EFFECTS OF RADIO-FREQUENCY ELECTRICAL FIELDS ON THE BEHAVIOR OF THE YELLOW MEALWORM, Tenebrio molitor (L.)

by

[redacted]

A Thesis

Presented to the Faculty of

the Graduate College in the University of Nebraska

in Partial Fulfillment of Requirements

for the Degree of Doctor of Philosophy

Department of Entomology

Under the Supervision of Dr. Harold J. Hall

Lincoln, Nebraska

1964

TITLE

Effects of Radio-Frequency Electrical Fields on the Metamorphosis of the Yellow Mealworm, Tenebrio Molitor (L.)

BY

Ahmed Mohamed A. A. Radwan, Ph.D.

APPROVED DATE

Harold J. Hall	April 19, 1966
O. E. Tsugawa	April 19, 1966
E. D. Wilson	April 19, 1966
Robert E. Johnston	April 19, 1966
Eugene E. Hill	April 19, 1966

In Publication Committee

Graduate Council University of Nebraska

ACKNOWLEDGMENTS

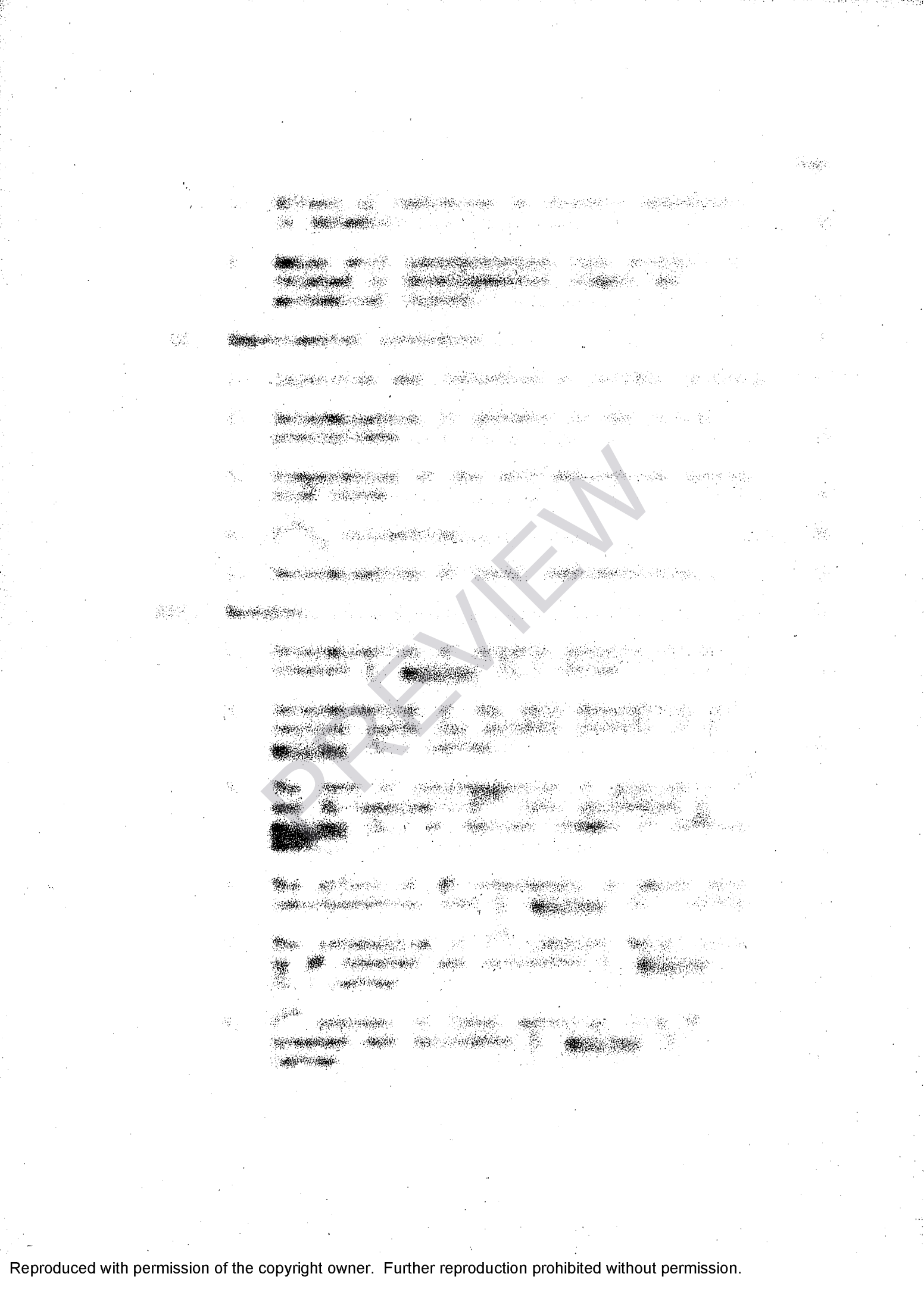
This study was made under the supervision of Dr. Harold J. Ball to whom the author wishes to express his gratitude for his helpful guidance, criticism and suggestions in the preparation of this thesis.

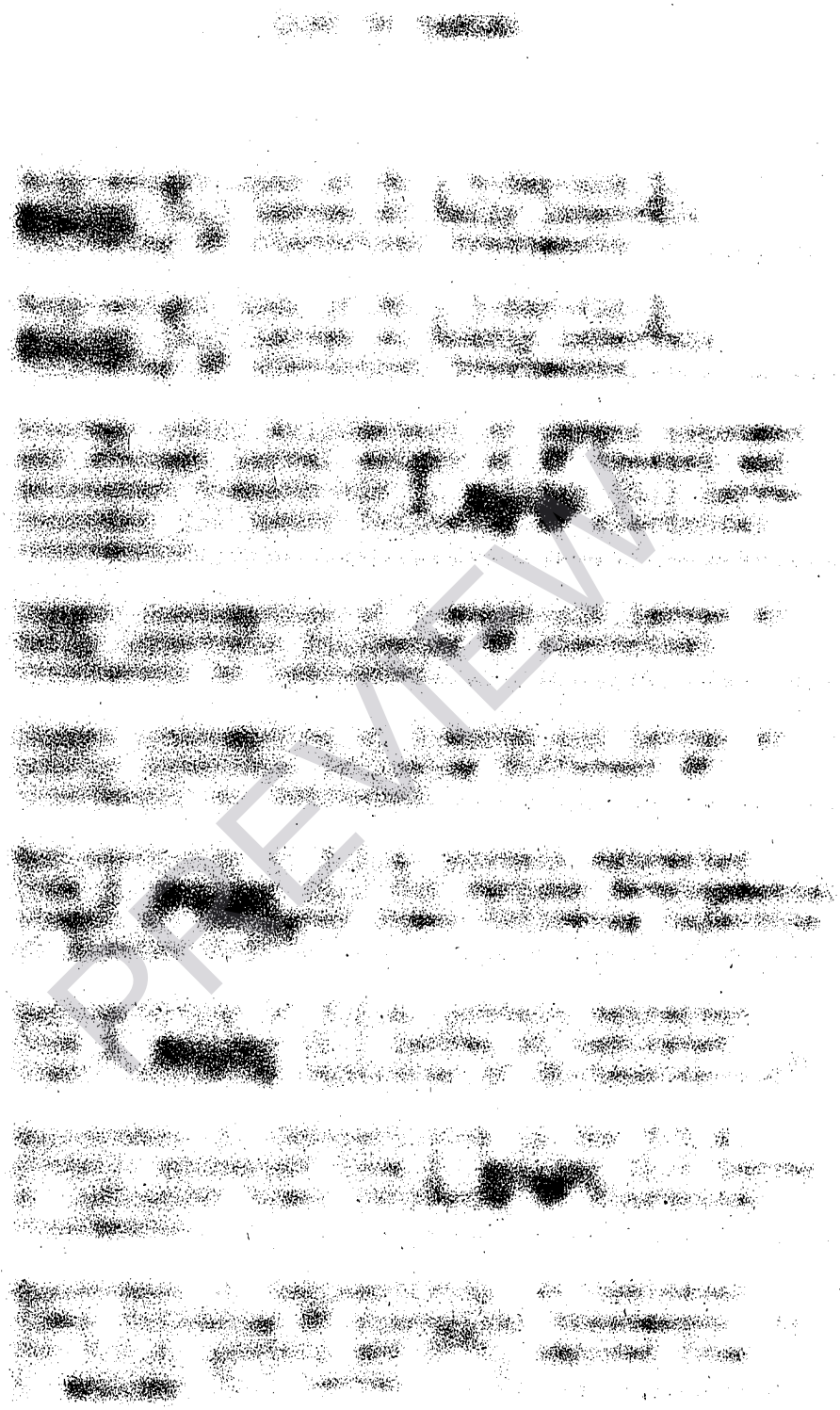
The author is deeply indebted to Dr. Robert B. Johnston for his interest, encouragement and criticism in the conduct of this research. Dr. Johnston provided most of the equipment used for amino acid metabolism, as well as the laboratory space for conducting the experiments and offered valuable suggestions.

The author wishes also to express his sincere appreciation to Professor Stuart O. Nelson and Mr. Lawrence E. Stetson for their assistance in treating the insects, and in designing the special containers used for treatment.

Recognition is also due to the United States Department of Agriculture, Agricultural Engineering Research Division for the use of certain equipment.

TABLE OF CONTENTS





LIST OF ILLUSTRATIONS

APPENDICES

Appendix A

Appendix B

INTRODUCTION

During the past four decades extensive studies have been made of the biological effects of various types of electromagnetic energy. Electromagnetic energy includes a wide range of radiation from low-energy radio waves to X rays and gamma rays, which are basically similar in nature. Since the early work of D'Arsonval (1893) investigators have provided important information on the effects of electromagnetic energy on living organisms. The need for furthering our knowledge relative to the biological effects produced by various sources of radiation has become increasingly evident.

In an attempt to further the understanding of the action of radio-frequency (RF) electromagnetic energy on living organisms, various investigators studied the mechanism of lethal action of RF treatments on insects. Most researchers concluded that the main cause of death resulted from internal heating. One investigator, however, suggested that a mechanism other than internal heating might be responsible for the cause of death of the treated insects.

The purpose of this investigation was to study the effects of sublethal dosages of continuous and pulse-

modulated RF treatments on yellow mealworm larvae, Tenebrio molitor (L.). The following major objectives were undertaken:

1. to determine the weight loss of insects at various time intervals following exposure to RF treatment
2. to determine whether oxygen consumption of treated insects would increase or decrease in comparison to untreated insects as a measurement of general metabolic disturbance
3. to determine the effect of RF treatments on protein metabolism of the insects by the rate of incorporation of radioactive amino acids and
4. to determine the effect of RF treatments on catabolism of the insects by determining the amount of $C^{14}O_2$ in expired air.

REVIEW OF LITERATURE

The effect of electromagnetic energy on living organisms has been investigated by numerous workers engaged in various branches of biological research since the original observations of D'Arsonval in 1893. In these original observations, D'Arsonval noted a rise in temperature and an increase in metabolism of laboratory animals following exposure to high-frequency electric fields. The utilization of radio-frequency (RF) electric fields as a tool for the possible destruction of insects was first reported by Headlee (1929-1930). Subsequently, numerous papers appeared describing various insect reactions associated with RF treatments. Headlee and Burdette (1932) observed an increase in the temperature of honey bees killed by RF fields and noted differences in the individual susceptibility of the treated insects. They further noted that adult holometabolous insects were more susceptible to the heating effects of RF electric fields than were the larvae and concluded that such increased susceptibility resulted from the fact that the nervous system is more centralized in the adult holometabola than in the larvae. A determination of the selective heating effects of various substances found in living animals re-