ENVIRONMENTAL INFLUENCES ON THE FLIGHT AND MIGRATORY POTENTIAL OF *HELICOVERPA PUNCTIGERA* AND *H.ARMIGERA* (LEPIDOPTERA: NOCTUIDAE).

by

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DECLARATION

I certify that the substance of this thesis has not already been submitted for any degree and is not being currently submitted for any other degree.

I certify that the help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

Marc Coombs

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CONTENTS

Abstract

This study examined the role of environmental factors in influencing the flight capacity of *Helicoverpa punctigera* (Wallengren) and *H. armigera* (Hübner) moths (Lepidoptera: Noctuidae).

Flight capacity of female and male moths were measured by means of a tethered flight technique. Flight capacity was found to be age dependent in both species. In *H. punctigera,* flight ability increased from the first night following emergence up to night 4, and was maintained at least until night 10. In *H. armigera,* a peak in flight capacity occurred on night 4, followed by a decline with increasing age. Long flying (> 5 hr duration) moths were evident in both species from the night following emergence. Attainment of reproductive maturity was rapid in both species, with 91 % of *H. punctigera* and 77 % of *H. armigera* ovipositing by night 3. Hence, the increase in flight capacity recorded for both species during early adult life is coincident with the onset of reproductive activity. Both species retain the capacity for extensive inter-crop and inter-regional movement throughout most of the reproductive phase of their adult lives. Neither successful mating or the absence of adult food sources influenced flight capacity during early adult life.

Throughout the study the rearing methodology employed was designed to minimise the effects of inbreeding depression and inadvertent selection of genotypes. This was achieved by maintaining a broad base of mating pairs (25 - 30) for successive laboratory generations of both species. All experiments were conducted with insect material that had been in culture for not more than four generations.

Determination of the reproductive maturity and mating status of migrant *H. punctigera* and *H. armigera* moths collected from light traps mounted on towers shows that migration occurs prior to the onset of initial egg maturation and prior to mating in both species.

On flight mills, *H. punctigera* moths maintained average flight speeds of 3.2 (males) and 3.6 (females) km hr^{-1} and achieved maximum overnight (10 hr) flight distances of more than 60 km on night 4. *H. armigera* moths maintained average flight

speeds of 4.8 (females) and 5.2 (males) km hr^{-1} and also achieved maximum overnight flight distances of more than 60 km. There was no correlation between body size or morphometric parameters with distance flown in either species.

Maintenance of *H. punctigera* and *H. armigera* populations, originating from different geographic localities, under uniform laboratory conditions revealed genetic variation for some life history traits and flight capacity. Genetic differences in preoviposition periods were detected among populations of both *H. punctigera* and *H.armigera,* and in flight capacity during early adult life among *H. punctigera* populations, and at peak flight capacity among *H. armigera* populations.

H. punctigera and *H. armigera* moths utilise a preflight warmup behaviour (wing shivering) to elevate thoracic temperature to a level at which flight is possible. Both species maintain thoracic temperatures of 20 - 32 °C during free flight at ambients of 12 - 30 °C. Preflight warmup duration is inversely related to ambient temperature. Both *H. punctigera* and *H. armigera* moths require 12 - 15 mins at ambients of 10 °C to elevate thoracic temperature to a level sufficient for flight. Neither species were able to initiate preflight warmup or maintain flight at ambient temperatures of less than 5 °C. The inability of adults to maintain flight at ambients of less than 5 °C may serve to limit flight in cold upper air at night. Endothermy (wing shivering) became energetically more expensive for both species as the difference between thoracic temperature and ambient temperature increased.

Differing larval diets were shown to phenotypically modify body size parameters, but did not influence flight capacity. Both species displayed wide plasticity in the size at which successful pupation occurred. The lower pupal weights that permitted adult emergence were approximately 24 % (91/372) and 37 % (153/413) of the maximum pupal weight recorded for *H. punctigera* and *H. armigera* respectively. Low thresholds and high plasticity of pupal weight may have evolved in response to conditions of high temporal variation of host plant quality and availability.

H. punctigera adults display polyphenic variation of life history traits and flight capacity in response to seasonal changes in temperature and photoperiod. Successive

generations of *H. punctigera* maintained in field cages, exhibited an increasing incidence of the following traits; increased time to first oviposition, increased forewing to body length ratios, and increased flight capacity. Expression of these traits may potentially serve to extend the range of migration for this species during autumn. The likelihood and significance of autumn migration in the seasonal redistribution of this species remains to be determined.