Studies of

the Reproductive Biology and of the Structure, Composition, and Physiology of the Egg of

Graphognathus leucoloma Boheman

(Coleoptera: Curculionidae)

A thesis presented in partial fulfilment
of the requirements for the degree of
Master of Science in Zoology
at Massey University

David George Holdom

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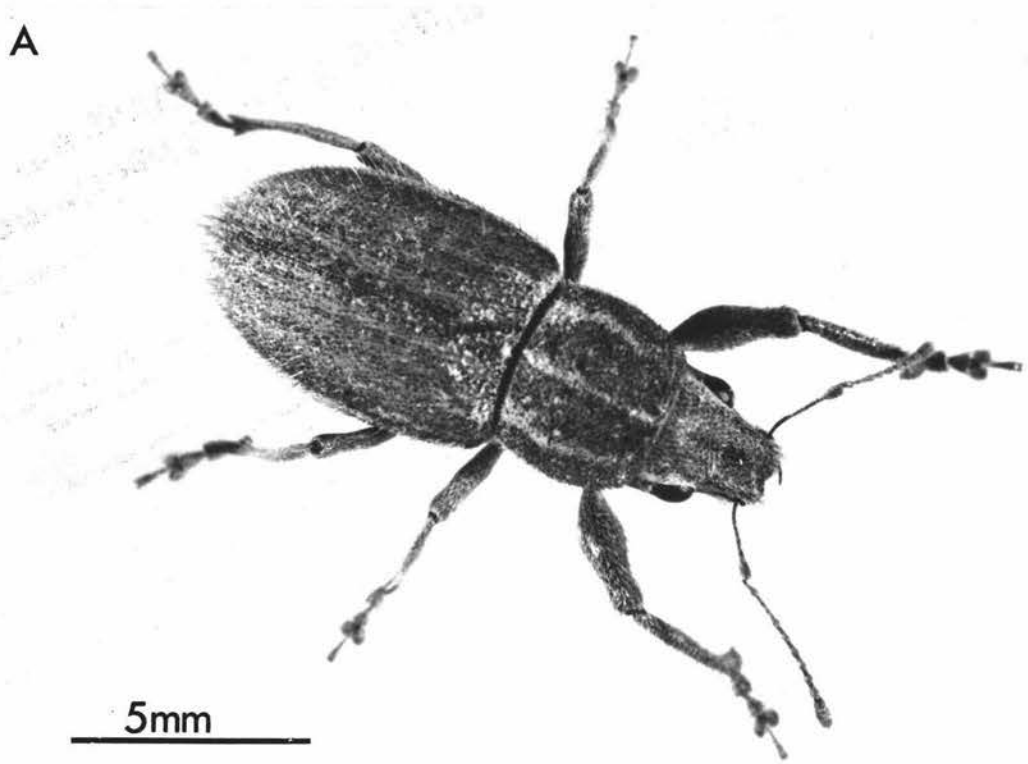
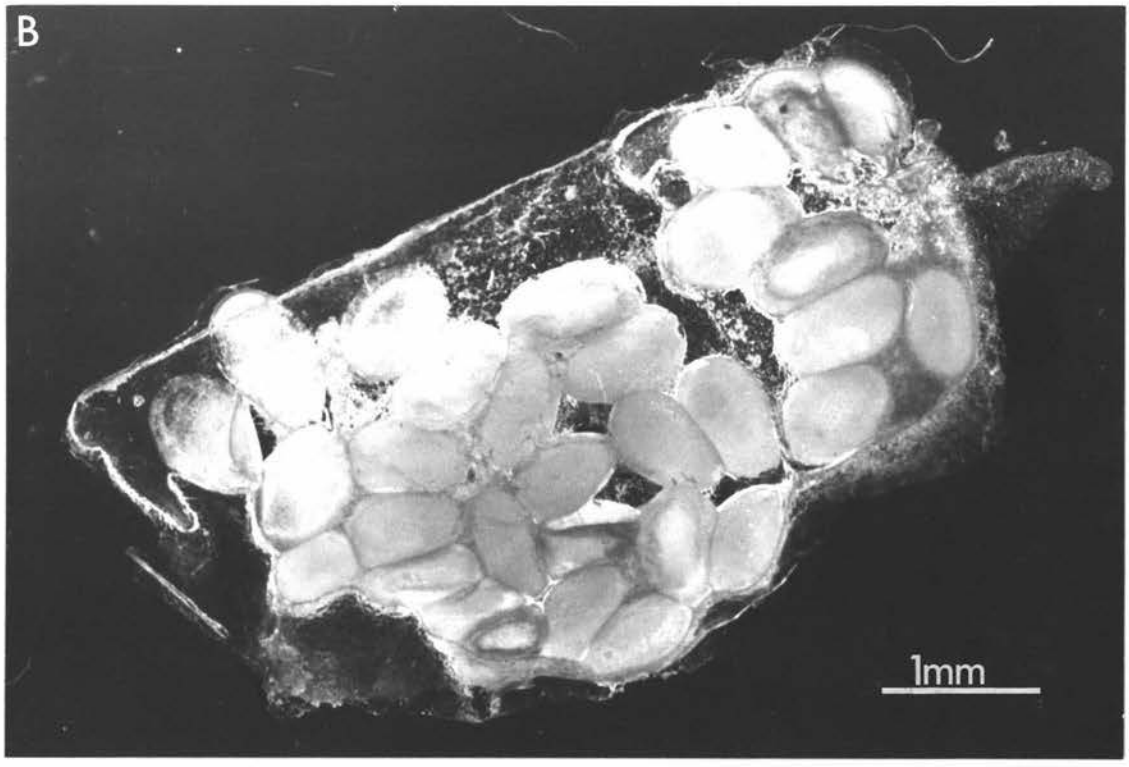
A. Graphognathus leucoloma Boheman, adult.

B. Graphognathus leucoloma Boheman, eggs.


A
5mm


B
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To the late Stan and Blanche Bason,
whose enthusiasm and love of nature
were a major influence
on my interest in biology

ABSTRACT

The published information regarding the biology and pest status of Graphognathus leucoloma Boheman is summarized.

A study was made of egg development at temperatures ranging from 4 to 37.8°C and relative humidities ranging from 40 to 100%. Egg hatch was frequently very low and showed considerable variability. Median duration of development ranged from about 14 days at 31.5°C to 95-97 days at 15°C, with the developmental-hatching threshold between 12.1 and 13.5°C. Sub-threshold temperatures were lethal. Virtually no hatching occurred below 100% RH but the eggs could withstand considerable dessication and would hatch when moistened. Possible effects of humidity on the duration of development and of parental age on egg viability are also discussed. Some reasons for the very low egg viability are suggested, along with modifications to the experimental design to eliminate them.

Studies were made of adult and pupal size, and of longevity, pre-oviposition period and reproductive output. Some reasons for unexpectedly low fecundity and long pre-oviposition period are discussed.

The structure of the egg envelopes and the cement in which the eggs are laid was studied, using scanning and transmission electron microscopy, and Nomarski differential interference microscopy. A histochemical study of these structures, supplemented by some simple chemical tests, was also made, to elucidate in part their composition. The chorion is 4-9µm thick and composed entirely of protein; some 250,000 aeropyles are scattered over the surface, and its structure is such that it could probably act as a plastron when the egg is submerged. There is no micropyle. Disulphide linkages are probably important in the structure of the chorion, as in many other species, but unlike other beetles so far studied, no crystalline proteins were found. The vitelline membrane was found to be a three-layered structure 0.3-0.5µm thick composed of protein and acid mucopolysaccharides, and to be highly resistant to chemical attack. Waterproofing is probably provided by a layer of lipid on the outer surface of the vitelline membrane. The cement was found to be a complex, variable and heterogeneous mixture of protein and up to five acid mucopolysaccharides, which is unlike that of any other species reported. Some possible functions of the cement and the significance of its composition are suggested.

A note on the citation of publications, and the referral to species and their systematic status.

Any publication by three joint authors is cited in full the first time it is referred to and thereafter is abbreviated to the form: senior author *et al*. Publications with more than three joint authors are cited in the form: senior author *et al*. each time they are cited, including the first. The specific name of any organism is given in full only on the first time it is referred to, and the names of insect species and genera and their taxonomic status are listed in Appendix Five.

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Credit for the frontispiece and Figs. 3.1, 3.2 and 3.3 must go to the staff of the Central Photographic Unit, who also processed the light micrographs. Miss A. Turner drew Figs. 2.1 to 2.6.

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ABBREVIATIONS USED IN THE TEXT

°C	degrees celcius
P	Probability
RH	relative humidity
≏	approximately equal to
<	less than

ABBREVIATIONS USED IN THE FIGURES

aer	aeropyle
B	bacteria
C	chorion
cem	cement
G	glycogen granules
ic	inner layer of chorion
ilin	inner lining of chorion
ivm	inner layer of vitelline membrane
lae	lining of aeropyle
mvm	middle layer of vitelline membrane
oc	outer region of chorion
ovm	outer layer of vitelline membrane
trl	trabecular layer
vtm	vitelline membrane

CHAPTER ONE

THE STUDY ANIMAL

1.1 ORIGINS AND OCCURRENCE

The white-fringed weevil, Graphognathus leucoloma Boheman (Coleoptera, Curculionidae, Brachyderinae), is a native of South America, where it occurs in Argentina, Brazil, Chile, Peru and Uruguay (Berry, 1947; Young et al., 1950). Its known range now includes many south-eastern states of the U.S.A. as far north as Maryland (Anonymous, 1969), all five mainland Australian states (Chadwick, 1970), South Africa (Joubert, 1951) and New Zealand. In New Zealand, G. leucoloma was found in Northland in 1944, where it was believed to have been introduced with American war equipment about 1940 (Cottier, 1962), but it now occurs throughout the North Island and has been found in Nelson (Perrott, 1964) and Ashburton (May, 1975) in the South Island.

Buchanan (1947) recognised three species of Graphognathus: G. leucoloma, G. peregrinus and G. minor, and six races of G. leucoloma, of which five occur in the U.S.A. Only G. leucoloma is recorded outside North and South America, but no details regarding strains appear to have been published.