STUDIES ON THE SENSORY PHYSIOLOGY OF THE COTTON LEAFWORM SPODOPTERA LITTORALIS BOISDUVAL

By

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Thesis Presented in Partial Fulfilment of the Requirements for the Degree of

MASTER OF SCIENCE

(Plant Protection)

Faculty of Agriculture

Ain Shams University

1972

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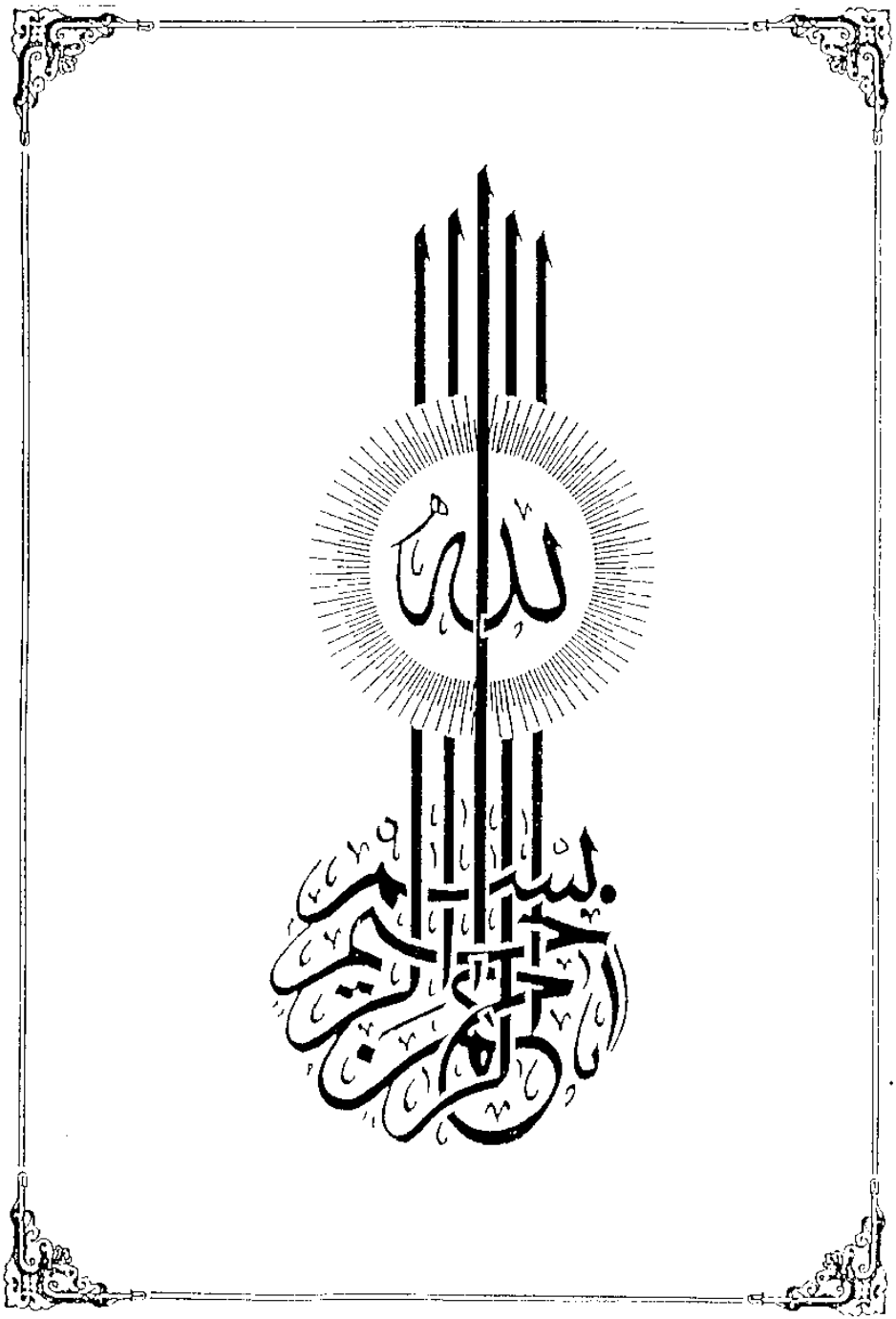

APPROVAL SHEET

Title of Thesis : Studies on The Sensory Physiology of The Cotton leafworm *Spodoptera littoralis* Boisd.

Degree : M.Sc. (Plant Protection)

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Date: 4.6.1972

ACKNOWLEDGEMENTS

The writer wishes to express her sincere thanks and gratitude to Professor A. Khalifa, Head of the Department of Plant Protection, Faculty of Agriculture, Ain Shams University, Dr. H.S. Salama, Associate Professor, National Research Centre, for their helpful supervision, sincere guidance and constructive criticism.

Deep thanks are also due to Dr. A.M. Rizk, Associate Professor of Phytochemistry, National Research Centre, for his continuous guidance, valuable suggestions and kind help throughout the chemical investigations.

The writer is also indebted to Mr. M.M. Seif El-Nasr and other colleagues in the laboratory for their help.

CONTENTS

I. INTRODUCTION

Feeding behaviour of phytophagous insects and their selection to their food plants is regulated for the most part by taste and smell. In a very short time an insect can identify acceptable and non acceptable compounds on the basis of their chemical structure (Thorsteinson 1960).

An attempt was made to study the sensitivity of the larvae of Spodoptera littoralis Boisd. to chemicals which may occur in its host plant and have a role in regulating the insect selection to its food. An insect like the cotton leafworm which has more than one hundred host plants is likely to have sensory organs which are less specific than one which has a limited number of host plants like the cotton bollworm Pectinophora gossypiella.

It is hoped that the results obtained from the present study would shed some light on the response of the insect to the chemical constituents of its host plants and may accordingly facilitate the use of attractant baits as a means of control.

II. REVIEW OF LITERATURE

Dethier (1937) and Dethier and Schoonhoven (1966) proved experimentally that the senses of taste and smell are important in host plant selection. The effect of plant odors seems critical in the first step of feeding of lepidopterous larvae. The extirpation of the sense of smell caused the larvae to make taste bites on plants which are not eaten normally (Dethier 1953). The chemical sense organs are classified into olfactory and contact chemoreceptors. Contact chemoreceptors have been shown to be localized on different parts of the body and its appendages, namely :

a) The antennae, as in bees [Minnich (1932), Kunze (1933), Marshall (1935), Frings (1944)], and in ants (Schmidt 1938).

b) The mouth parts or adjacent surfaces of the preoral cavity as in lepidopterous larvae (Dethier 1937, 1939; Frings 1945); bees (Von Frisch 1927, 1928, 1930, 1934); flies (Minnich 1926, 1931).

c) The distal segments of the legs as in bees (Frings 1944, Kunze 1933; Marshall 1935; Minnich 1932), flies (Abbot 1928, Barrows 1907; Chadwick and Dethier 1947, Deonier 1938, 1939; Deonier and Richardson 1935; Dethier

and Chadwick 1947; Frings 1941; Frings and O'Neal 1946; Krijgsman 1930; Minnich 1926, 1929), and in adult Lepidoptera (Anderson 1932; Minnich 1921, 1922; Weiss 1930).

The olfactory and gustatory capabilities of lepidopterous larvae have been investigated by McIndoo (1919) and Eger (1937). The antennae were presumed to bear principal olfactory organs, and taste organs were localized on the epi- and hypopharynx (Dethier 1937, 1941a). More recently, it was proved electrophysiologically that the maxillary palp bears gustatory receptors (Ishikawa 1963; Ishikawa and Hirao 1963).

The antenna of Spodoptera littoralis is three segmented. The first segment bears no sensilla (Kamel 1969). The second segment is the largest and carries three basiconic sensilla : two of which are large and one is small, in addition to two trichoid sensilla and one campaniform sensilla. The terminal segment assumes the form of a small palp attached apically and carries four sensillae at its tip, a sensillum styloconicum, two large sensilla basiconica and a small thin walled sensilla basiconica. The maxilla, labium and hypopharynx are united together to form the labium. The labium consists of a submentum, a fleshy mentum and a prementum bearing the chitinous spinnert anteriorly and two minute three segmented labial palps laterally. The maxilla bears

the maxillary palps, each of three segments. The first segment has a lateral conspicuous protuberance called the headpiece. On this headpiece there are one basiconic sensilla and two styloconic sensilla. The third segment of the maxillary palp bears five basiconic sensilla on the extreme end of the segment. On the labrum epipharynx there are six pairs of trichoid sensilla, three of which are median and the other three are lateral. There are also three campaniform sensilla on each side of the epipharynx. Three epipharyngeal setae are located on either side of the inner surface of the epipharynx.

Kamel (1969) found that amputation of the antennae and the maxillary palps did not cause any change in the discriminative ability of the larvae towards non olfactory compounds like sugars or salts. The operated larvae still accept the sugars and reject the salt solutions. Amputation, however, greatly abolished the sensitivity of the larvae towards volatile compounds like ethyl alcohol. It was deduced, therefore, that the organs of olfaction are mainly localized on the antennae and maxillary palps, while those of taste are localized on the labrum epipharynx. The knowledge on the correlation between insect preference to host plants and their chemical constituents is rather limited. Viehover (1918) observed the attraction of the bollweevil Anthonomus

grandis Bohem. to the distillate of cotton plants but this observation was not supported by experimental evidence. Keller et al. (1963) and Minyard et al. (1965) have presented strong evidence for the existence of an attractant for the bollweevil in cotton plant. The possible existence of an attractant in the cotton flower buds for the bollweevil was also recorded by Hedin et al. (1966).

Power and Chesnut (1925) tried to identify the volatile and non volatile components of cotton plants. They succeeded in isolating essential oils, trimethyl amine, ammonia, acetaldehyde, methanol, amyl alcohol, dipentene and some unidentified sesquiterpenes.

Salama, Risk and El-Sharaby (1971) gave a short note on the presence of two stimulants in cotton leaves (Gossypium barbadense) which were efficient in eliciting the feeding response of Spodoptera littoralis. Nayar and Fraenkel (1962) isolated two fractions in mulberry leaves which stimulated feeding of Bombyx mori. These were a mixture of high molecular n-aliphatic alcohols and a mixture of phytosterols.

Beck (1956), Davies (1965), Kamm and Pronk (1964) and Thorsteinson (1960) found that nutrients such as carbohydrates, amino acids, and also some vitamins in the

plants might act as phagostimulants of insects. Larvae of *Papilio ajax* discriminate between eight essential oils, which occur in Umbellifera (Dethier 1941b).

III. REARING OF COTTON LEAF WORM

A. Culture kept on castor oil leaves :

A standard laboratory culture of the cotton leafworm was maintained in the laboratory on leaves of castor oil. For this purpose, egg masses were dipped in 1% formaldhyde for 2 minutes and then left to dry. Every egg mass was kept in a clean glass jar (250 ml.) containing fresh castor oil leaves after being washed with water and dried. The hatched larvae usually orientate themselves towards the leaves where they feed. Fresh leaves were supplied daily. Larvae in the third instar were then transferred in groups of ten to bigger clean jars (1 litre) and provided with fresh leaves to avoid overcrowding. The jars used in rearing were always washed with soap and 5% formaldehyde and then dried in order to avoid any possible contamination with virus infection. The pupae were removed and placed in wooden cages 70 x 90 x 50 cm. with wire gauze sides (2 mm. mesh) the floor of which was covered with a layer of saw dust. After emergence the adults were fed on a 10% honey solution. Leaves of Nerium oleander were provided as oviposition sites. Egg masses were transferred to glass jars where they were left to hatch.

B. Culture kept on semiartificial diet :

Artificial diets are in common use for rearing the larvae of several noctuid species (Adkisson et al. 1960; Vander Zant et al. 1962; Ignoffo 1963; Berger 1963; Shory 1963; Shory and Hale 1965). Salama and Tolba (1967), Salama (1970) also refered to the successful development of Chilo agamemnon; Ostrinia nubilalis and Spodoptera littoralis on a diet mainly composed of dry kidney beans, agar, ascorbic acid and Brewer's yeast. Dimetry (1970) used the same diet but substituted the kidney beans with horse beans for rearing the cotton leafworm.

In the present work another culture was maintained on different formulations of a semiartificial diet composed of dry beans, Brewer's yeast, agar and mould inhibitors.

The constituents of the four tested diets in grams are given below. Diet No. 1 was used by Salama (1970) and consisted of the following materials .

Diet No. 1 (Salama, 1970)

Dry kidney beans (Phaseolus sp.)	150.0 g.
Agar	6.5
Brewer's yeast	16.0
Ascorbic acid	1.5
20% sorbic acid in ethanol (95%)	2.0

Benzoic acid	2.0 g.
HCl 10%	1.0
Formaldehyde 40%	1.0

Diet No. 2

This included in addition to the forementioned constituents two grams of a vitamin mixture composed of the following materials (Vander Zant, 1959).

	mg/100 g of diet
Niacinamide	1.00
Calcium pantothenate	1.00
Thiamin HCl	0.25
Riboflavin	0.50
Pyridoxine HCl	0.25
Folic acid	0.25
Biotin	0.02
Vitamin B_{12}	0.002

Diet No. 3

This was composed of the constituents of diet No. 1 but ascorbic acid was not added.

Diet No. 4

The constituents of diet No. 4 were the same as those of diet No. 2, but a vitamin mixture and yeast were reduced to one half and one fourth of their normal amount, respectively.