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**THE BEHAVIOURAL BIOLOGY OF  
ARGENTINE STEM WEEVIL IN RELATION  
TO HOST-PLANT CHARACTERS.**

A thesis presented for the degree of

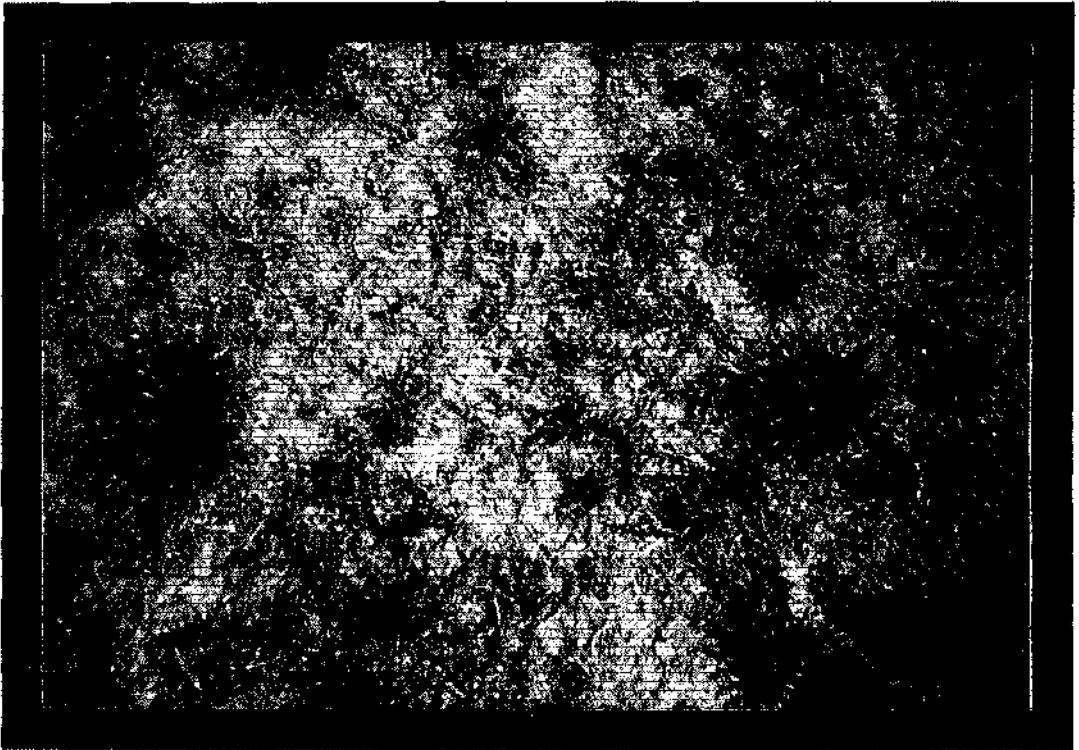
**Masterate in Science  
in Zoology**  
(by thesis only)

*Massy University  
Palmerston North*

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**1987**

*FRONTISPIECE*



Severe Pasture Damage by Argentine Stem Weevil.

(Photo by D.L. Gaynor)

## ABSTRACT

Literature on the biology, damage, and control of Argentine stem weevil (ASW), *Listronotus bonariensis* (Kuschel), is reviewed. Plant resistance with respect to control in other insects is reviewed in detail.

Orientation, feeding and oviposition behaviour of ASW were investigated in relation to ryegrass.

The visual and olfactory components of orientation were examined. Weevils did not discriminate between coloured nutrient agar plugs, nor between treatments in an olfactometer. Antennectomised weevils could discern between tissue from resistant ryegrass (infected with *Acremonium lolii* endophyte) and susceptible ryegrass (endophyte-free) when feeding, but not in the olfactometer. Host selection is probably mediated by a touch/taste system. The "apparency" of ryegrasses offers the most likely mechanism for location by ASW.

ASW shows a gradation of feeding preferences between leaf tissue from twelve ryegrass cultivars. Annual cultivars were most preferred, then hybrids, perennials without endophyte, and lastly, perennials containing endophyte. In feeding trials with clonally replicated plants, weevils strongly preferred endophyte-free tissue. When restricted to endophyte-infected tissue, ASW feeds towards the leaf tip, where the lowest concentration of endophyte occurs. The amount of food consumed was inversely proportional to endophyte concentration. Weevils also prefer to feed on annual cultivars which have the least fibre and lowest tensile strength. Partial isolation of an extract that prevents ASW feeding, obtained from endophyte-infected ryegrass tissue after partitioning and dialysis, revealed a compound similar to "peramine". Age, size, and sex of weevils made no difference to the amount of food consumed.

Oviposition preferences paralleled feeding preferences in twelve ryegrass cultivars. Plant characteristics examined in relation to oviposition were endophyte concentration and distribution, age, fibre content, and tiller diameter. Endophyte concentration and fibre

content in ryegrass sheath material followed a similar pattern, low in annuals, intermediate in hybrids and endophyte-free perennials, and high in endophyte-infected perennials. Tiller age had no effect on oviposition preference. Tiller diameter was positively correlated with oviposition preference, large diameter tillers (annual cultivars) being preferred. The behavioural components of oviposition are described, and evidence found which suggests a possible role for epideictic pheromones.

The external receptors probably used in host-plant selection were identified and described. The antennae, mouthparts, tarsi, and ovipositor possess numerous sensilla, any of which could respond in the host selection process.

## **ACKNOWLEDGEMENTS.**

The initial impetus into Argentine stem weevil research was provided by Mr D.L. Gaynor and Dr D.D. Rowan. I am indebted to them for their continued guidance, advice and encouragement throughout this project. I am grateful to Dr I. Hallett, Auckland DSIR, for the use of the Philips 505 SEM; and Mr D.H. Hopcroft, Palmerston North DSIR, for assistance with the Cambridge 250 "Mark III" SEM. In addition, expertise and assistance in their respective fields have been provided by Mr J. Allen, for volatile collection and analysis; Dr P.S. Evans, leaf strength analysis; and Dr D.R. Musgrave, Christchurch DSIR, for laboratory equipment and space for ELISA determination. I gratefully acknowledge the staff of the Plant Health Department of Massey University for the use of time lapse video equipment and microscopes, Miss J. Manley for the use of her office, Mr M. Moffat for computer analysis and graphics, and other staff from the Botany and Zoology Department for providing equipment and expertise.

For reading and commenting on the entire draft of this thesis I thank Dr I.A.N. Stringer and Dr P.G. Fenemore, their constructive discussions have been greatly appreciated. Prof. B.P. Springett, Dr O.R.W. Sutherland and Dr R.A. Prestidge kindly appraised various chapters and offered comments and corrections. I also benefitted from discussions with Dr M. Forde; Mr M.J. Christensen; Dr G.C.M. Latch; Dr R.A. Prestidge; Dr S.L. Goldson; Dr L.A. Malone; and Mr G. Kuschel.

The friendship and interest shown by the senior students and staff of the Botany and Zoology Department of Massey University were much appreciated.

Finally, special thanks must go to my family, in particular Donna, for the continued support and encouragement throughout this project.

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## **CHAPTER 1**

### **INTRODUCTION**

"The susceptibility or resistance of different plant species or varieties to an insect species varies with their suitability or unsuitability, respectively, for the establishment of an insect population" (Saxena 1985). Other things being equal, the greater the suitability of a plant, the greater its susceptibility and the greater the potential for resultant damage. Therefore, in order to understand the role of behavioural responses in the susceptibility or resistance of plants to an insect species, it is necessary to compare the responses of the insect to known susceptible and resistant plants, and, to examine the role of plant characters in determining such responses.

There are three main types of behavioural response by an insect which determine selection or rejection of a plant. These collectively form the host-plant selection process. These are: 1 - orientational responses, determining the insect's arrival on or avoidance of a plant in response to attractant, neutral, or repellent stimuli; 2 - feeding responses, determining the quantity of food ingested from the plant, and 3 - oviposition responses.

The various plant characters which may influence these behavioural responses of insects act in two ways: 1 - by providing sensory stimuli, and 2 - by providing mechanical features which may facilitate or hamper behaviour. The sensory stimuli from various plant characters may be perceived at a distance or by contact. The distance-perceivable characters may involve visual (colour, form, shape), hygro (water vapour), and olfactory (non-aqueous volatiles) stimuli. The contact-perceivable characters are chemical (gustatory) and physical (tactile) stimuli.

In order to understand the host-plant selection process of an insect and thus mechanisms of plant resistance and the characters involved, a comparison of these three behavioural responses to a range of resistant and susceptible plant species or varieties is essential. Then, by manipulating either the insect's behavioural responses, or, more effectively the plants characteristics, new control strategies may be developed against the insect.

The objective of the present study is to provide fundamental information which could lead to future population management of the Argentine stem weevil, *Listronotus bonariensis* Kuschel, (Coleoptera : Curculionidae). This insect, referred to as ASW throughout the text, is a major pest of pasture grasses and graminaceous crops throughout New Zealand. It has been estimated to cause losses in excess of \$150 million per annum (Pottinger pers. comm. 1985), and adult populations in excess of 20 million per hectare are common (Pottinger 1977). Considering New Zealand's reliance on grassland agriculture, such losses, if sustained, could be exceptionally detrimental to the national economy. Both adults and larvae feed on graminaceous plants, with the larval stage considered the most destructive due to its stem-mining habit and hence difficulty of control. Larval attack is more evident in dry summers and on short-rotation ryegrasses, where it can result in up to 98% tiller mortality (Kelsey 1958). However, as larval stem weevils are restricted to their host plant for their entire development, the amount of damage is ultimately determined by the discriminatory behaviour of the ovipositing female in locating and selecting suitable host plants, hence only the adult stage is considered in this thesis.

Of the graminaceous plants which are considered hosts of ASW, ryegrasses (*Lolium* spp.) are preferred (Prestidge *et al.* 1985c). Early research on ryegrasses recognised their variable susceptibility to ASW (Kelsey 1958; Timlin 1964; Pottinger 1961a, b, and 1977; Barker *et al.* 1981; and Prestidge *et al.* 1982). Many short rotation ryegrass cultivars are highly susceptible, while many perennial cultivars exhibit variable resistance (Goldson 1982; Kain *et al.* 1982a and b; Gaynor and Hunt 1983; and Barker *et al.* 1984). This resistance has been linked to the presence of an endophytic fungal infection within certain ryegrass plants (Prestidge *et al.* 1982; Mortimer *et al.* 1982), although Gaynor and Hunt (1983) noted genotypic differences unrelated to endophyte content. It is because of such apparent variability that a selection of available ryegrass cultivars was examined for a), their susceptibility and resistance to adult ASW with respect to the three behavioural components of orientation, feeding, and oviposition, and b), the plant characters which influenced these responses.