

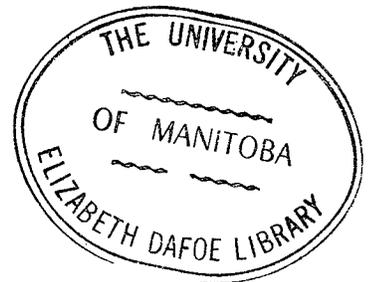
THE EFFECT OF DAYLENGTH AND TEMPERATURE ON THE INDUCTION  
AND TERMINATION OF DIAPAUSE IN *Aedes atropalpus* (COQUILLET),  
AND FIELD AND LABORATORY STUDIES OF AUTOGENY AND  
HIBERNATION IN SOME MOSQUITOES FROM MANITOBA.

A

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by  
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## ABSTRACT

THE EFFECT OF DAYLENGTH AND TEMPERATURE ON THE INDUCTION AND TERMINATION OF DIAPAUSE IN *Aedes atropalpus* (COQUILLET), AND FIELD AND LABORATORY STUDIES OF AUTOGENY AND HIBERNATION IN SOME MOSQUITOES FROM MANITOBA.

Embryonic diapause, which is determined by daylength, has been demonstrated in a multi-voltine mosquito, *Aedes atropalpus* (Coquillett). Experiments conducted under controlled temperature and photoperiod show that short-days, 8 hours to 14 hours light per 24 hour day, induce diapause in the autogenous Belleville strain of *A. atropalpus*. The effect of long photoperiods is shown to be independent of low temperatures, therefore indicating that in nature the deposition of diapausing eggs in autumn is due to the influence of the shorter days experienced by the mosquitoes. Experiments also show that the sensitive stages for light reception are the fourth larval instar, pupa and adult.

Two strains of *A. atropalpus* were studied, one being the autogenous strain from Belleville, Ontario (44°N latitude) and the other being the anautogenous strain from Austin, Texas (30°N latitude). A latitudinal difference in critical photoperiod for the two populations is noted. The critical photoperiod for the Austin strain lies between  $12\frac{1}{2}$ -13 hrs. light per day and for the Belleville strain it lies between  $14-14\frac{1}{2}$  hrs. light per day.

A light interruption around eight hours in a diapause inducing scotophase causes the Belleville strain *A.atropalpus* females to produce non-diapause eggs and it is proposed that the 'lights-off' signal triggers some endogenous secretory rhythm with an 8-hour periodicity.

A temperature of 30°C terminates diapause sooner than a temperature of 20°C. A long photoperiod (16L:8D) also brings about the termination of diapause. Results of an experiment to determine where the photoreceptors lie in the embryo are presented.

The effects of photoperiod and diet on fecundity in autogenous *A.atropalpus* are discussed. It is seen that photoperiod has a direct influence on fecundity and an optimum egg production was reached at 16L:8D photoperiod. More eggs were also produced when the larvae were fed a protein rich diet.

The effect of photoperiod and temperature on the biting activity and ovarian development of anautogenous *Culiseta inornata* (Williston) showed that this species exhibits the phenomenon of "gonotrophic concordancy".

Studies on the autogenous ovarian development in *Aedes* species at Churchill, Manitoba (58°N) showed that four species, *A. communis* (Degeer), *A. nigripes* (Zett.) *A. impiger* (Walker) and *A. campestris* (Dyar & Knab) are autogenous.

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TABLE OF CONTENTS

CHAPTER		PAGE
I	INTRODUCTION . . . . .	1
II	REVIEW OF LITERATURE . . . . .	6
	DIAPAUSE . . . . .	6
	INFLUENCE OF PHOTOPERIOD AND TEMPERATURE ON DIAPAUSE AND HIBERNATION . . . . .	13
	(1) Lepidoptera, Coleoptera, Diptera (excluding Culicoidea) . . . . .	13
	(2) Diptera: Culicoidea (Culicidae, Ceratopogonidae and Chironomidae) . . . . .	17
	a. Embryonic diapause.	
	b. Embryonic and larval diapause.	
	c. Larval diapause.	
	d. Adult diapause or hibernation.	
	AUTOGENY IN CULICIDAE . . . . .	30
	MOSQUITO STUDIES AT FORT CHURCHILL, MANITOBA . . . . .	36
III	MATERIALS AND METHODS . . . . .	40
	1. INVESTIGATIONS ON OVIPOSITION MEDIA AND COLONY MAINTENANCE IN <i>Aedes</i> <i>atropalpus</i> . . . . .	40
	(a) Selection of oviposition media by autogenous <i>A. atropalpus</i> (Belleville strain) . . . . .	40
	(b) Storage of eggs . . . . .	42
	(c) Colony maintenance . . . . .	43
	2. PHOTOPERIODIC EXPERIMENTS . . . . .	46
	(a) Experiments on the induction of diapause in <i>A. atropalpus</i> (Belleville strain) . . . . .	46

CHAPTER	PAGE
(b) Experiments to terminate diapause in <i>A. atropalpus</i> (Belleville strain) . . . . .	50
(c) Effect of photoperiod on fecundity in autogenous <i>A. atropalpus</i> (Belleville strain) . . . . .	52
(d) Effect of photoperiod on biting activity and ovarian development in <i>Culiseta inornata</i> . . . . .	53
3. STUDIES ON AUTOGENY IN <i>Aedes</i> SPECIES AT CHURCHILL, MANITOBA . . . . .	55
IV RESULTS . . . . .	60
1. SELECTION OF OVIPOSITION MEDIUM BY AUTOGENOUS <i>A. ATROPALPUS</i> (BELLEVILLE STRAIN), AND STORAGE OF EGGS . . . . .	60
(a) Oviposition stimuli . . . . .	60
(b) Storage conditions for eggs . . . . .	62
2. INFLUENCE OF PHOTOPERIOD AND TEMPERATURE ON DIAPAUSE INDUCTION IN <i>A. ATROPALPUS</i> . . . . .	64
(a) Combined effect of photoperiod and temperature in the autogenous <i>Aedes atropalpus</i> (Belleville strain) . . . . .	64
(b) Effect of different photoperiods, at a constant temperature, in autogenous <i>A. atropalpus</i> (Belleville strain) . . . . .	66
(c) Effect of different photoperiods at a constant temperature in the anautogenous <i>A. atropalpus</i> (Austin strain) . . . . .	70
(d) Effect of photoperiod on different stadia of autogenous <i>A. atropalpus</i> (Belleville strain) . . . . .	74
(e) Effect of light interruptions in scotophase on diapause induction in autogenous <i>A. atropalpus</i> (Belleville strain) . . . . .	76

CHAPTER	PAGE
3. TERMINATION OF DIAPAUSE IN AUTOGENOUS A. <i>ATROPALPUS</i> (BELLEVILLE STRAIN) . . .	83
4. EFFECT OF PHOTOPERIOD AND DIET ON FECUNDITY IN AUTOGENOUS A. <i>ATROPALPUS</i> (BELLEVILLE STRAIN) . . . . .	90
(a) Effect of photoperiod on fecundity . . . . .	90
(b) Effect of diet on fecundity . . . . .	92
5. EFFECT OF PHOTOPERIOD AND TEMPERA- TURE ON BITING ACTIVITY AND OVARIAN DEVELOPMENT IN ANAUTOGENOUS C. <i>INORNATA</i> . . . . .	94
6. STUDIES ON AUTOGENY IN <i>AEDES</i> SPECIES AT CHURCHILL, MANITOBA (58°N) . . . . .	98
(a) Tundra species . . . . .	98
(b) Woodland species . . . . .	105
V DISCUSSION . . . . .	116
PART 1 - SELECTION OF OVIPOSITION MEDIUM BY AUTOGENOUS A. <i>ATROPALPUS</i> (BELLEVILLE STRAIN), AND STORAGE OF EGGS . . . . .	116
PART 2 - PHOTOPERIODIC EFFECTS ON DIAPAUSE INDUCTION IN AUTOGENOUS A. <i>ATROPALPUS</i> (BELLEVILLE STRAIN) . . . . .	118
PART 3 - TERMINATION OF DIAPAUSE . . . . .	131
PART 4 - EFFECT OF PHOTOPERIOD AND DIET ON FECUNDITY IN AUTOGENOUS A. <i>ATROPALPUS</i> (BELLEVILLE STRAIN) . . . . .	135
(a) Effect of photoperiod . . . . .	135
(b) Effect of diet . . . . .	136
PART 5 - EFFECT OF PHOTOPERIOD AND TEMPERA- TURE ON BITING ACTIVITY AND OVARIAN DEVELOPMENT IN C. <i>INORNATA</i> . . . . .	137
PART 6 - STUDIES ON AUTOGENY IN <i>AEDES</i> SPECIES AT CHURCHILL, MANITOBA . . . . .	142

CHAPTER	PAGE
3. TERMINATION OF DIAPAUSE IN AUTOGENOUS A. <i>ATROPALPUS</i> (BELLEVILLE STRAIN) . . .	83
4. EFFECT OF PHOTOPERIOD AND DIET ON FECUNDITY IN AUTOGENOUS A. <i>ATROPALPUS</i> (BELLEVILLE STRAIN) . . . . .	90
(a) Effect of photoperiod on fecundity . . . . .	90
(b) Effect of diet on fecundity . . . . .	92
5. EFFECT OF PHOTOPERIOD AND TEMPERA- TURE ON BITING ACTIVITY AND OVARIAN DEVELOPMENT IN ANAUTOGENOUS C. <i>INORNATA</i> . . . . .	94
6. STUDIES ON AUTOGENY IN <i>AEDES</i> SPECIES AT CHURCHILL, MANITOBA (58°N) . . . . .	98
(a) Tundra species . . . . .	98
(b) Woodland species . . . . .	105
 V DISCUSSION . . . . .	 116
 PART 1 - SELECTION OF OVIPOSITION MEDIUM BY AUTOGENOUS A. <i>ATROPALPUS</i> (BELLEVILLE STRAIN), AND STORAGE OF EGGS . . . . .	 116
 PART 2 - PHOTOPERIODIC EFFECTS ON DIAPAUSE INDUCTION IN AUTOGENOUS A. <i>ATROPALPUS</i> (BELLEVILLE STRAIN) . . . . .	 118
 PART 3 - TERMINATION OF DIAPAUSE . . . . .	 131
 PART 4 - EFFECT OF PHOTOPERIOD AND DIET ON FECUNDITY IN AUTOGENOUS A. <i>ATROPALPUS</i> (BELLEVILLE STRAIN) . . . . .	 135
(a) Effect of photoperiod . . . . .	135
(b) Effect of diet . . . . .	136
 PART 5 - EFFECT OF PHOTOPERIOD AND TEMPERA- TURE ON BITING ACTIVITY AND OVARIAN DEVELOPMENT IN C. <i>INORNATA</i> . . . . .	 137
 PART 6 - STUDIES ON AUTOGENY IN <i>AEDES</i> SPECIES AT CHURCHILL, MANITOBA . . . . .	 142

CHAPTER	PAGE
VI	149
SUMMARY . . . . .	
LITERATURE CITED . . . . .	154
APPENDICES . . . . .	180

LIST OF TABLES

TABLE		PAGE
I	The number of eggs laid by autogenous <i>Aedes atropalpus</i> (Belleville strain) in different test solutions. Experiments conducted at 20°C and 16L:8D photoperiod. .	61
II	A preliminary study to determine a satisfactory method of storing <i>Aedes</i> eggs free from fungal growth at 20°C and under moist conditions . . . . .	63
III	The combined effect of temperature and photoperiod on the induction of embryonic diapause in autogenous <i>Aedes atropalpus</i> (Belleville strain) . . . . .	65
IV	Effect of different photoperiods on the induction of diapause in autogenous <i>Aedes atropalpus</i> (Belleville strain) reared at 23°±2°C. . . . .	67
V	Effect of photoperiods on the induction of diapause in anautogenous <i>Aedes atropalpus</i> (Austin strain) reared at 23°±2°C. .	71
VI	Effect of long-day (16L:8D) and short-day (8L:16D) photoperiods, applied to the developmental stages of <i>A. atropalpus</i> (Belleville strain) reared at 23°±2°C, on the production of embryonic diapause . . .	75
VII	Effects of 1-hr. light-breaks, during a 16 hr. scotophase, on the incidence of embryonic diapause, in <i>Aedes atropalpus</i> (Belleville strain) reared at 23°±2°C. . . . .	77
VIII	Effects of 1-hr. light-breaks, during a 12 hr. scotophase on the incidence of embryonic diapause in <i>Aedes atropalpus</i> (Belleville strain) reared at 23°±2°C . . . . .	80
IX	Effect of hatching diapause eggs of <i>Aedes atropalpus</i> (Belleville strain) at 10 day intervals from the day of oviposition. The eggs were maintained at a photoperiod of 8L:16D and a temperature of 23°C. . . . .	84

TABLE		PAGE
X	Effect of a high temperature (30°C) on the termination of diapause in <i>Aedes atropalpus</i> (Belleville strain) eggs. The eggs were maintained at a diapause inducing photoperiod of 8L:16D . . . . .	86
XI	Effect of photoperiod on the termination of diapause in eggs of autogenous <i>Aedes atropalpus</i> (Belleville strain) at 25°C . . . . .	87
XII	Effect of photoperiod in terminating diapause when <i>Aedes atropalpus</i> (Belleville strain) eggs were exposed to a localized illumination provided by "Fibre Glass Optics Light Guides" at 23°+1°C. . . . .	89
XIII	Effect of photoperiod on the fecundity of autogenous <i>Aedes atropalpus</i> (Belleville strain) reared at 23°+2°C. . . . .	91
XIV	Effect of diet on the size and fecundity of <i>Aedes atropalpus</i> (Belleville strain) reared at 20°C, and 16L:8D photoperiod. . . . .	93
XV	Effect of different combinations of temperature and photoperiod on the feeding activity and ovarian development of an-autogenous <i>Culiseta inornata</i> . . . . .	95
XVI	Ovarian development in <i>Aedes nigripes</i> (Zett.) and <i>Aedes impiger</i> (Walker) from Camp Nanuk, Churchill, Manitoba . . . . .	104
XVII	Ovarian development in laboratory and field reared <i>Aedes communis</i> (Degeer) from Churchill, Manitoba (58°N) . . . . .	109
XVIII	Summary of studies showing percentage autogeny in four species of <i>Aedes</i> at Churchill, Manitoba . . . . .	110
XIX	Autogenous egg development in <i>A. campestris</i> from Churchill, Manitoba, reared at 20°C and 16L:8D photoperiod. (Larvae obtained from eggs which hatched at 20°C prior to cold conditioning, equivalent to second generation females.) . . . . .	112

## TABLE

## PAGE

XX	Effect of different larval diets on autogenous ovarian development in <i>Aedes campestris</i> from Churchill, Manitoba, reared at 20°C and 16L:8D photoperiod. . .	114
XXI	Effect of photoperiod on autogenous ovarian development in <i>Aedes campestris</i> from Churchill, Manitoba, reared at a constant temperature of 20°C.. . . .	115

## LIST OF FIGURES

FIGURE		PAGE
1.	Light boxes and incubators used in the photoperiod experiments. . . . .	48
2.	The effect of photoperiod on the incidence of embryonic diapause in the autogenous Belleville Strain of <i>Aedes atropalpus</i> reared at 23°+2°C. . . . .	69
3.	The effect of photoperiod on the incidence of embryonic diapause in the autogenous Belleville Strain of <i>Aedes atropalpus</i> and in the anautogenous Austin Strain of <i>A. atropalpus</i> , reared at 23°+2°C. . . . .	73
4.	Effects of 1-hr. light breaks made during a 16 hour scotophase on the incidence of embryonic diapause in <i>A. atropalpus</i> (Belleville Strain) . . . . .	79
5.	Effects of 1-hr. light breaks made during a 12 hour scotophase on the incidence of embryonic diapause in <i>A. atropalpus</i> (Belleville Strain) . . . . .	82
6.	<i>A. nigripes</i> and <i>A. impiger</i> habitats at Camp Nanuk, Churchill, Manitoba. (Tundra habitat) . . . . .	101
7.	<i>A. communis</i> habitat at Goose Creek, Churchill, Manitoba. (Semi-forested habitat) . . . . .	107

## APPENDIX

APPENDIX	PAGE
A. Data of experiments designed to determine which oviposition medium was preferred by autogenous <i>Aedes atropalpus</i> (Belleville strain). . . . .	181
B. Composition of larval diets used in experiments. . . . .	183
C. (1) Sketch-map illustrating the location of pools at Camp Nanuk, Churchill, Manitoba. . . . .	186
(2) Sketch-map illustrating the location of pool, C2, at Goose Creek, Churchill, Manitoba. . . . .	188
D. Effect of 2-hr. light-breaks, during a 16 hr. scotophase, on the incidence of embryonic diapause in <i>Aedes atropalpus</i> (Belleville strain) reared at $23^{\circ}\pm 2^{\circ}\text{C}$ . . . . .	189
E. Effect of 2-hr. light-breaks, during a 12-hr. scotophase, on the incidence of embryonic diapause in <i>Aedes atropalpus</i> (Belleville strain), reared at $23^{\circ}\pm 2^{\circ}\text{C}$ . . . . .	190
F. Duration of daylight inclusive of civil twilight for Austin, Texas ( $30^{\circ}\text{-}20'\text{N}$ ) and Belleville, Ontario ( $44^{\circ}\text{-}15'\text{N}$ ) . . . . .	191
G. Daylength curves for Austin, Texas ( $30^{\circ}\ 20'\text{N}$ ) and Belleville, Ontario ( $44^{\circ}\ 15'\text{N}$ ) . . . . .	193

## CHAPTER I

### INTRODUCTION

A majority of the mosquitoes in North America belong to the genus *Aedes* Meigen. The aedine species which have only a single generation per year (univoltine) have an obligatory diapause in the egg stage, i.e. the eggs do not hatch even though they are laid in summer when conditions are suitable for hatching. These eggs will remain in diapause and will hatch only after a period of cold conditioning. Multi-voltine species of *Aedes* like *A. vexans* (Meigen), *A. atropalpus* (Coq.) etc. lay eggs in summer which hatch within a few days after embryogenesis is complete, provided the oviposition sites are inundated and other conditions for hatching are favourable. Until quite recently, it was thought that overwintering eggs of multi-voltine *Aedes* were not in a state of diapause, and would hatch any-time conditions of temperature and moisture were favourable. It now appears that there are exceptions to this, and the case of *A. atropalpus* is one of these exceptions.

While maintaining a culture of the Belleville strain of *A. atropalpus* in our laboratory in early 1967, for studies on autogeny, it was surprising to find that several batches of eggs failed to hatch even when they were subjected to a hatching stimulus, although these eggs

contained live embryos. In earlier studies Kappus (1964) had reported egg diapause in *A. triseriatus* (Say) and Vinogradova (1965) had described egg diapause in *A. togoi* (Theobald) induced by short photoperiods on the female parent. Since my work on *A. atropalpus* was begun, Anderson (1968) has reported on the influence of temperature and photoperiod in a Connecticut strain of *A. atropalpus*, and found that diapause is induced under certain conditions. My work was done independently of Anderson's and in many cases my experiments have duplicated what he has done, and confirm his findings. In other cases my work extends into areas not investigated by Anderson.

It is apparent from the earlier experimental studies of species of Lepidoptera (eg. *Bombyx mori* L) that have an embryonic diapause in the seasonal cycle, that the factors of light and temperature play a significant role in determining whether the eggs should be of the diapause type or should develop without interruption (Kogure 1933). Hence I undertook this investigation to determine whether photoperiod and/or temperature influences the autogenous Belleville strain of *A. atropalpus* to lay diapause eggs. Kappus and Venard (1967) rightly stated that "the induction of facultative diapause in culicid eggs has been little studied, and it may well be that upon investigation the eggs of a number of culicid species will prove to be photoperiod sensitive."

Photoperiod is the most reliable of all environmental signals used by insects for forecasting seasonal changes and is the one most frequently used for controlling diapause. Generally, diapause is considered as a suppressed state of development in the life cycle which ensures survival through unfavourable seasons. Beck (1968), Danilevskii (1965), Adkisson (1964), to mention but a few workers, have shown that most insects enter a period of diapause as daylengths in autumn decrease to a value critical for the particular species in a given latitude. In the temperate regions the insects remain in diapause during the winter months. Generally, as the daylengths increase during the subsequent spring, diapause is terminated and the emergence is timed to coincide with the availability of food and ideal conditions for growth and development.

In the insects exhibiting a facultative diapause, the ambient conditions, during some earlier stage(s) of development of the species concerned, would determine whether the genetic response to facultative diapause will actually be triggered or not. Since diapause is induced to enable the insect species to survive a period of adverse environmental conditions, it is possible that multi-voltine species have some special mechanism which ensures the synchronization of the different developmental stages with the appropriate environmental conditions.