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

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ABSTRACT

THE EFFECT OF DAYLENGTH AND TEMPERATURE ON THE INDUCTION AND TERMINATION OF DIAPAUSE IN *AEDES ATROPALPUS* (COQUILLETT), 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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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 anytime 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.