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Disease could control grasshoppers

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Grasshoppers are among the pests which, since pre-Biblical times, have caused great loss to man's agricultural efforts.

In Western Australia, grasshoppers and locusts are serious pests both in agriculture and domestic gardens. In the northern Kimberley and Pilbara regions periodic plagues of the yellow-winged locust *Castrimargus musicus* devastate tropical pastures. Further south, in the eastern wheatbelt and adjacent pastoral areas, enormous plagues of the Australian plague locust *Chortoicetes terminifera* occurred almost annually until farmers and scientists started an intensive cultural and chemical control programme. In the sub-coastal sandy pastures of the south west the wingless grasshopper *Phaulacridium* spp. and the small plague grasshopper *Austroicetes cruciata* annually occur in great numbers to the dismay of landowners and home gardeners. But there are prospects for biological control.

**Protozoan pathogens of grasshoppers**

The wingless grasshopper is currently the target of a control programme based on the disease organism *Nosema locustae*. *Nosema* is a spore-forming protozoan which attacks only members of the insect order Orthoptera, which contains the locusts, grasshoppers and crickets. However, *N. locustae* will not infect all orthopterans—for instance many crickets are not susceptible and not all grasshoppers are equally susceptible.

Spores of *Nosema* must be ingested before infection can occur. Once eaten by a susceptible grasshopper host the spores germinate and the organism multiplies within the host's tissues—principally the fat body in the case of *N. locustae*. After 14 to 20 days the protozoan starts to form spores, thick-walled resistant structures which accumulate within the insect. If the infection is
sufficiently severe the fat body is almost completely destroyed and replaced by spores. When this happens the insect may die before it has laid eggs. Often, egg-laying may occur, but the total egg production is reduced.

*Nosema locustae* is the least virulent of the three species of *Nosema* known to infect grasshoppers. This means that although the disease organism takes a long time to cause symptoms in its host, and the host can tolerate a heavy infection, the organism has the opportunity to produce many spores. This is significant to the spread of the disease through the pest population. In the case of *N. locustae*, the pests may start to die after four weeks. By this time vast numbers of spores will have been produced.

The other *Nosema* species, *N. cuneatum* and *N. acridophagus* are very much more virulent than *N. locustae*. This means that although they can quickly reduce the density of a pest population (deaths start after 10 to 14 days) they have insufficient opportunity to produce many spores. These species may be valuable in a pest management programme in rapidly reducing the pest density. Less virulent species like *N. locustae* are of more value in long-term suppression of a pest population.

**Laboratory grasshopper rearing and multiplication of spores**

The programme is aimed now at producing, in the laboratory, a large quantity of infective material of *N. locustae*. It will be used in field trials to assess the potential of this control approach.

The disease is multiplied in a suitable host grasshopper, one which ideally has the following properties:

- **large body size for maximum spore production**
- **susceptibility to the disease**
- **easy to culture in the laboratory.**

The Department's early laboratory work was based on the giant Kimberley grasshopper *Valanga irregularis* and the spur-throated locust *Austracris gutulosa*. But entomologists experienced difficulty with these grasshoppers as they were susceptible not only to *Nosema* but also to a range of other debilitating diseases. Other species will be used for future work.

When the young nymphal grasshoppers have reached the third instar (about half grown) they are inoculated with the disease by feeding them the spores on an artificial diet. Following inoculation the grasshoppers are kept isolated from the non-infected stock to allow the disease to run its course.

**Maximum spore production** is obtained just before the host dies. The grasshoppers are homogenised in a blender and the resultant liquid filtered and centrifuged. After centrifugation the solids are recovered as a plug on the bottom of the centrifuge tube. The disease spores are readily identified as they form a white band. The spores can easily be separated out as a pure suspension. Some of these spores may be used to inoculate new laboratory hosts. Most are stored in tubes in liquid nitrogen for future field use.

**Field distribution of disease spores**

Field populations are inoculated in spring and summer when most of the hoppers have reached third instar. The spore suspension is removed from liquid nitrogen storage, thawed and sprayed on to a bran bait carrier. The bait must be distributed late in the day or on an overcast day as the spores are rapidly inactivated by ultra violet light.

The degree of infection and deaths produced in the population is related to the rate at which spores and bran are distributed. A balance must be struck between the total area baited and the level of infection produced. A spore concentration of $2.5 \times 10^7$ spores per hectare in 1.5 kg of bran bait seems the most efficient use of spore material. At this rate a density reduction of 50 per cent can be expected in any one year, while the survivors will suffer reduced fecundity.

**Nosema in Western Australia**

Work on *Nosema locustae* in this State is entering its second year. Two small scale field releases have been made already but problems with laboratory preparation of spores have curtailed production of infective material. At Lancelin, where two hectares of wingless grasshopper infested country were baited in 1979, infection was detected in 30 per cent of grasshoppers on the release site. This was a most encouraging result in view of the small area treated.

*Nosema* will not eradicate grasshoppers and locusts. The disease organism is most effective in crowded populations such as are found in southern areas in late summer. Normally, almost no infection would be expected under conditions of low host density. As a pest management tool *Nosema* may be useful in suppressing chronic grasshopper problems below an economic threshold level, but it will never completely eradicate the grasshopper.