THE UNIVERSITY OF MANITOBA

AN ECOLOGICAL STUDY OF MOSQUITOES IN THE AREA OF PINAWA, MANITOBA, WITH SPECIAL REFERENCE TO THE DISTRIBUTION AND ABUNDANCE OF THE GENUS AEDES

by

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ABSTRACT

In Winnipeg, the developmental sites of pest mosquito larvae are localized and in close proximity to potential hosts. This discovery motivated a study of the distribution and abundance of both larval and adult mosquitoes at Pinawa, Manitoba. If pest mosquito developmental sites were found to be localized and predictable, source reduction of pest mosquitoes, the control method being developed in Winnipeg, might be applicable.

At Pinawa, the density of mosquito larvae generally increased with increases in the amount of vegetative cover. During the 1971 season almost all mosquito production took place in the early spring and was the greatest per unit area in the most densely vegetated areas. Certain species of mosquito larvae were associated with areas of particular degrees of vegetative cover.

Studies of adult mosquitoes revealed that as the amount of vegetative cover increased, the numbers of mosquitoes captured in CO_2-baited traps also increased. Some mosquito species were associated with open areas and others with wooded habitats. Collecting mosquitoes as they attempted to feed on man in a recreational area of Pinawa showed that pest mosquito abundance was greatest in the early spring when Aedes abserratus, Aedes intrudens, Aedes communis, and Aedes punctor were most

abundant. Aedes implicatus comprised large proportions of spring mosquito larvae populations in almost all areas examined but it was not taken attempting to feed on man during 1971.

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Chapter I

INTRODUCTION

(i) Motivation for the investigation

In a study of the ecology of mosquito larvae in the Winnipeg area, Dixon (1969) found that the developmental sites of pest mosquito larvae are localized and in close proximity to the source of a blood meal. In most cases this blood source is a concentration of domestic animals. Horsfall (1942), when studing the biology and control of a rice field mosquito, found that fields over which livestock had grazed are outstandingly high in larval abundance, whereas those over which livestock had not been grazed have few or no larvae present.

Knowing that the developmental sites of pest mosquitoes are found in association with potential host animals, mosquito control operations may direct their effort at these areas rather than search over large areas where mosquito larvae may be rare or absent. In addition, such localized mosquito production provides a case against widespread application of insecticides that merely contribute to pollution of the environment.

If such localized mosquito production also occurs in non-agricultural, woodland areas, and the

location of larval mosquito developmental sites is predictable, a strategy of mosquito control similar to that described above could be adopted. In such woodland areas, where the economy may be based on logging, mining and hydro-electricity generation rather than on cereal crop and livestock, much less is known about the distribution of potential host animals. Therefore, some other measurable environmental variable must be used to systematically study the distribution and abundance of mosquito larvae.

Shemanchuk (1959), when studying mosquito production in irrigated areas of southern Alberta, compared mosquito productivity on the basis of farming practices, which varied in the efficiency of drainage systems and in the length of time since the practice of irrigation was initiated.

Happold (1965a), in a study of the ecology of woodland mosquitoes in central Alberta, compared the productivity of mosquito larvae developmental sites differing in position, permanence, and the amount of shading by plants.

In the present study, little is known about potential mosquito host distribution, although large differences in the amount and type of vegetative cover exist among different areas. It was proposed that the abundance of mosquito larvae be compared among such areas. If consistently high mosquito larvae abundance

was found to be associated with areas of particular vegetative cover and type, the control of mosquito larvae would become feasible where it was previously thought impractical due to assumed uniform, widespread mosquito production.

In addition to a knowledge of mosquito larvae distribution and abundance, information concerning the distribution and abundance of adult mosquitoes is also useful in planning mosquito control measures. If adult mosquitoes are found to be more abundant in certain areas with a particular type and amount of vegetative cover, control directed at such sites will be more effective than control which is widespread and which may be applied to areas where adult mosquito densities are low.

Identification of the pest mosquito species of utmost importance. Knowing the distribution and abundance of the larvae and adults of the pest mosquito species, control measures may be restricted to these, thereby neglecting other species which may be very abundant but of no importance as a pest.

(ii) Objectives of the investigation

The aims of the study were:

i) to compare the abundance of larval and adult mosquitoes in areas differing in the amount and type of vegetative cover and to determine if associations exist between particular mosquito species and certain areas.

ii) to determine which species are the most important as pest mosquitoes within recreational areas of the town of Pinawa, Manitoba.

Chapter II

DESCRIPTION OF THE STUDY AREA

For the most part, information presented in this description was taken from Weir (1960), although some observations were made during the time in which the inv tigation was in progress.

The study was carried out in a woodland region of south-eastern Manitoba which lies on the south-western edge of the pre-cambrian shield (Fig. 1). The area is situated in a narrow band of mixed deciduous and coniferous woods bordered on the north by the boreal forest and to the east by wooded grassland. Forty percent of the area is covered by bogs and lakes.

Within the study area, the Whiteshell Nuclear Research Establishment comprises almost the total economy although in surrounding areas it is based on logging, hydro-electricity generation and livestock production.

Although livestock are not found within the study area, a variety of other animals may serve as potential mosquito hosts. Waterfowl and upland game birds such as the sharp-tailed grouse (Pedioecetes phasianellus), spruce grouse (Canachites canadensis) and ruffed grouse (Bonasa umbellus) occur in relatively

light densities throughout the study area whereas the moose (Alces americana andersoni), black bear (Euarctos americanus) and white-tailed deer (Odocoileus virginianus) are found in relatively high density. Other potential host animals occuring in the study area are the beaver (Castor canadensis), muskrat (Ondatra zibethica), fisher (Martes pennanti), lynx (Lynx canadensis), bobcat (Lynx rufus), coyote (Canis latrans) and numerous species of small mammals and birds. On 24 June, 1971, mosquitoes (probably Aedes vexans) were observed attempting to feed on the cottontail rabbit (Sylvilagus floridanus).

Weather conditions are characterized by a large annual range of temperature with the average (based on the 30 year period 1921-1950) in June being 60° F, July 66° F and January - 5° F. Average precipitation (based on the 30 year period 1921-1950) is 21 inches, with that of May, June and July being 7 inches and snowfall being an average of 50 inches.

Within the study area, mosquito abatement operations are limited to the town of Pinawa, where insecticide fogging is used in an attempt to control adult mosquitoes. During the spring and summer of 1971, those areas producing mosquito larvae within the town itself were larvicided for the first time.

Chapter III

MANITOBA MOSQUITOES AND A SYNOPSIS OF THEIR BIOLOGIES

Forty-five species of mosquitoes, distributed among six genera, have been recorded form Manitoba (Table I). Thirty-one of these species were found to occur within the study area, Aedes trivittatus and Culiseta minnesotae were recorded for the first time in Manitoba.

The life cycle of mosquitoes, involving a complete metamorphosis, is represented by four distinct stages, ie: from the egg hatches a larva, which transforms into a pupa from which the winged adult later emerges. The larvae and pupae of all species are aquatic, being found in standing and slowly moving water.

Depending on the overwintering stage, three types of mosquito life cycles are recognized in Manitoba. Mosquitoes of the genus Anopheles, Culex and Culiseta overwinter as adults. Inseminated females hiberinate in dark protected places such as caves and hollow trees, emerging in the early spring to feed and deposit eggs. There may be more than one generation per year.

The genus Mansonia and Wyeomyia overwinter in the larval stage. Development resumes as a response to increases in daylength and temperature in Wyeomyia smithii at least, and adults appear in late spring to

Table I

List of mosquitoes recorded from Manitoba

Aedes abserratus 1*[a]	Anopheles earlei 4*
aurifer 6	punctipennis 6
barri 1*	walkeri 6*
campestris 6	
canadensis 6*	
cataphylla 5	
cinereus 6*	
communis 6*	Culex apicalis 6
decticus 1	pipiens 6
diantaeus 2*	restuans 6*
dorsalis 6*	tarsalis 6*
excrucians 6*	territans 3*
fitchii 6*	
flavescens 6*	
hexodontus 2	
impiger 2	
implicatus 7*	Culiseta alaskaensis 6
intrudens 6*	impatiens 6
nigripes 6	inornata 6*
nigromaculus 6	morsitans 6*
pionips 6*	minnesotae X*[b]
punctor 6*	
riparius 6*	
spencerii 6*	
sticticus 6*	
stimulans 6*	Mansonia perturbans 6*
trichurus 6*	
triseriatus 1	
trivittatus X*[b]	
vexans 6*	Wyeomyia smithii 6*

[a] Source of record: 1, Brust and Kalpage (1967); 2, Freeman (1952); 3, McLintock (1944); 4, McLintock and Rempel (1963); 5, Stone et al. (1965); 6, Twinn (1949); Vockeroth (1954a).

[b] = new record

* = species found to occur at Pinawa, Manitoba

early summer. Mansonia perturbans oviposits on the water surface of marshes and Wyeomyia smithii deposits eggs within the leaf of the pitcher plant, Sarracenia purpurea. The bionomics of this species has been studied by Evans (1971).

In terms of numbers and human annoyance, mosquitoes of the genus Aedes are the most important in Manitoba. Overwintering occurs in the egg stage. These eggs, deposited during the spring and summer on moist debris above the water line in drying pools of water, hatch when flooded by melting snow and spring and summer rains.

Aedes mosquitoes exhibit two general bionomic patterns. One group of species has but a single generation per year (univoltine) while another smaller group may have a number of generations per year (multivoltine) (Table II). Aedes campestris, Aedes canadensis, Aedes cinereus and Aedes spencerii, generally regarded univoltine, are partly multivoltine (Brust, 1968).

Both univoltine and multivoltine Aedes emerge in the spring, mate, feed and oviposit. Eggs laid by univoltine species enter an obligatory diapause, not hatching until the following spring despite repeated inundation during the spring and summer months. Eggs laid by multivoltine species hatch after inundation, with the result that a brood of mosquitoes may develop in pools formed after each summer rain.

Oviposition behaviour controls the distribution

Table II

Bionomic classification of Aedes mosquitoes

Univoltine species		
Aedes abserratus	Aedes diantaeus	Aedes nigripes
Aedes aurifer	Aedes excrucians	Aedes pionips
Aedes barri	Aedes fitchii	Aedes punctor
Aedes canadensis	Aedes flavescens	Aedes riparius
Aedes cataphylla	Aedes hexodontus	Aedes spencerii
Aedes cinereus	Aedes impiger	Aedes sticticus
Aedes communis	Aedes implicatus	Aedes stimulans
Aedes decticus	Aedes intrudens	Aedes trichurus
Multivoltine species		
Aedes campestris	Aedes nigromaculus	Aedes trivittatus
Aedes dorsalis	Aedes triseriatus	Aedes vexans

of mosquito larvae. It may be influenced by a number of factors. Good sites for oviposition by Aedes mosquitoes are the moist margins of pools that are exposed as the water table falls. Other factors favourable to ovipositing Aedes females are a substrate of plant detritus and protection from wind and direct sunlight (Horsfall, 1963).

Chapter IV

HABITAT CLASSIFICATION FOR LARVAE OF *AEDES* MOSQUITOES

Mosquito larvae are found in temporary, semi-permanent, and permanent bodies of standing water. Temporary pools contain water for periods usually not exceeding three weeks; semi-permanent pools contain water almost all spring and summer; and permanent pools contain water during the entire year.

The hords of pest mosquitoes appearing throughout the Canadian prairie and woodland during late May and June belong to the genus *Aedes* (Rempel, 1953). The larvae are found only in temporary and semi-permanent pools resulting from snow melt and rain (Happold, 1965a). This study is concerned with the distribution of abundance of these species in different habitats.

Although many mosquito habitat classifications have been described, few have been devised to serve as a basis for studying the relative abundance of *Aedes* mosquitoes in a woodland terrain. In the present study, the system of habitat classification is based on the dominant plant present. Associated with the various changes in plant dominance are changes in the type (temporary or semi-permanent), number, size and shape of pools; changes in the physical structure of the plant community; and the degree of shading by plants.

Five easily recognized, distinct habitat types are defined. Each successive habitat type shows an increase in the amount of vegetative cover. Vegetative cover shelters mosquitoes from excess light, dryness and wind thus providing a situation favourable to oviposition by Aedes mosquitoes (Horsfall, 1963).

When describing pools in each habitat type, those termed small range in size from 1 - 5 square meters in surface area, medium sized pools from 6 - 25 square meters and extensive pools include those greater than 25 square meters in surface area.

The five habitat types are:

1. Disturbed habitat:

Abandoned farmer's fields, clearings for hydro-electricity transmission lines, surveyer's line cuts, roadside ditches and other open, treeless areas resulting form man's disturbance or fire are examples of the disturbed habitat type. Such sites are uncommon in the study area except in the land surrounding and within the Whiteshell Nuclear Research Establishment and the town of Pinawa.

As a result of vehicular traffic, fire or soil removal, the topography of the disturbed habitat is in many cases irregular, with pools usually abundant and ranging in size from long narrow tire ruts (Fig. 2) to larger areas where topsoil has been removed or where ditches have been constructed (Fig. 3).