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Temperature dependant generationcycle for the cicindelid beetle *Pentacomia egregia* CHAUD. (Coleoptera, Carabidae, Cicindelinae) of the Amazon valley*

by

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Abstract

Experiments with the cicindelid beetle *Pentacomia egregia*, living in the floodplain forests of the Amazon river, indicate the temperature to induce the habitat change of the beetles and reproductive cycle of the females.

Keywords: *Pentacomia egregia*, **Cicindelinae, tropical seasonality, reproduction cycle, floodplain forest.**

Resumo

O besouro *Pentacomia egregia* da subfamilia Cicindelinae existe na mata inundaveis do Rio Amazonas. O cyclo de reprodução e a mundança do habitat depende da flutuação sesonal da água. Experimentes com flutuações da temperatura diaria de 22 - 30 °C e 26 - 30 °C e temperaturas constantes de 26 °C e 28 °C mostra que as temperaturas altas na noite de pelo menos 26 °C causa a mundança do habitat e o desenvolvimento das gonadas das fêmeas. O desenvolvimento das gonadas dos machos è não controllado para as temperaturas nas condições tropicales do Rio Amazonas.

* heartly dedicated to Prof. Dr. Harald Sioli to his 75th birthday.

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Introduction

Within the inundation forest of the Amazon valley the cicindelid beetle *Pentacomia egregia* CHAUD. exists on the higher ground parts. Larval period of the species occurs during the low water period, whereas adult beetles are found during the high water period. During that period the beetles live at the tree trunks above the water level.

The beetle orientates to the tree trunks scototactically, particularly after falling onto the water (IRMLER 1973).

The analysis of the state of development has shown, that the adult males and females have different reproduction cycles. The males develop relatively fast at the beginning of the high water period, whereas the females are mature at the end of the high water period in July/August (PAARMANN et al. 1982).

Temperature measurement in the habitat of *Pentacomia egregia* resulted in a temperature seasonality dependant on the water level fluctuation (IRMLER 1976). During the low water period the night temperatures are at about 22 °C, however during the high water period 26 °C are found in the night (Fig. 1). These conditions are different to those in the terra firme forests, where nightly minimum temperatures are about 22 °C throughout the year (GOES RIBEIRO 1976). Possibly in the inundation forest the nightly temperature fluctuation during the year is connected with both the reproduction seasonality and the habitat change of the species.

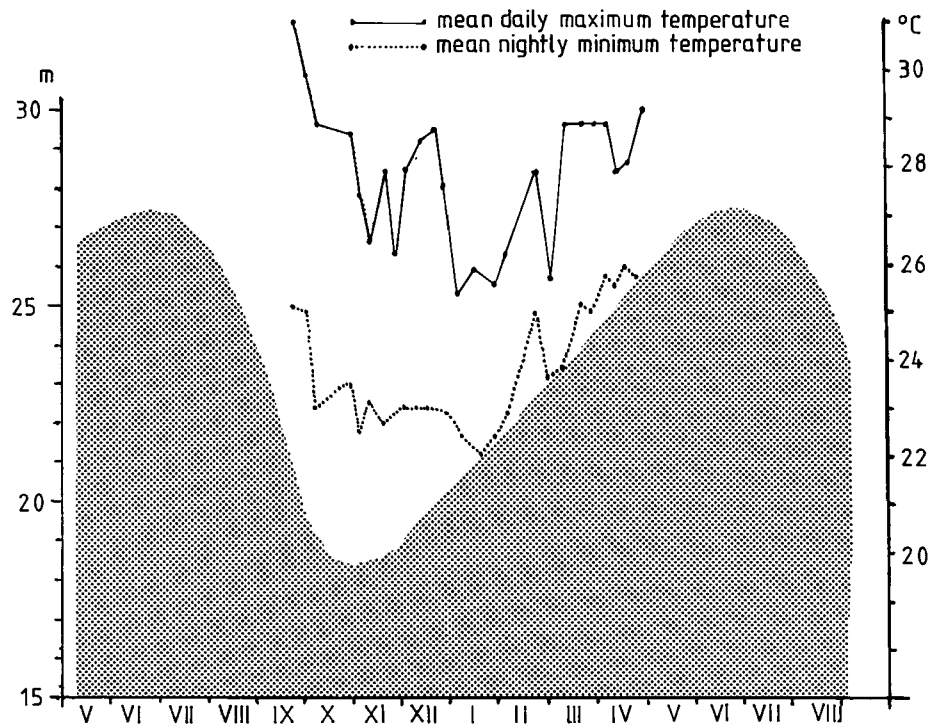

Fig. 1:
Both weekly mean daily maximum and mean daily minimum during the emersion phase in a várzea forest (Lago Janauari), (dotted area = water level changes).

Results

1. Habitat change

In April 1981 14 specimens of the species could be transported from Manaus (Brazil) to Germany, where they are kept under two different temperature conditions in an incubator with a night-day temperture fluctuation of 22 - 30 °C and 26 - 30 °C respectively, 7 specimens each. The day-night rhythm for temperature as well as for the light period was 12/12 hours. The animals were fed with living *Drosophila* flies and could be maintained from April to August. They lived in a rectangular glass vessel filled with loam at the bottom. On one side a black paper of 10 cm breadth served as the image of a tree.

During the study period the individuals occuring on this black strip were counted daily. The number of individuals on the black strip was compared with that of those resting on the ground. The results show a distinct higher part of the population occuring on the black strip under the warmer conditions of the 26 - 30 °C night-day temperature fluctuation (Fig. 2).

Furthermore the activity of the species was investigated. The activity has been measured using an actograph which drew the movements of the specimens on a paper. The specimens kept under the colder conditions of the night-day temperature fluctuation of 22 - 30 °C (Fig. 3).

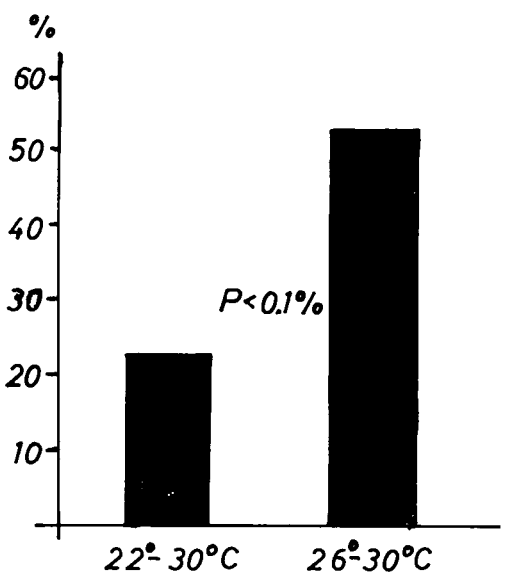

Fig. 2:
Percentage of population living at black strips of paper (tree image) within the cultures of 22 - 30 °C and 26 - 30 °C.

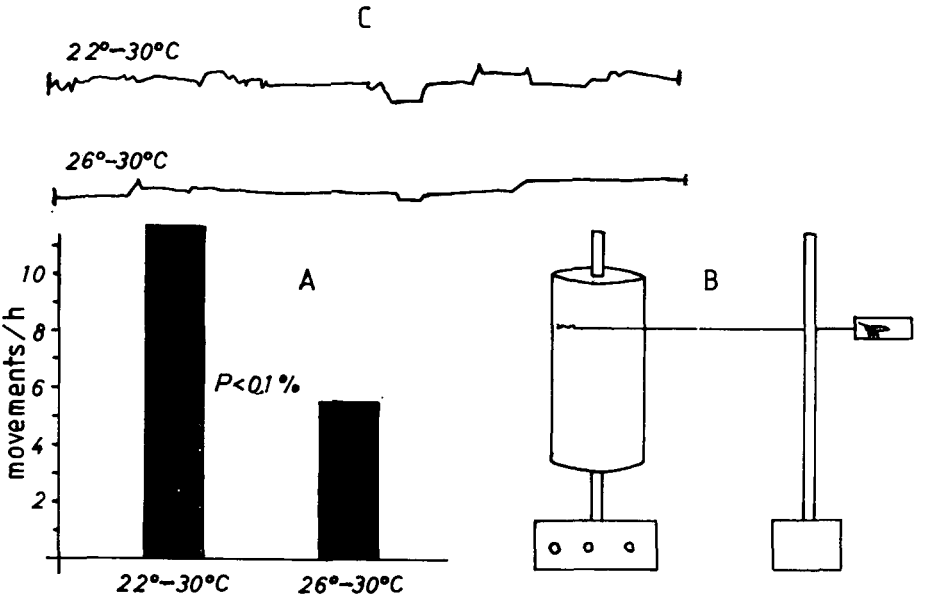

Fig. 3:
Movements/hour within the populations cultivated at 22 - 30 °C and 26 - 30 °C (A). Actograph (B) and examples of actograms (one hour each) (C).

Both experiments fit well with observations in the field. The temperature experiments suggest, that *Pentacomia egregia* orientates to the tree trunks because of the higher night temperatures, which correspond to the increasing water level. The population density of the trunk dwelling beetles in the field increases before the water reaches the habitat of the species. After the water arrives, the habitat space of the trunk dwelling population decreases and water arrives the decreased activity during that time may be an adaptation to diminish the danger to fall onto the water.

2. Reproduction cycle

The investigation of the reproduction cycle was executed as well under the temperature conditions of a night-day rhythm of 22 - 30 °C and 26 - 30 °C. Furthermore, another experiment was carried out, with about 20 specimens each, at constant temperatures of 26 °C and 28 °C. These temperatures respresent the mean daily temperatures of the daily fluctuations between 22 - 30 °C and 26 - 30 °C respectively.

In both experiments no egg laying occurred probably because of wrong substrate respectively constant temperatures. The beetles were fixed in alcohol after dying and the state of development of the gonads was then investigated, using to the criteria mentioned by PAARMANN et al. (1982).

Copula occurred in the experiment during May under all temperature conditions used. Longvity seemed to decrease with higher temperatures. The constant day-night temperatures may have had a negative effect on the animals because the mortality was distinctly higher than in the experiments with the day-night temperature fluctuation (Fig. 4).

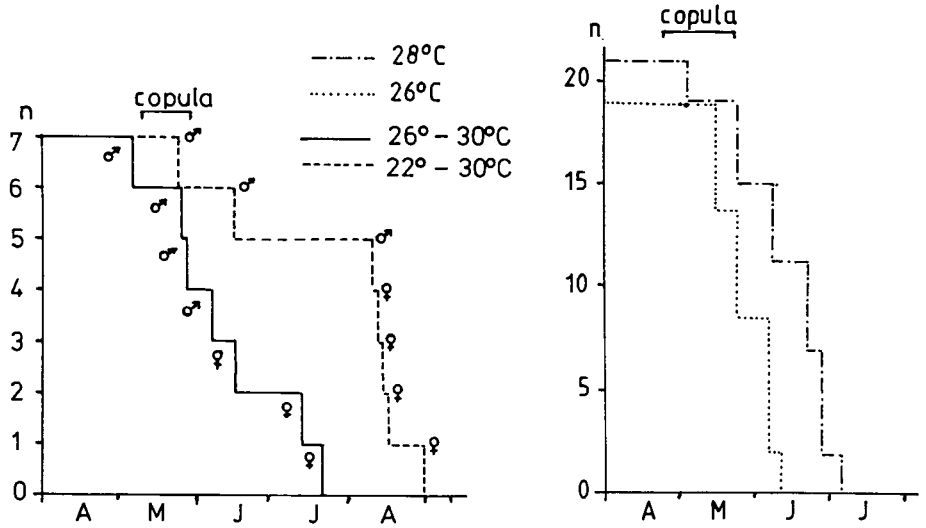

Fig. 4:
Mortality of *Pentacomia egregia* within the different cultures. In the culture of 26 °C and 28 °C only one male each was found.

In Fig. 5 and 6 the gonad development data are presented. In the experiments with the day-night temperature fluctuation the number of animals is too low to draw any definite conclusions, especially if the sexes are treated seperately. However there is a suggestion that temperature affects the reproductive cycle.

The development of males of *Pentacomia egregia* is not controlled by the temperature. They become mature also under the temperature conditions of a non-flooded forest with daily temperature fluctuation of 22 - 30 °C. This explains the relatively early mature state of the males observed in the field already at the beginning of the high water period. The copula occurs consequently before the females become mature. The early dying of the males in the laboratory corresponds well with the field observations (IRMLER 1973).

For the reproductive cycle of the females the annual night temperature fluctuation in the habitat of *Pentacomia egregia* seems to be important. In the experiment, the females kept under the night temperature of 22 °C remained immature. While at a night temperature of 26 °C the females become mature. This is realized both under the fluctuating temperature conditions and under the constant temperatures. These results suggest that the reproductive cycle of the female beetles is not controlled by the daily mean temperature but by the length of the period with temperatures of at least 26 °C. Within the life cycle of *Pentacomia* females a certain period with temperatures above 26 °C is necessary. If night temperatures are only at 22 °C the warm period seems too short to reach the mature state.

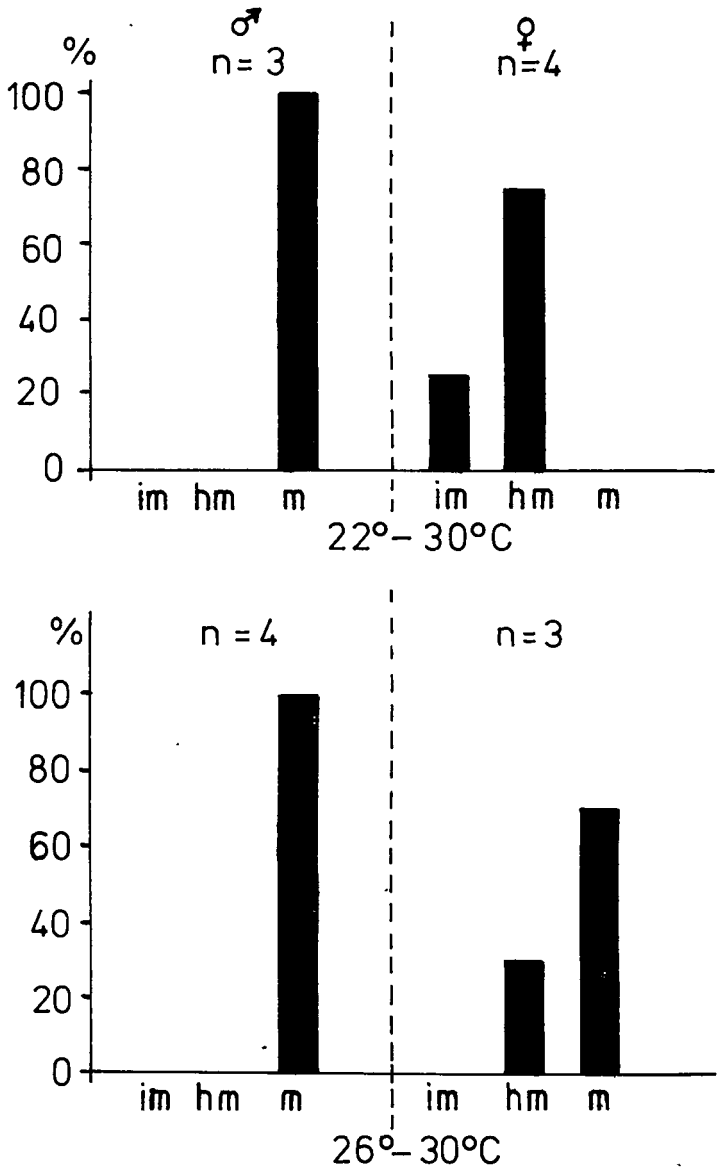

Fig. 5:
State of maturity for males and females in the cultures with day-night temperature fluctuation (im = immature, hm = half mature, m = mature).

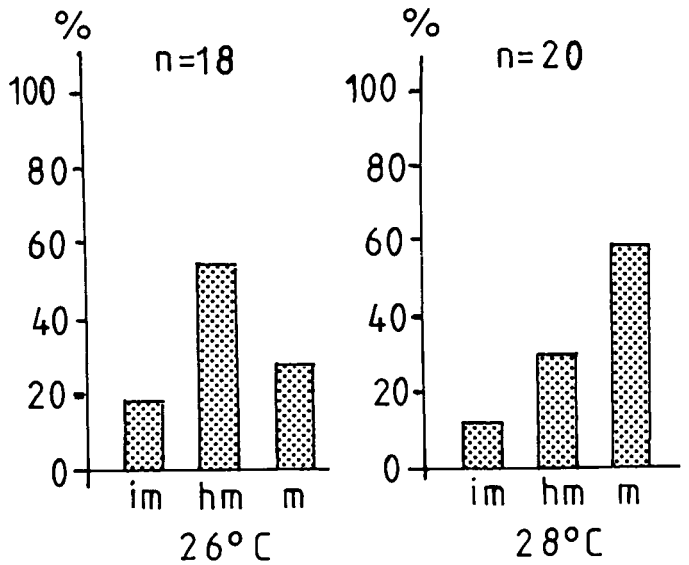

Fig. 6:
State of maturity for females in the cultures with constant day-night temperatures (im = immature, hm = half mature, m = mature).

Discussion

The investigation of seasonality of tropical animal populations is still in the beginning. Seasonal fluctuations are wide spread in tropical mountain areas (PAARMANN 1976) and in the tropics with distinct rain and dry periods (WOLDA 1978a, 1983). In those habitats diapause seems to exist, to survive the dry period (PAARMANN 1977; WOLDA & DENLINGER 1984). However for the wet tropical forests no or only low seasonal fluctuations of animal populations are supposed (YOUNG 1982; WOLDA 1978b).

In Central Amazonia exists indeed a dry and rain period. However the forests are considered as lowland wet tropical forests (SALATI et al. 1979). In the investigated habitats seasonality is induced mainly by the seasonal water level fluctuations. In the inundation forests of the Amazon as well as of the Rio Negro a distinct seasonality of animal populations has been found for both aquatic (IRMLER 1975) and terrestrial animals (IRMLER 1979; ADIS 1981; STURM & ADIS 1984). Especially habitat changes play an important role within the life cycles of many terrestrial animals (IRMLER 1979; ADIS 1981, 1982; ADIS & SCHELLER 1984). In the present nearly nothing is known about the control mechanisms of these habitat changes.

For leaf eating insects the occurrence of the food was discussed to induce the seasonality (WOLDA 1978b). PAARMANN (1977) also discussed the temperature as release for a primitive form of gonad diapause of carabids.

In the presented experiments with *Pentacomia* the high importance of small temperature fluctuations is stressed. The annual temperature fluctuations of the night temperature is supposed to be essential for the reproductive cycle of the beetle. Constant temperatures seem to effect a higher mortality as a day-night temperature fluctuation.

With other species of the inundation forest no similar experiments could be executed. Probably the direct contact with water corresponding with a change of orientation also induce habitat changes (IRMLER 1981). However, for *Pentacomia* the direct contact with the water could not control the habitat change, because the species migrate to the tree trunks already before the water reaches the habitat, according to observations in the field (IRMLER 1973).

A form of gonad diapause as supposed by PAARMANN (1977) for tropical carabids in mountain areas may be excluded for *Pentacomia egregia.* For this species the female gonad development seems to be induced by a direct temperature effect. The experiments with the constant temperatures show that the 26 °C level is essential for the gonad development. The females therefore seem to be in a high degree polystenotherm. Nevertheless this reproductive cycle controlled by the temperature can be considered as an adaptation to the extreme conditions in the inundated habitat.

Summary

The cicindelid beetle *Pentacomia egregia* occurs in the inundation forests of the Amazon valley. The reproductive cycle and the habitat change depend on the seasonal water fluctuations. Experiments with daily temperature fluctuations of 22 - 30 °C and 26 - 30 °C respectively constant temperatures of 26 and 28 °C show that probably the high night temperature of at least 26 °C induces both the habitat change and the gonad development of the females. The gonad development of the males is not controlled by the tropical temperature conditions of the Amazon valley.

Acknowledgments

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