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Compiled by Hildegard Klein
ARC-Plant Protection Research Institute

2. BIOLOGICAL CONTROL OF INVASIVE CACTUS SPECIES (FAMILY CACTACEAE)

2.1 Cactus biocontrol: General aspects

The biological control projects against the various pest cacti in South Africa have been among our country's most successful biocontrol projects. Most of the early South African biological control projects involved cactus species, starting with the control of smooth prickly pear (*Opuntia monacantha)* in 1913, which was the first biological weed control project in South Africa. In most cases, cochineal insects (*Dactylopius* spp.) or the closely related mealybugs *(Hypogeococcus pungens)* were the most important biological control agents, although the cactus moth *(Cactoblastis cactorum)* also played a role in many of the projects.

The destruction during the early 1930s of impenetrable stands of prickly pear (*Opuntia ficus-indica),* which had overrun many thousands of hectares of farmland in the Karoo, was the most spectacular biocontrol success in South Africa and one of the most striking examples of its kind in the world. Yet most South Africans who have only heard of this one example of biological control, perceive it as a threat. This leaflet is aimed at clearing up some of the popular misconceptions regarding biological control of cactus weeds.

HOST-SPECIFICITY IN CACTUS BIOCONTROL

Biological weed control is a specialised science, and is practised according to very strict rules and regulations. Consult leaflet 1.3 in this series for more information on biological control of weeds in general.

No organisms are released for weed control unless very thorough host-specificity test have been carried out, which show that the candidate biocontrol agent is sufficiently host-specific. However, among the insects released for the control of cactus species there are several species that attack more than one cactus species or variety. Although this seems to contradict the rule of host-specificity, and often causes concern amongst the general community, it is certainly not an indication that biocontrol agents are likely to adapt to a diet of crop plants or indigenous plants once they have devoured all the prickly pear plants in the country, as uninformed persons often predict.

The biocontrol agents released against cactus species in South Africa are all restricted to cactus species (plants belonging to the family Cactaceae), and do not threaten any other plants. South Africa has no indigenous cactus species. Although some of the indigenous South African plants in the Euphorbiaceae ("naboom" family) resemble cacti, they belong to an unrelated family. The only cactus species that are being used commercially here are cactus pear (the refined, spineless form of *Opuntia ficus-indica)* and a few hybrids, e.g. *Opuntia robusta* (bloublad). All other cacti in South Africa are either declared weeds, or they are ornamentals with invasive tendencies.

The family Cactaceae is so widely separated from other plant families that its natural enemies virtually never attack plants in any other families. This has made it easy to find natural enemies that are sufficiently host-specific for release in South Africa. The biological control of cactus weeds in South Africa has therefore been exceptionally successful and several of the biocontrol agents that were introduced into South Africa to control cacti, feed on more than one invasive cactus species. This is not an issue, because all the cacti involved are either declared weeds or can be regarded as expendable.

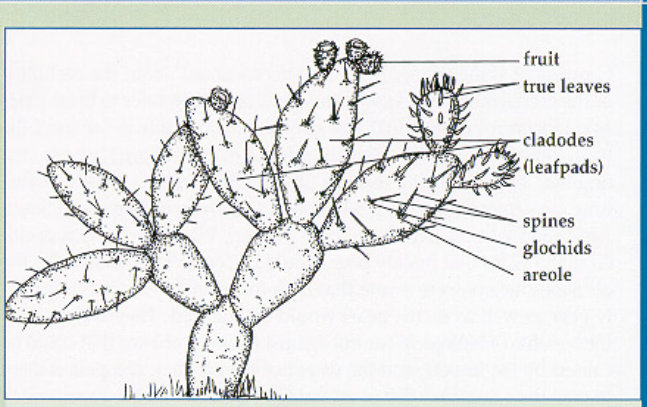

Figure 1. A typical platyopuntia cactus.

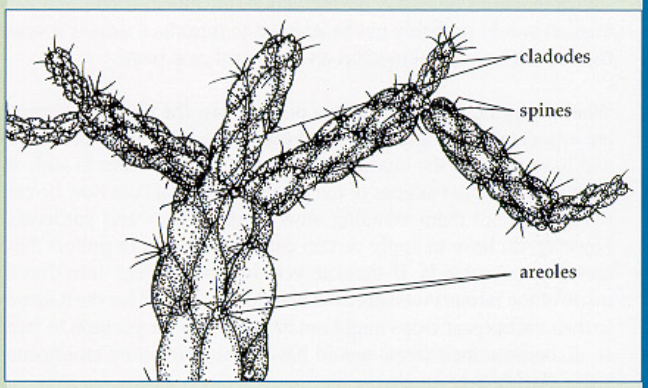

Figure 2. A typical cylindropuntia cactus.

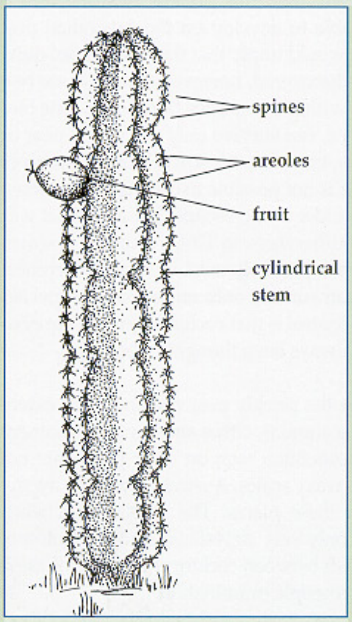

Figure 3. A typical organ-pipe cactus.

The prickly pear cochineal *(Dactylopius opuntiae)* (see leaflet 2.2) attacks both the weedy prickly pear and the commercially cultivated, spineless cactus pear. These are, however, two forms of the same plant species *(Opuntia ficus-indica),* which only differ with regard to the number of spines on their leafpads. When left to reproduce from seeds, the spineless cactus pear often reverts to its original, spiny form (prickly pear), and because it is too spiny for cattle to feed on, it becomes a weed problem. The fact that the cochineal insect accepts both forms of *Opuntia ficus-indica* does not make it less specific, because it is still restricted to only one host plant species.

2.1 Cactus biocontrol: General aspects

The cactus moth *(Cactoblastis cactorum)* (see leaflet 2.3), which was introduced to control prickly pear, has a slightly wider host range. Apart from prickly pear and cactus pear, it damages a number of other *Opuntia* species as well. However, it attacks no plant outside the family Cactaceae.

Growers of spineless cactus pears are concerned about the cochineal or the cactus moth attacking cactus pear, and often refer to these pests as a biocontrol project that has gone astray, but this is far from the truth. Both insect species were introduced to control prickly pear - the original, invasive, spiny form of *Opuntia ficus-indica* - which, at that time, was threatening the livelihood of hundreds of farmers in South Africa and was declared a national disaster. When Parliament decided in the 1930s that prickly pear should be controlled biologically, the decision-makers were aware that both forms of *O. ficus-indica* (prickly pear as well as cactus pear) would be attacked. They weighed up the benefits of biological control against future problems that could be caused by the insects, and the extent of the problem compelled them to take the calculated risk of releasing cochineal and the cactus moth in order to reduce the damage by prickly pear. It was the right decision at that time, but today the regulations are much stricter, and permission would probably not be granted to introduce similar species that have the potential to affect an important crop plant.

When attacking cultivated cactus pears today, the biocontrol agents are actually still doing exactly what they were originally meant to do and have reduced the invasive potential of *O. ficus-indica* to such an extent that certain varieties of the plant (cactus pear) can now be cultivated without them invading other land. Farmers and gardeners, however, do have to apply certain control measures to protect their cactus pear orchards. If these insects had never been introduced, many of the farmers who are now blaming biocontrol for the damage to their cactus pear crops might not have been in the position to farm at all, because their farms would have been overrun by an impenetrable prickly pear jungle.

Until recently, it was thought that the prickly pear cochineal *(Dactylopius opuntiae)* is also able to develop on the Australian pest pear *(Opuntia stricta)*, and this would imply that the insect is not quite host-specific. It has now been discovered, however, that there are two distinct host races or biotypes within the species *D. opuntiae*. One biotype, known as the *ficus* biotype, can survive only on prickly pear or cactus pear, while the other one, known as the *stricta* biotype, survives only on Australian pest pear. It is not possible to distinguish between these two biotypes, not even under a microscope, but a method was developed recently to detect differences in DNA. Current research also indicates that such biotypes probably exist in several cochineal species, where each biotype can survive only on one cactus species. The implication for biological control is that cochineal insects are even more specific than they have always been thought to be.

Another misconception is that the prickly pear cochineal has extended its host range to include jacarandas, citrus and various ornamental plants. The white insect pests often seen on these plants are not cochineal insects, but could be waxy scales, Australian bugs or mealybugs that occur naturally on these plants. The similarity between cochineal and these insects is only very superficial, and any entomologist will be able to distinguish between cochineal and any of these insects, with or without a microscopic examination.

The biocontrol agents of the organ-pipe cacti, such as harrisia cactus *(Harrisia martinii)* and queen of the night *(Cereus jamacaru)*, also accept several closely related host species. Both species of biocontrol agents introduced against harrisia cactus (see leaflets 2.5 and 2.6) can also develop on the closely related queen of the night cactus, which is a serious weed. They will probably also damage similar cactus species that have not become problematic in South Africa yet, but are already growing in some succulent lovers' gardens. This was a known fact when it was decided to introduce them, but permission was given for their release because these insects would pose no threat to indigenous or crop plants in South Africa.

SOME BOTANICAL ASPECTS OF THE INVASIVE CACTUS SPECIES

Most of the members of the cactus family lack true leaves (exceptions are the primitive, leafy cacti such as pereskia). The "thorns" on cactus species are actually modified leaves, which have assumed the function of defending the plant against herbivores. The cactus stems, called cladodes or leafpads, have taken over the function of photosynthesis, which means that they are green and, in many species, also flattened.

There are two types of thorns on a cactus stem, leafpad or fruit: long, stiff spines and short, extremely fine glochids. The spines and/or glochids occur in groups on several raised areas, called areoles, on the stem, leafpad or fruit (fig.1). Both cactus pear and prickly pear have glochids, but only prickly pear has spines.

In South Africa, problem cacti can be divided into four groups:

- the **platyopuntia** cacti: those with flattened stems or cladodes (also known as leafpads, joints or segments), e.g. prickly pear, jointed cactus, Australian pest pear and smooth prickly pear (fig. 1)
- the **cylindropuntia** cacti: those with short, branched, cylindrical stems, e.g. imbricate cactus and rosea cactus (fig. 2)
- the **organ-pipe** cacti: those with long, mostly upright, columnar stems, e.g. harrisia cactus and queen of the night cactus (fig. 3)
- the **leafy** cacti: a group of primitive cacti with true leaves, e.g. pereskia.

BIOLOGICAL CONTROL AGENTS OF INVASIVE CACTUS SPECIES

The invasive platyopuntia cacti are controlled in South Africa by mainly cochineal species and the cactus moth; the cylindropuntia cacti are controlled only by cochineal species, and the organ-pipe cacti by a mealybug and a stem-boring beetle. The biological control of specific cactus species will be discussed in separate leaflets in this series.

CONTACT PERSONS

Weeds Research Division, ARC-PPRI, Private Bag X134, Pretoria 0001; Tel (012) 329 3269; Fax (012) 329 3278; e-mail weeds@plant2.agric.za.

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