastern Minnesota so the N. Dak. observation extended the distribution for considerable distance into the northern plains area.

Anopheles walkeri Theobald

Harwood Slough, Fargo 15 VII 48 (WS & EL); Valley City 14 to 21 VIII 48 (MAL).

The larvae inhabit water by overflows from rivers, which occasionally go dry. This species occurs sparingly throughout western North America. The adults are vicious biters attacking from early evening until long after dusk. This species appears to be a potential vector of malaria but addi-

tional research will be necessary to determine its importance as a transmitter of the disease.

Chaoborus Sp. Possibly *americanus* (Johannsen)

Mandan 16 VIII 38 (JTS).

The members of this genus are non-biting mosquitoes and have short mouthparts. The larvae or "phantoms" are transparent and have prehensile antennae. They are considered beneficial because they are predacious on mosquito larvae. This species is represented from North Dakota by one specimen in such poor condition that absolute determination is impossible.

Culex apicalis Adams

Valley City 21 VIII 48 (MAL).

The larvae occur in grassy marshes, and can be found all summer. The adults do not bite warm blooded animals, but have been observed attacking frogs.

Culex pipiens Linnaeus

Fargo 8 VIII 41 (JAM); Valley City 2 VII to 10 VIII 48 (MAL).

This is the common house mosquito of Europe, introduced by commerce into various temperate regions. It does not persist in the tropics. The larvae occur in artificial receptacles by preference, but are also found in ground pools when contaminated by animal refuse.

Culex restuans Theobald

Cass Co. 6 VII 42 (HST); Fargo 23 VI 39 (JAM & HO), 23 VI to 6 VII 42 (HST), 5 VII to 30 VII 41 (JAM), 3 VIII 38 (JAM), 13 VIII 20 (OAS); Valley City 20 VI to 21 VIII 48 (MAL).

The larvae are found in woodland pools with rotting leaves, dirty ground puddles and rain-water barrels if there are decaying leaves present. In the northeastern states it is an abundant and annoying mosquito frequently entering homes.

Culex salinarius Coquillett

Cass Co. 15 VII 42 (JAM).

This mosquito is called a salt marsh mosquito as it is very abundant near the seashore. They also occur inland and larvae have been occasionally taken in water barrels. It winters in the adult form in sheltered places.

Culex tarsalis Coquillett

Alice 9 VIII 41 (WJ); Argusville 15 VIII 41 (WJ); Cass Co. 8 VIII 41 (WJ); Fargo 5 VII to 15 VIII 41 (JAM & HST), 6 to 16 VII 48 (JRA), 2 to 20 VIII 47 (RLP), 3 VIII 38 (JAM), Grand Forks 4 VIII 47 (RLP); Mandan 24 VII to 16 VIII 38 (JTS); Minot 6 VI 48 (KSE & WDN); Rugby 1941 (CBP); Towner 1941 (CBP); Valley City 16 VIII 41 (JAM & HST), 21 IX 37 (JAM), 8 VII to 21 VIII 48 (MAL); Walsh Co. 15 IX 42 (HST).

The larvae are found in almost every kind of ground pool, breeding in foul water, either in the open or in shaded areas. It is said to prefer bird blood but at dusk it is very active and will make persistent efforts to enter houses. Hearle (1926) states "It is one of the most painful biters and the numb pain and swelling which follow probing lasts for hours". Dr. J. M. Brennan (personal letter 1948) states that, "It may be of interest that Dr. Ekland was successful in isolating the virus of the western strain of equine encephalomyelitis from a lot of *Culex tarsalis* from Moffit, North Dakota."

Culiseta inornata (Williston)

Benson Co. 19 V 39; Cass Co. 3 VI to 15 VII 42 (HST & JAM); Fargo 17 IV 37 (CJC), 2 V 40, 23 V 48 (LJP), 5 V to 30 VIII 41 (JAM), 13 IX 47 (RLP), 11 IX 48 (LJP & RCP); Harwood 10 VIII 41 (WJ); Jamestown 19 V 39 (JAM & SS); LaMoure Co. 30 V 39; Mandan 28 IX 38 (JTS); Minot 17 VII 38 (TS); Oberon 19 V 39 (JAM & SS); Traill Co. 29 IX 41 (HST); Valley City 30 V 39 (JAM & SS), 20 VI to 21 VIII 48 (MAL), 21 IX 37; Verona 29 V 39 (JAM & SS); Walsh Co. 15 IX 42 (HST).

The larvae live in dark permanent pools in timbered areas. The adults hibernate. It is said that they seldom attack man, preferring larger mammals. This species has been found naturally infected with the virus of western equine encephalitis and is a proven laboratory vector.

Culiseta morsitans (Theobald)

Valley City 26 VII to 21 VIII 48 (MAL).

This species is distributed throughout the northern United States, Canada and Europe. It breeds in spring fed forest pools or cold springs, always in small numbers. The adults do not bite man and only single specimens are taken so that their habits are unknown.

Mansonia perturbans Walker

Fargo 6 to 9 VII 48 (JRA); Harwood Slough, Fargo 15 VII 48 (WS & EE); Northwood 23 VII 48 (RLP & KSE).

The larvae, on hatching, descend to the bottom of the body of water and attach themselves by their air-tubes to the stems or roots of water

plants from which they get their supply of air. The adults are fierce biters and will fly several miles from their breeding grounds and readily invade houses.

Psorophora signipennis (Coquillett)

Mandan 17 VII 38 (JTS).

The larvae develop rapidly in temporary rain pools in arid country and it has been known to pass from egg to adult in five days under favorable conditions. The adults bite by day as well as evening in the open.

Uranotaenia sapphirina (Osten Sacken)

Fargo 3 VIII 38 (JAM).

This species is seldom collected. It is the opinion of most workers that this species rarely, if ever, bites humans.

Key to Abbreviations of Collectors

JRA J. R. Anderson	MAL M. A. Leraas	RCP R. C. Post
CJC C. J. Challey	EL Everett Lobb	RLP R. L. Post
WJC W. J. Colberg	NFM N. F. McCalley	SS Stanley Saugstad
DD Donald Denning	JAM J. A. Munro	TS Tilman Saugstad
HGD H. G. Dyar	DBN D. B. Nelson	JTS J. T. Sarvis
KSE K. S. Engel	WDN W. D. Nostdahl	WS William Smith
HCH H. C. Hartman	HCO H. C. Olson	OAS O. A. Stevens
WJ William Jellison	CBP C. B. Philip	HST H. S. Telford
RBK R. B. Knapp	LJP L. J. Post	LRW L. R. Waldron

Relative Abundance

The relative abundance of North Dakota mosquitoes is listed in Table 1 for the years when intensive collecting was undertaken.

Table I—Percentage Occurrence of North Dakota Mosquitoes in Collections

Species	Year 1938 Light trapped			1947	1948	
	Fargo	Mandan	Minot	Hand Caught Fargo Park Dist.	Hand Caught Statewide exclusive of Valley City	Mechanical Trapped Valley City
Aedes campestris					2	X
Aedes canadensis		1				X
Aedes dorsalis	33	4	22		16	3
Aedes excrucians						X
Aedes fitchii*						
Aedes flavescens					3	X
Aedes idahoensis		1	9			X
Aedes intrudens						X
Aedes nigromaculis		1			2	X
Aedes punctor						X
Aedes riparius					X	X
Aedes spenceri					6	X
Aedes sticticus				32		
Aedes triseriatus				1		X
Aedes trivittatus		41	9		3	X
Aedes vexans	49	43	54	54	54	83
Anopheles occidentalis					2	1
Anopheles punctipennis						1
Anopheles quadrimaculatus*						
Anopheles walkeri					X	X
Chaoborus americanus			X			
Culex apicalis						X
Culex pipiens						X
Culex restuans	4					1
Culex salinarius*						
Culex tarsalis	13	6	4	12	3	7
Culiseta inornata		1	2	1	1	1
Culiseta morsitans						2
Mansonia perturbans					3	
Psorophora signipennis		2				
Uranotaenia sapphirina	1					

X Indicates trace or less than ½ percent.

* Date and locality of capture recorded under seasonal appearance and distribution of species.

It is of interest to note the high abundance of *Aedes sticticus* in 1947 when 32 per cent of the mosquitoes collected in the Fargo parks were this species. This mosquito breeds primarily in tree hole cavities in the large oak trees of the Fargo parks along the Red River and has not been taken elsewhere in the state.

Collections by means of a mechanical trap at Valley City by M. A. Leraas show a higher incidence of *Aedes vexans* than recorded by hand caught specimens throughout the state. A much lower incidence of *Aedes dorsalis* was obtained in the mechanical trap than found in similar ecological situations in North Dakota. From these records it would indicate that flight habits and attractivity of the traps influence the proportion of certain species captured. Therefore, hand collecting of those species attracted to man and animals should supplement mechanical traps in order to evaluate the relative nuisance of mosquitoes in a given area.

References on Biology and Distribution of North Dakota Mosquitoes

Carpenter, S. J., Middlekauff, W. W., and Chamberlain, R. W.
1946. The Mosquitoes of Southern United States East of Oklahoma and Texas. Am. Midland Nat. Monograph 3:292.

Dyar, H. G.
1922. The Mosquitoes of the United States. Proc. U. S. Nat. Mus. 62 (1):1-119.

Hearle, E.
1926. The Mosquitoes of the Lower Fraser Valley, B. C. and Their Control. National Research Council Report No. 17. Ottawa, Canada.

Matheson, Robert
1929. A Handbook of the Mosquitoes of North America. pp. XVII-268. CC. Thomas Publishers.

Munro, J. A. and Saugstad, S.
1939. A Preliminary Survey of Mosquitoes in North Dakota. N. D. Agr. Expt. Sta. Bim. Bull. 1 (5):7.

Munro, J. A. and Telford, H. S.
1943. The Mosquito Problem in North Dakota. N. D. Agr. Expt. Sta. Bim. Bull. 6 (1):7-10.

Philip, C. B.
1943. Flowers As A Suggested Source of Mosquitoes During Encephalitis Studies, and Incidental Mosquito Records in the Dakotas in 1941. The Journal of Parasitology 29(5):328-329.

Post, R. L., Munro, J. A., and Somsen, H. W.
1947. Control of Mosquitoes in Recreational Areas. N. D. Agr. Expt. Sta. Bim. Bull. 10 (2):61-66.

Telford, H. S. and Wester, C.
1941. Notes on Disease Carrying Mosquitoes of North Dakota. N. D. Agr. Expt. Sta. Bim. Bull. 4 (2):13.

Ross, H. H.
1947. The Mosquitoes of Illinois. Illinois Nat. Hist. Survey. Bull. 24 (1):1-36.