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COMPARATIVE STUDY OF TEMPERATURE DEPENDENT DEVELOPMENT OF FINAL INSTARS LARVAE OF *DANAUS CHRYSIPPUS* AND *JUNONIA IPHITA* (LEPIDOPTERA: NYMPHALIDAE) AT ROOM TEMPERATURE

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ABSTRACT

The present study focused on developing the scenario of the room temperature effect on the development of two distinct butterfly species, *Danaus chrysippus* and *Junonia iphita*. Temperature required for development of final instar larvae of *D. chrysippus* (25.9°C) was much higher than *J. iphita* (19.09°C); whereas in contrast to that in pre-pupation stages *J. iphita* (8.21°C) acquired at much higher temperature than *D. chrysippus* (7.93°C). In case of chrysalis stages *D. chrysippus* (28.3°C) required much higher temperature in comparison to *J. iphita* (26.8°C). In the study the pupation stages is merged with the chrysalis stage. The completion of chrysalis stages was much lower in *D. chrysippus* (average 03 days) than *J. iphita* (average 6.25 days). The present study furnished that development rate was greatly accelerated with thermal threshold roaming around room temperature. However in *D. chrysippus* thermal threshold scenario stands static as in the present study all the specimens were reported dead in the cocoon stages providing a keynote information about the temperature manipulation on two distinct species which can be utilized as grass root level for successful conservation management.

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KEY WORDS : *Danaus chrysippus*, *Junonia iphita*, Temperature

Introduction

Temperature plays a crucial role in development of insects. Temperature influences the rate of growth and development, the duration of metamorphosis as consequences for biochemical and physiological processes for fecundity and species survival[8] particularly determining the importance of an organism's life-history, including development and growth strategies [9,21].

It was found that developmental rate goes on accelerated with temperature upto an optimum temperature, after which retardation was approached as the upper temperature threshold increases ultimately causes death of the organism[18]. Several nonlinear models based on the estimates of lower and upper temperature thresholds and optimal temperature for development of a given stages describe the developmental rate [1,11,12,22]. Among insects, butterflies are a charismatic group and are regarded as model organisms in studies of evolution, behavior, ecology and biogeography[18].

The two distinct species *Danaus chrysippus* also known as the plain tiger or African monarch is

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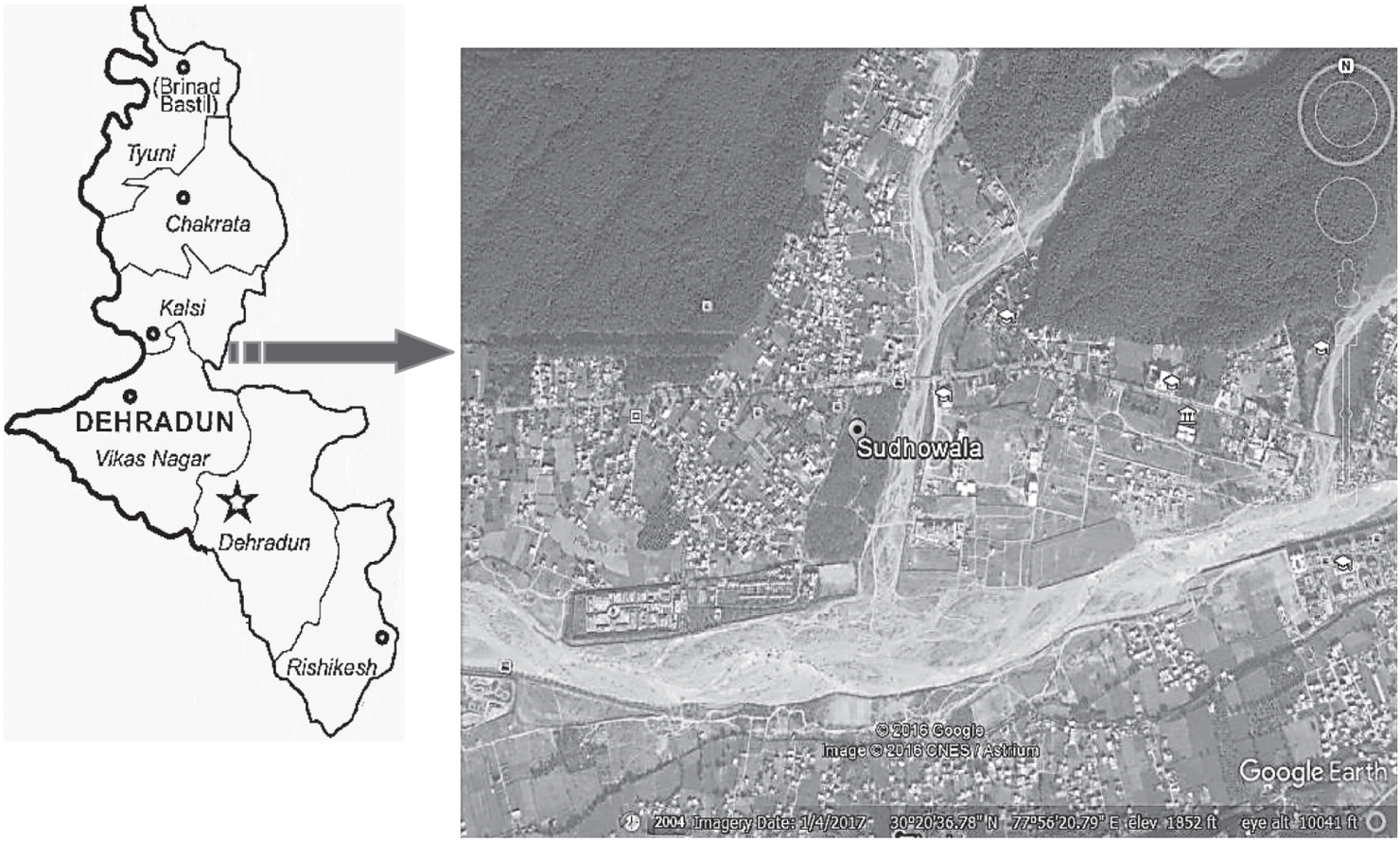


Fig.1 : The satellite image of the study site (Sudhowala, Dehradun)

a common Asian and African butterfly, and *Junonia iphita* Cramer commonly known as chocolate pansy or chocolate soldier belongs to family Nymphalidae and order Lepidoptera were known to metamorphose reluctantly on temperature variation especially in final instars[7]. Mature larvae of both the species were cylindrical. Larvae of the *D. chrysippus* were covered with bands of black and white interspersed with thick, yellow dorsolateral spots. The most striking characteristics were the three pairs of long and black tentacle-like appendages. These tentacles were present on the third, sixth and twelfth segments, while in case of *J. iphita* mature larva were cylindrical, slightly pubescent and armed with nine longitudinal rows of many-branched spines, except on the head which was clothed with short bristles. Colour of the larva was dark dull brown. Temperature experienced in the natural environment is essential for the life history of an organism [9,21]. On the basis of this concept[10] provided recent reviews on the effect of temperature in insect population.

Based on the effect of the temperature on the metamorphosis of the insect, the present study focused on developing the scenario of the room temperature effect on the development of two distinct butterfly species, *Danaus chrysippus* and *Junonia iphita*.

Materials and Methods

STUDY SITE

The final instars larvae of butterflies were collected from Sudhowala (30°20'36.78" N, 77°56'20.79" E) Dehradun, located on the North West coast of India in state Uttarakhand during the month of September-October 2016 (Fig. 1).

COLLECTION AND EXPERIMENTAL SET UP

Sites were regularly searched for the reproductive activity of the *D. chrysippus* and *J. iphita* being identified by using proper keys and catalogues[6]. The period of copulation and oviposition was under observation. Regular walks in different patches of the study sites were undertaken at shorter intervals or even daily to record the developmental growth of the organism right from egg to their final instars larvae in their natural habitat, following which final instars of both the species were collected and transported to the Zoology laboratory, Alpine Institute of Technologies, Dehradun, without causing any damage, to study the effect of room temperature on their development. The experimental set up was maintained in semi-adaptive condition similar to that of the outer environment by manipulating the humidity and temperature using wet cotton plugs and selective use of room heater. The temperature was recorded

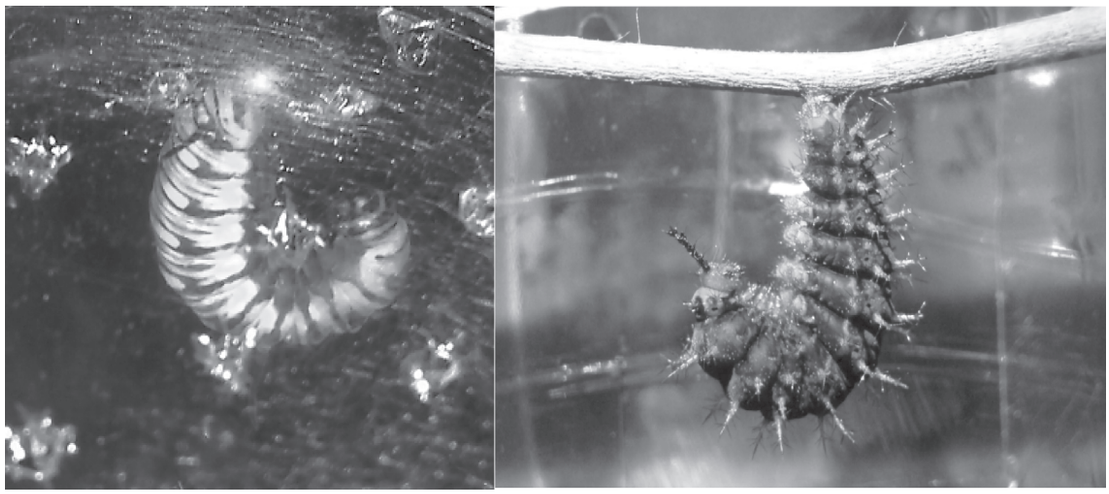
A. **B.**

Fig. 2: (A-B) Images of final instars larvae of *Danaus chrysippus* and *Junonia iphita* feeding on their host plants.

in a digital wall hanging thermometer throughout the experiment period. Larvae of *D. chrysippus* and *J. iphita* were acclimatized for at least 3 hours and then provided with the leaves of *Calotropis gigantea* and *Diptheracanthus prostratus* respectively over petri dishes[14,17]. For performing experiments, five specimens of both the respective species were selected and mean temperature-values of each stages were recorded.

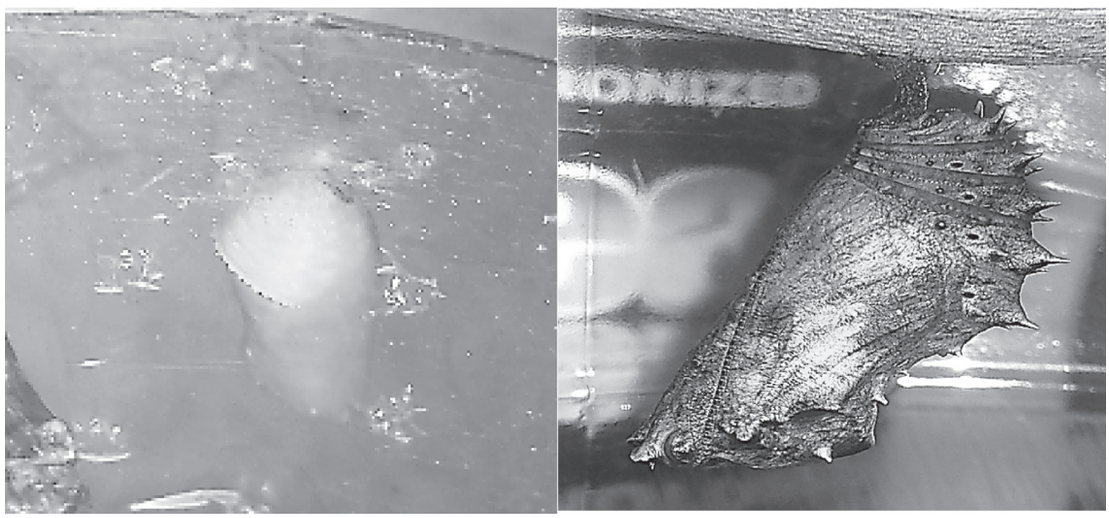
Result and Discussion

The present study signifies that the metamorphosis stages of the *D. chrysippus* and *J. iphita* butterflies can be sub divided as eggs, initial instar larvae, final instar larvae, pre-pupation stage, pupation stage and finally chrysalis stage[5]. Among these from final instar stages the temperature based experiment was procured in the lab for the present study. The comparative representation of



A. B.

Fig. 3: (A-B) Images of pre pupation stage of *Danaus chrysippus* and *Junonia iphita*.



A. B.

Fig. 4: (A-B) Images of Pupa (Chrysalis stages) of *Danaus chrysippus* and *Junonia iphita*.

the various stages were represented as final instar stages (Fig.2); pre-pupation stages (Fig.3); pupation (chrysalis) stages (Fig.4) and finally chrysalis natality and mortality stages (Fig.5).

In case of final instar larvae the developmental mean range of temperature of *D. chrysippus* (25.9°C) was much higher than *J. iphita* (19.09°C); whereas in contrast to that in pre-pupation stages *J. iphita* (8.21°C) acquired at much higher temperature than *D. chrysippus* (7.93°C). In case of chrysalis stages *D. chrysippus* (28.3°C) required much higher temperature in comparison to *J. iphita* (26.8°C). In the study the pupation stage was merged with the chrysalis stage. The completion of chrysalis stages were much lower in *D. chrysippus* (average three days) than *J. iphita* (average 6.25 days) may be due to the fact that *D. chrysippus* was found dead on in cocoon whereas *J. iphita* successfully emerged. The overall parameters were depicted in the Fig.6 (A & B).

Developmental rate was determined by many underlying physiological processes that often vary in thermal sensitivity and in thermal thresholds, below or above which these processes are strongly inhibited[3]. Rearing at a constant temperature that surpasses a thermal threshold of any underlying physiological process can result in developmental stagnation, and eventually mortality[3,8], increasing temperature lead to a decrease in age and size at maturity together with an increase in growth rate[2] suggesting the fact that temperature plays the major role in development of the insect life cycle[4,14,15,16] .The present study furnished that developmental rate was greatly accelerated with thermal threshold roaming around room temperature, however in the pre-pupation stages occurred during the dawn time when temperature was around 8-10°C. In *D. chrysippus*; this thermal threshold scenario stands static as in the present study all the specimens were reported dead in the cocoon stages, which is referred as life history puzzle[2].

Among the two species *J.iphita* found to feed voraciously in larval stages in comparison to *D. chrysippus* which is similar with the studies conducted[3,15,19,20,23] reflecting the phenomena that, the stored energy compensates the energy expenditure of non-feeding pupal stage[19]; suggesting the scenario of dead chrysalis stage of *D. chrysippus* may be due to the reason of low stored energy during feeding stages. As the temperature is most important abiotic factor for the survival and development of any individual, it was predicted that if there was no disease to pupa of *D. chrysippus*, then temperature was the only reason of mortility[14]. On the other hand the provided temperature was sufficient for the survivorship of the *J. iphita*[17].

A. **B.**

Fig. 5: A. Image of the Dead chrysalis of *Danaus chrysippus* and B. Mature (adult) form of *Junonia iphita*.

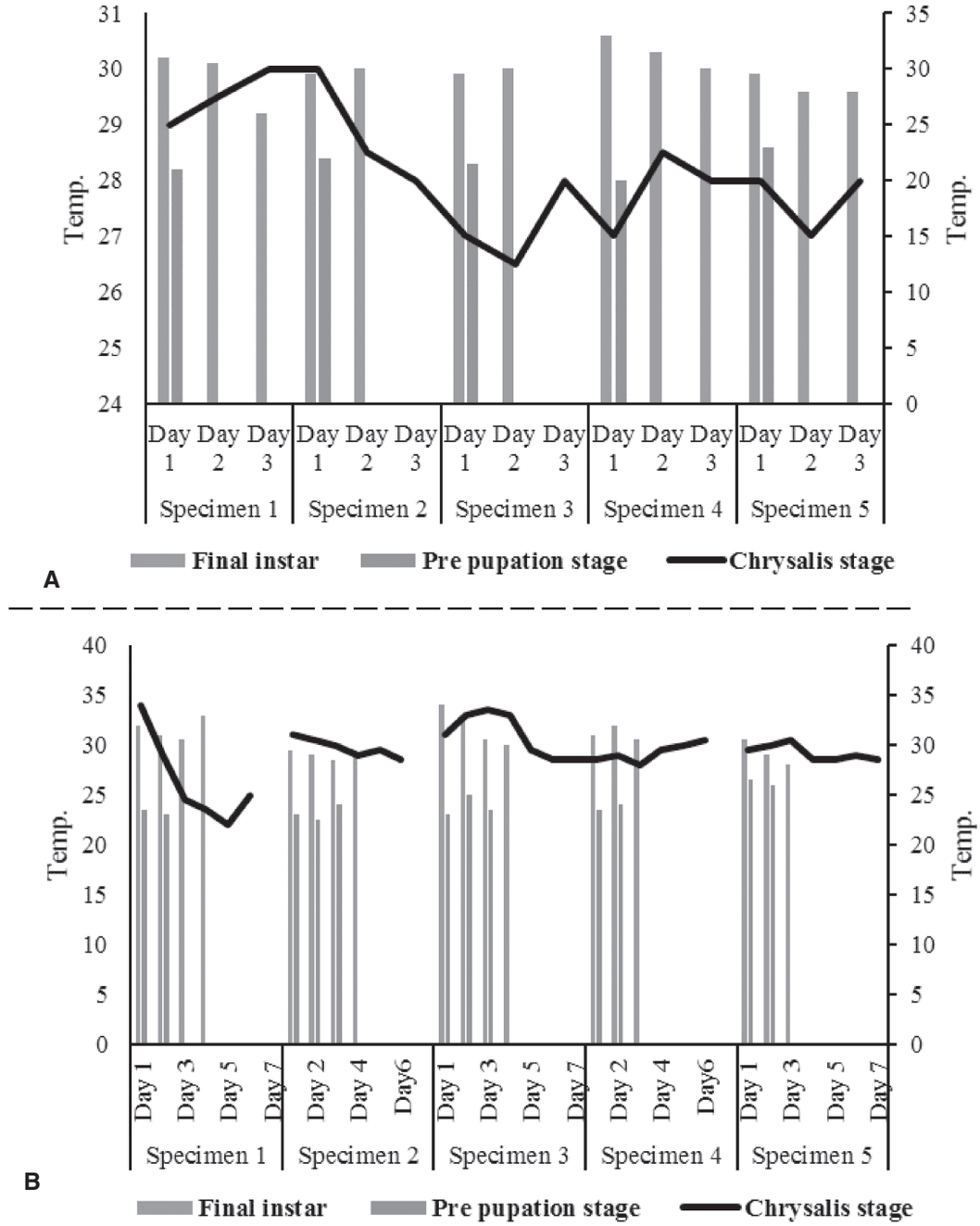


Fig. 6: (A-B) The column- line diagrams depict the fluctuation of stages along with temperatures A. *Danaus chrysippus* and B. *Junonia iphita*. (The discontinuous line determine the completion of the phase much earlier than estimated days)

The biodiversity crisis currently seems to appear more critical among butterfly species than other species[24]. Butterflies being highly diversified in their habits require specific ecological conditions for their survival. Knowledge of butterfly habitat larval host plants and metamorphosis is a prerequisite for any butterfly conservation program[5]. Thus, with the advent of threats of global warming the present study provides a keynote information about the temperature manipulation on the two distinct species of same family which can be utilized as grass root level for successful conservation management.

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