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A N N U A L R E P O R T

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THE CAUSES AND THE ROLE OF DIAPAUSE OF INSECTS PESTS

Report period: May 29, 1962 to Dec. 31, 1962

Summary

A diapause is one of the very important factors that enable insects to survive the unfavourable conditions, mostly seasonal changes of climate. Diapause can be induced by any of the factors of environment e.g. temperature or photoperiod but generaly a group of factors plays role. Survival of unfavourable period even in the state of anabiosis requires having of reserve of nutritional components by an organism. Data connected with the ecological and physiological aspects of insect diapause have special value in case of control methods of noxious insects. An insect studied in this research is a typical representative of phytophagous insects belonging to the order Hymenoptera. Informations on the diapause of these insects are very scanty. In theese investigations we try to determine the external factors that cause the diapause of Athalia colibri Christ. and to study the chemical changes in the organism of insects before and during diapause. Therefore we have reared this insect under artificial conditions in thermostates at various length of photoperiod and at temperature that according to the literature is not favourable for appearance of diapause. These preliminary investigations showed that photoperiod plays very important role for the course of diapausis of larvae of Athalia colibri. Short photoperiod provokes the diapause while the long photoperiod causes a pupation without resting period. Up to now it was believed on the basis of works of Riggert /1939/ and Saringer /1955/ that the diapause of Athalia colibri is influenced by temperature but photoperiod does not play any role. In our studies we exposed eggs, larvae and adult insect to various length of photoperiod, while Saringer exposed only larvae. Informations received so far need to be studied in detail in next periods.

Detail Report

Introduction

In the case of noxious insects a diapause as a resistant phase of insect life to the unfavourable conditions is of special interest. Survival of members of insect population in a diapause phase creates always a threat of an mass appearance of this pest; chemical control is not fully effective and treatmenets must be repeated. It is general trend to base the plant protection on biological control methods and therefore knowledge of life cycle of pests and their resting stages is necessary.

Several papers were published on various aspects of insect diapause. Bonnemaison /1945/ and Andrewartha /1952/ reviewed the effect of ecological factors on diapause. Lees /1955/ in his monograph on physiology of diapause of insects reviewed the literature on this subject up to 1953. Limited space does not allow to make extensive review of the literature.

In result of studies on the diapause of insects it was found that diapause may be caused by such external factors like temperature, humidity and photoperiod. However, on the other hand the course of diapause is probably regulated by neurohormonal mechanism. Every species has its own reaction to the factors provoking diapause but some groups of insects reacts in analogical way to the specefic factors. Biochemical processes before diapause and enzymatic processes during the diapause were also studied. In spite of a number of various studies the list of insects of which the diapause was studied is not very large, and up to 1953 included less than two hundred species /Lees 1955/.

Especially little number of papers deal with the diapause of sawflies. Therefore this study was undertaken on the factors governing the mechanism of diapause of Athalia colibri. In the first phase of our research we shall try to determine the external factors causing diapause; in the second phase we shall study to what degree chemical constituents of the insect body and enzymatic activity determine active and resting stages.

Informations on the biology of Athalia colibri was found in papers by Riggert /1939/, Saringer /1955/, Reich /1961, 1962/. Although some of these papers have monographic character /e.g. Saringer, 1955/ studies dealing with the biology of Athalia colibri are incomplete and need to be verified. According to Riggert /1939/ the diapause of Athalia colibri is a function of external factors, mainly of temperature. It would mean that this is a pseudodiapause /Saringer, 1955/. Treshold values of temperature for the diapause determined by Riggert /1939/ are: minimum - 16.5°, and maximum - 20.5°C. Higher temperatures lasting 24 hours caused that exposed and larvae pupated without diapause. Unfortunatley, it was not determined what stage is receptive to temperature that breaks preparing for diapause. Riggert accepted that other factors also influence the course of diapause and part of coccons in his studies in 1935 stayed in diapause through 1936 and emergence of adults was observed in June 1937. Saringer, in his investigations used larvae of older instars collected in September and studies the effect of temperature ranging from 18° to 22°C. Emergence of adults started in November and lasted until May. This led Saringer to believe that apart of temperature there are also other factors responsible for diapause. He applied photoperiod of various length in the breeding of larvae of second generation from the eggs to adults but no differences were observed in the behaviour of pupating larvae. Therefore Saringer concluded that photoperiod does not play any role in the diapause of Athalia colibri. Reich /1961/ repeated in some sense Riggert's experiments with the role of temperature supplementing them by use of humidity. Accepting results of works of Riggert and Saringer, Reich stated that only temperature causes the diapause of Athalia colibri. It should be, however emphasized that Reich used the autumn generation.

Materials and Methods

Insects used in this study were collected in field at several localities. Due to abnormal weather conditions in 1962 Athalia colibri did not appear in normal number. Spring generation that is normally observed in Poland in May and first days of June apeared in 1962 at the end of June and in beginning of July in very low density.

Larvae of 3rd to 5th instars collected in the rape plantations have been used to establish breeding stocks in 4 cages placed in plantation of field mustard. The mustard was sown at different periods in order to have plants of various size.

Adult sawflies that emerged from cocoons were collected and used for studies on the effect of photoperiod /14.VII.62/. Adults were fed with 10% water solution of sugar and mustard flowers as a source of nectar. According to Reich such food combination favors maximal multiplication.

Three groups of insects were reared under described conditions:

1. In thermostat at temperature of 25°C and 11 hours automatically regulated photoperiod.
2. In thermostat at temperature of 25°C and at 18 hours automatically regulated photoperiod.
3. In the laboratory room without regulation of temperature and at day length if this time of year.

Insect were exposed to theseconditions throughout whole first generation /eggs, larvae and adults/ and also in second if such appeared. Insect were kept in 0.5 liter glass jars covered with metal mesh. Food was changed every day. Daily observations recorded:

in case of adults - longevity /number of laid eggs/ of adults

in case of adults - mortality, moulting, migration into soil for pupation and adults emergence.

Results

a/ Experiments carried out showed that length of photoperiod is an important factor causing diapause of Athalia colibri.

b/ Short photoperiod /11 hours/ at temperature 25°C caused diapause in great majority of exposed population.

c/ Long photoperiod at temperature 25°C caused pupating without diapause of great number of insect.

d/ Results of rearing of insects in laboratory room at various photoperiods confirmed results obtained in the above experiments.

e/ Interference of effect of low temperature and short photoperiod in laboratory rearing was very clear and caused diapause of all insects in studied population.

Figures characterizing number of insects used in these experiments and effect of photoperiod on diapause are given in the Table 1.

In order to show course of observed phenomenons in relation to time, a diagram showing emergence of adult sawflies in every combination is prepared. As it is seen, pupation without diapause is observed during 15-20 days after migration of larvae into soil for pupation. At this time emergence of adults reaches its maximum. Larvae which are in diapause pupated in very low number even at the relatively high temperature in the period from 15 to 50 days after migration to soil. Rearing of adults and larvae in laboratory room in the period when photoperiod become shorter /from 13.5 to 12 hours/ and temperature ranged from 15° to 23°C caused general appearance of diapause. On the other hand, temperature 19.5 to 25°C and 15 hours day in August favored mass emergence of adults without diapause.

Discussion

Preliminary studies showed that photoperiod has direct influence on diapause of Athalia colibri. A slight tendency of the interrelation of the effect of temperature and photoperiod was noticed in laboratory rearing of insects. In the light of these studies and of Saringer we may accept that the photoperiod determines diapause affecting egg stage or through females organism. Further experiments will allow to solve this problem.

Treshold temperatures which favors diapause determined by Riggert and Saringer need to be verified. They both claimed that temperature 25° is unfavourable for diapause but in our experiments we did not observe such phenomenon. Conclusions of Riggert, Saringer and Reich about importance of temperature are clear in the light of our studies. In their studies they used larvae of autumn generation which already had determined diapause by effect of short photoperiod. Therefore low temperatures were not responsible for causing the diapause and acted only together with photoperiod. High temperature reduced determinating action of photoperiod on diapause.

Mentioned above problems indicates that it is necessary to use in ex-

periments individuals of the first summer generation. We shall be able to study this problem in the next year.

Conclusions

Although some experiments need to be repeated we can make at present the following conclusions:

a. Results of our studies indicates that short photoperiod causes the diapause of Athalia colibri Christ.
b. Long photoperiod causes pupation without diapause.
c. Determination of diapause by photoperiod is due to action on egg stage or on female's organism.
d. A correlation between action of temperature and photoperiod was noticed.

Plan of Work

In the next year we plan to study the following aspects of the effect of photoperiod on insect diapause:

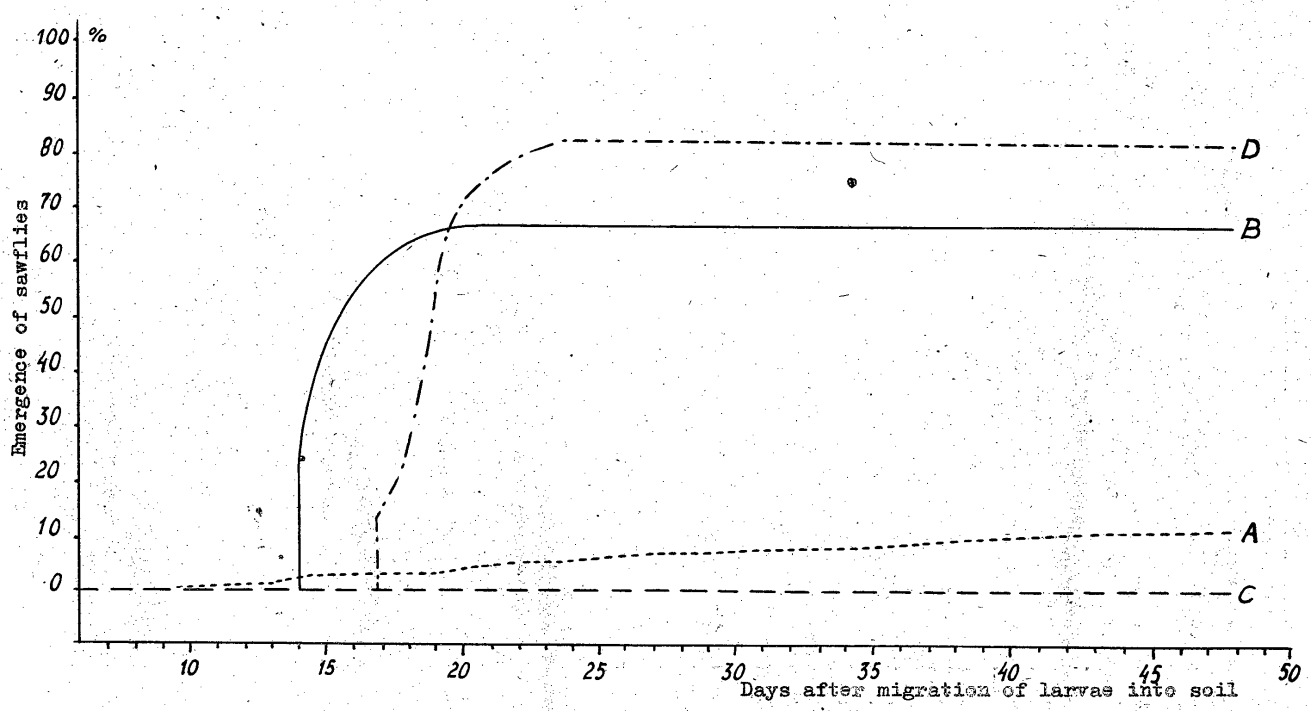
a. In what developmental stage the diapause is determined
b. Treshold values of length of photoperiod which cause the diapause
c. Interrelation of the effect of temperature and photoperiod
d. Preliminary studies on indirect effect of photoperiod on diapause trough host plants.

We also plan to start chemical analysis.

Table 1

Influence of photoperiod on the diapause of Turnip sawfly - Athalia colibri F.Christ.

Rearing conditions imagines and larvae	Number of observed insects	Emergence of sawflies during period of 30 days from migration into soil in %%	Mortality of larvae in the soil in %%	Diapaused larvae in %%
11 hrs photoperiod at 25°C /thermostat/	286 24 149	4,4 - 9,6	34,8 16,8 49,6	60,8 83,2 40,8
18 hrs photoperiod at 25°C /thermostat/	65 32	70,7 61,2	1,5 38,8	27,8 -
13,5-12 hrs photoperiod at 15°C-23°C /laboratory/	185	-	16,8	83,2
15 hrs photoperiod at 19,5°C-25°C /laboratory/	80 56	80,0 82,1	12,5 17,9	7,5 -



INFLUENCE OF PHOTOPERIOD ON THE DIAPAUSE OF TURNIP SAWFLY ATHALIA COLIBRI CHRIST.

A- 11 hrs photoperiod at 25°C /thermostat/
B- 18 hrs photoperiod at 25°C /thermostat/
C- 13,5-12 hrs photoperiod at 15°C-23°C /laboratory/
D- 15 hrs photoperiod at 19,5°C-25°C /laboratory/

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