OVERWINTERING SITES OF ADULT MOSQUITOES IN SASKATCHEWAN[1]

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ABSTRACT. During the winter of 1977–78, investigations on the overwintering of adult mosquitoes were conducted in the southeastern region of Saskatchewan where the average daily minimum air temperature for January is −20.4°C. Only *Anopheles earlei* (2 females) were recovered from 23 traps placed over mammalian burrows. *Culex tarsalis* (2 females), *Cx restuans* (1 female), *Culiseta inornata* (1 female) and *An. earlei* (2 females) were recovered from 17 traps placed over crevices and caverns located in rough stony embankments. Since all the mosquitoes are known summer-time hosts of western equine encephalomyelitis virus, an interest in their overwinter survival is partly related to their role in the natural history of the virus in Saskatchewan.

Among the established mosquito hosts of western equine encephalomyelitis (WEE) virus in Saskatchewan (McLintock et al. 1970 and unpublished data), *Anopheles earlei, Culex tarsalis* and *Culiseta inornata* are known to overwinter as adults. In a study of mosquitoes of Saskatchewan extending from 1942 to 1952, Rempel (1953) stressed the significance of the winter biology of these species and frequently remarked on the difficulties of locating adult mosquito overwintering sites. Some 20 years later, McLintock et al. (1970) re-emphasized these difficulties and briefly outlined the constraints which they imposed on extending ecological investigations of *Cx. tarsalus* and *Cs. inornata.* Apart from the purely biological significance, studies on the winter survival of these species might provide useful information related to the build-up of spring and summer populations and to the epidemiology of WEE in the province. Accordingly, a study was launched by the late Dr. R. E. Bellamy in 1973 to identify overwintering sites of mosquitoes in Saskatchewan. Bellamy's investigations were conducted over 3 winters and were primarily concerned with the examination of mammalian burrows. From these sites, *An. earlei* was the only species recovered (Unpublished data). The study was resumed in the winter of 1977–78 when 3 other overwintering species were recovered for the first time in Saskatchewan, and from sites other than mammalian burrows. This report records these findings.

The study was undertaken in the southeastern region of Saskatchewan in the vicinity of the town of Weyburn, where mosquito traps (chicken-baited —Rainey et al. 1962, and modified New Jersey light traps—McLintock 1946, Spalatin et al. 1963) have been routinely operated each summer since 1964. Compared to other areas where similar traps are operated as part of our arbovirus surveillance program, this region normally yields the largest number of mosquitoes and greatest variety of species. Partly for these reasons and partly because WEE is endemic in this area, the region was selected for our mosquito overwintering study. Here, winters are cold; average maximum and minimum January temperatures are −10.7°C and −20.4°C respectively, and the average duration of snow cover is 130 days at average maximum depth of 33.0 cm. Geographically, much of the southeastern region forms part of the Saskatchewan Plains. However, the specific localities which

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served as mosquito trapping stations for the study constitute an extension of the Missouri Coteau, which is a long narrow ridge separating the Saskatchewan Plains Region on the east from the Alberta Plateau Region to the west. In relation to the Coteau, two trapping stations can be described.

The first, which is designated the "Lomond station," is situated in the Lomond community pasture approximately 26 km south-south-east of Weyburn near to the village of Goodwater (Lat. 49° 30′ N, Long. 103° 42′ W). This is an upland area located along the base of the eastern face of the Missouri Coteau, being part of the boundary between the Plains Region and the Coteau proper. The general elevation is about 600 m above sea level. The local relief is rough, presenting partly as eroded stony embankments rising between 6 m and 20 m above the surrounding areas, and in these lower areas temporary and permanent sloughs abound. Numerous subterranean crevices and caverns with external openings varying from a few centimeters to more than a meter, occur among the boulders on these exposed embankments. From the sandy outwash areas at the foot of each slope, it is evident that continuous erosion takes place, subjecting the local terrain to endless variation and modification during each season. At this trapping station mammalian burrows were uncommon, but, where they existed, they were most often found along the upper, less stony edges of the slopes. As described below, overwintering mosquito traps were placed over crevices, caverns, and burrows at this location.

The second trapping station was established on the western side of the Coteau in the Big Muddy Valley close to the town of Minton (Lat. 49° 05′ N, Long. 105° 35′ W). Gently to strongly rolling hills with hard rocky outcrops predominate in this area with local relief amounting to 60 m. At our "Big Muddy station," mammalian burrows are common, and this was partly the reason for selection. Consequently, investigations here were restricted to burrows.

Our overwintering mosquito traps were similar in design and in principle of operation to those employed by Harwood and Halfhill (1960) in their study of mammalian burrows as mosquito resting sites. Where large crevices were to be sampled the trap was supported on a wooden framework, and a green polyethelene sheet was spread over this framework to reduce the size of the external opening. Sheets and traps were held in place with metal spikes, rocks and soil. Traps were set at both stations on October 11 and 12, 1977, and left in place for the duration of winter. The first spring inspection took place on April 25, 1978. This followed from the observations of Bennington et al. (1958) and Shemanchuk (1965) that the emergence of overwintering mosquitoes coincided with the soil temperature inversion between 5 cm and 100 cm which, in this area, occurs between early and late April. The second inspection was on May 9 when we were obliged to remove our traps because of unexpected activity in our study areas. Motorcycle enthusiasts were active on the slopes at the Lomond station and cattle had commenced grazing at the Big Muddy location, resulting in the dislodgement and partial destruction of a number of traps.

Table 1 shows that only *An. earlei* was recovered from burrows while *Cx. restuans, Cx. tarsalis, Cs. inornata* and *An. earlei*, were recovered from crevices and caverns. All specimens were females and all were fresh and unrubbed. On May 9, temperatures in crevices and caverns which were productive ranged from 12.8°C to 15.1°C at a depth of approximately 90 cm, against an air temperature of 24.2°C. The premature removal of our traps at this time might have been responsible for the small number of specimens recovered, and this precluded observations on the phenology of emergence and related climatic events. Nonetheless, the findings are significant in relation to the nature of the more productive overwintering sites and to the species of mosquitoes recovered.

There is no clear demonstration from our findings that crevices and caverns in

Table 1. Overwintered mosquitoes trapped in Southern Saskatchewan, 1978

Trapping Station and Nature of Trap Sites	Number Traps Set	Female Mosquitoes Recovered	
		April 25	May 9
Lomond Station			
a) Crevices & Caverns	17	1 *Cx. tarsalis* 1 *Cx. restuans*	1 *Cx. tarsalis* 1 *Cs. inornata* 2 *An. earlei*
b) Mammalian burrows	5	1 *An. earlei*	1 *An. earlei*
Big Muddy Station			
Mammalian burrows	18	none	none

rocky areas are preferred overwintering sites for *Cx. tarsalis* (Harwood 1962) or for *Cx. restuans* and *Cs. inornata*, but there is an indication at least that these serve as alternate sites to mammalian burrows. Evidence that the latter provide suitable overwintering quarters for *Cx. tarsalis* and for *Cs. inornata* on the Canadian prairies was provided by Shemanchuk (1965). This, along with similar findings in Colorado (Bennington et al. 1958) and with the local observation of resting *Cx. tarsalis* and *Cs. inornata* in badger (*Taxidea taxus*) and skunk (*Mephitis mephitis*) burrows during late September (McLintock et al. 1970), undoubtedly led to the earlier concentration on these structures in Saskatchewan.

The second significant feature concerns the possible role of adult mosquitoes in maintaining WEE or other arboviruses during winter. For several years, field data in support of this concept were largely inconclusive (Reeves 1974) but the recent isolation of St. Louis encephalitis virus from overwintering *Cx. pipiens* in Maryland and Pennsylvania (Bailey et al. 1978) has demonstrated that a thorough re-examination of this issue is warranted. Such a re-examination might usefully include those mosquitoes which are recognized as being of less importance than the primary summertime hosts of the virus concerned, and it is in this category that *Cx. restuans* and *An. earlei* might receive some consideration as potential overwintering hosts of WEE virus in western Canada. The former species is rare in Saskatchewan but more abundant in Manitoba (McLintock and Rempel 1963) where it has yielded the virus on one occasion (Norris 1946). Similarly *An. earlei* which also occurs in relatively small numbers in Saskatchewan (Rempel 1953), was found infected once only in this province over a period of 17 years (Unpublished data). In contrast, *Cx. tarsalis* and *Cs. inornata* are among the primary summertime hosts of WEE virus on the Canadian prairies (McLintock et al. 1970; McLintock and Iversen 1975) but the significance of late seasonal virus isolations from these mosquitoes remains uncertain, in so far as these isolations relate to virus overwintering. Shemanchuk and Morgante (1968) isolated the virus from recently blood-fed *Cx. tarsalis* and *Cs. inornata* collected from mammalian burrows during late August in southern Alberta and concluded that infected individuals of these 2 species enter hibernation. There is some doubt that these mosquitoes represented part of the population destined to overwinter, but, if so, it is also questionable whether they would have survived until spring (Reeves 1974). A similar degree of uncertainty applies to related observations in Saskatchewan where the latest seasonal isolation of WEE virus from any host was from *Cs. inornata* collected in late September (McLintock et al. 1970).

The central issue is whether blood-fed and therefore potentially infected mosquitoes enter hibernation and survive the winter. Dow and coworkers (1976) in Colorado presented evidence which appeared to support the concept that

blood-fed *Cs. inornata* successfully hibernated. However, this evidence was based on the examination of post-hibernating females, which were either gravid or parous up to the appearance of the first blood-fed specimens in spring. As the investigators cautioned, the expression of autogenous egg development by overwintered *Cs. inornata* would provide an alternate explanation to pre-hibernation blood feeding and some support for this has subsequently emerged. Among post-hibernating *Cs. inornata* from Alberta, Hudson (1977) observed gonotropic states similar to those recorded by Dow et al. (1976) and he offered additional evidence that blood feeding activity in this species ceases at about the end of August. Furthermore, the specimens he examined at this time were all nulliparous. Consequently, the fate of infected females which may be available much later in the fall (as cited above for Saskatchewan) and which would have fed earlier, remains unresolved. The examination of individuals collected from their actual overwintering sites before they have had a chance to disperse, may help to clarify this and related issues.

ACKNOWLEDGMENTS. We thank J. Shemanchuk and other colleagues of the Animal Parasitology Section, Agriculture Canada Research Station, Lethbridge, Alberta, for useful suggestions and for the loan of traps, and L. Burgess and R. H. Burrage for criticism of this article in manuscript.

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