OBSERVATIONS ON THE FLIGHT ACTIVITY OF STEM WEEVIL *HYPERODES BONARIENSIS* KUSCHEL IN CANTERBURY, NEW ZEALAND

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Summary

This study has shown that stem weevil adults in Canterbury have dispersive flights throughout a period commencing in late August and ceasing in late April. Flight activity is simulated to a change in weather from a north-easterly to a south-westerly air stream. In Canterbury such a change passes through a period of north-westerly weather, and for a variable period preceding the south-westerly front, wind speed drops, the relative humidity falls, and temperature increases. Flight was only observed to commence when the wind speed was less than 8 m.p.h., the relative humidity below 64% and temperature greater than 61°F. The regular flight activity of the stem weevil serves to disperse its populations, with the result that even newly sown grass and cereal crops are quickly infested and subsequently suffer severe damage by larval populations of it.

INTRODUCTION

APART from the work of Pottinger (1961a, b), little is known about the flight activity of the stem weevil, *Hyperodes bonariensis* Kuschel. A summary of this study (presented for the degree of Master of Agricultural Science) is given here. Kelsey (1958) noted that mating flights occurred during periods of bright sunlight from sea-level to 4,500 ft, while Morrison (1959) reported that stem weevils had been observed swarming in still afternoon sunshine in April over pastures at Lincoln College.

Spontaneous flight activity has been reported for many insects in calm, warm, sunny weather, but little is known of the weather conditions and climatic factors which affect it. Most work on flight activity among insects has been concerned with aphids, flies and locusts. Few comprehensive studies appear to have been made on the flight activity of beetles, although Atkins (1958, 1959, 1960) has investigated the flight of two beetles, *Priacma serrata* Lec. and *Dendroctonus pseudotsugae* Hopk.

Henson (1951), Rainey (1951) and Wellington (1954, 1957) have studied mass weather effects on insects and have recorded the apparent effects of approaching and receding fronts on insect activity. Wellington (1957) suggests that particular types of weather have their own peculiar identifying features which effect a particular behaviour response in certain insects. Wellington further noted that characteristic types of micro-environmental weather are produced by particular general weather systems and that the variability within the micro-environment can be classified in terms of general weather types. Wellington's (1957) conclusion that classifying insect activity in relation to general weather patterns rather than on static recordings alone is supported by the earlier study of Henson *et al.* (1954). As populations, weather and climate are all dynamic and not static as fixed climatic recordings are, the explanation of one dynamic

happening (such as flight behaviour) using another dynamic concept (such as air mass climatology), is more applicable than relating activity entirely to a specific set of static factors operative at set times and which never occur simultaneously throughout the micro-environment.

In 1960, Johnson published a theory outlining principles for a general system of insect migration and dispersal by flight. He noted that, in spite of a voluminous literature referring to insect flight, few mass migrations or dispersals of insects have been described. Nearly all the insects studied have been making their first flight or one soon afterwards. Johnson regards most post-teneral flights and post-hibernation flights as exodus flights which become dispersive and take insects to new breeding sites from which new adults of another generation migrate. Generally, insect flights are made without reference of individuals of the species to each other.

This study was initiated to record the flight activity of *H. bonariensis* more precisely and to determine when flights occurred; the conditions initiating flight; the characteristics of flights; and the relationship of flight activity to the infestation of newly sown fields.

EXPERIMENTAL

Coloured, cylindrical adhesive traps similar to those used by Broadbent *et al.* (1948) were set up over selected fields. The traps consisted of galvanized iron cylinders (stovepipe), 4-in. in diameter and 12 in. long. Following the suggestions of Close (1959), they were covered with cellulose acetate film, and smeared with cup grease (Shell compound 0) as an adhesive. Care was taken to erect the traps in positions where the ground was uniformly flat, away from natural depressions, hillocks, hedgerows and other obstacles which could markedly affect the amount and rate of airflow around the traps. As near as possible, all were exposed to similar conditions. Sectors corresponding to the eight points of the compass were marked on the inner side of the cellulose acetate film, in order to record the position on the traps on which the weevils alighted. Yellow, green, red, blue, black and white traps were used to determine whether or not the weevils were more attracted to any specific colours. The traps were set up on July 1, 1959, and inspected each morning and evening until January 31, 1960, and periodically thereafter until June 30, 1960, when trapping finished. Fresh grease was applied regularly and intervals between application were determined by the amount of weathering on the previous coating. In spring and autumn, grease often lasted one to two weeks, in the summer sometimes only one to three days.

One group of traps was set up within a wheat field and another group along the fence-line between two ryegrass fields. The traps were spaced at 11 yd intervals and two each of the various colours were randomized along a straight line in a north-south direction. The trap bases were maintained at about 4 ft above the pasture and wheat crop. Trapping in the wheat field ceased on December 1, 1959. Two yellow and two green traps were erected over a ryegrass sward adjacent to the Meteorological Station on December 1, 1959, to assist correlation of flight activity with climatic factors.

Meteorological information for correlation with flight activity was obtained from both the Harewood and Lincoln College meteorological stations. Continuous recording equipment for measuring wind speed and direction, humidity, temperature and barometric pressure was not always available. From April 20, 1959, until Nov-

TABLE 1: TOTAL STEM WEEVIL ADULTS CAUGHT, THE TIMES FLIGHTS WERE OBSERVED TO COMMENCE AND CEASE AND WEATHER CONDITIONS OPERATING ON DAYS OF OBSERVED AND RECORDED FLIGHT

Date	No. caught			Time (hr)		°F	Relative Humidity			Wind Direction		Pressure Change			
	12 traps over ryegrass	12 traps over wheat	4 traps over grass (Met. Stn)	Commencement of flight	Cessation of flight		Commencement of flight	Cessation of flight	Minimum during flight	Preceding flight	Following flight		Sky condition		
20.4.59	—	—	—	1330	1615	70	62	71	34	44	33.5	NE	W	Sun	—
22.4.59	—	—	—	1400	1500	64	72	72	44	43	39	NE	SW	Sun	F
24.4.59	—	—	—	1200	1345	68	62	70	43	46	42	NE to calm	SW	Sun	—
31.8.59	10	11	—	—	—	—	—	73	—	—	26.5	NE	SW	Sun	—
1.9.59	149	155	—	1330	1630	61	60	70	34	33	30	NE	SW	Sun	—
6.9.59	39	65	—	1300	1630	68	69	72.5	30	20	17.5	NE	SW	Sun	F
23.9.59	6	16	—	—	—	—	—	66	—	—	28	ENE	SW	Sun	—
7.10.59	2	—	—	—	—	—	—	69	—	—	29	NE	SW	Sun	—
11.10.59	1	—	—	—	—	—	—	66.5	—	—	36.5	NE	NW	Sun	—
23.10.59	27	14	—	1130	1350	66	60	66	32	41	28	NE	SW	Sun	—
25.10.59	34	27	—	1200	1400	68	70	70.5	44	38	36	NNE	NW	SC	F
26.10.59	92	26	—	1130	1345	61.5	68	80	38	34	30.5	NE	SW	Sun	F

13.11.59	.....	30	4	—	1115	1400	70	71	78	40	42	36	NE	NW	SC	F	R
19.11.59	.....	36	10	—	1500	1630	80	78	69.5	—	—	36	NE	SW	SC	F	R
24.11.59	.....	7	—	—	1045	1200	—	—	82.5	38	32	30	NE	SW	Sun	F	R
25.11.59	.....	3	—	—	—	—	—	—	63.5	—	—	19	NE	SW	Sun	—	—
29.11.59	.....	7	1	—	—	—	—	—	84	—	—	17	NE	SW	Sun	—	—
1.12.59	.....	183	—	—	1300	1800	—	—	84	—	—	42	NE	SW	Sun	F	R
7.12.59	.....	45	—	57	1000	1130	—	—	77	—	—	48	NE	SW	HC	F	R
8.12.59	.....	9	—	—	—	—	—	—	82.6	—	—	32	Calm	NW	SC	—	—
12.12.59	.....	4	—	1	—	—	—	—	71.5	—	—	64	S	—	SC	—	—
19.12.59	.....	4	—	—	—	—	—	—	62.3	—	—	34	NE	—	SC	—	—
22.12.59	.....	1	—	18	—	—	—	—	75	—	—	58	NE	SW	SC	—	—
23.12.59	.....	9	—	4	—	—	—	—	68	—	—	64	SW-NE	SW	Sun	—	—
23.12.59	.....	4	—	—	—	—	—	—	71	—	—	55	SE	—	SC	—	—
27.12.59	.....	37	—	5	—	—	—	—	84.4	—	—	30	E-NW	SW	SC	F	R
2.1.60	.....	22	—	—	1700	1800	—	—	68	—	—	53	NE	NW	Sun	—	—
3.1.60	.....	17	—	17	—	—	—	—	78.8	—	—	52	NE	SW	Sun	—	—
10.1.60	.....	84	—	4	—	—	—	—	72	—	—	42	NE	SW	SC	F	R
11.1.60	.....	4	—	—	1500	1545	—	—	86	—	—	16	NW	SW	SC	—	—
19.1.60	.....	20	—	20	1500	1700	—	—	92	—	—	38	NE	NW	HC	F	R
29.1.60	.....	1299	—	393	—	—	—	—	65	—	—	48	Calm	SW	SC	—	—
20.2.60	.....	35	—	—	—	—	—	—	85.5	—	—	44	NE-NW	SW	SC	—	—
25.2.60	.....	83	—	—	—	—	—	—	78	—	—	24	NE-NW	SW	SC	—	—
27.2.60	.....	—	—	—	—	—	—	—	89	—	—	34	N	SW	SC	—	—
10.3.60	.....	—	—	—	—	—	—	—	64	—	—	59	NE	SW	SC	F	R
21.4.60	.....	931	—	—	1400	1445	—	—	—	—	—	—	—	SW	Sun	—	—

F = falling
R = rising

HC = high cloud
SC = scattered cloud

ember 30, 1959, continuous temperature and relative humidity taken outdoors and within half a mile of all the traps with a Casella thermohygrograph 2 in. above ground level were made available.

Sticky traps as described and used in this study were chosen with a full understanding of their shortcomings compared with more efficient quantitative trapping methods such as suction traps discussed by Johnson (1950), Eastop (1955) and Heathcote (1957). They were the best traps available for this study and, although total numbers caught cannot be used to indicate the density of flights, they can be used to indicate the days on which flights took place. The traps also assisted in recording the time of commencement and cessation of flight, especially when the weevils were flying at densities too low to be visually observed.

RESULTS

Weather conditions on the days of recorded flight, total adult weevils caught and the times flights were observed to commence and cease are presented in Table 1. From February 1, 1960, until June 30, 1960, the traps could only be inspected periodically and only catches which could be recorded as occurring on a certain date are presented in this table. No adults were caught subsequent to April 21, 1960. The results of trapping are summarized in Table 2.

TABLE 2: SUMMARY OF THE TOTAL NUMBER OF STEM WEEVIL ADULTS CAUGHT OVER RYEGRASS AND WHEAT

	<i>Traps over Ryegrass</i>	<i>Traps over Wheat</i>
Trap colour:		
Blue	430	50
Black	431	39
Red	489	53
Green	587	58
White	636	61
Yellow	657	68
Total	3,230	329
Sector:		
North-east	436	30
North	554	27
North-west	519	85
West	295	42
South-west	476	74
South	361	42
South-east	263	15
East	326	14
Total	3,230	329

TRAP CATCHES

Analyses of variance tests were made on the results to determine whether the catches in the different sectors and between the various coloured traps were significantly different. The results of these tests are summarized in Table 3. As significant differences were obtained in both fields for catches between different coloured traps and sectors of the compass, Duncan's Multiple Range test was used to test the series of means for each of these, for significant differences. The results of this test are summarized in Table 4. On the basis of these results red, green, white or yellow traps could be

used for trapping adult weevils in flight. As yellow traps caught more weevils than any other coloured traps and catches on yellow traps are significantly different from catches on black traps, in both fields, yellow would be preferable to other colours. Duncan's Multiple Range test revealed significant differences only between means of adults caught per sector for traps in the wheat field. Catches on the north-west and south-west sectors were significantly different from the catches on the east and south-east sectors. When total weevils caught on the western halves of the traps (north-south-west) were compared by analysis of variance test with numbers caught on the eastern halves (south-north-east) of the traps, the higher catches on the western sides were found to be significantly different at the 5% level of significance.

In observed flights it was noticed that the weevils alighted on the traps and were not passively blown on to them. No freshly trapped weevils were observed with grease on their dorsal surfaces. Except during calm periods when the weevils alighted freely on all faces, the majority landed on the face in the direction the wind was blowing, although, probably because of eddies around the traps, weevils did alight in other sectors. That the weevils alight on to the traps suggests that they are able to make some selection on where and how they alight.

During flight periods, the wind passed from the north-east, through a north-westerly direction to the south-west, rarely being noticeable as a distinct westerly. Because there was variation between the amount and length of time that the wind blew from different quarters, total catches vary between the sectors. Flights began as the north-east wind waned and as the air stream began to move through the northerly arc and ceased as soon as the wind velocity or other climatic factors became adverse. If the flow of warm, dry air preceding the south-west front was slow, then the weevils continued to fly and this is reflected in the comparatively large catches on western halves of the traps. The length of calm, warm, dry air determines the length of flight.

Another factor which could influence catches in sectors was the total population of weevils present in the sward to the east and west of the traps. Regular flotation extractions of adult weevils from turf samples in fields adjacent to the traps (Pottinger, 1961a) indicated that populations were higher throughout the trapping period to the east of traps, yet greatest catches were recorded from the west.

Because the traps had a small surface area exposed per unit volume of air flowing around them, all flights recorded were probably of reasonable size. Thus the days of flight as indicated by the trap catches are probably not indicative of all flights. Examination of meteorological records suggests that flights could have taken place on several other days but were not observed.

FLIGHT ACTIVITY

Flights were observed on 17 occasions and records of another 19 made from the twice-daily inspection of the traps. It is apparent that the weevil flew only when particular weather conditions prevailed. During observed flights, the sky was clear overhead, the wind light and less than 8 m.p.h., the temperature always over 60°F, the relative humidity less than 59%, and the barometric pressure falling prior to flight and rising subsequent to flight. It was also noted that these flights took place during a change in weather from a north-easterly air stream to a south-westerly one.

TABLE 3: SUMMARY OF ANALYSIS OF VARIANCE TESTS ON NUMBER OF ADULTS CAUGHT ON DAYS OF FLIGHT, TRAP COLOUR AND SECTOR OF THE COMPASS

	Colours	Sectors	Days of Flight
Traps over ryegrass	**	*	**
Traps over wheat	*	**	**

* Significant at the 5% level.

** Significant at the 1% level.

TABLE 4: SUMMARY OF DUNCAN'S MULTIPLE RANGE TEST COMPARING BETWEEN MEANS OF TOTAL STEM WEEVIL ADULTS CAUGHT, FOR TRAP COLOUR AND SECTOR OF THE COMPASS ON DAYS OF FLIGHT

(All the significant differences indicated are at the 5% protection level)

RYEGRASS

Colour	Blue	Black	Red	Green	White	Yellow
$\bar{x}$	13.87	13.90	15.77	18.94	20.52	21.19
(S.E. = 1.87; 150 error d.f.)			a	b	b	a
	c		b	c		
	d		d			
	e		e			

Sector	SE.	W.	E.	S.	NE.	SW.	NW.	N.
$\bar{x}$	8.48	9.52	10.52	11.65	14.06	15.35	16.74	17.87
(S.E. = 3.44; 210 error d.f.)	No significant differences between any of the means compared.							

WHEAT

Colour	Black	Blue	Red	Green	White	Yellow
$\bar{x}$	3.9	5.0	5.3	5.8	6.1	6.8
(S.E. = .809; 45 error d.f.)		a	b	b	b	a
	b		c	c		
	c		d			
	d		e			

Sector	E.	SE.	N.	NE.	W.	S.	SW.	NW.
$\bar{x}$	1.4	1.5	2.7	3.0	4.2	4.2	7.4	8.5
(S.E. = 1.79; 63 error d.f.)			a	b	b	b	a	a
	c		c	d	d			
	d		e					
	e		f					
	f		g					

Flights always took place during the day, usually in late morning or early afternoon. The earliest recorded flight activity began at 10.00 a.m. and the latest ceased at 7.15 p.m. Flight periods ranged from 45 minutes to 5 hours but generally most flights observed lasted one to two hours. Only the larger flights were observed because of the weevil's small size, its inconspicuousness during flight, and low densities per unit volume of air. Small flights lasting only a few minutes, if they occurred, would probably go unnoticed unless recorded on the traps.

Stem weevils are clumsy fliers and are unable to make strong or active flight. When wind speeds exceeded 2 m.p.h. they drifted with the breeze. They made controlled flight only under almost calm conditions and then the weevils made vigorous upward flight and hovered over the ground. Flight activity ceased in winds exceeding 8 m.p.h. Accurate records of how high or how far the weevils flew, or drifted, were not made, although they were caught 90 ft above ground level on a water tower and in the middle of a cultivated field 200 yd distant from the nearest source.

Prior to the commencement of flights, especially during the late summer and autumn when populations of adults were higher in pastures, increased weevil activity could be seen on the ground. Within the sward, adults crawled over the ground and foliage. This is unusual as their normal behaviour on bright, sunny days is to shelter deep in the sward. Eventually they climbed up the stems and leaves and launched themselves from there into the air. During flight periods in the late summer and autumn, the air was often thick with stem weevils. Greatest visual densities of adults were seen over established pastures rather than over cereal crops, fallow and new-sown areas. As the stem weevils came close to the ground, they gave the appearance of falling rapidly over the last three or four feet, rather than alighting. Weevils were observed to land in cereal crops, pastures and fallowed areas with the cessation of flight activity. Observation suggested that many weevils left the field in which they initiated flight, but it was also apparent that not all adult weevils were flying at once. The age of flying weevils could not be determined but many of the adults trapped subsequent to December had the distinct reddish tinge of newly emerged adults.

An attempt was made to relate barometric pressures recorded at Harewood Meteorological Station, but flight apparently can take place whether the barometric pressure is high or low. Prior to each flight there was a drop in barometric pressure and an increase afterward. Following the cessation of flight, the relative humidity often rose sharply and it was always higher preceding flight than during flight. A similar relationship exists for wind, and an inverse one for temperature. All these changes are associated with the change from a north-easterly weather system to a south-westerly one, which always passes through a westerly arc. Other weather systems do not have the same corresponding conditions associated with them. Initially the south-west winds are dry and warm as they push the westerly air lying over the Canterbury plains ahead of the colder, moister south-west front. Weevils continue to fly in this dry, warm air until it is replaced by the south-westerly air mass moving in.

CONCLUSIONS

In all, 36 separate flights of *Hyperodes bonariensis* have been recorded and 33 have been characterized by a particular type of weather pattern, whilst 3 lack sufficient observation. Even in the absence of detailed and continuous climatic recordings in the

study region, it has become clear that *H. bonariensis* flight activity in Canterbury is closely associated with the onset of frontal weather preceding a change from a north-easterly to a south-westerly air stream. Flight activity is so well co-ordinated to these changes, which are a regular feature of Canterbury weather, that, on fine sunny days when south-west weather was forecast, flight activity could be predicted. *Hyperodes bonariensis* appears to be another insect whose flight activity can be correlated with changes in general weather conditions, based on the kind of principles outlined by Wellington (1954, 1957), even though much information about the exact climatic stimuli involved in the weevil's activity is still lacking. Such a correlation allows for an immediate understanding of the weevil's behaviour, permits prediction of flight activity, and yields a better understanding of its dispersive characteristics.

This is of practical significance to the farmer because flight activity facilitates infestation of newly sown or uninfested susceptible crops and pastures. However, one year's observations in one locality are insufficient from which to draw final conclusions and a more intensive study of this aspect of the weevil's activity is indicated. Such a study has been recommenced at Lincoln College.

As *H. bonariensis* flies only during frontal weather between a change from north-easterly to westerly weather in Canterbury, it would obviate the need to attempt to analyse accumulated static records for every day.

The observation that all the adults present in a population never fly at once, could be explained as due to variation among adults of response to climatic stimuli or to some physiological conditions associated with the stage of development of each individual. From the records available, it would appear that a similar relationship exists for *H. bonariensis* as Atkins (1959, 1960) has found for *Dendroctonus pseudotsugae* in response to a favourable stimulus invoking flight activity among some individuals. Although the weevils prefer bright, sunny weather for flight, on three occasions flights were recorded under partly cloudy or high cloud conditions. In the light of Atkins' work, no fixed upper or lower limits for specific climatic factors can be set, as different combinations of temperature and humidity alone could result in variation of response to flight owing to altered rate of evaporation from the insect's body. More exact recordings on such climatic factors as temperature, humidity, atmospheric pressure, wind speed, light and evaporation are required to substantiate fully the factors initiating and maintaining *H. bonariensis* flight activity.

The initial observations made in this study show that, as Atkins found, before flight takes place a minimum temperature is required whilst high humidity is inhibitory. Without substantiating laboratory studies, optimal temperature and humidity for flight cannot be deduced. On days when larger flights were observed, the relative humidity was less than 40% and the temperature greater than 70°F during the period of peak flight activity. This suggests *H. bonariensis* relies on evaporation, after the body has warmed sufficiently to maintain flight, to prevent overheating and consequently flight muscle paralysis.

The drop in pressure preceding flights has three possible connections with flight:

- (1) It may be part of the general weather pattern without any stimulating effect on *H. bonariensis* flight activity.
- (2) It may act as a triggering mechanism on sensory organs controlling flight.

- (3) As Atkins (1960) found, falling pressure could probably aid increased wing beat frequency and thus flight activity.

Frontal air weather is generally turbulent and this turbulence could aid flight by helping to lift weevils upwards. Wind speed appears to be a major factor in determining flight activity of the stem weevil and on some days of flight, when temperature and humidity still remained favourable, only the wind speed appeared to be inhibitory.

In Canterbury, where the observations were made, the optimal combination of climatic factors for *H. bonariensis* to fly appear to be associated only with the frontal weather of a change from north-easterly to south-westerly weather as outlined above. Elsewhere in New Zealand a similar wind change may not effect the same response in the weevil, as differences in topography, the characteristics of the different air masses passing over the country, and associated frontal weather between them would differ.

Kelsey (1958) stated that flights were for mating. This could not be verified by field observation. Pairing was observed to occur on the ground and not necessarily succeeding or preceding flight. Flights occurring in late April, after the cessation of oviposition, would hardly serve this purpose but would rather assist in the dispersal of newly emerged adult populations from their breeding sites.

Dispersal appears to be directly or indirectly a function of all flights from the commencement of such activity in late August until its cessation in late April. In the winter months the adults do not fly, either because climatic conditions are not favourable, or because they may not be in a physiological state conducive to flight when in the overwintering condition. Flights commence in spring at the time oviposition commences and, rather than serving as "mating flights" they appear to distribute weevils among available breeding sites or to better breeding sites than obtained in their overwintering positions.

That all flights are of major importance in dispersing populations appears to be well supported by adult populations within the sward of different fields in the vicinity of the study area throughout the year. Following the autumnal flights of 1959, Pottinger (1961a) found that the overall population in field N.6, a 15-month-old short-rotation ryegrass pasture, was 24.7 weevils per square foot on April 23, 1959, whereas on April 15, 1959, it has been 52.2 per square foot. In field N.9, a two-months-old short-rotation ryegrass pasture, the population rose from 3.4 recorded on April 12, 1959, to 12.5 adults per square foot on May 12, 1959. In N.11, an Aotea wheat field, the population rose from 0 to 2.8 adults per square foot between March 27, 1959, and May 14, 1959. In the spring, some fields, especially cereal crops and autumn-sown pastures, showed slight increases which can only be explained by the dispersion of adults from more highly populated areas.

Following emergence of first-generation adults, populations in short-rotation ryegrass swards rose to over 100 adults per square foot but showed a rapid decline during January and February during which time large flights take place. Field N.1, a one-year short-rotation ryegrass pasture, had a population of 67.7 adults per square foot on January 8, 1960, and 46.2 per square foot on February 16, 1960. Paddock N.6 had an adult population of 115.9 per square foot on January 2, 1960, 81.3 per square foot on January 15, 1960, and 51.1 on February 2, 1960. During this time mortality of senescent adult weevils was not sufficient to account for this decrease.

As such flights appear mainly to aid dispersal, this would be of value to the populations for the following reasons:

- (1) It would ensure a more even spread of adults over a greater area.
- (2) It would allow better utilization of oviposition sites, spread of the resulting larval population, reduced competition between larvae and adults for food, and reduce the chance of local populations being eliminated by catastrophic mortality.
- (3) Maximization of overwintering sites would be enhanced.

Dispersal of the large populations which build up even in newly sown fields over the first generation appear to be essential for the maximization of the population's full reproductive capacity. In cereal crops, green growth essential for second-generation weevils is usually absent and in such places populations of weevils are forced to disperse or die. However, shortage of food does not appear to be the prime stimulating factor, nor does crowding of individuals as flights are initiated in fields with large food reserves, plentiful oviposition sites and low populations.

Pottinger (1961a) has shown that flight activity is responsible for the infestation of newly sown areas such as pastures and cereal crops. As this activity is carried out over an eight-month period each year, it tends to even populations up between different fields in an area. Infestation of pastures and cereals is therefore a more or less continuous process and points to potential difficulties of controlling this pest with insecticides.

Stem weevil is not an important pest in cereals but it is in pastures where the net return on farming activity does not allow the continued expense of insecticide application. An insecticide effective against stem weevil for long periods, available at reasonable cost, licensed for use in New Zealand by the Agricultural Chemicals Board, and field tested is not known to the writer. It is apparent that, when a satisfactory insecticide becomes available, its use will have to be co-ordinated in some way with the flight activity of this insect.

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