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BEETLES, MITES AND CHICORY:

Dung beetles - past present and future

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Summary: A brief account of the history, habits and life cycle of dung beetles is presented. Australia has native dung beetles but these are adapted to coarse marsupial droppings. An introduction program has brought in species from around the world particularly southern Europe and Africa. There are now 30 species that can be found in Australia and only one of these has spread to its geographic limits. The benefits of dung beetle activity are also outlined. These include less pollution of pastures, less nutrient run-off, lower populations of bush and buffalo flies, more efficient nutrient recycling and improved habitat and food supply for earthworms. Finally, breeding habits and current introduction techniques are presented.

Dung beetles spend almost their whole lives eating and breeding in dung. For the ancient Egyptians, the scarab species, from which the family derives its Latin name - *scarabaiedae* - was a sacred symbol of resurrection. In the pharaoh's spirit world, the Sun's rays radiated from a scarab's head and its dung ball was the world, caught in an eternal cycle of daily renewal or recycling which leads to a more sustainable system.

More than 4000 of these remarkable creatures have evolved and adapted to the world's different climates and the dung of its many animals. Australia has 270 species of native dung beetles adapted to coarse textured marsupial dung which is tobacco like in consistency but these native species are inefficient in clearing away the dung of domestic animals brought by European settlers. Indeed today in Australia, 26 million cattle produce over 300 million cowpads per day, which equated to 450,000 tonnes per day of wet dung which fouls grazing land, locking up valuable nutrients and creating an enormous breeding ground for bush flies, buffalo flies and other pests such as internal parasites. Our native dung beetles were simply not adapted to handle these conditions.

Dung beetle introduction

Introducing species to control dung-breeding flies was suggested in the 1960'2 by Dr George Bornemisza of CSIRO. In 1970, he commenced a project to remedy this situation by introducing dung beetles which were fully adapted to recycling cattle dung by burying it in the soil and creating a balance in the grassland ecosystem. After Dr. Bornemisza developed new techniques for egg sterilisation, egg transplant and mass breeding of beetles in 1970 he departed for Africa and commenced a program of looking at some of Africa's 2,500 species of dung beetles.

In selecting a species for Australia some of the criteria used were that beetles did not take dung beyond grass root depths, as some of the larger African species do, the ease with which the species could be bred in glasshouses and the number of generations per breeding season.

Pairs were set up in containers and thousands of brood balls were produced. The eggs were removed from each of 3,000 balls, they were washed and then surfaced sterilised in formalyn solution for five minutes.

In those days we would receive a telegram in Canberra advising of the number of eggs arriving and size of the natural beetle made ball. A team in the Quarantine rooms at CSIRO in Canberra would then commence rolling 3,000 balls of Australian dung, into which one egg was placed after a cavity was made in each ball. After closing in the egg and placing the brood ball in correctly moistened soil and at the prescribed temperature for that species, we would wait the 3 - 10 weeks for a beetle to emerge. Emergence percentages were very low, often 1 to 2%t. From a few dozen parent-al beetles a release colony of approximately 500 beetles were produced in stainless steel, temperature controlled pens. Beetles were then dispatched to farmers or Department of Agriculture staff for release.

The present situation

As at July 1996, there have been 57 species received into Canberra quarantine breeding rooms. Of these 44 species were successfully bred and released. However, currently there are 30 species known to be established in Australia.

Only one of the 30 species of introduced dung beetles in Australia has spread to its climatic/geographic limits. This species, *Euoniticellus intermedius* - from Africa, was released across inland areas of Australia 20 years ago. It was often assisted its natural rate of spread by hitching a ride to a new area on cattle trucks. The species is a small day flying species and is attracted to fresh dung dropped in cattle trucks during loading.

The remaining 29 species require harvesting from localities where the species is well established, and released in new areas which are climatically suitable for the species. By using the computer modelling program CLIMEX it is possible to predict the potential distribution of every dung beetle species throughout Australia.

Dung Beetle habits

Dung beetles are effective because they share a common purpose and seldom impede each other's progress with territorial squabbles. The team effort begins when hundreds of pairs - up to 1500 hundred in the case of smaller species, land on a dung pad.

Most species are burrowers that bury dung in tunnels directly underneath the pads which are hollowed out from within. Larger species from France excavate the deepest tunnels along which they make sausage shaped brood chambers. Smaller Spanish species make shallower tunnels where dung is buried in chambers that hang like fruit from a pear tree. Intermediate depths may be inhabited by species originating from South Africa and the Mediterranean. Some surface-dwellers cut perfectly shaped balls from the pad which are rolled away and attached to the base of plants, or buried.

For maximum dung burial during spring, summer, and autumn, it is desirable to have six or more species of dung beetles with overlapping periods of activity. In cooler areas, the French species which are slow to recover from winter cold and producing 1-2 generations between spring and autumn, have been matched with three temperate-climate species: the Spanish and Mediterranean types, which multiply quickly as soon as spring arrives and the South African species which recovers from winter slowly but breeds rapidly. The African ball-rolling species prefers climates like the NSW north coats where it commonly works with its tunnelling South African relative. In warmer climates many species are active for longer periods of the year.

Some species fly during the day, others at night and other species at dawn and dusk. Likewise each species has its "corridor" of time in which it works during the year, the activity period can fluctuate from year to year according to seasonal patterns/ fluctuations, *e.g. Bubas bison*, a winter rainfall species is activated each winter when temperatures drop and the beetle pupa gets wet. Emergence of an adult beetle occurs one three weeks after these weather conditions prevail.

Above-ground benefits

A number of beneficial effects from dung beetles have been shown or suggested:

Less pasture pollution. Up to 20% of an acre per year can be put out of service due to the cow pad and the area of rank grass around each pad (Waterhouse 1974).

Reduced parasite load on stock through interruption to the life cycle of some internal parasites (Bryan 1973).

Reduced bush fly and buffalo fly breeding through the burial of shredding dung pads. Bush fly larvae require 5 to 6 days and Buffalo fly larvae 3 to 5 days in the pad to mature and survive. Dung beetles can reduce fly populations by burying, dispersing and breaking up the dung before the fly larvae can complete their development. If cow or horse dung is buried within 72 hours good fly control will be obtained, however if beetle numbers are low and complete burial is not occurring some fly control will occur due to the dung dispersal and the desiccation of the dung due to the breaking up of the dung crust.

Reduced nutrient input into rivers and dams. The burial of nutrient rich dung in tunnels excavated by beetles would have a good beneficial effect on reducing nutrient run-off into waterways, for example there are approximately 10 million cattle in the Murray Darling basin which drop approximately 180,000 tonnes of dung each day. Seeing there are at least 14 species of dung beetles yet to spread to their climatic boundaries within the basin, the beetles have a two fold effect with the reduction of nutrient runoff. Dung beetles reduce nutrient from the dung, they create a situation which can reduce dissolved nutrients from applied fertilizers from reaching waterways. I am confident a large proportion of the 180,000 tonnes of dung will be buried one day.

Below-ground benefits

Other below ground benefits have also been suggested:

Nutrient recycling by dung beetles leads to improved effect on soil fertility due to plants taking up more nitrogen, phosphorus and sulphur which leads to greater yields.

Increased soil aeration

Improved root penetration by grasses in poor and compactable soils improving moisture and nutrients availability in the plant-root zone.

Improved habitat and food supply for earthworms which are well recognised as another of natures recyclers. Dung beetle larvae in some cases consume approximately one third to half of a dung ball depending on the dung quality. The beetle tunnel system also assists earth worm movement.

Dung Beetle Breeding Habitats

The adults work in pairs to build their nests in tunnels under a pad. In each ball of dung an egg is laid which hatches in 1 - 3 days and the larvae feeds for 12 to 20 days in the ball as it feeds and grows in size it works downwards and pupates at the bottom of the ball. The pupal stages lasts for 5 -7 days before turning into a young adult which then takes 3 - 6 days to harden its wing cases and legs and breaks out of its cocoon and climbs to the soil surface to fly off in search of fresh dung. Some species with life cycles of only a few weeks produce several generations per year, but the larger ones take many months to reproduce and regenerate only once or twice per year. When the new generation of beetles has left the nest, the abandoned burrows are an attractive habitat and food supply for soil-enriching earthworms.

Distributing the beetles

I have during the last two years sent out over 400 consignments of beetles to farmers and Landcare groups. After harvesting a species, the beetles are cleaned and numbers calculated. I send to a farmer between 1200 and 1500 beetles as a starter colony. An air freight system is used and I can frequently get beetles from Canberra to a farmers paddock in 12 to 20 hours. The beetles are packed in moistened Canadian peat moss and dispatched to arrive at their destination at a time convenient to the farmer for collection from an airport or freight depot.

Each consignment has a release instruction sheet. The two main points being:

- Concentrate the beetle release on a one quarter hectare area in the centre of his property.
- Release the 1200 beetles onto 10 - 12 fresh cow pads.

Waiting for results

A colony may take from 1 to 5 years to have an impact on dung burial. Small dung beetle species which have an egg to adult period of 30 days will build up in numbers much sooner than some of the large species which have an egg to adult period of up to 60 or 80 days and more with some species. A release of *Bubas bison*, a winter active species in 1995 is showing definite signs of establishment in 1996 in the Wagga Wagga district.

References

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