

Saving the National Tree of the Turks and Caicos Islands: *Pinus caribaea* var. *bahamensis*

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Abstract

The Caicos Pine Recovery Project (CPRP) is working to save the National Tree of the Turks and Caicos Islands (TCI) *Pinus caribaea* var. *bahamensis* and to maintain the ecological integrity of TCI's unique pine ecosystem. Caicos pine is an endemic variety of the more widely dispersed *Pinus caribaea*. In TCI, the taxon is threatened with extinction, due to a severe infestation of the non-native invasive pine tortoise scale, *Toumeyella parvicornis*. To date the infestation has killed around 90% of the mature pine trees and is affecting nearly all of the remaining trees. This has led to the near destruction of the threatened pine's habitat in TCI.

The Project is working to control the invasive insect, propagate healthy pine seedlings for *ex-situ* conservation, undertake habitat restoration using nursery-grown plants, enhance local capacity, collect important baseline and monitoring data, collect seed for long-term storage and provide basic infrastructure to support the Project. Royal Botanic Gardens, Kew is working in partnership with TCI's Department of Environment and Maritime Affairs (DEMA) and Department of Agriculture in cooperation with the Turks and Caicos National Trust and the Environmental Health Department, along with several other international organisations and individuals, to save the species from being extirpated from TCI.

Introduction

TCI is one of the UK Overseas Territories (UKOTs) in the Caribbean. Their National Tree has almost been lost to an invasive pest species. The Caicos Pine Recovery Project (CPRP) includes horticultural skills for *ex-situ* recovery and restoration of this damaged habitat; showing the importance of these skills to conservation and restoration work. The Royal Botanic Gardens, Kew's UK Overseas Territories Programme has been working with the National Trust and the Government of TCI to save the Caicos Pine, *Pinus caribaea* var. *bahamensis*, and restore its habitat. The UKOTs comprise 16 former colonies that have elected to retain their direct British links and as such form part of the Nation State of the United Kingdom, thus being British citizens. They include many remote oceanic islands, and contain unique species and habitats – and by far are the most important for UK biodiversity.

The Turks and Caicos Islands are situated just at the southern tip of the Bahamas archipelago. The Turks Islands are separated from the Caicos Islands by Turks Island Passage, which is more than 2,200 m or 7,200 ft deep. The pine trees occur on three of the Caicos Islands: Pine Cay, Middle Caicos and North Caicos.

The Caicos pine is the dominant canopy species of the "pineyard" (as it is locally known) ecosystem (Fig 1), an open pine savannah, which is adapted to periodical burning caused by lightning strikes during the wet season. This habitat is home to many important plant species. This tree is an endemic variety of the more widely dispersed *Pinus caribaea*. This variety of pine is a keystone species of the ecosystem and only occurs on four islands in the Bahamas and three islands in TCI. The loss of this species has the potential to change entire ecosystem processes. Its

disappearance from the Islands could degrade the ecosystem's hydrology and vegetation structure.

The discovery of a non-native invasive scale insect on the pines by Kew's Martin Hamilton in 2005 (Hamilton, 2007) led to a confirmation of the scale species as pine tortoise scale, *Toumeyella parvicornis*, by Chris Malumphy at the UK Food and Environment Research Agency (FERA) (Malumphy *et al.*, 2012) .

This pine tortoise scale (Fig 2) is a well known pest species in North America on the pine family, *Pinaceae*. It is believed that the scale insect arrived on Christmas trees imported from North America. This is one example of an extreme emergency; because of the lack of bio-security at the borders. In TCI, the pine is threatened with extinction, due to the pine tortoise scale (Manco, 2010). To date the insect has killed circa 90% of the mature pine trees and is affecting nearly all of the remaining trees. A secondary effect of the scale feeding on the pine trees is sooty mould; which develops when frass (sugary secretion) drops onto understory plants. This greatly reduces the photosynthetic capacity of the ecosystem's plants.

Information on this non-native scale insect's natural range and life cycle raised alarm bells and generated the urgent need to take action to conserve the Caicos pine. Native to the northern pine forests of the USA, the scale is kept in check by dormancy during the severe winters there. Its occurrence in TCI represented the first record for the Caribbean and for this host species. TCI's consistently tropical climate allows the scale to survive and multiply year round, resulting in the ecosystem devastation seen today. The pine tortoise scale secretes a wax coating for defence; this coating causes them to resemble reptilian or fish scales, hence their common name.

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The Caicos Pine Recovery Project was established in 2008 to address this emergency – bringing together the TCI National Trust and DEMA on the island with Kew and FERA, working together to save the National Tree of the TCI and maintain the ecological integrity of TCI's unique pine ecosystem (Hamilton *et al.*, 2010a).

The key knowledge gap was an understanding of the current extent and status of the pineyards. The extent of the remaining pineyards in TCI: Pine Cay, Bottle Creek & Ready Money on North Caicos, and Conch Bar in Middle Caicos, have all been mapped onto a GIS which has been incorporated into the TCI Government's national GIS (Hamilton *et al.*, 2010b). Also mapped are the pine forests in the Bahamas, with help from the Bahamas National Trust (Sanchez, 2012). In the Bahamas conditions are more suitable for the pine as annual rainfall is higher than in TCI. Healthier trees seem to have a greater resistance to pests. The trees are also taller, more robust and healthier in the Bahamas.

As well as mapping the extant pine forests, we developed an *ex situ* programme by establishing *ex situ* collections of Caicos pine in order to secure the taxon and to build up stocks for potential reintroduction and restoration. To house the collection the team (Kew and TCI partners) built a temporary nursery in which the pines could be grown and protected from the scale insect. The first plants into the nursery were collections from two populations; 97 seedlings, in 2008.

Seedling rescues continued to fill the nursery, choosing plants which were in danger of dying in the wild from scale or even fire (Fig 3). Those plants that show signs of infection are treated with a soap wash to remove the scale. Each individual plant had a small amount of DNA taken for a population genetics study. At the same time, a priority task was to build capacity with in-territory partners for developing good *ex-situ* collections of the species. A comprehensive Caicos pine seed collection programme was also started at this stage. Seed has been collected where possible, although cone production has been severely curtailed by the disease. Currently in-territory there is

a healthy *ex situ* collection grown from wild collected seed with documentation for each individual plant.

At RBG Kew there are seedlings from two populations of the pine tree. The seed and resulting seedlings have enabled further research on this species in the controlled conditions of the Quarantine House. Some of the research carried out at Kew has consisted of germination trials; as a result a clear and precise protocol has been developed for seed germination. Together with partners in TCI, a very specific method has been developed for sowing and germinating the seed to avoid damping-off fungus killing the seedlings (Fig 4).

DNA material was taken from 90 individuals in the TCI *ex situ* collection and from 459 mature individuals in the wild across the Bahamas and TCI pine populations, for research on conservation genetics using plastid and nuclear microsatellite markers. This genetic research in the Jodrell Laboratory at Kew has been carried out by Michele Sanchez who worked on this taxon for her PhD (Sanchez, 2012) (Fig 5). Results from nuclear DNA have shown genetic differences between the populations found in TCI and those found on the four other islands of the Bahamas, with some unique alleles which were only present in one or the other. However, populations from both countries were genetically similar at plastid DNA, indicating recent genetic differentiation through isolation by distance (Sanchez, *et al.* 2014).

Work is also being carried out on the plant chemistry and mycorrhizal associations of the species. Initial findings indicate that there may be a chemical difference in trees that have far less scale infestation, which we hope may imply some pest resistance in some of the wild trees.

The situation continues to worsen for the pine tree (Fig 6). Although the numbers of scale insects are decreasing; this is simply a direct result of the numbers of trees dying. There are hints of natural resistance with the odd few trees here and there (in particular on one island) which remain almost scale insect-free. So far experimental re-introductions on Pine Cay have found that the scale insect is likely to colonise them early; this is after some monitoring on 75 trees which were planted out from the nursery in May 2012.

Summary

At the Millennium Seed Bank (MSB) at RBG Kew there are collections from two of the three islands in TCI. The adjusted seed quantity is over 2,400 for the last season's collection, after discounting empty and infested seeds. BNMP-2011 (i.e. Pine Cay collections) yielded 6653 seeds. The X-ray of a sub-sample gave 104 good seeds, 14 infested and 163 empty. So the 'adjusted' seed quantity is 2462. BNMM-2011 (i.e. Middle Caicos) yielded 61 seeds. The X-ray of a sub-sample gave four good seeds, and 16 empty. So the 'adjusted' seed quantity is 12.

Approximately 100 saplings are currently growing securely at RBG Kew. These are from seed collected on two islands in TCI. Some will be destined for Kew's newly restored Temperate House in 2018 when it re-opens after a full restoration. Each pine grown from seed has had DNA sampling material collected for further research and storage in Kew's DNA bank at the Jodrell Laboratory.

In May 2012 on Pine Cay the first outline plan for some experimental re-introduction plots occurred. These plots were planted up with 25 trees of mixed ages in each plot. Careful selection was made of the area on Pine Cay in order to create a restoration-monitoring model for the pine and the scale insect (Earle-Mundil, 2010; Green, 2011).

Conclusion

This is a very long-term project; its key aims are yet to be completed. Trials are being carried out at the MSB to ensure that the pine seed can be stored safely for the long term. Germinating seed to

produce robust saplings in TCI must continue. In May 2012 on Middle Caicos a trial burn was conducted. More prescribed burns are required to maintain the pine forest ecosystem, as these forests are fire-dependant. Funds for the Project still need to be raised. Plot monitoring data will need to be collected regularly. Last but not least, the need is to make every person in the Territory aware of their National Tree's plight and the issues surrounding bio-security.

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Figure 1. TCI Pineyard ecosystem



Figure 2. Pine Tortoise Scale on pine trees



Figure 3: Caicos Pine Recovery Project Nursery



Figure 4. Germination protocol steps for pine seed



Figure 5. Field and laboratory work by Dr. Michele Sanchez



Figure 6. Middle Caicos Island pineyard mortality