

Scarab grubs in northern tableland pastures

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The underground larval stages of a number of cockchafer or scarab beetles (family Scarabaeidae) feed on humus and plant roots in natural and improved pastures on the northern tablelands. These scarabs, or white curl grubs, sometimes occur in high population densities and may then cause serious localised damage to pastures. The infested patches may vary in extent from a few square metres to several hectares.

At times, the grubs also damage lawns, golf courses, bowling greens and playing fields and severely attack cultivated crops planted in land recently under pasture.

Grassland is the natural habitat of scarab grubs. Clearing the native vegetation and replacing it with improved pastures has created conditions that favour scarab grubs. Their numbers are regulated by weather conditions, disease, birds and natural enemy insects. Control of root-feeding scarab grubs in pastures with insecticides is not economic.

Life cycles

The larvae of the small brownish cockchafer, *Sericesthis* spp., which have one-year life cycles, are the most important scarab pests of pastures. Larvae of species that have two-year life cycles, including the Christmas beetles, *Anoplognathus* spp., the large brownish cockchafer, *Antitrogus* spp. and *Rhopaea* spp., and the black and greyish brown coloured black soil scarab, *Othnonius batesi*, are only of occasional concern.

Species with two-year life cycles have overlapping generations of larvae, so that larvae can be found in the soil all year round.

Adults

The beetles are present from November to March. They are 15 to 30 mm long with oval bodies. They vary in colour. Some are dull and slightly iridescent brown, dark brown, reddish brown or yellowish brown and black. Others are bright metallic and iridescent mixtures of green, blue and brown. The underside of the body is often covered with short, greyish hairs and the wingcovers usually do not reach the tip of the abdomen. The antennae end in enlarged clubs. The beetles live for 1 to 9 weeks and each female may lay 20 to 40 eggs.



A scarab or white curl grub. Photo: M. Hill.

Beetle swarming

When the soil is soft and moist, the young, newly formed beetles leave the pupal chambers where they developed and burrow up near the surface, where they wait for suitable conditions before emerging. On very warm days from November to March, large numbers may leave infested pastures and fly away in swarms to find food plants and new breeding sites. Swarming occurs in the morning or at dusk, depending upon the species. Each species usually swarms at about the same time of the year.



Swarming beetles are sometimes attracted to lights.

The period and intensity of beetle activity vary from year to year, depending upon the weather. If late spring and summer are very dry the newly formed beetles cannot leave the pupal chambers and will die there. After thunderstorms there may be mass emergences of beetles over a wide area.



Pruinose scarab, *Sericesthis geminata*. Length 11 to 16 mm. Photo: M. Hill.



Dusky pasture scarab, *Sericesthis nigrolineata*. Length 10 to 13 mm, dark reddish brown colour, narrow blackish longitudinal lines on the wing covers. Photo: M. Hill.



A Christmas beetle (the opaline cockchafer, *Anoplognathus porosus*). Length 17 to 25 mm. Photo: S. J. Davidson.

Some beetles, including the pruinose scarab, *Sericesthis geminata*, the dusky pasture scarab, *S. nigrolineata*, and the Christmas beetles, *Anoplognathus* spp., fly to eucalypts and other trees to feed and mate before returning to the soil, where the females lay eggs. However, adult

females of at least one of these species (the pruinose scarab) may also mate and lay some eggs where they emerged before flying to eucalypt trees. Other beetles, including the tableland pasture scarab, *Antitrogus morbillosus*, black soil scarab, *Othnonius batesi*, and the pasture white grubs, *Rhopaea* spp., do not feed, but may make short dispersal flights before mating.



Antitrogus sp., one of the large brownish cockchafer. Length 18 to 26 mm. Photo: M. Hill.

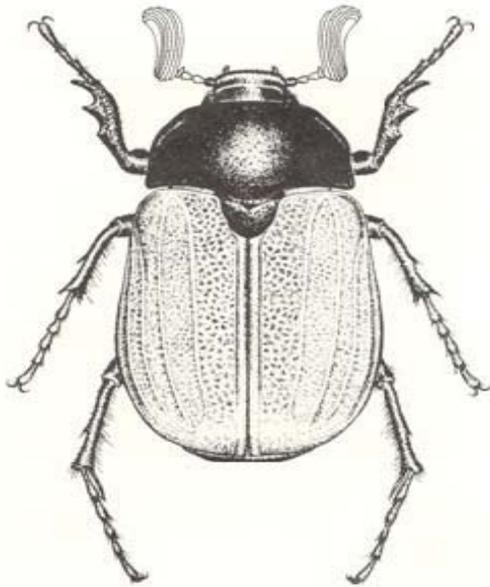


Adult pasture white grub, *Rhopaea* sp. Length 20 to 30 mm. Photo: M. Hill.

Beetles that fly to trees may feed and mate for several consecutive nights after swarming. Very heavily infested trees can be severely defoliated. Repeated heavy defoliations by a complex of leaf-eating insects, including the scarab beetles, are contributing to the decline and death of eucalypt trees on the northern tablelands. Isolated trees and small stands of trees surrounded by pasture are much more susceptible to attack by scarab beetles than trees in urban areas.

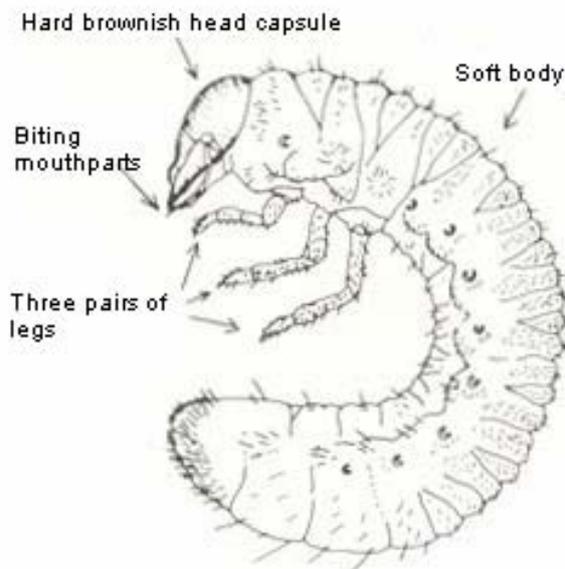
During the day the dull-coloured *Sericesthis* spp. beetles hide under litter beneath the trees or in the soil of adjacent grassland. However, the brightly

coloured *Anoplognathus* spp. beetles remain on the trees throughout the swarming period.



*The blacksoil scarab, Othnonius batesi. Colour black and greyish brown. Length 14 to 17 mm
Illustration: A. Westcott.*

The beetles do not migrate to any extent. Those species that fly to trees and mate rarely travel more than 1 to 2 km from where they emerge and may reinfest the pasture where they developed as larvae. The non-feeding species seldom move far from the emergence sites and normally stay in the same paddock.



A third stage scarab larva.

Egg laying

The beetles prefer grass-dominant pastures for egg laying and avoid areas of bare soil and legume dominant pastures. Soil moisture also influences egg laying. The females do not like dry or wet soils,

and if conditions are very dry they favour moister, lower areas of pastures for egg laying.

Eggs are generally laid 2 to 13 cm below the soil surface, either singly or in clusters and usually in cells or cavities that the female makes in the earth. Newly laid eggs are white, oval and 1.5 to 5 mm long. They hatch after about 2 to 4 weeks.

Larvae

There are three larval stages. The larvae usually take about 10 months or about 21 months to reach maturity, depending on whether the species has a one-year or a two-year life cycle.

Newly hatched first stage larvae are 2 to 7 mm long with white bodies and brown or yellowish brown heads. If the soil is soft and moist they make their way upward and feed on decaying organic matter near the surface. The first stage larvae normally ingest large quantities of soil and decaying organic matter. If there are large numbers of them they may also attack the roots of pasture plants. They develop to second stage larvae, which can feed extensively on plant roots as well as organic matter.



Third stage larva of a pasture white grub, Rhopaea sp. Length up to 60 mm. Photo: M. Hill.

Fully grown third stage larvae are white or creamy-white, soft-bodied grubs 20 to 60 mm long and 5 to 10 mm wide. When resting they are C-shaped. They have hard, brown, yellowish brown or reddish brown head capsules, strong biting mouthparts and three pairs of legs. The enlarged rear end commonly has a dark grey tinge caused by faecal matter in the hind gut showing through. Third stage larvae take about 7 months or about 14 months to complete development, depending upon whether the species has a one-year or a two-year life cycle. Most damage is caused by the third stage larvae. They cut off plant roots and feed on organic matter. When there are many of them they can be very destructive.

Most larvae of the species with a one-year life cycle develop to the third stage by mid to late autumn, about 3 months after hatching. Development continues at a reduced rate during winter and larval feeding intensifies in spring. The larvae stop feeding and become prepupae by mid to late spring.

The species with a two-year life cycle spend the first winter as second stage larvae. They develop into third stage larvae in mid to late spring, about 8 months after hatching.

Larvae feed during late spring, summer and autumn and then remain relatively inactive during the second winter. They resume feeding in the following spring and become prepupae by late spring or early summer.

Prepupae and pupae

When fully fed, the third stage larva makes an oval chamber, in which it will pupate, 2 to 25 cm deep in the soil. The contents of the hind gut are voided and the larva becomes a prepupa. During this time the curved, white or creamy white body becomes straighter and then shrivels, leaving the rear end wrinkled and upturned. After 2 to 3 weeks the prepupae transform to pupae, which are pale yellow or yellow-brown and 15 to 35 mm long. After 3 to 6 weeks the pupae have developed into adult beetles.

They stay in the pupal chambers until conditions become favourable for emergence.



A scarab prepupa. During this period the body becomes paler, straighter, thinner and more wrinkled. Photo: M. Hill.

Damage

The extent of damage to pastures by scarab grubs varies with the intensity of infestation, the seasonal conditions and grazing management. It is usually most serious where the soil is shallow and plant growth is restricted by dryness and overgrazing. Damage is worsened when drought and overstocking reduce the plant's capacity to replace severed roots.

The grubs usually feed in the warmer months only, but may continue throughout the year if the winter is mild. During warm weather in spring, summer and autumn, most larvae feed within 1 to 2 cm of

the soil surface. Larvae are often present throughout the pasture in limited numbers but may be very numerous in scattered patches varying in extent from a few square metres to several hectares. Adjacent pastures can differ greatly in degree of infestation.



A scarab pupa in a chamber in the soil. Photo: M. Hill.



Scarab larva killed by a fungus, Cordyceps sp. The fungus then grows upwards to the soil surface. Photo: M. Hill.

Where the larval population is dense, all the plant roots may be cut off. The soil underneath is loose and spongy due to the movement of the larvae and their ingestion of soil. Grazing animals may uproot damaged pasture, and birds searching for the larvae sometimes tear out large areas.

Localised patches in pastures can be completely destroyed by the combined effects of scarab grub attack, drought, overgrazing and dislodging of damaged plants, but this is uncommon. Established pastures are rarely harmed severely by one season's infestation by white curl grubs. If there is no drought or overstocking, damage to pastures will usually not become serious until the third or fourth season after the initial attack.

Population regulation

Scarab grub populations are naturally regulated by adverse weather conditions, disease, parasitism by insects and predation by birds and insects. During

and after seasons when adverse weather conditions suppress grub populations, the predators, parasites and diseases may help to maintain them at non-damaging levels. However, when widespread and severe scarab grub outbreaks occur, only the main controlling factor – the weather – can restore the natural balance.

Insectivorous birds and parasitic wasps are the most useful natural enemies. The other insect enemies are usually less important. However, large-scale land clearing on the northern tablelands has destroyed many nesting and roosting sites of non-migratory, insectivorous birds and has reduced food sources for parasitic wasps. To improve biological control, existing on-farm native vegetation should be preserved, and more breeding habitats for these birds (particularly the Australian magpie) and parasitic insects should be created.

Weather

If conditions in spring and summer are very dry, many newly formed beetles die in the soil. Beetles that survive and emerge do not live long and the females lay few eggs. If hot and dry conditions persist during summer and autumn, many eggs die from desiccation, and many newly hatched larvae die in the cells or cavities where the eggs were laid. New larvae that do make their way upwards may die from heat stress.

Protracted wet weather in autumn, winter and spring may cause many larvae and pupae to die from drowning or disease. Continued heavy rainfall in summer may cause waterlogging of the soil, and kill many eggs and newly-hatched larvae.

Diseases

Scarab grub populations are sometimes reduced by fungal, bacterial, viral or protozoan diseases. Affected grubs are abnormally coloured and have symptoms such as gangrenous legs, convulsive movements or general paralysis.

Insectivorous birds

White curl grubs in northern tableland pastures are preyed upon by a large number of insectivorous birds. The most important are the straw-necked ibis, *Threskiornis spinicollis*, and the Australian magpie, *Gymnorhina tibicen*.

The straw-necked ibis roosts near swamps, lakes and other wet areas and is not as widely distributed as the Australian magpie. Ibises usually uproot large sections of infested pasture while feeding on the grubs and so aggravate existing damage.

The Australian magpie inhabits open-timbered country and is also found in urban parks and gardens. These habitats coincide with the principal habitats of scarab grubs. Magpies find and remove

the grubs one at a time and seldom disturb the surface of affected pastures.

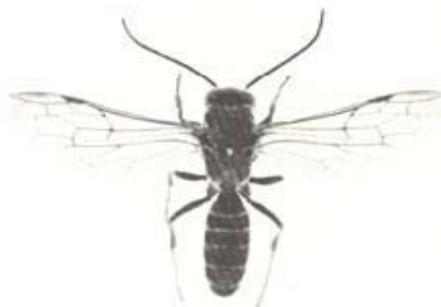
Parasitic wasps

Scarab grubs are parasitised by hairy flower wasps (family Scoliidae) and thynnids or flower wasps (family Tiphidae). The wasps feed on the nectar of some flowers and on honeydew secreted by sucking insects such as scales, aphids and leafhoppers. They are only found in areas where these sources of food are available.

Adult scoliids are 15 to 30 mm long with wingspans of 25 to 40 mm. They are usually black or blue-black and have yellow, reddish yellow, orange-yellow, white or red spots, or transverse bands, on the head and body. They are often thickly covered with hairs. Their wings are smoky or dark with metallic iridescence and the veins are absent or only faintly visible towards the wing tips. Males are slender with large eyes and long, straight antennae, while the females are stout with small eyes and short, curled antennae.



A female hairy flower wasp (family Scoliidae). These wasps are 15 to 30 mm long and usually have no veins at the wingtips. Photo: M. Hill.



A male thynnid or flower wasp (family Tiphidae). These wasps are 15 to 25 mm long. Photo: M. Hill

Adult tiphids (thynnids) are 15 to 25 mm long with wingspans up to 40 mm. They are usually black, brown, reddish brown, orange-brown or reddish. They have dark brown, yellow or black spots or transverse bands on the head and body. The males are stout, with well developed legs, long, straight

antennae and smoky or reddish brown wings. Females are wingless and antlike, with short, curled antennae and short, stout legs.



Wasp egg near the head of this scarab larva.



Wasp larva feeding on the scarab larva.

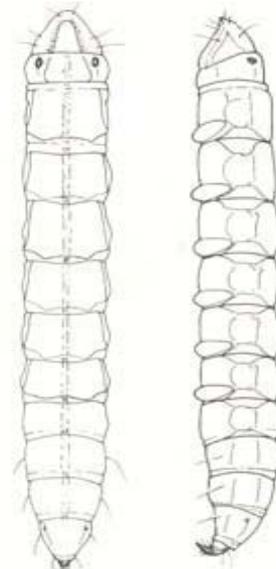


Pupa alongside the remains of the scarab larva. Hairy flower wasp young feeds on third stage scarab larvae in cells in the ground.
Photos: C. Haywood.

On warm, sunny mornings in spring, summer and autumn, male scoliids and thynnids fly over scarab grub infested pastures, searching for female wasps. After mating, the female wasps burrow into the soil to locate third stage grubs and paralyse them by stinging. Thynnid wasps lay an egg on each grub and then leave. Scoliids drag the grubs deeper into the ground, make earthen cells around them and then lay an egg on each grub.



Hairy flower wasp feeding. Photo: S. J. Davidson.



Larva of a robber fly. Length 30 to 40 mm when fully fed. Illustration: A. Westcott.

After hatching from the egg, the parasite larva feeds on the body of the scarab grub. When fully fed the larva pupates in a 20 to 35 mm long cigar-shaped cocoon which is smooth, brown and very tough.

Adult scoliid and thynnid wasps live for about 2 months. There are one or more generations a year, depending upon the species. The wasps overwinter as fully grown larvae, pupae or adults in cocoons in the soil.

Predatory and parasitic flies

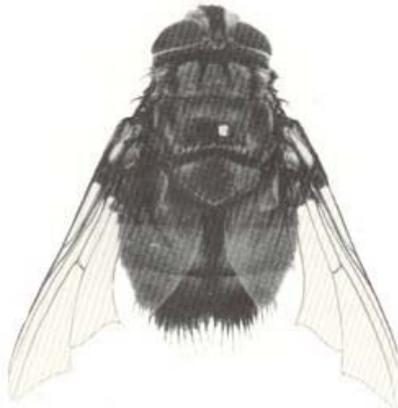
The soil-dwelling larvae of robber flies (family Asilidae) prey upon scarab grubs. Some adult robber flies also prey upon the adult beetles. Fully fed asilid larvae are 30 to 40 mm long with white or creamy white cylindrical bodies and hook-shaped heads. Robber fly adults are 20 to 25 mm long with wingspans of 30 to 40 mm. They have slender black or brownish bodies, long, bristly legs, a pair of clear or smoky wings and a bayonet-like beak.

Adult beetles and scarab grubs are also parasitised by flies of the family Tachinidae. Eggs are laid

either in or on the beetle or in the soil and the parasite larva feeds on the body contents of the beetle or grub. Tachinid flies are 6 to 15 mm long with wingspans of 10 to 25 mm. They have stout and often very bristly bodies ranging from dull grey or brown to shining metallic mixtures of green, blue, red and black.



A robber fly. Length 20 to 25 mm. Photo: S.J. Davidson.



A tachinid fly. Tachinids are 6 to 15 mm long. Photo: M. Hill.

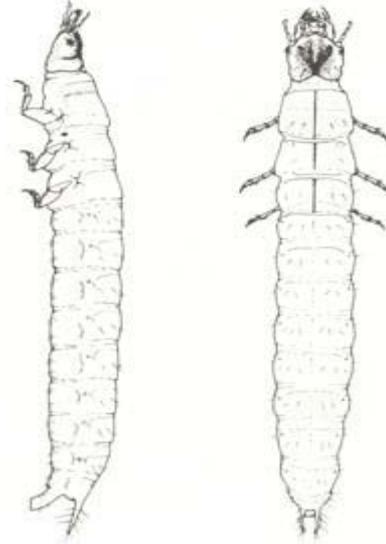


A carabid beetle. Carabids are 6 to 20 mm long. Photo: S. J. Davidson.

Predatory beetles

Adult and larval stages of carabid beetles or predatory ground beetles (family Carabidae) prey upon white curl grubs. These beetles, which hunt at night and hide by day, are 6 to 20 mm long with flattened, elongated bodies and long legs. They

vary in colour from black or brownish to green or purple. Many give off a disagreeable odour when disturbed. The fully grown carabid larva is 10 to 25 mm long, slender and semi-flattened, with a large dark head, three pairs of short legs and a prominent pair of spine-like, fleshy processes on the rear of the body. The body is white, pale yellow or brown, often with dark plates.



Larva of a carabid beetle. Length 10 to 25 mm when fully fed. Illustration: A. Westcott.



Two types of larvae of click beetles (family Elateridae). Elaterid larvae are 15 to 40 mm long when fully developed. Photos: S. J. Davidson. Left. Soft semi-flattened larva. Right. Hard round larva.

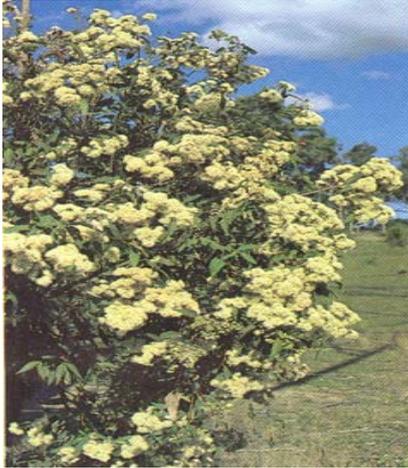
Larval stages of click beetles (family Elateridae) also prey upon white curl grubs. Fully grown elaterid larvae are 15 to 40 mm long and differ widely in form and colour. Some have soft, semi-flattened, smooth, yellow or creamy white bodies, darker wedge-shaped heads and forked, tooth-edged tails. Others have hard, round, smooth bodies which are yellow, brown, reddish brown or yellowish brown, and have flattened, rounded or conical tails and wedge-shaped heads.

Controlling scarab grubs

Cultivation, if feasible, can be used to suppress scarab grub populations. Several shallow cultivations with a fine-toothed heavy harrow during the warm

summer/autumn period will destroy many eggs and grubs through the combined effects of mechanical injury, desiccation and exposure to predation.

Close grazing of pasture during late spring, summer and autumn will make eggs and grubs in the topsoil more susceptible to desiccation and predation, but can encourage some other pasture insect pest problems, such as wingless grasshopper.



Nectar-bearing native plants provide food for adults of natural enemy insects that kill scarab grubs. Photo: R L. Davidson.

Promoting natural control agents

Steps can be taken to encourage insectivorous birds and parasitic insects, particularly the wasps. You should provide suitable nesting and roosting sites for the birds and keep small fenced areas of nectar-bearing native plants (including eucalypts, tea-trees, rough-barked apple and blackthorn) near or in pastures as sources of food for the insects. Keep a range of plant species in these areas at all times. Keep grazing livestock out.

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Magpies are useful predators of scarab grubs. They need clumps of trees for successful nesting. Photo: S. J. Davidson.

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