AgriCos e-Newsletter
ISSN: 2582-7049
Volume : 02 Issue : 02 February 2021 Article No: 24

Eco-Physiological Phases of Insect Diapause

Mogili Ramaiah[1] and Archana Anokhe[2]
[1]Ph.D. Scholar, Division of Entomology, ICAR-Indian Agricultural Research Institute (IARI), New Delhi
[2]ICAR- Directorate of Rapeseed and Mustard Research, Bharatpur, Rajasthan

SUMMARY

Insects clearly posses a range of coordinated and integrated mechanisms that have evolved to allow them to survive and flourish under potentially adverse environmental conditions. Diapause an important part of the life-cycle in many species of invertebrates which helps in ecological studies, pest population modeling and predict population responses to the environment on seasonal or linear or on an evolutionary scale. Increasing precision in the knowledge of how the responses to environmental factors change at an individual ontogenetic level. Studies of insect thermal relations have direct applications to numerous research fields, including pest management, cryopreservation and forensic entomology. Such studies will continue to play a key role in forecasting the effects of climate change and in the prediction of potential impacts of agricultural pest species or disease vectors in the future.

INTRODUCTION

Diapause is a period of suspended or arrested development during an insect's life cycle. Insect diapause is usually triggered by environmental cues, like changes in daylight, temperature, or food availability. "State of arrested development in which the arrest is enforced by a physiological mechanism rather than by concurrently unfavorable environmental conditions" (Beck, 1962). The word diapause was originated from Greek word "*diapausis"*, meaning "pause ". In 1893 William Wheeler coined the term diapause, while describing the different stages of embryo morphogenesis in grasshopper, *Xiphidium ensiferum.* Then in 1904, Henneguy pointed out that diapause was not a stage in insect development but it is a condition of arrested growth in insect. The classic experiments by Fukuda (1951, 1952) and Hasegawa (1952) let the stage for the understanding and further development of diapause mechanism in insects (Richard *et al.* 1987).The phases of diapause were deciphered by V. Kostal.

Quiescence: Quiescence is the immediate response (without central regulation) due to limiting environmental factors below the required physiological thresholds. It is the transitory interruption of development in response to adverse conditions. It is a less preparatory than diapause.

Dormancy: Dormancy is a broad term which includes any state of suppressed development (developmental arrest) in an organism, which is adaptive and usually accompanied with metabolic suppression. The dormancy includes both diapause and quiescence. Both have arrested development while the later returns back to normal activity on return of favorable condition.

Diapause: Diapause is a programmed interruption of the development. It is a preplanned program of progress which includes preparatory phase and exploitation phase. The major mechanism includes metabolic suppression and nutrient storage.

Life stages of insect and Diapause:

Instar	Insect species
Egg diapause	Mulberry silkworm, Grass hoppers, locust
Larval diapause	Pink bollworm
Pre pupal diapause	*Plodia interpunctella*
Pupal diapause	*Pieris brassicae,* Red hairy caterpillar
Adult diapause	White grub, *Epilachna, Leptinotarsa*
Imaginary diapause	Mosquitoes

Phases of Diapause:

The different phases of diapause include pre-diapause, diapause and post diapause phase. Pre-diapause phase is the preparatory phase of diapause which senses the environmental stimuli and induces several genetic responses for further physiological modifications for diapause. Metabolic depression and storage of nutrients like

lipids and carbohydrates play are the major activities in pre diapause phase. During the diapause phase the stored nutrients are used up for maintenance and metabolism during diapause while other normal metabolism of insects remains suppressed. The insect remains in the arrested stage during the entire phase of diapause. In post diapause phase the metabolic arrest is reduced and insect returns back to the normal development and metabolism. The whole diapause is genetically mediated and the successful completion of diapause relays on the quantity and quality of nutrients storage.

Phases of Diapause (Kostal, 2006):

I. Pre diapause

Induction phase; This phase occurs at a genetically predetermined stage of life and occurs well in advance of the environmental stress. This sensitive stage may occur within the lifetime of the diapausing individual, or in preceding generations i.e, resulting in egg diapause. During this phase, insects are responsive to external cues called token stimuli. Token stimuli can may be any change in photoperiod, thermoperiod, or allelochemicals from food source. This triggers the switch from direct development pathways to diapause pathways.

Preparation phase; Though insects may go directly from induction to initiation without a preparation phase. The preparation phase usually follows the induction phase. During this phase, insects accumulates and stores molecules such as lipids, proteins and carbohydrates. These molecules are used to maintain the insect diapause phase throughout and to provide supplement for development following diapause termination. Diapausing puparia of the flesh fly, *Sarcophaga crassipalpis* increase the amount of cuticular hydrocarbons lining on the puparium which effectively reduces the ability of water to cross the cuticle.

II. Diapause

Initiation phase: Photoperiod is the most important stimulus initiating diapause. The initiation phase begins when morphological development ceases. In some cases, this change may be very distinct and can involve moulting into a specific diapause stage, or be accompanied by colour change, behavioural change, migration, aggregation or some enzymatic change. Adults of the fire bug, *Pyrrhocoris apterus*, have the enzymatic complement that allows them to accumulate polyhydric alcohols, molecules that help to lower their freezing points and thus avoid freezing during diapausing.

Maintenance phase; During the maintenance phase, insects experience lowered metabolism and developmental arrest. Sensitivity to certain stimuli which act to prevent termination of diapause, such as increased photoperiod and temperature. At this stage, insects are unresponsive to changes in the environment that will eventually trigger the end of diapause, but they grow more sensitive to these stimuli as time progress.

Termination phase; In insects that undergo obligate diapause, termination may occur spontaneously, without any external stimuli. In facultative diapausers, token stimuli must occur to terminate diapause. These stimuli may include chilling, freezing or contact with water, depending on the environmental conditions being avoided. These stimuli are important in preventing the insect from terminating diapause too soon. The effect of diapause slowly decreases until the insect can resume its developmental process under favourable condition.

III. Post diapause

Development and metabolism remain inhibited because of unfavorable environmental conditions. Insects become normal when favorable conditions reached.

REFERENCES

Andrewartha, H. G. 1952. Diapause in relation to the ecology of insects. *Biological Reviews*, **27**(1): pp 50-107.

Beck, S.D. 1962. Photoperiodic induction of diapause in an insect. *Biological Bulletin*, 122: 1.

Denlinger, D. L., Yocum, G. D. and Rinehart, J. P. 2012. Hormonal control of diapause. *In*: Gilbert, L.I. (Ed.), Insect Endocrinology. Academic Press, San Diego, pp. 430-463.

Kostal, V. 2006. Eco-physiological phases of insect diapause. *Journal of Insect Physiology*, 52(2):113-27.