Observations on the Biology of the Immature Stages of *Prionoplus reticularis* White (Col. Ceramb.)

By John S. Edwards

Department of Zoology, Auckland University

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Abstract

Field and laboratory observations on the life history and biology of the immature stages of *Prionoplus reticularis* White are recorded. The incubation period is 23 ± 2 days. Hatching behaviour is described. Average duration of the larval stage is considered to be 2 and 3 years. Gallery and pupal chamber formation is described. Prepupal and pupal behaviour is described. A Muscardine disease and Mymarid parasite are recorded.

Introduction

Since Broun's (1880) description of the larva and pupa of *Prionoplus reticularis* White, little has been recorded of the biology of its immature stages. It has received attention as a timber borer (e.g., Clarke, 1932; Kelsey, 1946), and its host range has been examined (Edwards, 1959). Hudson (1934) and Miller (1952) mention *Prionoplus* as a food of the Maori. Dumbleton (1957) has described the immature stages. It is the purpose of this paper to record observations on the biology of immature stages made largely on populations in *Pinus radiata* at the Riverhead State Forest and on material in laboratory cultures.

The Egg

Dumbleton (1957) has described the egg. They are deposited in groups usually numbering between 10 and 50, though up to 100 may be found in a batch in cryptic sites or cracks in the bark of fallen wood. They are united by a clear secretion which rapidly hardens to affix the eggs firmly to the substratum. In the moist conditions often prevailing in the restricted space of the oviposition site the egg groups frequently support growths of Phycomycete fungi, but these do not affect their viability. They are very susceptible to desiccation and collapse within a few hours at low humidities. Fertile eggs are more resistant to desiccation than are eggs laid by unmated females. The incubation period at 20 ± 2° C. and relative humidity c. 75% is 23 ± 2 days. All egg batches collected in the field had hatching percentages between 94% and 98%. No development took place in 230 eggs laid by unmated females and maintained under optimal incubation conditions.

Hatching

The larva moves continually, sometimes turning about in the egg during the hours preceding the hatching. In breaking free from the egg the mandibles are forced against the chorion with sufficient force to pierce it. Several such perforations are made before one is enlarged by peripheral chewing to form a circular subterminal aperture, 0.5 mm in diameter (Pl. 60, fig. 2). The fragments of chorion produced while the exit is being formed are not ingested. Accessory hatching structures such as specialized mandibles or egg bursting spines are absent, but long lateral setae are present on abdominal segments 1–6, each accompanied by a short appressed backwardly directed spine at a point postero-dorsal to the spiracle (Fig. 2a). Observation of hatching behaviour of numerous larvae has shown that these structures function in providing support and purchase while the larva leaves the egg and excavates the initial gallery as observed of *Lamia textor* by Pavan (1948), rather than as accessory egg bursters (Duffy, 1953). Most larvae emerge from the egg through the side in contact with underlying wood. The head is supported by the periphery of the exit hole and the body remains within the egg until the gallery is deep enough to afford lateral support to the thorax. Establishment is a critical phase in the life history; in the field as many as 50% of larvae may pierce the chorion but fail to establish, probably as a result of water deficit.

The Larva

Dumbleton (1957) has described the larval stages of *Prionoplus*. The following points relating to the first instar may also be noted:

1. Spiracles biforous, bicameral (Fig. 2a), single in later instars.
2. Abdominal segments 1–6 bear a backwardly directed triangular spine accompanied by a short seta (Fig. 2a), whose function during hatching is discussed above.
3. Ninth abdominal segment transverse, as in *Prionus coriarius* (Duffy, 1953) (Fig. 1).
4. Mandibular and lateral setae relatively longer, and terminal setae shorter than those of later instars.

Duration of Larval Stage

The remarkable longevity of Cerambycid larvae under suboptimal conditions is well known (Duffy, 1953). The minimum and average duration of the larval stage of *P. reticularis* were not determined with certainty since no eggs were bred through to pupae during the course of this study.

No adults had emerged one year after the establishment of larvae in previously unattacked logs under field conditions. Previously attacked logs, on which no eggs were allowed to hatch after enclosure in insect-proof cages, and which yielded 204 adults during the first summer of enclosure and 123 in the second, still contained 30 larvae between 15 and 43 mm in length at the conclusion of the second emergence season. These observations suggest that for most individuals metamorphosis is completed at the second and third summers, a conclusion which agrees with estimates of Broun (1880) and Dumbleton (1957). While the larval gut remains full throughout the year, active feeding and gallery formation appear to be arrested or slowed during the winter months last instar larvae which fail to pupate by late December pass the cold months in facultative diapause and enter the prepupal phase without feeding in the following spring.

Larvae were kept 2¼ years in the laboratory without food, during which time they underwent 2–4 moults and resumed feeding immediately when provided with *Pinus*. Under conditions of low humidity and starvation, late instar larvae readily undergo prothetelic moults, when leg and wing rudiments are most commonly produced.

Larval Galleries (Plate 60, fig. 1)

The short establishment gallery made by the first instar larva usually extends about 2 mm into the wood, perpendicular to the surface. The larva then turns into the longitudinal axis of the wood—i.e., along the grain, and there forms a wide chamber where the first moult takes place. The subsequent behaviour is greatly variable and depends on three main factors:

(1) The size of the log.
(2) The state of decay of the wood.
(3) The degree of previous attack.

In sound timber and recently fallen logs the gallery is linear and fairly superficial. The more advanced the decay and the greater the previous attack, the more tortuous and irregular the galleries. The heart wood and the region immediately surrounding it are the last to be attacked and development appears to be retarded when this wood is eaten for the larvae from central positions in the log are almost invariably small at all times of the year, and notably lacking in fat body. Larvae tend to remain in uneaten wood: galleries intersect only when attack is advanced. All the wood that is excavated is ingested and the gallery behind the larva is completely filled with faecal frass as the larva advances. The last instar larva moves

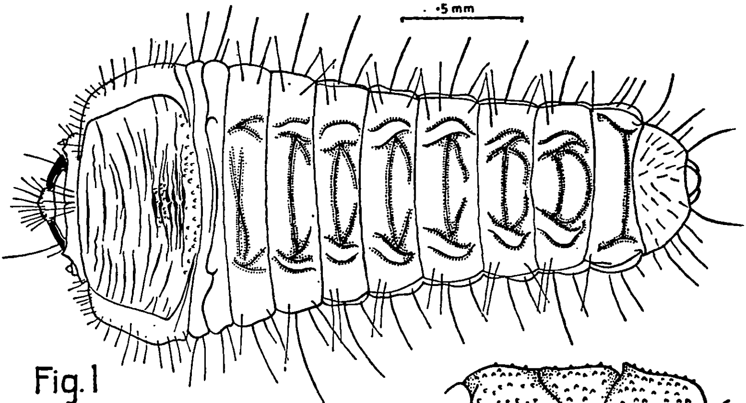
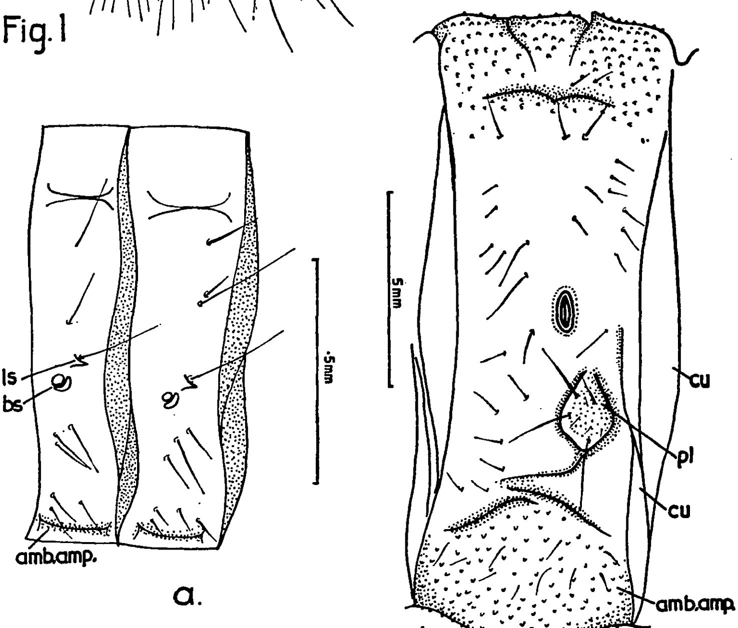


Fig. 1



a. Fig. 2 b.

TEXT-FIG. 1.—First instar larva. Dorsal. 2a—Abdominal segments of first instar larva, lateral. 2b—Abdominal segments of final instar larva, lateral.
amb amp, ambulatory ampullae; bs, biforous spiracle; cu, cuneus; ls, lateral appressed spine and seta; pl, pleural tubercle.

to a superficial position, more frequently in the upper part of the log before the pupal chamber is formed.

Host Woods and Larval Nutrition

The host range of *P. reticularis* has been dealt with elsewhere (Edwards, 1959); it is essentially a gymnosperm feeder. The early limit for successful establishment appears to be cessation of resin secretion, for it is capable of digesting sound wood from the time of hatching. Newly hatched larvae were established in various woods by inserting them into drill holes of diameter $\frac{1}{32}$in and depth $\frac{1}{6}$in, and covering the surface of the wood with damp filter paper. Larvae thus established in sound and decayed *Pinus radiata, Agathis australis,* sound *Salix* sp. and in wads of filter paper rarely survived the critical first instar period, but of those that did so, several lived for 32 weeks in sound *P. radiata* and for 28 weeks in filter paper wads, while unfed larvae died within 15 to 20 days of hatching. Preliminary experiments in progress at the conclusion of this study indicate that laminated filter paper blocks treated with mould inhibitor provide an adequate substratum for Cerambycid larvae, with the advantage that the layers may be readily separated for observation purposes and replaced with minimum disturbance to the larva. Water content and dietary requirements are readily supplied and controlled under these conditions.

The Prepupa

The last instar larva moves to a position within 3in to 4in of the surface before starting to construct the pupal chamber. This is a more or less ovoid cavity greater in diameter than the normal gallery, and during its construction the mandibles are used in a way quite different from the feeding behaviour in which fragments of xylem are nipped through and ground on the molar plates before being passed through the pharynx. During building behaviour the larva successively pinches the mandibles along groups of tracheids from the head of the gallery back. The fragments so formed are torn free from the wall as short lengths resembling "wood waste" as used for packing, measuring about 3 cm by 1 cm. These are pushed back into the gallery behind with a characteristic sideways movement of the head and body. The process is repeated throughout a period of 12 to 24 hours until the gallery behind is packed and a chamber is formed in which the larva can move freely. When the plug is complete the walls are lined with fine wood flour obtained from the last frass to be voided when the gut is emptied. Larvae provided with filter paper in which to build their chamber tear innumerable fragments from free edges of the wads and bind these with a translucent mucilaginous material regurgitated from the mouth, probably digestion products of the cellulose. The wall so formed has considerable tensile strength.

The pupal chamber (Pl. 60, fig. 3) is completed in one to three days and the larva then enters the seemingly inactive prepupal phase known as the "resting stage". During these ten to fifteen days the abdominal segments contract and the body as a whole darkens slightly. The moult then occurs.

The pupa lies ventral surface uppermost on the flattened last larval cuticle, which forms a cushion between it and the chamber floor. During the early pupal period pigmentation is absent and the abdomen is incapable of movement. After 24 hours pigment is visible in the tips of the mandibles and terminal spines. By the fourth day the cuticle has become deep yellow and the cuticular asperities become visible as dark brown points. Further pigmentation develops late in the pupal period, for after 20 days the body remains yellow, the eyes are light grey and the tarsi red brown. Between the 20th and the 25th day there is a rapid increase in pigmentation. Darkening does not occur until after eclosion and emergence at about the 25th day.

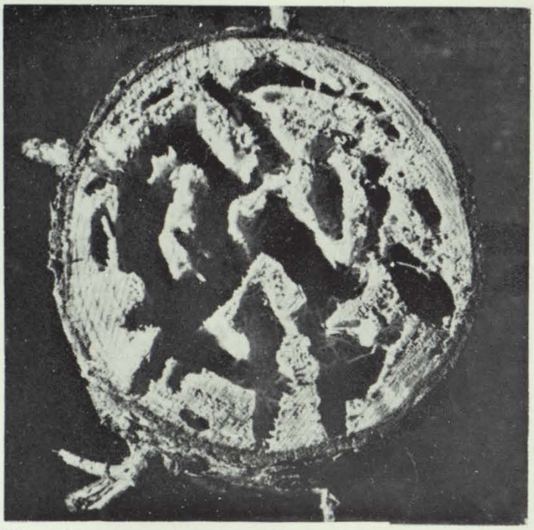


Fig. 1 1 c.m.

1 c.m.

Fig. 2

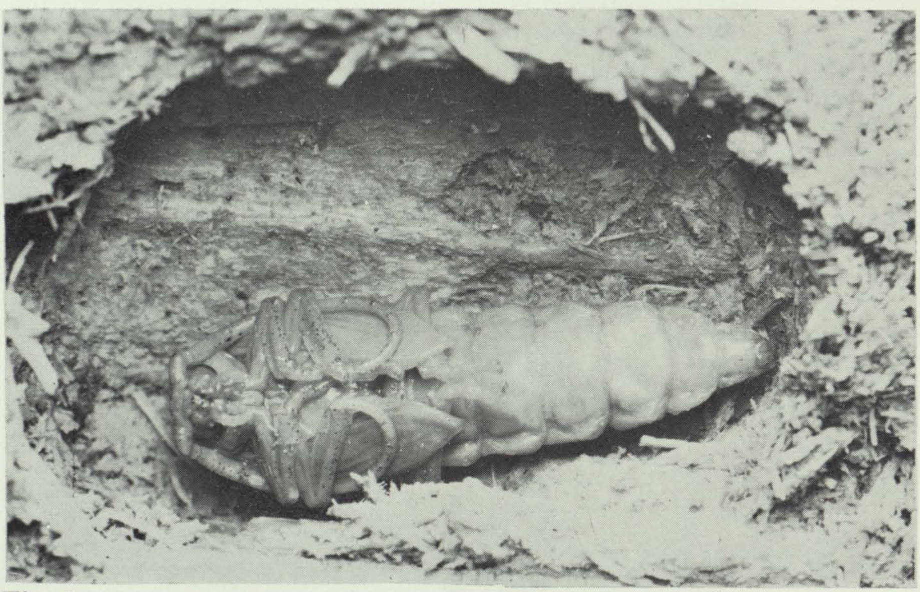


Fig. 3 1 c.m.

FIG. 1.—Cross section of log of *Pinus radiata* showing galleries of *Prionoplus reticularis* larvae.

FIG. 2.—First instar larva hatching. Head and thorax are visible through the completed sub-terminal exit hole.

FIG. 3.—Female pupa within pupal chamber.

From about the 5th day of the pupal stadium the abdomen is occasionally oscillated in a regular manner at the rate of about 8 oscillations per second, for periods up to 5 seconds. This behaviour may be evoked by disturbance, but also occurs spontaneously at regular intervals. The lamiine genera *Agapanthia* and *Phytoecia* are known to produce a rattling noise by rubbing the spinose body against the dry walls of dead stems, and some Aseminae and Lepturinae also show this behaviour (Duffy, 1953), but its presence has not hitherto been noted in the Prioninae.

Eclosion proceeds in a typical manner by rupture along the frontal suture, then longitudinally to the posterior border of the mesothorax. The head, feet and wings are freed in that order during movements which arch the body through the ruptured cuticle. The freed adult may enter an inactive period of three to five days before work begins on the exit tunnel.

Disease and Parasites

Prionoplus is subject to attack in immature stages by a Muscardine fungus (? *Beauvaria* sp.). The prepupal "resting phase" and the early pupa seem most susceptible; it is in these stages that mummification usually occurs. The overall incidence of infection is low (estimate: 1/1000) at Riverhead but localised regions of high mortality are to be found.

A Mymarid egg parasite emerged from *Prionoplus* eggs collected at the Whakarewarewa State Forest. It was not found in extensive egg collections from Riverhead. The species, new to the New Zealand fauna, is described by Hincks (?)

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DR. JOHN S. EDWARDS,
School of Agriculture,
Downing Street,
Cambridge, England.