

New discoveries for the endangered Illawarra Socketwood (*Daphnandra johnsonii*, Atherospermataceae)

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The New South Wales Government's *Saving our Species* program (SoS) aims to secure threatened flora in the wild through targeted conservation projects. Monitoring and conservation efforts for the Illawarra Socketwood (*Daphnandra johnsonii*), listed as Endangered on both the NSW *Biodiversity Conservation Act 2016* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, has resulted in multiple gains in our knowledge of this species. The Illawarra Socketwood Recovery Plan (DEC 2005) highlighted that limited seed development and factors responsible for the production of 'pseudo fruit' are essential aspects of the species' biology requiring investigation. We are pleased to report that we are now able to explain the cause of deformed fruit in this species. Increased field survey and monitoring has also led to the discovery of many new populations, and we have commenced genetic work to better understand the extent of clonality in this species.

The species

- Perennial medium-sized rainforest tree.
- Endemic to the Illawarra region of NSW.
- Clonal species, reproducing primarily by coppicing and suckering.

Threatening processes

- Habitat loss and fragmentation.
- Low levels of viable seed.
- Suspected low levels of genetic diversity and high levels of clonality.
- Invasive weed species.
- Browsing and stem damage from livestock and feral deer.

Habitat and distribution

Illawarra Socketwood grows on rocky hillsides and gullies of the Illawarra escarpment and coastal lowlands in Illawarra Subtropical Rainforest habitat, and occasionally in warm temperate rainforest (DEC 2005). It is known between Toolijooa in the south to Avondale in the north, with a disjunct northern population at Scarborough (Figure 1).

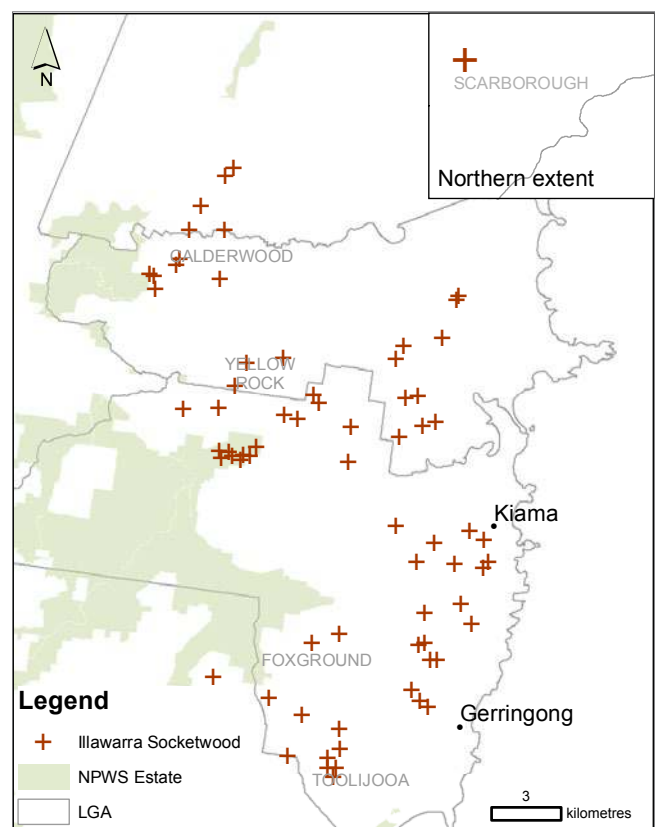


Figure 1. Distribution of *Daphnandra johnsonii*. The inset shows the disjunct northern population at Scarborough.

A new discovery, the Illawarra Socketwood gall midge

Most Illawarra Socketwood populations are known to produce only 'pseudo-fruit', a globose malformed fruiting receptacle containing no seed (DEC 2005). The reason for this has remained unexplained. Low seed germination rates are also reported for this species by both the Australian Botanic Garden Mount Annan and Wollongong Botanic Gardens.

To pursue this knowledge gap, fruit were collected from two populations in the Kima Local Government Area in April 2017, with assistance from Wollongong Botanic Gardens. The malformed fruit were split and inspected under a microscope, revealing multiple larvae within (Figure 2).



Figure 2. Dissected fruit showing emergent pupal cases.
Photo: Jemma Lemmon

The malformed fruit were collected and bagged and within ten days of collection larvae pupated and emerged as adults.

The insects were reared with support from the University of Wollongong and identified by Dr Peter Kolesik as an undescribed species of the Dipteran family Cecidomyiidae, commonly known as gall midges. This is the first gall midge described for a host plant within the Atherospermataceae family (Southern Sassafras). The insect has been recently described and named after its host plant as *Asphondylia daphnandrae* (Kolesik *et al.* 2019).

Gall inducing insects are known for their tight associations with one, or a few, closely related host species (Blanche 2012). It is therefore likely that *A. daphnandrae* feeds exclusively on Illawarra Socketwood or related congeners. *Daphnandra apatela* has also been observed to bear galled fruit (Foreman and Whiffin 2007). Further investigation is needed to affirm whether it is also a host plant for *A. daphnandrae*.

Fruit infested with *A. daphnandrae* are readily observed around March to April by their globose galls, which contain no viable seed (Figure 3). The larvae are legless, orangey yellow in colour, and 1.5–2 mm in length (Kolesik *et al.* 2019). Non-infested fruit produce elongated fruiting receptacles and are more likely to contain developed seed (Figure 4).

The impact of the Gall Midge on Illawarra Socketwood

Fewer than 2% of the Australian vascular plant genera are reported to have native gall-inducing insects (Blanche 2012). Galls can form on leaf or stem tissue, but when flowers are targeted, seed production can be substantially limited, potentially influencing the structure of ecological communities (Blanche 2012).



Figure 3. Galled fruit infested with *Asphondylia daphnandrae* larvae. Photo: Jemma Lemmon



Figure 4. Healthy non-galled fruits. Photo: Jemma Lemmon

Sexual reproduction of Illawarra Socketwood appears to be limited by *A. daphnandrae*. The larvae feed on the inside of deformed fruits and no seed develops inside (Kolesik *et al.* 2019). It is also suspected that low levels of genetic diversity within Illawarra Socketwood populations contributes to low levels of seed production. Understanding the relative influence of these factors is a focus for future work.

At present, only one population is known that does not appear to contain the midge. Further work is needed to confirm the extent of the midge across all Illawarra Socketwood populations and the extent to which it limits seed production. Some trees may be partially affected by the midge allowing for normal fruit to develop, although this appears to be the minority of cases observed to date.

Given that *Daphnandra johnsonii* is the only one of five species of *Daphnandra* listed as threatened, the contribution of the gall midge to its status and limited distribution is an interesting question.

Genetic work and population estimates

Illawarra Socketwood relies predominantly on clonal reproduction from suckers and coppicing stems. Given this, we are unable to easily quantify the number of genetically distinct individuals (genets) that comprise populations. In this context we arbitrarily define populations as plants separated by at least 200 m (DEC, 2005). Seventy-two populations are currently known, including eight new populations recorded since 2016 under the SoS project.

SoS is currently funding genetic work with the Royal Botanic Gardens Sydney to improve our understanding of the extent of clones within and between Socketwood populations. To date we have collected samples from 183 plants across 24 wild populations. We suspect that some populations contain just one genetic individual. If this were to be true for most populations, the total population may be less than 200 plants. We look forward to receiving these analysis results soon.

Future work

Exploring methods and outcome for some level of control of the gall midge would be a worthy future pursuit in the conservation efforts for Illawarra Socketwood. If methods can be developed to limit the impact of the gall midge, we can explore whether natural seed production can be enhanced.

The outcomes of the genetic work will provide enhanced understanding of levels of clonality within populations and enable us to make informed estimates of population size. If the level of clonality is very high, then investigation of options to improve genetic diversity may be required, potentially in concert with gall midge control.

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