2.2 Cochineal insects (Dactylopius spp.)

Cochineal insects are sap-sucking insects that feed only on cactus species (plants within the family Cactaceae). There are nine species of cochineal, and each species feeds on only one or a few related species of cactus. It was recently discovered that there are host-specific races or biotypes within some of the species of cochineal insects, and that each biotype can only develop on one cactus species, although the different biotypes look exactly identical. Cochineal insects are all of South American or North American origin.

The following cochineal species were introduced into South Africa to control invasive cacti:

<table>
<thead>
<tr>
<th>Cochineal species (biocontrol agents)</th>
<th>Host plants (target weeds)</th>
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<tbody>
<tr>
<td>Dactylopius australis</td>
<td>Opuntia aurantiaca (jointed cactus)</td>
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<tr>
<td>Dactylopius ceylonicus</td>
<td>Opuntia inamata (smooth prickly pear)</td>
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<tr>
<td>Dactylopius opuntiae</td>
<td><em>Opuntia ficus-indica</em> (prickly pear)</td>
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<td><em>Opuntia stricta</em> (Australian pest pear)</td>
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<td>Dactylopius tomentosus (probably different biotypes)</td>
<td>Opuntia imbricata (imbricate cactus)</td>
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<td>Opuntia fulvida (rosea cactus)</td>
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</tbody>
</table>

Life cycle of a typical cochineal insect

Cochineal insects usually live in colonies or clusters of individuals grouped together on the surface of the cactus plants (fig. 1). Adult females (fig. 2) resemble small puffy sacks, about the size of a match-head, but are normally not seen because they are covered with a coat of white, woolly wax. The body fluids are typically dark red due to a high content of carminic acid, which is the source of red cochineal dye. The waxen coat protects the insects from heat, cold and predation by ladybird beetles, and the carminic acid seems to deter parasites. The adult males (fig. 3 and 4) are seldom seen and bear no resemblance to the females. They are tiny, pink, mobile insects with two semitransparent wings and long “tail” filaments.

Female cochineal insects lay up to a thousand eggs (fig. 4a), which hatch almost immediately and give rise to minute, pink nymphs (fig. 5), less than 1 mm in length, known as “crawlers” because they have functional legs which enable them to move about. Male and female crawlers differ from each other in behaviour and development.

Female crawlers (fig. 4b) are covered with elongate, stiff bristles that act as a parachute or sail and enable the insects to disperse on the wind when overcrowded. On warm days, the crawlers move upwards and aggregate on the highest points of the cactus plants or surrounding vegetation. From there they are blown off by the wind and carried up to several metres. This form of dispersal relies on chance and results in only a few of the crawlers landing on another host plant. Unsuccessful crawlers climb upwards again and can repeat the dispersal process several times over a few days before they die from starvation.

The crawlers that land on or near a suitable host plant insert their sucking mouthparts and start to feed, usually in shady spots or close to the base of a spine. In uncrowded conditions, many of the crawlers settle around the parent females and do not disperse. Once settled, the female never moves again and feeds in the same place for the rest of her life. If removed from the plant, a nymph or young female will
be unable to insert its long, delicate mouthparts into the plant again, and will die from starvation.

The female nymphs now start to secrete the characteristic woolly, waxy filaments that cover and protect their bodies (fig. 4c). As they grow, the insects moult (shed their skin) twice, but their legs remain small and become non-functional. After the second moult, the females are mature and ready to mate (fig. 4d). They start laying eggs about three weeks later and continue to do so for approximately 50 days.

Male crawlers (fig. 4e) are not as well adapted for wind dispersal as the young females and male cochineal insects disperse mostly during the adult stage. The males have fewer and shorter bristles than female crawlers, but can also be wind dispersed. Most remain beneath the protective wax covering of their mother, or settle in groups near her. Shortly after starting to feed, they secrete a waxy coating. At the first moult, the waxy covering is shed with the old skin and the crawlers have very little protective wax. They spend a few more days feeding and crawling about on the plant before secreting more wax to form an open-ended, hollow, "pupal" cocoon (fig. 4f). Inside the cocoon, the males undergo three further molts, including a "pupa" (fig. 4g) and finally become winged adults (fig. 4h), which leave the cocoons and fly away to find a female to mate with. The males live for about three days and do not feed.

Note: Another cochineal species, Dactylopius coccus, also known as the "true cochineal", has been used for centuries as a source of red cochineal dye. Although the body fluids of all cochineal species contain red dye (carminic acid), D. coccus is the only species that has a high enough concentration of carminic acid to make it economically viable to extract. The true cochineal feeds only on prickly pear or cactus pear varieties (Opuntia ficus-indica). It differs from D. opuntiae in that it is considerably larger, has a powdery rather than woolly wax layer (fig. 6), does not harm the plant significantly, and is therefore not regarded as a biological control agent.

How to tell whether cochineal insects are present
The insects usually first appear on the undersurfaces of the lowest parts of the plants, close to ground level. About two months later, conspicuous clusters of white, wax-covered females start appearing all over the plant (fig. 1). When crushed, the insects discharge a dark-red fluid. Initially, the plants become discoloured and swollen around the feeding sites of the insects. With time, as the cochineal becomes more abundant, the affected parts start to wither, turn brown and die.

How cochineal damages its cactus host
When the adult or immature cochineal insects feed on the plant sap, the plant discolors and swells around the feeding site, and eventually dies. It is not quite clear what causes this damage to the plant, but entomologists suspect that the insects secrete toxic saliva into the plant. The young succulent leaf pads are most vulnerable and are usually the first to succumb. About a year after cochineal has first infested a cactus plant, most of the outer parts will have died and fallen to the ground, leaving only the hard, woody main stems. These woody stems may take another six months to die, depending on the cactus species and the age and size of the plant.

Factors affecting the efficacy of cochineal insects
- Lack of mobility: Female cochineal insects are sessile and only disperse during the crawler stage. Even the crawlers are unable to fly and can only cover small distances, and therefore depend on wind for long distance dispersal.
- Food limitations: After the dieback of the cactus plants, a temporary lack of food plants may drive the local populations of cochineal to extinction so that no insects remain to colonise the new plants that arise from the underground tubers or germinate from seeds.
- Cactus population density: Passive crawler dispersal is most effective in dense infestations of cactus. Dispersal becomes inefficient and wasteful in sparse cactus infestations because most crawlers miss the target hosts.
- Surrounding plants: Small cactus plants are often protected from prevailing wind by taller species. Under these relatively calm conditions, crawlers are not easily dislodged and dispersal is
Cochineal insects (*Dactylopius* spp.)

Limited. Also, surrounding vegetation often conceals the cactus plants and thereby restricts the target area for the crawlers, further reducing the chances of successful establishment.

- **Climate:** Rain erodes the wax layers around the females, exposing them to natural enemies such as ladybird beetles, and also lodges the adult insects and crawlers from the plants. This causes populations to decline and reduces their effect in high-rainfall periods or regions. This is compounded by the fact that the wet weather favours growth of most cactus plants and improves their chances of recovering from cochineal attack.

- **Chemical control:** Herbicides that are used to control cacti (e.g., MSMA) do not necessarily harm the cochineal insects directly. However, when their host plants are killed, the insects are unable to flee to a healthy plant and therefore die prematurely along with the treated plants. The problem is compounded because, like the insects, the teams applying herbicides are most efficient in finding and dealing with large clumps of cactus plants, where most of the cochineal insects are usually concentrated. By destroying the dense aggregations of plants and overlooking small, isolated ones, herbicide control methods are in direct conflict with biological control.

- **Plant size:** Cochineal is unable to kill very large, woody cactus plants.

**Collection and redistribution of cochineal insects**

The purely passive dispersal of cochineal insects is very limited, as discussed earlier. Manual distribution of cochineal is essential to ensure that the insects reach every cactus plant.

As the cochineal insects used for biocontrol in South Africa will only develop on cactus plants of the same species as the one from which they were collected, it is important to identify the problem cactus correctly. Once you have identified your cactus species, look for the same species infected with cochineal in your vicinity. Leafpads from those plants should be collected for redistribution of cochineal. If you cannot locate any suitable cochineal locally, contact your Provincial Office of DLRM to find out where a starter colony can be obtained.

Cut off several cochineal-infested cladodes and carefully place each of these into the centre of an uninfested cactus plant, preferably in a position where it will be protected from wind and rain. Once the insects have settled and started multiplying, their dispersal can be accelerated by manually carrying cochineal-infested leafpads to distant plants.

Cochineal insects can survive on cut leafpads for several weeks, depending on the number of insects per leafpad. Cochineal-infested leafpads can be packed into a box and sent by mail, but you have to ensure that the leafpads cannot move around in the parcel and squash the cochineal insects. Keep the leafpads in place with pins or cotton thread, and pad them with crumpled tissue paper. Ensure that moisture does not build up in the parcel, because this will cause the leafpads to decay. Remember that the crawlers can only move around for a few days after hatching, therefore they will have to complete their life cycle on the cladode on which they settle initially. If the cladodes will not reach their destination within a week, a couple of fresh cladodes should be supplied on which the crawlers can settle.

As cochineal disperses better in dense stands of cactus than between isolated plants, one cochineal-infested cladode might be enough to control a dense cactus stand. Isolated plants will, however, need one infested cladode each. If the cactus grows amongst dense vegetation, more cochineal might be needed.

**Figure 6.** The "true cochineal", *Dactylopius coccus*, from which carminic acid is extracted, does not kill its host plant, and is therefore not regarded as a biological control agent.

Always take care to remove some cochineal-infested material for redistribution before the cactus plants in a particular area have been destroyed, otherwise the insects could become extinct locally. After wet periods it will probably be necessary to supplement the cochineal populations with colonies from elsewhere.

Cochineal insects are more effective in controlling small cactus plants. It might be necessary to hand-feel large cactus plants once they are heavily infested with cochineal, and then leave the cochineal to kill the plant remnants. This will prevent rooting, and will also ensure that cochineal insects are available to attack any regrowth.

**CONTACT PERSONS**

Consult leaflet 1A in this series for the most updated contact details.

- **Biocontrol research:** Weeds Research, ARC-PPRI, Rietondale. Tel. (012) 329 3269; Fax (012) 329 3278; e-mail: weeds@plant2.agric.za.
- **Supply of biocontrol agents:** National Department of Agriculture: Directorate of Agricultural Land Resource Management (DLRM): your nearest Provincial Office.

**FURTHER READING**

