TWO-YEAR LIFE-CYCLE IN GRASS GRUB AND ITS IMPLICATIONS ON CONTROL

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Summary

Development and feeding level in the soil of grass grub (*Costelytra zealandica* (White)) with one- and two-year life-cycles in Otago are described and the implications for control measures discussed.

INTRODUCTION

IN MOST REGIONS of New Zealand, the grass grub (*Costelytra zealandica* (White)) has a univoltine life-cycle (Miller, 1921; Cottier, 1962) and all work published to date on biology and control has been concerned with univoltine grubs. However, it has recently been established (Perrott and Stockdill, 1972) that a population at Macraes Flat, Otago, had a clearly-defined two-year life-cycle, and similar populations were found elsewhere in Otago and Southland. Control measures for these populations should differ from present recommendations for one-year grubs, particularly in their timing.

Reported here are observations on the development and behaviour of larvae at Invermay (one-year cycle) and Macraes Flat (two-year cycle).

Published work on larval weight gain and depth of feeding in the soil is limited (Elliott and Perrott, 1965; Fenemore, 1969) although these have obvious importance in relation to control.

SAMPLING

Four or more 14 cm spade squares of pasture were taken monthly from plots of about 13 m² at Invermay (altitude 24 m) and at Macraes Flat (485 m), which produced 40 or more larvae at each site. These larvae were examined and weighed individually on the same day as collection.

DEVELOPMENT OF UNIVOLTINE GRUBS

Figure 1 shows that the weight gain of grubs from Invermay produces a sigmoid curve typical for insects growing under favourable conditions. The main flight period of beetles took place from late November to mid-January. The main periods of occurrence of each instar (excluding a few stragglers) as shown in Fig. 1 are: I, December until early March; II, late December to mid-June; III, late January to mid-November. Pupae first appeared in early October.

FIG. 1: Weight gain (means and 5% fiducial limits) and occurrence of instars of larvae at Invermay and Macraes Flat, 1971-2.

DEVELOPMENT OF GRUBS WITH TWO-YEAR LIFE-CYCLE

The flight period of beetles at Macraes Flat commenced a fortnight to one month later than that at Invermay and consequently larvae hatched later in the season. Initially these seemed to develop at a similar rate to young larvae at Invermay but after March growth slowed down and then ceased from May to September (Fig. 1). In their first year, larvae overwintered mainly as second instars although a small proportion of firsts (less than 5%) were present until September. Second instars quickly changed to third after September. Weight gain recommenced in September, continuing rapidly to January after which little change took place until pupation in the following November.

DAMAGE TO PASTURE

Damage to pasture by grass grubs will depend on several factors but the two most important are probably the availability of moisture to plants and the amount of root pruning by the larvae. Maximum root pruning should occur when grubs are growing fastest. It is seen from Fig. 1 that maximum growth of Invermay grubs takes place from mid-February to mid-April and for Macraes grubs mainly in December and early January. Since fewer than 10% of second instars ever reached weights above 80 mg, damage must have been caused mainly by third instars.

DEPTH OF LARVAL FEEDING

The percentage of larvae found seasonally at different depths in the soil is shown in Fig. 2. The majority of grubs at Invermay were found within the top 5 cm throughout the year except in October immediately before pupation in spite of their apparent cessation of feeding in June (Fig. 1). Most grubs at Macraes also fed near the surface, but there was

FIG. 2: Percentage of larvae found at different depths in pasture at Invermay and Macraes Flat, 1971-2.

a downward movement by overwintering second instars after May, 1971. Sampling in 1972 has indicated such movement after April. In November when feeding had recommenced, the greatest percentage were again found near the surface. When fully fed in April they again started to descend to lower levels. It should be mentioned that the soils at neither site ever became very dry during the period of observations.

DISCUSSION

Populations with an apparent two-year life-cycle have been found at other sites in Otago and Southland by Perrott and Stockdill (in press) and since by the writers. In Otago (and at one site in Canterbury) these have been found, so far, only at altitudes of over 300 m but occur lower in Southland. The most likely cause of the extended cycle is low climatological temperatures which become more pronounced with increasing altitude and latitude.

It might be expected that adverse environmental conditions could give rise to overwintering populations of grubs with a mixed range of sizes, but these do not seem to occur. At Hindon, Otago (452 m), it has been found (K. Stewart, unpubl.) that larvae hatching from eggs laid in December and January split into two groups, one of which matures in one year while the other follows a similar pattern of growth to Macraes larvae. Larvae seem to be able to react to unfavourable environment by entering a two-year life-cycle determined possibly by failure to reach a critical body weight before winter.

Although the two growth patterns may be distinct, low temperature does not seem to be the only determining factor. Populations with varying proportions of individuals at a markedly different stage of development have been observed at low altitudes at Nelson (Power, 1970), Canterbury (Kelsey, 1951), Ashburton (G. Halliwell, pers. comm.), Banks Peninsula (S. Moore, pers. comm.), Rotorua (R. Moody, pers. comm.) and the Taieri Plain during the present studies. Generally speaking, however, the proportions of apparent two-year grubs do not seem to be high at these lower altitudes.

The extended life-cycle should affect control measures in the following ways:

- (1) Damage occurs at different times of the year to "normal" grubs. Damage from "normal" grubs at Invermay will be maximum from mid-February to mid-April whereas for "two-year" grubs this will be from mid-November to mid-January. For both life-cycles chemicals should be applied early since (a) damage by large grubs is prevented, (b) pasture has time to recover before winter, (c) young grubs may be more easily killed (Elliott and Perrott, 1965).
- (2) With two-year grubs, little damage can occur in the first year, except where two overlapping populations exist in the same area; here damage will occur each year. The latter situation is the most common.
- (3) Small two-year grubs are present for almost a year before serious damage appears, giving the farmer more time to locate populations beforehand by digging.
- (4) Damage from two-year grubs often appears more suddenly and can be more devastating than one-year grubs because of hot, dry weather common at the time of maximum feeding.

An important factor related to control (seldom recorded in trial results) is the depth at which grubs feed. Grubs at Invermay were near the surface and thus accessible to chemical control throughout their feeding period. In contrast, two-year grubs at Macraes descended to lower levels during winter and did not feed. In this state they would have been more remote from applied insecticides and thus less affected. They returned to near the surface in November during the period of maximum damage, thus restricting the most effective timing of chemical control to a relatively short period in the drier part of the year. Presumably treatments could also be made at the start of the growth curve in March-April when larvae are near the surface. In view of these differences in grass grub life-cycles and the common appearance of two-year grub populations, at least in Otago and Southland, special consideration of them is desirable in research and recommendations for grub control.

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REFERENCES

- Cottier, W., 1962. Life cycle of pasture insects. *Proc. 15th N.Z. Weed Control Conf.*: 216-33.
- Elliott, R.; Perrott, D. C. F., 1965: Response to insecticides in *Costelytra zealandica* (White) in relation to sex and weight. *N.Z. Jl agric. Res.*, 8 (1): 142-5.
- Fenemore, P. G., 1969: Field trial results with fensulfothion and trichloronate for control of grass grub (*Costelytra zealandica* (White)). *N.Z. Jl agric. Res.*, 12 (1): 137-45.
- Kelsey, J. M., 1951. Grass grub and grass caterpillar control. *N.Z. Jl Agric.*, 83 (2): 113-122.
- Miller, D., 1921. Life history of the New Zealand grass grub. *N.Z. Jl Agric.*, 23 (4): 199-203.
- Perrott, D. C. F., and Stockdill, S. M. J., 1972. Variation in the life cycle of the Scarabaeid *Costelytra zealandica* (White). *N.Z. Entomologist*, 5 (2): in press.
- Power, R. I. B., 1970. A record of precocious metamorphosis in *Costelytra zealandica*. *N.Z. Jl Sci.*, 13 (2): 206-208.