

INSECTS INFESTING PASTURES : I N N E W Z E A L A N D

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Grassland farming is the basis of our primary production and insect pests constitute one of the factors which limit or decrease that production. A survey of the relative importance of different pest species and of the means available for their control should serve a useful purpose. Such a stocktaking will help in comparing the pasture pest situation in New Zealand with that in other countries, and in indicating some of the overseas pests whose accidental establishment in New Zealand could be potentially very serious.

THE EXISTING PESTS OF PASTURES AND PASTURE PLANTS

It is instructive to consider first the origin of the pests, whether native or introduced, and then under each of these headings to class the pests as either general or omniverous feeders, or as specialised feeders.

In endeavouring to assess the relative importance of pest species it must be remembered that there is no absolute point (% of area affected or % of crop lost) at which insect damage becomes an economic loss. This will vary with circumstances such as stocking and season. In the case of the major pests it is fairly easy to rate them on the basis of intensity of damage, frequency of damage, and area of pasture affected. In the case of insects affecting seed production the actual loss is difficult to determine, since so many factors affect seed setting.

NATIVE PESTS

As would be expected; seeing that the main pasture plants are introduced species, the native-pests are all general feeders. Included here are two species, the New Zealand army worm and the cricket, which occur also in Australia but which either occur naturally in New Zealand or were accidentally introduced

so early in the settlement of the country that they may, be considered as natives. The group includes the two major pests of pasture in New Zealand, grass grub and subterranean caterpillar.

Grass Grub (*Odontria zealandica*)

Associated with it as minor pests are other species of *Odontria* and the green beetle (*Pyronota festiva*). *Odontria* and the following species (*Oxycanus*) will be considered in detail later.

Subterranean caterpillar (*Oxycanus* (= *Porina*) *ceruinatus*) and *O. despectus*.

New Zealand army worm (*Persectania ewingi*)

-This striped caterpillar belonging to a noctuid moth occurs throughout the country from sea level to the high tussock country and is periodically epidemic. It appears to be the principal "tussock moth" in high country, but its exact influence on the depletion of tussock is not clear. While it may do serious damage periodically, the effects of this are probably not as serious as that of over-stocking, rabbits, and burning. It is occasionally epidemic in cereal crops on the lowlands, especially in the South Island. If the insect were a serious factor in tussock depletion, control would be very difficult, though there might be possibilities in Australian parasites. In the meantime our only activity with this insect is an endeavour to define its role as a factor in tussock depletion.

The insect will be referred to again under ryegrass. pests.

Cricket (*Gryllulus servillei*)

This insect is periodically epidemic on, localised areas such as North Auckland and the Hauraki Plains where the heavy clay soils crack extensively during drying. The damage to pasture is most serious in February and March and ryegrass is particularly susceptible. Apart from the direct loss of butterfat production the damaged pastures are opened up to the invasion of weeds. The use of poison bran baits has always been the standard method of control for insects of this type, but the work of Banfield and Cottier in devising a satisfactory poison bait of sawdust, molasses, and DDT or "Gammexane" has reduced

the costs and avoided the difficulty of securing bran. The cost of materials is estimated at 3/6 per acre.

The remaining two insects are minor pests and are still under observation.

Crane Fly (*Macromastix* sp.)

The larvae (leather jackets) of this fly have been abundant in some seasons in localised areas such as Waihaorunga behind Waimate. The role of this insect as regards damage to established pasture is still not clearly defined, but under wet conditions they damage germinating seeds.

Wireworms

Although there are several species in New Zealand there is no evidence of large populations of larvae or of serious damage in pasture. Recently some damage by wireworms to wheat, turnips, and lupins has been seen in mid-Canterbury.

Scoparia sabulosella

A species reported from pasture and from red clover in the South Island. Occasionally locally abundant and doing damage.

Introduced Pests

These include both general feeders and specialised feeders.

General Feeders

Army worm (*Cirphis unipuncta*)

This species has been in New Zealand for many years and is periodically responsible for severe damage to pastures and also to maize. The trouble is most frequent on low-lying paspalum pastures subject to flooding in the North Auckland, Bay of Plenty, and Poverty Bay area, but it occurs also in hill-country. The usual method of control overseas is by poisoned bran baits, but in New Zealand bran is often difficult to obtain. If our experience with *Oxycanus* is any indication, sawdust as a carrier in place of bran is unlikely to be satisfactory against this insect. There is a need here for the testing of some of the new organic insecticides, and also for a survey of the existing parasites in New Zealand with a view to introducing any important overseas parasites which are not present.

Pasture Eating Dung Beetle (*Aphodius tasmaniae*)

This insect, which is known as quite a serious pest of pasture in Australia, is interesting in that while it has been established for many years around Christchurch and is known to occur near Cheviot on silty river flats, it gives little evidence of developing into a serious pest. The larvae are in appearance somewhat like grass grubs, but in habit they are like *Oxycaenus*, since they live in tunnels in the soil and emerge to graze on the pasture.

Australian Soldier Fly (*Metoponia rubriceps*)

This insect is presumed to be a relatively recent immigrant, since it has only recently been found to occur in a limited area round Opotiki. Large populations of the larvae or maggots occur in the soil of pastures. It is said to cause premature deterioration of the pastures, 'but this has not yet been clearly demonstrated. It is undoubtedly responsible for damage to maize. Control in pasture would be difficult.

Black Beetle (*Heteronychus sanctae-helenae*)

This African insect is known there as a pest of crops and lawns and in New South Wales as a pest particularly of maize and paspalum. The insect has recently established in New Zealand around Auckland and Dargaville and has been responsible for damage to maize in the latter area. It has yet to show its importance as a pest of paspalum.

A minor pasture insect may be mentioned here.

Opogona omoscopa

A species occurring in South Africa and Australia has been recorded from North Auckland and Thames.

Specialised Feeders

Ryegrass (*Lolium perenne*)

New Zealand 'Army worm (*Persectania ewingi*).

A native insect mentioned here because of the type of damage to ryegrass. Several instances have been seen or reported of complete or partial loss of ryegrass seed crops in Nelson and Blenheim in December-January. The whole seed head may be cut or the flowers eaten off. The damage could quite easily be completed before it was noticed. Attempts at control would

probably, have to rely on poison baits and these would have to be applied very quickly after diagnosis.

Wheat Sheath Miner (*Cerodonta denticornis*).

The maggot of this fly works in somewhat the same manner as that of the hessian fly. It causes white heads to be produced on the damaged stems. It appears to be a minor pest, though the white heads have on occasion amounted to 7 or 8 per square foot.

Wheat Stem Borer (*Hyperodes griseus*).

This South American weevil is a minor pest of ryegrass, the larvae boring into the stems.

Cocksfoot (*Dactylis glomerata*).

Cocksfoot Midge (*Stenodiplosis geniculati* var. *dactylidis*). This midge, which infests the seed of cocksfoot, may destroy up to 70 per cent. of the seed on roadsides, waste areas, etc., but the only satisfactory evidence as to its importance in larger areas for seed production indicated that rarely is more than 1 per cent. of the dressed or undressed seed destroyed.

Cocksfoot Stem Borer (*Glyphipteryx achyloessa*).

The caterpillar of this moth infests the seed stalks of cocksfoot and causes the production of white heads. The infestation tends to build up until in the older fields 30 to 60 per cent. of the stalks are affected. The actual loss of seed has not been determined; apparently many or most of the heads on the damaged stalks ripen normally.

Thrips (*Chirothrips* sp.)

This insect is at times abundant in cocksfoot heads, but no reliable estimate of the damage caused by it can be given.

Foxtail (*Alopecurus pratensis*).

Foxtail Midge (*Stenodiplosis geniculati*).

Jacks and Cottier have shown this midge to occur throughout New Zealand. Large numbers of midges emerge from foxtail, especially that growing on roadsides, etc. It is not clear whether *Dasyneura alopecuri* is present in New Zealand as is reported or whether all the seed loss is due to *S. geniculati*.

White Clover (*Trifolium repens*).

Clover Case-bearer (*Coleophora spissicornis*).

This European insect occurs throughout New Zealand. The larvae destroy the florets and seeds. It is at times very abundant, but the actual seed loss due to it has not been demonstrated. No attempts have so far been made to control it.

Red Clover (*Trifolium pratense*).

Clover seed chalcid (*Bruchophagus gibbus*). This European insect, whose grub lives inside the seed, is known to destroy up to 12 per cent. of the seed on individual crops in New Zealand, but the overall loss caused by it is not known. Some parasites are present, but there may be scope for further introductions.

Clover Thrips (*Haplothrips niger*).

The red nymphs of this species are at times very abundant in red clover, but their influence on seed setting and seed yield is not known.

Aphis (*Aphis helichrysti*).

Heavy infestations of this species are at times responsible for the wilting of clover heads which are also covered with sticky honey dew.

Subterranean Clover (*T. subterraneum*).

Lucerne flea (*Sminthurus viridis*). This is known to occur south of the Rangitata in the South Island and in Manawatu, Wairarapa, and Hawke's Bay, as well as at Pokeno and Tuakau. It was evidently established in New Zealand long before subterranean clover came into wide use. The most serious defoliation caused by this insect has been noted in the Maraekakaho area. It is probably capable of doing more damage under New Zealand conditions than the following species. Tremendous numbers are found on the pasture in spring. Lime sulphur sprays have been used to control it in Australia.

Red-legged earth mite (*Halotydeus destructor*).

This mite was first found in the Napier area in the early 1940's. It is known to occur also at Wairoa and in the Gisborne area. It is a serious pest of subterranean clover in Australia, but its behaviour

so far would indicate that it is unlikely to be so important as a pasture pest in New Zealand. In Australia D.D.T.-superphosphate has been used to control the' mite.

THE THREAT OF INTRODUCED INSECTS

There are a number of general feeders, particularly scarabaeids such as Japanese beetle and Asiatic beetle, which could be serious pests of grassland in New Zealand, but apart from these known pests of pasture there are probably many more, apparently unimportant in their country of origin, which could become epidemic in New Zealand.

Lolium perenne appears to have very few specific insect pests overseas. One, however, is the ryegrass midge (*Contarinia lolii*), relatively unimportant in England but possibly much more serious should it establish here.

The clovers, especially red clover, have a much longer list of serious pests overseas. The chance introduction of insects such as the clover seed midge (*Dasyneura leguminicola*), the clover root borer (*Hylastinus obscurus*), the clover nodule weevils (*Sitona* spp.), the leaf weevils (*Hypera* spp.) and the seed weevils (*Apion* spp.) and the clover head caterpillar (*Laspeyresia interstinctana*) could have serious effects on our pastures.

The desirability of tightening up quarantine in New Zealand is now receiving attention, and I am sure that farmers will give solid support to any measures that are thought necessary to help preserve our natural advantages in the field of primary production.

CONTROL OF PASTURE INSECTS

As regards control, the desirable end of having this achieved by some assiduous parasite without the necessity for the annual expenditure of time and money is unfortunately possible, particularly with native insects, in a minority of cases. While most insects have their parasites, these are often not capable of sufficiently reducing their hosts numbers to eliminate damage.

In the case of pests like army worm, where the damage occurs rapidly, everything depends on rapidity of diagnosis, knowledge of effective control measures, and availability of materials.

In all cases the cost of Control measures must be reasonably small in relation to the value of the crop to be protected.

Where our understanding of the behaviour of the pest is sufficiently complete it may be possible to forecast outbreaks or to vary cultural practices to prevent outbreaks or to minimise their effects. There are very few cases where this is yet possible. In the case of *Oxycanus* the present control measures are reasonably cheap, but there is a wide field for investigation into the preventive aspect.

No effective remedial measure is known for grass grub, and the line of attack most likely to pay dividends is by the unravelling of the factors which allow it to becoming abundant periodically.

SUBTERRANEAN CATERPILLAR' (*Oxycanus* spp.)

Insects of the *Lepidopterous* family *Hepialidae* are pasture pests only in New Zealand. (*Oxycanus* (= *Poring*)) and Australia (Oncopera). They may occur in Southern Chile, but pastures there are probably not highly enough developed for their depredations to be noticeable. They are peculiar in that the caterpillar lives in a tunnel in the soil but comes to the surface to feed as a grazing animal on grasses and clovers. The common pasture pests have one brood per year. In New Zealand *Oxycanus cervinatus* is the most destructive species, particularly in the low-rainfall areas of the east coast of the South Island, and on pastures shut up for seed production. While it occurs in the North Island, its effects are not so severe in the higher-rainfall areas. In the South Island the moth flies about mid-October. There is, however, another species, *Oxycanus despictus*, which is so far known to me in outbreak proportions only in the higher-rainfall areas of Golden Bay. This species does not fly until January-February.

Damage by *Oxycanus* may result in complete destruction of a pasture, especially in low-rainfall areas. With lower populations or in higher-rainfall areas the damage may not be complete and partial recovery may follow, but the pasture deteriorates by being opened up and invaded by weeds and undesirable species.

These species of *Oxycanus* are periodically epidemic, but we are still far from a satisfactory knowledge of the factors which promote epidemics. The evidence which we have at present indicates that epi-

demics may be largely bound up with the conditions of soil moisture or humidity at the soil surface when the eggs and young caterpillars are present. This soil moisture will be affected by such factors as -rain-fall, evaporation, density of plant cover, and soil type. With a better understanding of these interactions it may be possible to devise pasture management practices which will minimise the damage.

Fortunately there exist effective practicable control measures which are entirely economic, especially on seed-producing areas. Their employment on purely grazing pastures of lower productivity becomes more critical from the cost angle;

The testing of dusts, sprays, and baits in 1940 showed that a poison bait of bran, paris green, and molasses gave effective control at a reasonable cost. Later work showed that molasses, could be omitted. In 1942 the treatment was proved on a field scale, using mechanical spreaders, but no substitute. for. bran was found. In 1947 an attempt was made to find the attractive principle in bran, but the only success was in the use of wheat germ added to materials which are normally unattractive, such as chaff and bran. D.D.T. dusts and sprays and "Gammexane" dusts were found to give good control, but at an increased: cost over the poison bait treatment. The search for an alternative treatment necessitated -by the difficulty of obtaining bran led to the testing by Kelsey, Hoy and Lowe of the Ashburton sub-station of low-volume sprays of D.D.T., but, without success, The same workers have made an important advance in demonstrating the efficacy of D.D.T. and "Gammexane" incorporated in superphosphate. The estimated cost of applying 0.5 per cent. "Gammexane" in 1 cwt. superphosphate per acre is 23/-. Combining the two operations reduces the total cost and gives better control, particularly with large populations against which the bran bait was not fully effective. The material can be applied with equipment which is normally present on the farm, it is less toxic to man and animals, is not affected by rain, and has been stored 18 months without loss of toxicity. The maximum effect is secured when no straw remains on the pasture. The provision-of-'Gammexane'I superphosphate mixed at the works would now seem to depend on the guarantee of a minimum demand by the farmers.

We are thus well ahead with the chemical control of *Oxycaenus*, especially on the more valuable pas-

tures., but more work on the epidemiology of the insect is needed. Experiments are in progress. to determine the influence of irrigation on infestation by *Oxycanus*.

GRASS GRUB

The principal grass grub throughout New Zealand is *Odontria zealandica*, a native Melolonthid beetle which is periodically epidemic on varying soil types and rainfalls. Its effects are probably worst on low-rainfall areas where conditions are less favourable for grass growth. Similar damage is occasionally done by the larvae of other species of *Odontria* and by those of *Pyronota festiva*.

Grass grubs or white grubs of other species are pests in many countries and are extremely difficult to control in pasture areas. Control in crops is not so difficult. In the remedial treatment of grass grub, which feeds on the roots in the soil and does not come to the surface, no use can be made of poison baits. Satisfactory remedial measures would require to kill the larvae in situ without damaging the pasture or having to plough it up. In so far as chemical control is concerned this means that a sufficient quantity of highly toxic chemical must be placed in contact with the grubs. This again means that large volumes of liquid must be applied. The net result is that in spite of the development of new and potent insecticides the m&e costs involved in the application of large volumes of liquid; apart from the cost of materials, makes economic control of the grubs in extensive areas of pasture more costly than is warranted by the value of the pasture or the cost of resowing.

As this is a native insect, no ready-made parasites can be secured from overseas. There is, however, a possibility, well worth trying since all other methods are so unpromising, of introducing parasites of related grass grubs. This is being attempted by the Entomological Research Station, which has an officer stationed in Australia collecting parasitic insects and shipping them in the adult stage to New Zealand. Liberations of some of these have been made last season in Nelson and at Ashburton and further liberations are being made this season. The results are problematical, since these parasites may not be well adapted to our grass grub, to the climate, and to the

general environment here, particularly in extensive areas of pasture lacking suitable food plants for the parasites.

Other lines of work are being investigated also. A parasitic nematode worm is being bred for field trials and attention has been devoted to the bacterial diseases which have been used in the United States against Japanese beetle. Heavy rolling during July to September probably helps the grass more than it damages the grub.

Apart from the question of immediate remedies which can be used against the grub in pastures, attention has been devoted to an attack on the beetle by means of sprays and the pasture at the time of their emergence and flight. The results have shown significant decreases in both beetle numbers and in the succeeding larval population. It is, however, doubtful if the results obtained would warrant the cost of treatment.

Crass grubs in pasture have proved difficult of control in all countries. They have been a problem since New Zealand was settled and are likely to remain a problem for many years yet. For this reason, without neglecting any line which gives promise of immediate practicable control, we have stressed the necessity for a better understanding of the life history and habits of the insect, since we feel that satisfactory control may come eventually from soil and pasture management practices which militate against the development of outbreaks. Until we know what conditions favour outbreaks of grass grub we cannot devise measures to prevent them. Closely bound up with work of this type is an investigation into the probable effect of irrigation on grass grub populations and their effects on pasture under irrigation.

Turning now to the field of insect resistance in grasses, one may say that the grass grub larva is a general unselective feeder on roots and it is probable that resistance in the sense of unpalatability of grasses and clovers would be linked with unpalatability to stock. Resistance in the sense of powers of root regeneration after damage, as is exemplified by cocksfoot, would seem to be something worth investigating. Anyone who works in the Canterbury Plains must often be led to consider how much of the grub damage to pasture plants is attributable to sub-optimal conditions (particularly soil moisture). for

plant growth and to speculate on the need for pasture species or strains which are ecologically better adapted to these low-rainfall areas and to the grass grub attacks which are a characteristic feature of the area. Would a lower productivity pasture of species better adapted to the conditions and more resistant to grub attack give better long-term production than a higher productivity pasture which is subject to periodic failure due to drought or grass grub?

BUMBLE BEES

Finally I will turn from pests to beneficial insects. Our interest in bumble bees is because of their importance as pollinating agents in red clover seed production. The average seed yields in New Zealand appear to be lower than in several other countries where there is a greater variety of species *Bombus*. Whether this is due to some of the more efficient species being absent from New Zealand is not clear. It may be due, to unsuitable environmental factors, such as inadequate nectar sources at all seasons or lack of suitable nesting sites, which would affect all species. Undoubtedly *Bombus* species vary in their ecological requirements and in the size of the populations which they build up, and it is possible that some of the species which are not now present in New Zealand might do better if introduced than those which are present. This is a question which can be tested only by making the introduction, and it seems that no adverse effects would follow if this were carefully done.

There are two possibilities of obtaining-increased seed production with the existing *Bombus* species.

1. By increasing the supply of nectar-bearing plants which would provide food at critical periods and allow the building up of larger populations; It is, however, not proved that this-factor of seasonal food supply is a critical one; it is a possible factor.

2. By increasing the efficiency of the existing populations by either -reducing the size of the individual fields and giving the bees less work to do or by staggering the flowering of the clover in the field by variations in the time of shutting up after haying or grazing.