MIDSUMMER MOSQUITO ABUNDANCE IN SOUTHERN SASKATCHEWAN, 1962 [1]

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INTRODUCTION. The species that make up the mosquito fauna of the agricultural areas of the Prairie Provines of Canada are fairly well known (McLintock, 1944, 1948; Rempel, 1950, 1953; Shemanchuk, 1959; Strickland, 1938; Twinn, 1945, 1949; Wardle, 1949) but little is known of the relative abundance of the species or of how their abundance fluctuates from season to season or from year to year. It is well known that enormous flights of aedines can occur on the prairies and these large flights can usually be associated with the melting of heavy winter snowfall, with heavy rains or with irrigation cycles. From observations on these flights and from larval collections it has been possible to say that some species were more abundant than others and certain species, such as *Aedes spencerii* and *A. vexans*, have come to be recognized as pest species of major importance in the prairie region.

Quantitative support for this view can be seen in Table 1 which summarizes the results from four light traps that were operated in southern Manitoba from 1942 to 1948 at Lyleton (49° 04′ N; 101° 10′ W), Morden (49° 11′ N; 98° 06′ W), Ninette (49° 24′ N; 99° 37′ W) and Brandon (49° 50′ N; 99° 57′ W). These traps were started too late in each year (June 1) to sample the largest flights of *A. spencerii* and other predominantly snowpool species in Manitoba, but from June 1 to September 30 *A. vexans* was the most abundant species in the traps in 6 out of the 7 years and over the 7 years it was more than ten times more abundant than the next species, *Culiseta inornata;* in 1942 however, *C. inornata* was almost three times as abundant as *A. vexans* in the traps. Shemanchuk (1959), in a two-year study based on counts of larvae, and catches of adults in visual-attraction traps, found *A. vexans* to be the second most abundant species (after *A. dorsalis*) in the irrigated areas of Alberta.

Light traps are generally considered to be the most satisfactory single method at present available for sampling mosquito populations, but there are disadvantages as well as advantages in their use. Light traps have proved to be satisfactory for measuring fluctuations in numbers of mosquitoes over a period of time but less satisfactory for comparing the abundance of different species in a mixed population. There is evidence that a light trap does not take the same proportion of all species in a population, apparently because some species are attracted more than others by light (Barr *et al.*, 1960; Downey, 1962; Reed, 1959).

For this reason light trap catches are sometimes supplemented by collections made by other methods and some investigators have derived numerical factors to compensate for differences in the attraction of light. Thus, in Georgia, Love and Smith (1957) found that the attraction of light for *C. inornata* was five times greater than for *A. vexans*. It is unlikely that the same factor would apply between these two species on the prairies of Western Canada, but it seems reasonable to assume that on the prairies *C. inornata* would still be attracted by light more than *A. vexans* and that if the latter species occurred in large numbers in light traps it could safely be assumed to be more abundant in the population than *C. inornata*. *C. inornata* could only be assumed to be the more abundant if it

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TABLE 1.—Relative abundance of female mosquitoes taken in light traps in Manitoba June 1–September 30, 1942–1948.

Year	1942		1943		1944		1945		1946		1947		1948			
Species	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Totals	Per-cent
Aedes vexans	1317	22.2	5311	71.7	47056	92.8	1527	61.9	4400	69.1	19168	72.0	8444	57.7	97223	75.9
Culiseta inornata	3224	54.2	449	6.1	852	1.6	441	17.9	672	10.6	2772	6.8	941	6.4	9351	7.3
Culex tarsalis	424	7.1	158	2.1	297	<1	204	8.3	334	5.3	4357	10.8	1169	7.9	6943	5.4
Anopheles earlei	103	1.7	510	6.9	945	1.9	184	7.5	204	3.2	722	1.8	1549	10.5	4217	3.3
Aedes dorsalis	235	4.0	146	2.0	208	<1	21	<1	23	<1	1570	3.9	893	6.1	3096	2.4
Aedes campestris	302	5.1	281	3.8	281	<1	24	<1	68	1.1	219	<1	696	4.7	1871	1.5
Aedes sticticus	6	<1	5	<1	14	<1	1	<1	135	2.1	1256	3.1	104	<1	1521	1.2
Aedes flavescens	115	1.9	219	3.0	64	<1	31	1.3	394	6.2	147	<1	541	3.7	1511	1.2
Culex restuans	55	<1	5	<1	465	<1	3	<1	46	<1	210	..	38	<1	822	<1
Aedes spencerii	125	2.1	234	3.2	365	..	3	..	14	..	6	..	38	..	785	..
Aedes excrucians	18	<1	56	<1	14	..	8	..	12	..	1	..	78	..	187	..
Aedes cinereus	1	..	5	..	70	..	2	..	13	..	35	..	52	..	178	..
Aedes riparius	8	..	10	..	5	..	7	..	3	..	12	..	83	..	128	..
Aedes nigromaculis	0	..	1	..	1	..	0	..	37	..	14	..	19	..	72	..
Aedes canadensis	9	..	21	..	14	..	7	..	2	..	1	..	6	..	60	..
Culex territans	2	..	0	..	25	..	0	..	0	..	0	..	8	..	35	..
Culiseta impatiens	2	..	0	..	17	..	1	..	4	..	0	..	5	..	29	..
Mansonia perturbans	1	..	1	..	0	..	0	..	0	..	0	..	20	..	22	..
Aedes intrudens	0	..	0	..	0	..	1	..	4	..	1	..	4	..	10	..
Aedes fitchii	0	..	0	..	0	..	0	..	4	..	0	..	0	..	4	..
Aedes stimulans	0	..	0	..	0	..	0	..	1	..	0	..	3	..	4	..
Anopheles punctipennis	0	..	0	..	0	..	0	..	0	..	0	..	1	..	1	..
Totals	5947		7412		50993		2465		6370		40491		14692		128070	

occurred in marked excess in the trap catches.

During the summer of 1962 a cooperative study of the epidemiology of arboviruses was started in the Province of Saskatchewan. The study is concerned with levels of susceptibility in the human population, the range of vertebrate hosts, possible reservoirs and arthropod hosts. The work of 1962 was preliminary and the beginning of the study of arthropod hosts involved the establishment of procedures for collecting and handling mosquitoes for virus examination and for obtaining a measure of variations in the mosquito populations.

METHODS. Between June 26 and August 1, permanent trapping sites were established at Melfort (52° 52′ N; 104° 36′ W), Saskatoon (52° 08′ N; 106° 40′ W), Outlook (51° 29′ N; 107° 03′ W), Craik (51° 03′ N; 105° 49′ W) and Swift Current (50° 17′ N; 107° 48′ W) and the traps were operated at these sites until September 17. The trap was similar to that used in obtaining the data in Table 1; it was of the New Jersey type modified for taking the mosquitoes alive (McLintock, 1946) the light source being a 100-watt, rough service, incandescent bulb. The traps were operated each night from before sunset until 7:00 or 8:00 a.m.

In the morning, the cage containing the mosquitoes was removed from the trap, placed in a humidified cardboard carton and sent or taken to the laboratory at the University of Saskatchewan in Saskatoon. In the laboratory the mosquitoes were removed from the cages by means of an aspirator and identified as far as possible to species. The great majority (90 percent) of the indeterminate aedines were rubbed specimens of either *Aedes dorsalis* or *A. campestris* that could not be distinguished with certainty. The indeterminate *Culiseta* were specimens of *C. minnesotae*, *C. morsitans* or *C. incidens* that could not be distinguished with the keys on hand. Reliable weather records were available for four of the localities where the traps were operated.

During the summer, living mosquitoes were also collected in nine different localities in the southern part of the Province where cases of encephalitis were reported in horses (none was reported in man in Saskatchewan in 1962) and in five other localities where virus activity was suspected from previous antibody surveys in wild and domestic animals (R. Connell, J. Spalatin and A. Burton, unpublished data). In each of these localities a light trap was set up and operated at night with the attracting light supplemented with dry ice. During the day aspirators were used to collect mosquitoes in their resting places or from horses and cattle or from ourselves. The usual resting places were barns, stables, chicken coops, granaries or in the grass or shrubbery. Collections made other than by light trap alone were labeled "Miscellaneous." Two to four days were spent in each locality making these miscellaneous collections.

RESULTS. The first six columns of Table 2 indicate that the multivoltine *Culex tarsalis*, *Culiseta inornata* and *Aedes dorsalis* were more abundant than the univoltine *Aedes* in southern Saskatchewan during the summer of 1962, with *C. inornata* notably more abundant than *A. vexans*. In the 5 light traps, *C. inornata*, *C. tarsalis* and *A. dorsalis* together formed 66 percent to 86 percent of the total catch of each trap, whereas *A. vexans* and *A. spencerii* together formed from less than 1 percent to 3 percent. That this relative abundance was not solely an indication of the relative attractiveness of light for the different species can be seen by comparing column 6 with column 7; with one exception the same species predominated in the miscellaneous catches. The exception was *A. vexans*, but over 3,000 of the *A. vexans* listed in column 7 were taken on one farm in the southeast corner of the Province from September 5 to 9, otherwise *A. vexans* would have formed 5 percent instead of 40 percent of the total and would have ranked in seventh place in that column.

The large number of *A. vexans* in the southeast corner of the Province early in September was apparently part of a local-

Table 2.—Relative abundance of female mosquitoes in Southern Saskatchewan, 1962.

Location	(1) Saskatoon		(2) Outlook		(3) Swift current		(4) Melfort		(5) Craik		(6) All light traps		(7) Miscellaneous* catches	
Period operated	June 26–Sept. 17		Aug. 1–Sept. 17		July 21–Sept. 17		July 14–Sept. 17		July 19–Sept. 16				June 15–Sept. 9	
Number of trap nights	75		48		58		65		61		307			
	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent
Culiseta inornata	2795	52.2	1337	37.2	410	27.1	744	57.2	69	20.5	5355	44.2	2512	30.0
Culex tarsalis	1321	24.7	891	24.8	382	25.3	41	3.2	101	30.0	2736	22.6	616	7.4
Aedes dorsalis	508	9.5	485	13.5	240	15.9	75	5.8	85	25.2	1393	11.5	684	8.2
Aedes campestris	152	2.9	106	3.0	25	1.7	58	4.5	22	6.5	363	3.0	207	2.5
Aedes vexans	44	<1	23	<1	41	2.7	6	<1	4	1.2	118	1.0	3352	40.0
Aedes nigromaculis	0	..	22	..	27	1.8	0	..	15	4.5	64	<1	288	3.4
Anopheles earlei	16	..	3	..	3	<1	19	1.5	0	..	41	..	35	<1
Aedes riparius	11	..	1	..	0	..	8	<1	0	..	20	..	153	1.8
Culiseta minnesotae	7	..	7	..	1	..	4	..	0	..	19	..	2	<1
Aedes fitchii	0	..	0	..	0	..	0	..	0	..	0	..	9	..
Aedes flavescens	2	..	1	..	0	..	5	..	0	..	8	..	69	..
Aedes excrucians	0	..	0	..	0	..	0	..	0	..	0	..	8	..
Aedes punctor	1	..	1	..	0	..	2	..	3	<1	7	..	297	3.6
Aedes cinereus	0	..	0	..	0	..	0	..	1	..	1	..	7	..
Aedes canadensis	0	..	0	..	0	..	0	..	0	..	0	..	4	..
Aedes spencerii	2	..	0	..	1	..	0	..	0	..	3	..	139	1.7
Culex restuans	0	..	2	..	0	..	1	..	0	..	3	..	0	..
Culiseta incidens	0	..	0	..	0	..	3	..	0	..	3	..	0	..
Mansonia perturbans	0	..	0	..	0	..	0	..	0	..	0	..	2	..
Indeterminate *Aedes*	490	9.1	715	19.8	383	25.3	261	20.0	37	10.9	1886	15.5	..	..
Indeterminate *Culiseta*	2	..	2	..	0	..	73	..	0	..	77	..	..	..
Totals	5351		3596		1513		1300		337		12097		8384	

* Miscellaneous catches=Catches by aspirator, traps baited with CO_2 and with light+CO_2.

ized outbreak of *Aedes,* for over half of the *A. spencerii* and most (283) of the *A. nigromaculis* in column 7 were taken at the same time. Mosquitoes were annoying during our visit and had been annoying for the week preceding our arrival, yet there were no complaints in towns 12 miles northwest and 15 miles east, nor did the light traps at the routine collecting stations indicate an increase in the abundance of any aedine at that time. Hatching of the eggs of *A. spencerii* and *A. nigromaculis* late in the summer is not uncommon in Saskatchewan (Rempel, 1953).

In Figure 1 mean weekly temperatures and total weekly precipitation are compared with normals for the four localities for which records were available (Canada Department of Transport, Meteorological Branch). For the period during which the traps were in operation the general course of the temperature curves was the same for the four localities and there were as many weeks with above normal temperatures as below, but the deviations below normal were much greater than the deviations above so that, on the whole, it was a cool summer. At Melfort, total precipitation was below normal for the period of trap operation, but at the other three stations the total precipitation was above normal.

Eggs and larvae of the multivoltine species occur mainly in permanent and semi-permanent bodies of water that are only indirectly affected by rainfall, whereas larvae of the univoltine aedines occur predominantly in temporary rain pools that come and go during the summer months, depending mainly on the amount of rainfall. For the multivoltine species, temperature determines the rate of development of eggs and larvae in the permanent and semi-permanent pools and also the rate of development of the ovaries of the females; consequently for these species temperature determines the rate of population increase. For the univoltine aedines in the temporary pools, temperature determines the rate at which a brood emerges *after* rain has hatched the eggs and it is the amount of rainfall during the season that determines whether eggs will or will not hatch; consequently for these species rainfall determines the number of broods and seasonal abundance. For the univoltine aedines, rate of ovarian development does not affect the size of the population of the current season for, as far as we know, the eggs laid during a season do not hatch in that season even if they are submerged.

With the below-normal temperatures and above-normal rains (Fig. 1) we could have expected the univoltine aedines to be more abundant than the multivoltine species in the total catches of such a season, but Table 2 indicates that was not the case in southern Saskatchewan in the summer of 1962. This suggests that in southern Saskatchewan, temperatures below the meteorological normals for the summer are adequate for rapid development of the multivoltine species. This might have particular application to *C. inornata,* a species known to be tolerant of low temperatures in the laboratory (McLintock, 1952) and belonging to a genus in which tolerance to low temperatures appears to be characteristic (Dobrotworsky, 1954, 1960).

Another point worth noting in Table 2 is the relative scarcity of *Culex restuans.* This species had been reported from Saskatchewan on only two other occasions, both from near Regina (Rempel, 1953) which is also at about the most northerly latitude (50° 20′) that it has been found in Manitoba. In 1962 it occurred in the Outlook and Melfort traps and larvae were also found near Saskatoon, so the species is probably widely distributed, though scarce, throughout the southern part of the Province. In Manitoba *C. restuans* occurs throughout most of the agricultural area west of the Red River; it was one of the species from which the virus of western equine encephalitis was isolated (Norris, 1946) from specimens collected in 1944 but it varied greatly in abundance from year to year and was more abundant in 1944 than in the other six years (Table 1).

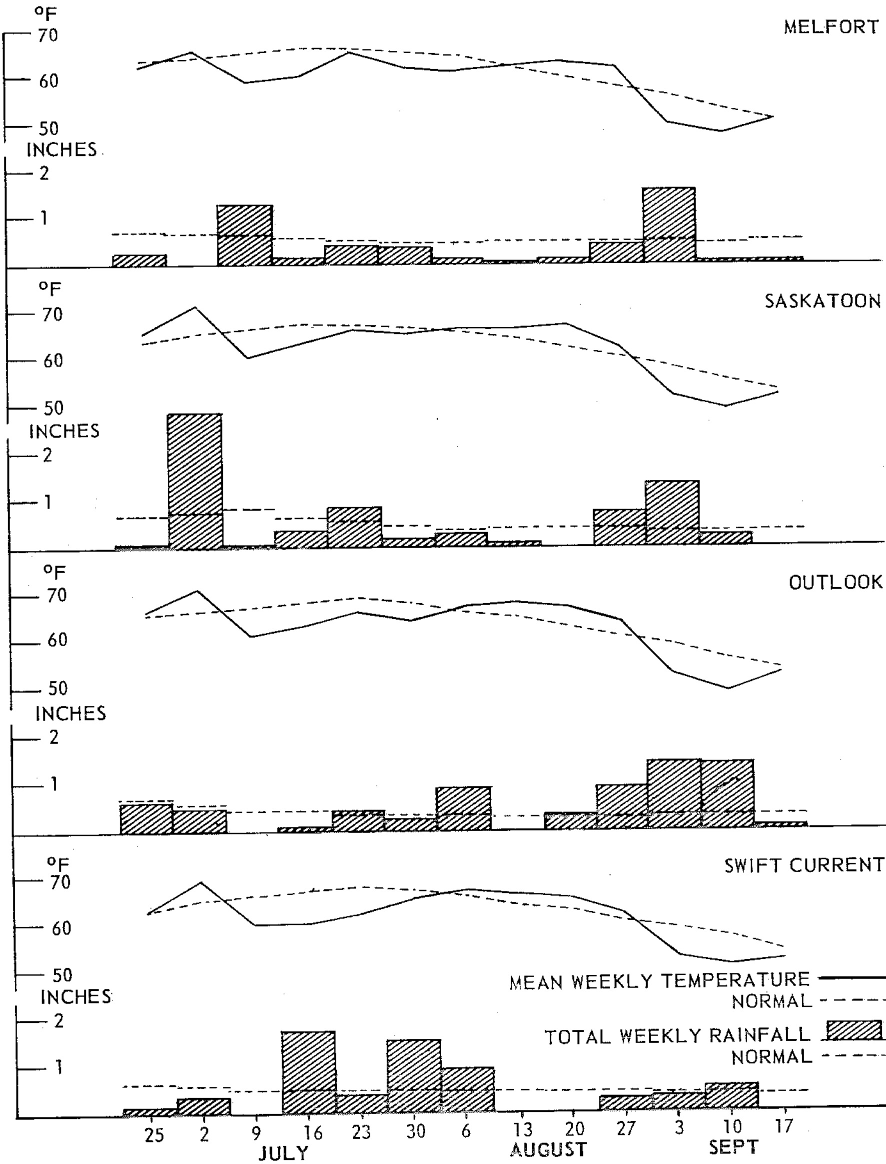

Fig. 1.—Temperature and precipitation at mosquito trap sites, Saskatchewan 1962.

Outbreaks of western encephalitis on the prairies occur in the summer months and are usually associated with high mean temperatures (Rempel, 1953; Dillenberg *et al.*, 1956; McLintock, 1948) and the absence of human cases in Saskatchewan in 1962 was consistent with that association. On the other hand an important conclusion to be drawn from the above observations is that, in Saskatchewan, large populations of the suspected mosquito vectors can occur during a summer of generally below-normal temperatures.

In future years, June 1 to September 30 will be the period of collecting, both for reasons of economy and because this is the period during which most of the cases of encephalitis are reported in man and horses in the Prairie Provinces (Donovan and Bowman, 1942; Fulton, 1938, 1941; Gareau, 1941; Savage, 1942). Although no cases of encephalitis were reported in man in Saskatchewan in 1962 there was ample evidence of virus activity and this will form the subject of another report.

SUMMARY. The results are presented of a preliminary survey of mosquitoes in the Province of Saskatchewan in 1962 during the months when cases of encephalitis are usually reported. The survey revealed an unexpected abundance of *Culiseta inornata* and *Culex tarsalis* (both commonly suspected to be transmitters of western equine encephalitis) in a year when cases of encephalitis were reported in horses but not in man.

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HARVESTING MOSQUITO PUPAE WITH COLD WATER [1]

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Harvesting mosquito pupae is one of the most menial and time-consuming tasks in the mosquito insectary. Perhaps the first method, and one still in use today, utilized a wide-mouth medicine dropper to pick the pupae one at a time from the larval cultures. Lewis (1933) collected pupae with an apparatus using a large rubber bulb to produce a vacuum. A refined, glass-blown, vacuum device (Fig. 1A) is used in this laboratory for picking small numbers of pupae. Some insectaries employed a small screen-wire scoop for this purpose. With certain species of mosquitoes the culture conditions can be so regulated that pupation occurs nearly simultaneously, thus eliminating the need for separating the developmental stages. With many species it is not possible to produce such uniform development, and harvesting of the pupae becomes a problem.

A number of workers have reported on devices and techniques for expediting the harvesting of pupae. McKiel (1957) reported on a simplified method for large-scale laboratory rearing of *Aedes aegypti* which required little effort or attention and separation of pupae and larvae was not required. A removable collecting cage, into which the adults emerged, was mounted over a thermo-regulated tank containing the aquatic stages. Fay and Morland (1959) described a mechanical device consisting of two glass plates, slightly separated and adjustable, for separating developmental stages, sexes and even species of mosquitoes. The stages were separated according to size when the cultures were poured through the apparatus. Separation of 1,000 pupae required 20 minutes in ordinary insectary production. In contrast, they reported that skilled operators required about 90 minutes to pick 1,000 pupae with a screen wire spoon. Bar-Zeev and Galun (1961) added iron dust to the cultures and exposed them to a magnetic field. Since only the larvae retained the ingested iron

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