A wasp counterattack to save pine trees

An alien woodwasp that probably entered South Africa in the planks of a packing crate has caused the destruction of millions of pine trees. To combat the pest, another wasp and other natural enemies have been brought into the attack.

By Geoff Tribe

South Africa is poorly endowed with natural forests, with only 0,3% of the land area afforested. Exploitation of these indigenous forests began with European settlement at the Cape of Good Hope in 1652 and gradually extended eastwards as local resources became exhausted. Timber was required for shipbuilding, housing, ox-wagons, furniture and fuel. The early Cape governors realized the necessity for the importation of fast-growing exotic tree species and the first introductions were the common oak (*Quercus robur*) followed by cluster and stone pines (*Pinus pinaster* and *Pinus pinea*). By 1847, attempts were made to halt the exploitation and conserve what remained of the indigenous forests by restricting access. Increased demand for timber arose in the 1870s for railway sleepers, telegraph poles and props for mines. The first commercial plantation

Above: The Sirex wasp injects a toxic mucus and a fungus into the pine tree when it lays its eggs, killing the tree. The Sirex larvae then penetrate the pine trunk right to its core, make a U-turn and end up pupating just below the bark, ready for the next life-cycle.

ANNALIZE MOUTON (2)

Right: As light as a feather – author Geoff Tribe holds a pine log that has been killed by the Sirex wasp. Biological control agents that have been successful in the Western Cape are now being bred at the ARC Plant Protection Unit at Stellenbosch for use in infected plantations in KwaZulu-Natal.

consisting of eucalypts was established at Worcester in 1876 to provide firewood for railway locomotives and the first tan wattle plantations were established in Natal shortly after this. However, it was only during World War II when timber imports were disrupted and prices escalated that a boom in afforestation began and continued after the war with a total area of commercial plantations in South Africa now exceeding 1,5 million hectares, of which slightly more than half is under pines.

A major reason why exotic trees are often able to grow rapidly and out-perform those in their country of origin is that they are not subjected to the depredations of the many pests and diseases that afflict them in their natural environment. Such contiguous and monospecific trees are, however, highly vulnerable should a pest become established on them. Most southern African plantations occur in areas where forests previously never existed, with the consequence that there are no reservoirs of generalized predators of forest insects that could immediately adapt to and exploit a newly arrived pest. Thus the discovery in Tokai Plantation in the Cape Peninsula in 1994 of the exotic woodwasp *Sirex noctilio*, which had devastated pine plantations in New Zealand, Australia and several countries in South America, represented a major challenge to the South African forestry industry.

Sirex noctilio is endemic to Eurasia and North Africa where adults are attracted to stressed trees, which they kill by injecting a phytotoxic mucus and the symbiotic fungus *Amylostereum areolatum* into the wood while laying eggs. The mucus causes the stoma of the tree to open which causes the tree to wilt, and so prevents the tree from drawing up resin which is a defensive mechanism the tree uses to neutralize foreign inclusions. Then the pathogenic dry-rot fungus germinates and starts spreading inside the wood where it feeds on the nutrients stored within the tree. Once the tree's defences are overcome, the Sirex eggs then hatch into larvae which feed on the fungus that they access while tunneling in the wood. Once they reach the dead heartwood, they perform a U-turn and end up pupating just below the bark. Depending on the level of nutrition in the wood, the adult woodwasps may vary considerably in size from 15 to 40 mm in length. The whole life cycle takes a year to complete with the main adult flight taking place in March.

The woodwasp dispersed at an annual rate of 48 km and by 2002 had proceeded beyond Plettenberg Bay. From here it was probably accidentally carried into the Eastern Cape and KwaZulu-Natal, where about 2 million trees are now infested.

GEOFF TRIBE

Many trees within this pine plantation at Wilderness were killed by Sirex when it first arrived here.

ANNALIZE MOUTON

Sirex noctilio laying its eggs along with tree killing agents (note the black egg-laying "drill").

Australian entomologists had, however, introduced several biological control agents which successfully brought Sirex under control, and three of these were imported into the Cape immediately after the wasp was discovered there.

Biological control has a long history in South Africa, with the earliest in Cape plantations being the training of domesticated pigs since 1925 to unearth and feed on the pupae of the indigenous pine tree emperor moth, *Imbrasia cytherea*. The feral pigs are very elusive but indications of their presence in certain plantations can still be found today.

Because it functions best at epidemic levels, the first biological control agent to be introduced against Sirex from Australia was the parasitic nematode *Beddingia (Deladenus) siricidicola* which was originally sourced from Hungary. It has a free living form that moves within the tracheid vessels of the tree and feeds on the symbiotic fungus, and a parasitic form. In response to detecting the high CO_2 and acidity from the waste products that surround the Sirex larva, the parasitic form of the nematode is produced which has a long stylet or spear with which it pierces the larva and enters its body. Here it reproduces prolifically before migrating to the ovaries, thereby sterilizing the females. Following pupation, the emerging female woodwasp then lays eggs containing nematodes into trees to which other females are also attracted, their progeny become infected, and the parasite is spread by this means throughout the plantation. A technique was developed in Australia where the nematodes are mass reared in the laboratory, placed in a gel suspension and squirted into holes, which had been made by a specially designed hammer, in trees containing Sirex larvae. Within three years a 96% parasitism rate had been achieved with this method. Because the nematode population is density dependent, i.e. it increases in numbers in tandem with its host, this percentage had diminished to 61% by 2006 as Sirex numbers decreased.

Megarhyssa nortoni *was released at Vanrhynsdorp but it is unknown whether it has become established.*

The second parasite was acquired through a parasite exchange with Uruguayan researchers. The parasitic wasp *Ibalia leucospoides* had entered Uruguay with its host and each female can lay more than 600 eggs. It is able to detect the odour emanating from the fungus, and lays its egg down the oviposition (egg-laying) channel of the Sirex female into either its egg or newly hatched larva. This life cycle of the parasite is in complete synchrony with that of its host, with its flight season commencing in mid-summer and terminating in mid-autumn. A parasitism rate of 33% was recorded in the south-western Cape in 2006.

The third parasite introduced was the wasp *Megarhyssa nortoni* which is endemic to North America where it parasitizes the mature larvae of a closely related woodwasp species just before they pupate. After it had bred in quarantine, permission was only granted for its release on the Gifberg at Vanrhynsdorp. It is still unknown whether it has become established.

The biological control of Sirex in the Western Cape has been so successful that today it is difficult to find trees killed by them. Over a six week period when the plantations and private woodlots were scoured for such trees ten years after the introduction of the biological control agents, only 31 Sirex-killed trees out of the several million healthy trees could be found. And these were mainly stunted trees which would normally be removed during thinning operations. This is similar to the normal behaviour of the woodwasp in its natural distribution range in Eurasia where they are not considered to be a pest and where they serve to kill such weakened trees, thus invigorating the remaining trees by removing competition.

Plantation trees are initially planted fairly close together to force them to grow upwards, followed by the removal of a percentage of these trees at seven year intervals, thus reducing competition and allowing them to increase further in size.

Ibalia leucospoides wasps were recovered from these infested Western Cape logs which had been placed in cages and have been sent to KwaZulu-Natal to combat the pest in that province. By taking a wedge of wood from a Sirex-killed tree and placing it in water for 24 hours, parasitic nematodes will swim out if they are present. Using this method, nematode-infested Sirex females emerging from the logs can be isolated and released in other provinces invaded by the pest where they will lay nematode-filled eggs.

How did Sirex enter South Africa? There is circumstantial evidence that they came from untreated pine crates used to encase imported equipment, which should have been incinerated at the delivery point but most probably ended up in an informal settlement. A very costly mistake! ■

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ANNALIZE MOUTON

The Ibalia leucospoides *wasp has proved to be an effective control agent for* Sirex noctilio.