FLIGHT AND DISPERSAL CAPACITIES OF *HELIOTHIS ARMIGERA* AND *H. PUNCTIGERA* ADULTS

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INTRODUCTION

The importance of flight to the biology of *Heliothis* has, in itself, played a major role in the establishment of the pest status of this insect. Flight serves a number of functions. Within habitats, flight enables adults to locate both their own feeding sites and those sites most suitable for the growth and development of their offspring. Between habitats, flight can allow escape from deteriorating conditions and the colonisation of new areas; for *Heliothis* moths this may occur on both a local and a regional scale.

The pattern of flight activity within or between habitats or crops is dependant upon the distribution of those habitats/crops in both space and time. Similarly the pattern of movement of moths over large areas may be determined largely by shifting seasonal patterns of habitat availability. In both these instances, the inherent flight capacity of an individual is critical in determining its ability to exploit the ephemeral nature of both cropping and non-cropping systems.

Flight performance can be considered under two broad catergories: firstly, an insect's capacity to maintain flight for varying durations, which may range from a few minutes to several hours, and secondly, the flight speed that an individual is capable of holding over the length of a given flight.

Characterising the flight behaviour of an insect such as *Heliothis* is central to any efficient system that attempts to model the movement of adults both within and between habitats. In recognising these facts, a study was undertaken to determine the capacities for flight of *Heliothis armigera* and *H.punctigera*, both of which reach economic pest status among Australian crops.

METHODS

Moths were flight tested on one of two tethered-flight systems, depending upon whether potential flight durations or flight speeds were being investigated. When determining changes in flight durations with, for example age, moths were suspended from a vertical rod. Loss of contact by the insects with the ground initiated flight. The durations of the subsequent flights were then recorded. When examining flight speeds moths were placed on a flight mill, where a circular flight path was enforced. Distance flown was automatically recorded and flight speeds calculated at set intervals.

In the first method moths do not expend energy in supporting their body weights during flight, and therefore, the measured flight durations are an over-estimate of the insect's ability under natural conditions. In comparison, moths tethered to a flight mill must overcome the resistance or drag of the mill arm, and thus the flight speeds recorded are an under-estimate of speeds that will be achieved in the field. Moths flown on a mill, however, typically fly to exhaustion. These limitations of each system must be taken into consideration when interpretating the data.

RESULTS AND DISCUSSION

Profiles of changes in flight ability with increasing age are shown in Figs. 1A and 1B for *H.punctigera* females and males. In both sexes flight ability increases in the first 3-4 days of adult life. For most of the remainder of the insect's life, flight levels remain elevated but variable. Mean flight durations for both sexes were approximately 35 minutes. Figure 2 illustrates the distribution of flights in 30min. categories for females (pooled data for moths of 3-10 days of age). The majority of moths undertake flights of less than 30mins., while only a small percentage make flights in excess of 2 hours. Males display a similar pattern of flight ability.

Age related flight profiles for *H.armigera* females and males are shown in Figs. 1A and 1B. As with *H.punctigera* flight ability increases in the first few days of adult life. Mean flight durations were greatest at 4 days of age for females and males, at 110 mins. and 175 mins. respectively. When flights are placed into 30min. categories (Fig.4), most moths were short fliers (<30mins).

Tables 1 and 2 show flight distances and flight speeds achieved by moths when flown on a mill. Mean flight distances recorded by males and females of both species increased between 1 and 4 days of age. This is be expected given the increase in age-related flight performance as seen in the profile data (Fig.1, 3). In both species mean flight distances of males were greater than those of females (with the exception of 1-day old *H.punctigera*). *H.armigera* adults, overall, fly further than *H.punctigera* adults. Upper flight distances achieved by both sexes of *H.armigera* and *H.punctigera* were in the order of 50-60km. during the 10 hours allowed.

In both species, flight speeds of males (as measured during the first hour of flight) exceeded those of females. Flight speeds of *H.armigera* were greater than those for*H.punctigera*.. Maximum recorded flight speeds for *H.armigera* were in the order of 8.7 km/hr for 4-day old males, and 7.9km/hr for *H.punctigera* males of the same age.

When extrapolating the data to the field, it should be noted that under natural conditions, moths are free of any tethering constraints and flight is downwind. Under these criteria, flight speed achieved by an insect will be a linear relationship of a moth's air speed plus the wind speed.

Both methods of investigating flight abilities of the two species indicate that *H.armigera* adults fly further and faster than *H.punctigera* . This indicates a greater potential dispersal and colonisation rate for *H.armigera*.. This dispersal and colonisation potential clearly demonstrates the importance for management practices to be undertaken on an area wide level. High selection pressure for pesticide resistance in one area, through the untimely application of pesticides or differing management strategies for varying crops may easily be confered to neighbouring areas in relatively short periods.

Table 1 Average distances (km) achieved during a 10hr. nocturnal flight by *H.armigera* and *H.punctigera* adults at 1 and 4 days of age.

		1-day old				4-day old			
		x	S.E.	n	Range	x	S.E.	n	Range
H.armigera	male	31.3	3.9	25	2.4-60.5	41.5	3.1	22	13.3-65.9
	female	25.9	4.1	19	0.8-59.2	33.1	2.9	27	5.9-62.8
H.punctigera	male	10.0	2.3	28	0.7-62.9	37.1	4.3	19	8.1-65.4
	female	12.1	2.6	25	1.6-52.3	28.8	3.1	36	5.4-64.1

Table 2 Average flight speeds (km/hr) achieved during the first hour of flight by *H.armigera* and *H.punctigera* adults at 1 and 4 days of age.

		1-day old				4-day old			
		x	S.E	n	Range	x	S.E	n	Range
H.armigera	male	3.3	0.2	25	0.9-5.9	5.5	0.5	22	2.8-8.7
	female	2.4	0.3	19	0.7-5.4	4.5	0.3	22	1.6-7.8
H.punctigera	male	2.1	0.3	28	0.3-6.5	3.8	0.4	19	1.9-7.9
	female	1.6	0.2	25	0.3-6.9	3.2	0.3	24	1.7-7.7

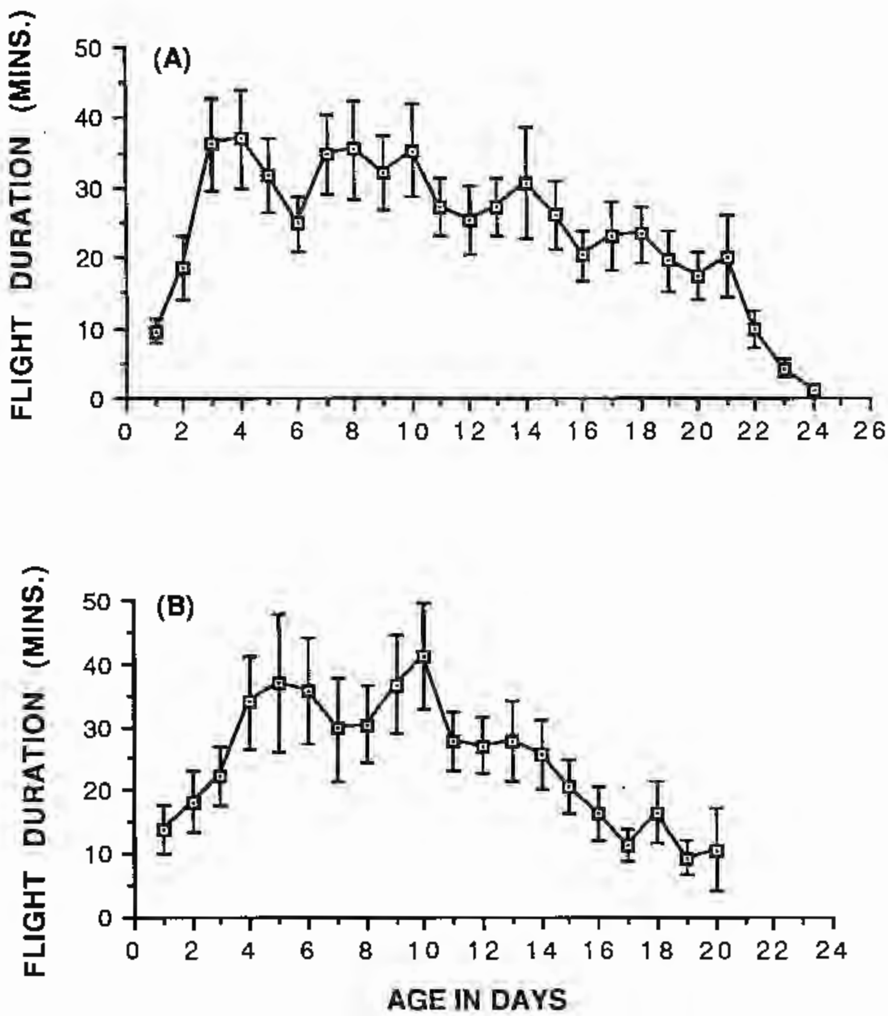

Fig. 1 Flight profiles for H.punctigera, (A) females and (B) males flown on consecutive nights throughout their lifetime.

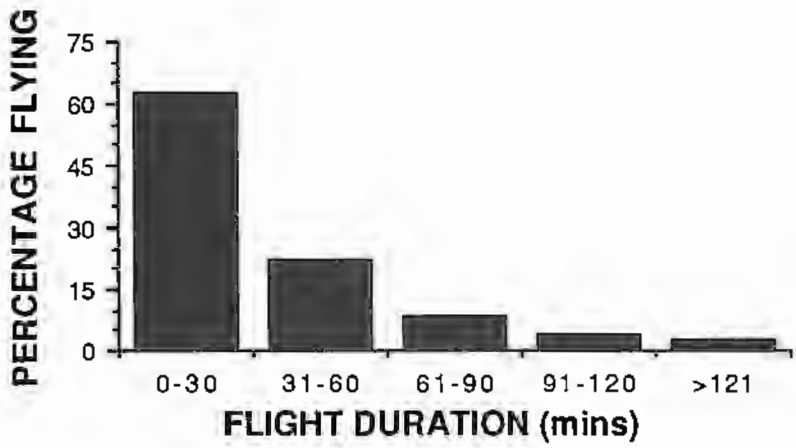

Fig.2 Percent ocurrence of flights in 30 min. categories for H.punctigera females. Pooled data for 3-10 day old moths.

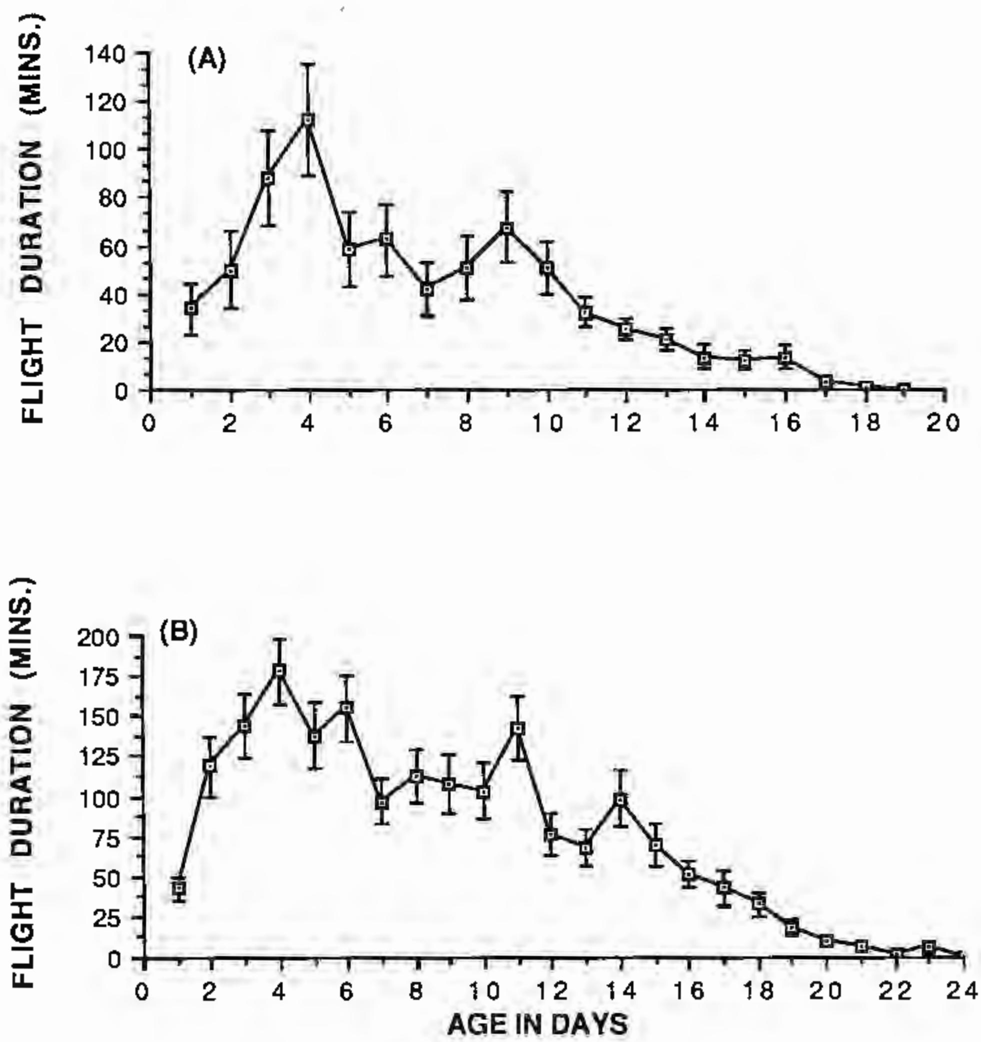

Fig. 3 Flight profiles for H.armigera, (A) females and (B) males flown on consecutive nights throughout their lifetime.

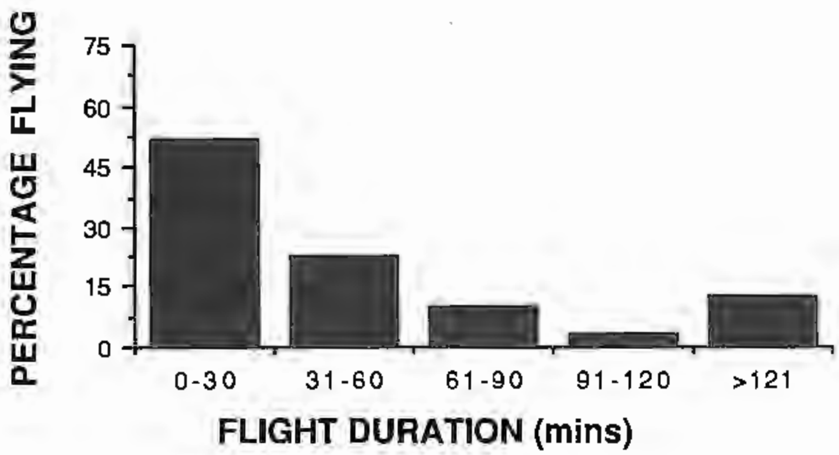

Fig.4 Percent occurrence of flights in 30 min. categories for H.armigera females. Pooled data for 3-10 day old moths.