Dawn of Migrants - Heat Requirements of the Flight Forms in *Callosobruchus maculatus*

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Introduction

Migration flight is an important response of insects to spacial or temporal variation in habitat quality. In some insects, the ability to disperse is discontinuous; populations consist of both distinct flightless and flying morphs. This phenomenon is called dispersal polyphenism, and is often used as subjects for studying phenotypic plasticity. Dispersal morph ratios usually depend on the intensity of environmental factors such as population density, predation, and food quality. These "cues" can promote changes during their early developmental stages, resulting in a specific developmental pathway to become flight morphs.

The bean beetle (*Callosobruchus maculatus*) is a worldwide pest of stored products that infests various types of beans. Their dispersal morph, or "flight form", exhibits heavier body weight, longer lifespan, and less fecundity than the "flightless form". Production of the flight forms in *C. maculatus* is triggered by an increase in temperature during the 2nd or 3rd instar periods (Sano, 1967, Appleby & Credland 2007). Normally, this increase in temperature results from accumulated metabolic heat of highly crowded larvae inside beans. Laboratory cultures of *C. maculatus* gradually lose their ability to produce flight forms under crowded conditions. Typical culturing practices results in the selection of the faster-developing and more fecund flightless morph. Although long-kept laboratory strains tend to lose their ability to produce flight forms, some experiments in previous studies were still able to produce flight forms. In this research, I investigated how laboratory strains with the ability to produce flight forms react to temperature cues differently from previous studies.

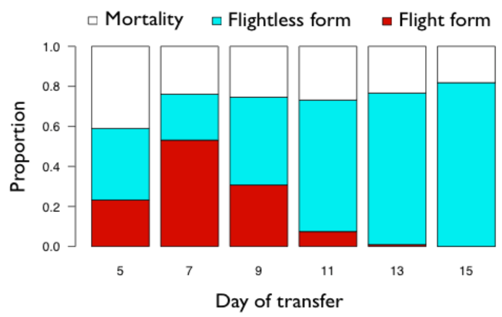
Materials & Methods

A total of 10 strains of *C. maculatus* cultures in the laboratory were investigated. Three strains were still able to produce flight forms despite being kept in the laboratory for a long time. The Kotakinabalu strain was obtained from Malaysia in 2003, the Nlongkak strain was obtained from Cameroon in 1998, and the Indra Chowk strain was obtained from Nepal in 2005. All cultures were reared in azuki beans at 30°C, 70 r.h. during this research.

The purpose of this experiment is to investigate the reaction to heat (in terms of morph ratios) of our three laboratory strains that are able to produce flight forms. For each strain, newly emerged adult females were allowed to mate and oviposit on mung beans (*Vigna radiata*) for 3-6 hrs, depending on the fecundity of each strain. The beans were examined on the 5th day after oviposition and only those with 1 hatched egg were used in the experiment. A minimum of 60 beans per set were transferred from the 30°C rearing chamber to a 35°C incubator during different periods of early development (ranging from the 5th - 15th day after oviposition). This change in temperature was enough to produce sufficient flight forms according to previous studies.

Results

The Kotakinabalu and Nlongkak strains hardly produced any flight forms, while the Indra Chowk strain produced a much more sufficient amount of flight forms (figure below). Optimal production occurred when the rise in temperature was applied on the 7th day after oviposition. The most sensitive period corresponded to the 1st and 2nd instar periods.



Discussion

The results showed a different reaction to the temperature cue from those of previous studies. The Kotakinabalu and Nlongkak strains did not react strongly to the cue, possibly because the long-term culturing in the laboratory has raised their temperature threshold. The Indra Chowk strain reacted differently from previous studies where the sensitive period was reported to be the 2nd instar or between the 2nd and 3rd instars. The cue-sensitive period of Indra Chowk was around the 1st and 2nd instars where the most of the larvae are still near the peripheral of the beans (cooler than the center if it were crowded). These changes in cue-sensing thresholds and cue-sensitive periods are most likely the results of adaptations to avoid sensing the cue and prevent the production of the less-fecund flight form in laboratory cultures.

In order to fully understand the mechanism of flight form in *C. maculatus*, further research is needed. Understanding how *C. maculatus* produces the flight form can be applied to design practices in pest control to prevent their dispersal over stored products.