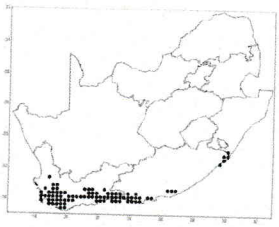
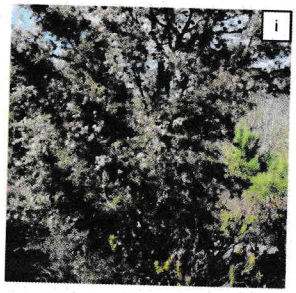
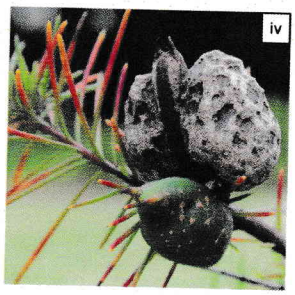


SILKY HAKEA is a small tree up to 5 m high (i), which was introduced from eastern Australia in the 1800s as a hedge plant, and has spread rapidly throughout the coastal mountains of the Western and Eastern Cape provinces. It prefers well drained, nutrient poor soil and is, therefore, most commonly associated with soils derived from Table Mountain Sandstone. The leaves are needle-like, sharp pointed, smooth, and up to 40 mm long (ii). Cream-coloured flowers are produced in late winter (iii). It has characteristic hard woody fruit (iv), each with two black winged seeds. The fruit is 25–30 mm long by 20–25 mm wide, with 2 'horns' at its apex. These fruit remain on the trees, and only open and release the seeds when the plant dies, usually by fire. This is an adaption shared by many of our indigenous protea species, which are also in the same family to which silky hakea belongs. As a result there is a mass germination of seed following fires, leading to dense infestations. Silky hakea is a category 1 declared weed in South Africa, is prohibited by law and must be controlled or eradicated.





THE PROBLEM

Fast growing and capable of producing large numbers of seed, silky hakea rapidly builds up populations, forming large dense stands following several fire cycles. The winged seeds can be transported by wind for relatively long distances, so that new invasions develop in neighbouring valleys. Since many infestations occur in remote or inaccessible areas, invasions can become extensive before they are noticed.

THE SOLUTION

Although extensive mechanical control programmes in the past successfully reduced the total amount of land invaded, access to many invaded areas is difficult or impossible in the mountains, making the cost of clearing prohibitive. A number of insect species have been introduced as biological control agents, and a fungus that naturally causes a gummosis disease of plants has been developed for deliberate use. Insects introduced to reduce seed production and, therefore, reduce re-establishment following fires, include the hakea seed weevil *Erytenna consputa* (released 1970), the hakea seed moth *Carposina autologa* (1970), and the hakea bud weevil *Dicomada rufa* (2006). Insects introduced to impact on the health of trees, and therefore their growth and survival, include the hakea stem-boring beetle *Aphanasium australis* (2001), and the hakea leaf weevil *Cydmaea binotata* (1979). Of these, the seed weevil, seed moth and stem-boring beetle are the most damaging. Various methods have been developed to use the gummosis fungus *Colletotrichum acutatum* to kill both seedlings and trees, and is produced on request by staff of ARC-PPRI in Stellenbosch.

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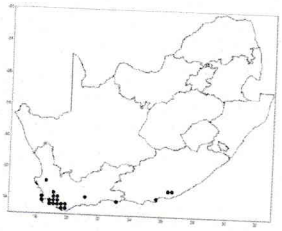
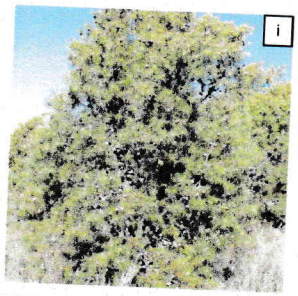
Rock hakea

Hakea gibbosa



ROCK HAKEA (*Hakea gibbosa*) is a much-branched, prickly and bushy shrub or tree that reaches as high as four metres (i). Native to Australia, the plant was originally brought to South Africa in the 1850s. The needle-like leaves are greyish-green, hairy, have sharply pointed tips, and are up to 80 mm long (ii). Cream-coloured flowers occur in loose clusters in the leaf axils (ii) between June and early September. These are followed by grey, woody fruits (iii) approximately 35 mm long and 30 mm wide, with two sharp apical horns. Each fruit consists of two halves, each of which contains a single, winged seed. The annual fruit crops remain on the plant, and the seeds in the fruits are only released after the plant dies—usually as a result of fire. Rock hakea is a category 1 declared weed in South Africa, which is prohibited by law, and must be controlled or eradicated where possible.


i

THE PROBLEM

Rock hakea is a serious invader of mountain fynbos in the Western Cape (iv) and has shown that it has the capacity to form dense thickets in the natural vegetation in which it largely occurs. Dense stands of the weed increase the risk of fire, increase fire intensity, and reduce water runoff in mountain catchments. Rock hakea is largely restricted to the Western Cape, where it occurs in the Cape Peninsula, Klein River Mountains, Steenboksberg and Franschhoek Mountains.

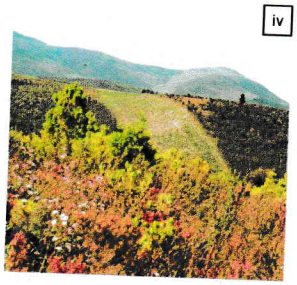

ii

THE SOLUTION

Mechanical control is the best method of controlling rock hakea, but the leaves are hard and prickly, which make it more difficult to work with than the other invasive hakea species. However, mechanical control is costly, and the plant often occurs in inaccessible areas. While herbicides have also been used to control rock hakea, these have played a minor role because they are expensive and difficult to apply, especially in infestations that are not easily accessible. The only sustainable solution to the problem is biological control and, to this end, rock hakea strains of three insect species introduced to control silky hakea were collected on rock hakea in Australia, and released on rock hakea in South Africa. The first agent introduced was the seed weevil, *Erytenna consputa*, the larvae of which feed on the seeds of the green developing fruits. The second insect was the stem-boring beetle *Aphanansium australe*, which tunnels in the base of the stem and roots. The most recent introduction is the hakea seed-moth, *Carposina autologa*, which feeds on the seeds in the mature fruits of the plant. These agents are discussed in separate fact sheets.


iii

iv



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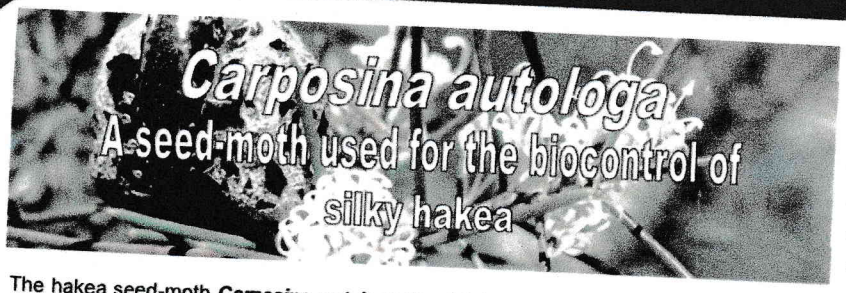
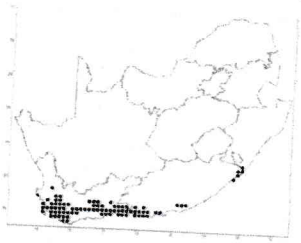
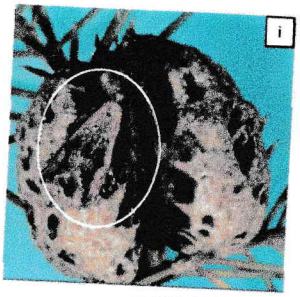


Carposina autologa
A seed-moth used for the biocontrol of silky hakea



The hakea seed-moth ***Carposina autologa*** Meyrick is native to Australia, and is found on both silky hakea (*Hakea sericea*) and rock hakea (*Hakea gibbosa*). The moth was released on silky hakea in South Africa in 1970 following extensive host-specificity testing to ensure that it could not survive on any indigenous plants, or plants of economic importance. In 2014, a strain of this moth was also released on rock hakea (*Hakea gibbosa*) in South Africa.

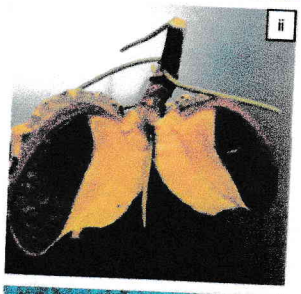


DESCRIPTION

The moth is brownish black in colour (i) and is not very conspicuous. The moths are small and their body length is 10—13 mm long.

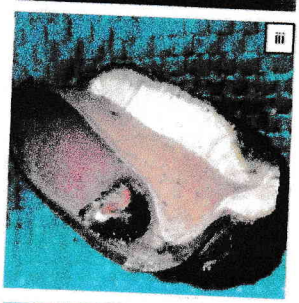
LIFE CYCLE

Carposina autologa has a one-year life cycle. In autumn, the moths lay single eggs in crevices on the surface of mature fruits, or between touching fruits. The eggs hatch a couple of weeks later, and the larvae enter the fruit at a point along the suture on the upper surface. Only a single larva develops per fruit, and both seeds are consumed by it. The mature larva exits via a tunnel it excavates through the woody fruit. The larva drops to the ground and pupates in the soil.



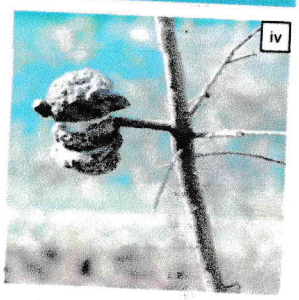
FEEDING DAMAGE

The fruit of silky and rock hakea consists of two halves, each of which contains a single black, winged seed (ii). A larva of the seed-moth initially feeds on one of the two seeds (iii) and only feeds on the second when the first one has been consumed. The only indication that the seeds have been consumed is the 2 mm larval exit hole on the side of the fruit.



IMPACT ON SILKY AND ROCK HAKEA

The larvae destroy the seeds in the mature fruits of hakea and, at some sites, the moth has destroyed more than 65% of the silky hakea seeds. It is still too early to predict the impact the moth will have on the seeds of rock hakea. The moth has been released throughout the South African range of silky hakea, and also in two rock hakea sites in the Western Cape Province. The seed-moth may be redistributed to areas where it does not occur by stripping all the fruits from the trees in April/May in areas where the moth is abundant, and then inspecting the fruits for newly-laid eggs using an illuminating magnifier. Any fruit halves that contain eggs are then attached to healthy fruits in the field, using a silicon adhesive, so that the emerging larvae can enter the healthy fruit (iv). Approximately 200 egg-bearing fruits should be released in each new infestation.



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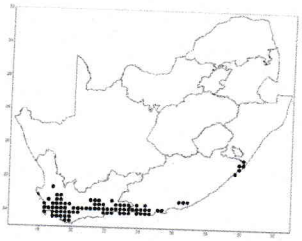
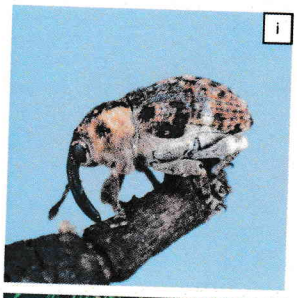
Erytenna consputa

A fruit weevil used for the biocontrol of silky and rock hakea



The hakea fruit weevil ***Erytenna consputa*** is native to Australia and is found on both silky hakea (*Hakea sericea*) and rock hakea (*Hakea gibbosa*) in South Africa, where it has been released as a biological control agent on infestations of these plants.



DESCRIPTION

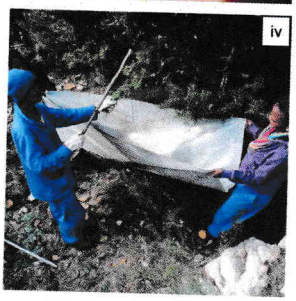
The weevils are mottled grey, red-brown with black, 4-5 mm long, and with a prominent snout (i). The larvae are usually found inside the green fruits and look like small, white grubs. The adults tend to shelter in the dry, brown fruits (husks) that remain after the larvae have hollowed out the developing fruits.

LIFE CYCLE

Between July and November, the adults lay their eggs in an excavation in the tips and buds of leaves near young fruit or, sometimes, in the apical horns of the fruit. A female may lay up to 100 eggs during a breeding season. The larvae hatch after about two weeks, then tunnel into the growing, young fruit. Only a single larvae can develop in each fruit, and it may have to move between two to three fruits before it completes its development. In October, when the larva is fully grown, it tunnels out through one side of the fruit and pupates in the soil. The adults emerge from the soil between October and January.

FEEDING DAMAGE

A fruit containing a weevil has a reddish colour at first, but begins to yellow as it withers and dies (ii). Fruits attacked by weevils have a small entrance and exit hole (iii) with frass (faeces) surrounding the eaten seed. Weevils are usually present in an infestation if there are black, dried, partially split remains of young fruits on the tree.



IMPACT ON SILKY AND ROCK HAKEA

The larvae destroy the green developing fruits of *Hakea sericea*. At some infestations, the weevils have destroyed more than 86% of the seeds. Weevils can be found on the plants throughout the year, but they are most active and are easiest to collect between May and July. To collect the weevils for redistribution to other infestations, hold a groundsheet under the hakea branches and beat the branch with a stick (iv). The weevils, feigning death, will drop onto the sheet and can be collected. Preferably, weevils should be collected between February and August. Once collected, they should be kept cool, and must be released within two days.

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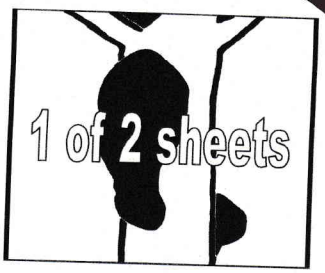
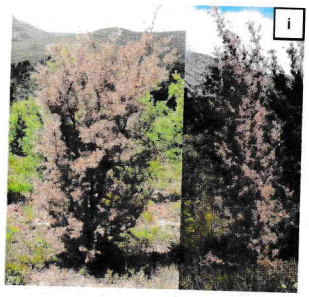
Colleotrichum acutatum

A fungus used for the biocontrol of silky hakea



The silky hakea gummosis fungus, ***Colletotrichum acutatum* J.H. Simmonds**, causes a serious disease of silky hakea (i), and has done so in parts of South Africa since the 1960s. Studies began in the 1980s for its deliberate use, and are still continuing. Various methods of use have been developed that target either the trees, or the recently germinated seedlings of this invasive species.

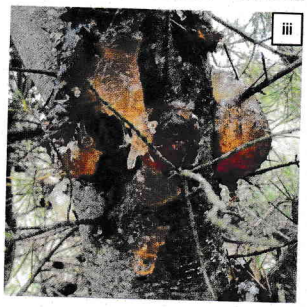


DESCRIPTION

The silky hakea gummosis fungus causes characteristic stem and branch cankers (dead areas of bark), which exude large quantities of gum (gummosis). The fungus produces masses of orange asexual spores (conidia) on special cushion-like structures (acervuli), the minute spores are hyaline and oval in shape. These fungal spores can be mass produced at the laboratories of the ARC-PPRI in Stellenbosch and used as an effective biocontrol agent against silky hakea.

DISEASE SYMPTOMS

As the bark is invaded by the gummosis fungus, cracked and discoloured cankers develop (ii). Large quantities of gum ooze from these cankers (iii). At this point, the stem frequently becomes malformed (iv). Only the bark of trees, not the wood, is killed.



DAMAGE TO PLANTS

As cankers develop and kill areas of bark, plant growth and seed production are reduced. Where cankers girdle the stem, the plant dies off completely above the inoculation point. If this happens at the base of the plant, the whole plant is killed, thus, deliberately inoculating plants just above ground level, in effect, ringbarks trees. Since the fungus spreads from inoculated trees to neighbouring ones, the number of trees killed over time is more than was treated. The fungus spreads by spores splashed by rainfall, and is most likely to occur in dense stands, since the effective range of splash is usually less than 2 meters.

IMPACT ON SILKY HAKEA

Both seedlings and mature silky hakea trees are killed by the gummosis fungus. The specific form of the fungus used is only known from silky hakea in South Africa, and has been proven to not pose a threat to any indigenous South African flora. It also does not infect other hakea species. Naturally occurring disease occurs in low levels throughout the invaded area of silky hakea, but this can be increased substantially by inoculating trees. Since rainfall favours the spread of the fungus, it is most effective in high rainfall areas and becomes progressively less effective in drier area. However, this can be compensated for by inoculating more plants, and more frequent applications.

ORDERING INFORMATION:

Orders for the fungus must be placed a month in advance and directed to Ms Gwen Samuels. Tel: (021) 887 4690 Fax: (021) 886 6479 E-mail: SamuelsG@arc.agric.za.

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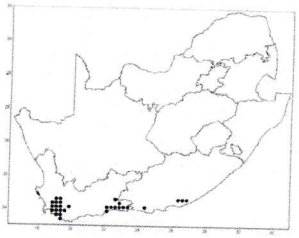
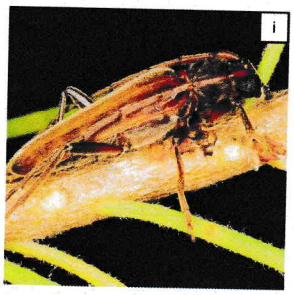
Aphanasium australe

A stem-boring beetle released for biocontrol of silky hakea and rock hakea



The stem-boring beetle ***Aphanasium australe*** (Boisduval) is native to Australia and occurs on both silky hakea (*Hakea sericea*) and rock hakea (*Hakea gibbosa*). Following extensive host-specificity testing to ensure that the insects cannot reproduce or survive on any other plant, this agent was cleared for release in South Africa in 2001. The first releases on silky and rock hakea were made in 2001/2 and 2003/4, respectively.



DESCRIPTION

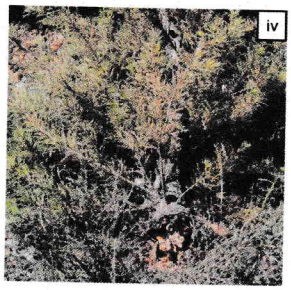
The adults are blackish brown (i) and emerge from the roots or stems during November to January. The body length of the females vary between 19-25 mm, making them larger than the males, which vary between 11-19 mm. The adults are active fliers.

LIFE CYCLE

Aphanasium australe has a prolonged life cycle that lasts up to two years. The females lay clusters of 10-20 eggs on the base of the stem at soil level in the case of silky hakea, and anywhere on the stem of rock hakea. The cream-coloured eggs are approximately 1 mm in length and take approximately 14 days to hatch. The hatching larvae enter the stem directly from the eggs and an indication of penetration is the reddish-brown gum that exudes from the larval entry point. The larvae develop slowly, and may take one to two years to reach maturity. The mature larvae hollow out a chamber beneath the bark and just above the soil surface, in which they pupate.

FEEDING DAMAGE

The developing larvae tunnel gregariously at the base of the stem, and in the sub-surface roots of infested silky hakea plants. Indications of larval presence in the plants are characteristic, thickened stem bases caused by scar tissue formation, and copious amounts of frass at the base of the plant (ii). In the case of rock hakea, the larvae tunnel in the stems higher up on the plant, forming characteristic thickening of the stem or branch (iii). This is coupled with copious quantities of frass.



IMPACT ON SILKY AND ROCK HAKEA

Larval feeding can kill mature plants growing under natural conditions, especially if the plants are stressed by drought, disease or other factors. Extensive tunnelling can weaken the plants structurally and may cause them to fall over, particularly when subjected to the strong winds typical of the Western Cape (iv). Internal boring in smaller plants reduces plant vigour and causes stunting. Larval damage to the plant may also provide sites for further infection to occur, for example, by the damaging indigenous fungus *Colletotrichum acutatum*.

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