NEW ECOLOGICAL FINDINGS FOR *SARCOCHILUS AUSTRALIS*, A UNIQUE ORCHID IN TASMANIA

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INTRODUCTION

Sarcochilus australis is a temperate twig epiphyte found in New South Wales, Victoria and Tasmania (Jones *et al.* 2006). The genus *Sarcochilus* is the largest of 25 genera comprising the orchid sub-tribe Aeridinae (formerly Sarcanthinae) (Jones 2006), and contains 19 epiphytic or lithophytic species, all but one of which are endemic to eastern Australia, with the remaining species occurring in New Caledonia (Jones *et al.* 2006). The genus exhibits monopodial growth, in which vegetative growth continues from the apical meristem, while inflorescences grow from axillary meristems (Goh 1976).

Plate 1. Photo showing a mature *Sarcochilus australis* plant attached to a *Coprosma quadrifida* host. Clearly visible are leaves, roots, remnant peduncles with flower nodes (one with two fruits releasing seed), and three emerging inflorescences with flower buds.

Sarcochilus australis is the only member of the genus and also the only epiphytic orchid to occur in Tasmania. Tasmania is unusual in having a single epiphyte in an orchid flora of approximately 200 species. Globally epiphytes dominate the Orchidaceae, with estimates of 70% of the 20-30,000 species having this habit (Alcantara *et al*. 2006). Australia as a whole has 243 named species of epiphytic orchids, making up almost one fifth of the country's orchid flora (Jones *et al.* 2006). New Zealand, with its similar climate and vegetation to Tasmania, has seven epiphytes in an orchid flora of some 120 species (St George 1999).

Sarcochilus australis flowers from late spring to early summer, and can produce a number of flowering racemes in a season, each with up to 15 flowers (Dockrill 1992). Ripening capsules grow from the plant until late winter/early spring when they dehisce and release seed. Dehiscent peduncles remain attached to the plant, with visible scars left from individual flowers. Remnant dehiscent fruits also remain on the remnant peduncles. Leaves and roots attached to hosts are visible all year round. The species generally attaches to its hosts on the lower two metres of the plant (personal observation). Plates 1, 2 and 3 show various images of *S. australis* in Tasmania.

Plate 2 (left). Mature *Sarcochilus australis* individual with a single raceme with flower buds almost open. Also visible are dehiscing fruits releasing seed.

Plate 3 (right). Open flower and unopened buds on small racemes.

While *Sarcochilus australis* is a favourite of orchid enthusiasts and naturalists alike, the species has been the subject of few detailed scientific studies. *S. australis* is not listed on any international, national, or state threatened species list, however, its conservation status in Tasmania has been queried by government organisations and community groups alike (Field *et al*. 2006; J. Shaw & W. Potts pers. comm. 2007). *Sarcochilus australis* is listed in the Forest Practices Authority's *Forest Botany Manual* (FPA 2005) as a priority for conservation, generally associated with moderate to high quality production forests, due to relatively few populations being known and to concern about loss of suitable habitat (F. Duncan pers. comm. 2008).

With the above in mind, research as part of an Honours project (Smith 2007, unpublished) was carried out with the aim of gaining insight into the population ecology of *S. australis* in Tasmania, to make available important information necessary for the future conservation management of the species.

METHODS

Adapted from full methods as stated in Smith (2007, unpublished). All specific site location details also available in Smith (2007, unpublished).

Distribution of Sarcochilus australis *in Tasmania*

On 2 March 2007 all known locations of *Sarcochilus australis* in Tasmania were sourced from the *Natural Values Atlas* (NVA), a web-based resource published by the Department of Primary Industries and Water (available by application at https://www.naturalvaluesatlas.dpiw.tas.gov.au). The NVA lists recorded observations of flora and fauna in Tasmania, and contained 96 recorded sightings of *S. australis* (Figure 1). In addition to this, advertisements were placed around the School of Plant Science, University of Tasmania, and posted on the Tasmanian Field Naturalist Club's website asking for people to report sightings of *S. australis*.

Sites to visit as part of this study were selected based on their accessibility, with the aim to visit as many sites as possible in a constrained time frame. Eleven known locations from across the species' range in Tasmania were visited and a search for *S. australis* plants was conducted. In addition, eight sites were visited in response to sightings personally reported by botanists and orchid enthusiasts as part of this study. At all sites the minimum search time was 30 minutes. While in the field, searches were also conducted at extra sites if they appeared to offer potential as *S. australis* habitat (based on botanical composition and forest structure) and were geographically close to known *S. australis* observations.

Every location at which *S. australis* was observed during this study was recorded using a handheld GPS unit. Locations at which the species had been observed in the past but where the species was not found in the present study were recorded similarly.

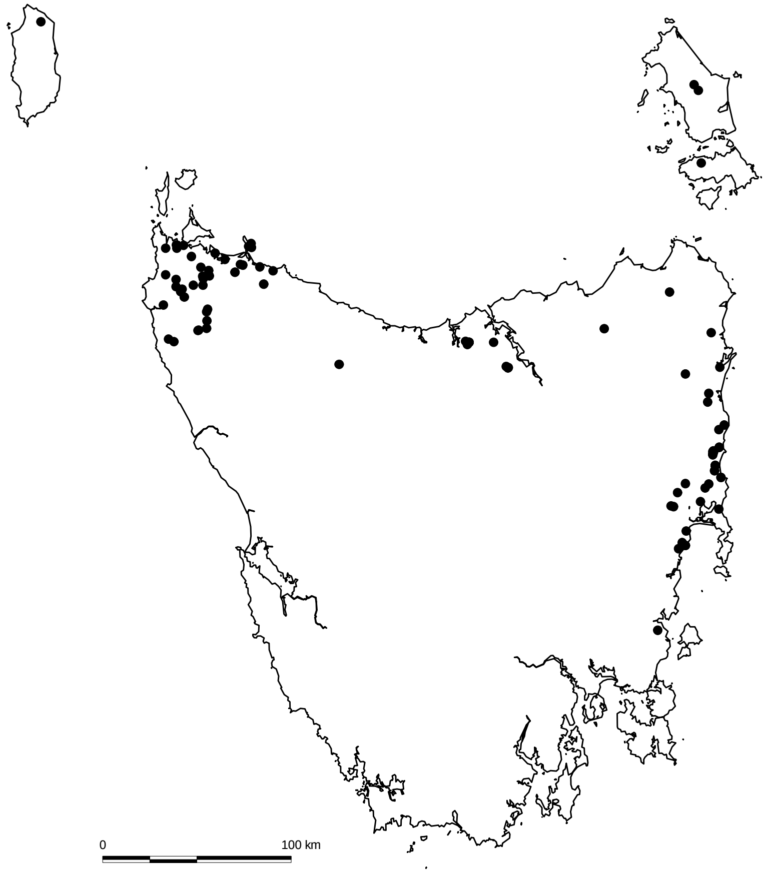

Figure 1. Distribution of *Sarcochilus australis* in Tasmania based on records from DPIW's *Natural Values Atlas*.

Population ecology and habitat preference of Sarcochilus australis *in Tasmania*

At 12 sites identified as populations of *S. australis*, as many individuals as was practical were sampled using randomly-placed transect lines through the population. For each plant encountered, a range of data was recorded. This included length of longest leaf, number of remnant peduncles and flower-nodes, number of new bud stalks forming, number of ripening and/or remnant fruits, and host species. Sampled individuals at each site were later placed into life-stage categories based on their size and reproductive stage. The categories consisted of seedlings, juveniles, or adults.

Due to the time of year this study was conducted, autumn to spring, no flowers were present on plants. Remnant peduncles from the last few years of flowering were present at all sites, however, and the number of flower nodes on each peduncle was clearly visible. Also visible were both currently ripening fruits, and the dehiscent bodies of fruits of previous years. Thus a count of flower-nodes and fruits was possible and represented an individual plant's recent reproductive history.

Rates (%) of fruit production to flower-nodes were identified for each site, and an average rate was taken for the State. The proportion of reproductively-active plants in each population was identified, as was a total for the State as a whole.

In addition to data for individual plants, the structure and species composition of the vegetation at each population site was recorded. Using the software package ANUCLIM (Houlder *et al.* 2000), climatic data for each population site was sourced. This included average maximum and minimum temperatures, and average rainfall.

Vegetation communities in which *S. australis* was found, based on dominant species and structure, were classified using the Tasmanian Vegetation Mapping Program (TASVEG) community codes (Harris & Kitchener 2005).

RESULTS AND DISCUSSION

Distribution

Sarcochilus australis was observed growing at 18 different locations across Tasmania (Figure 2). These encompassed sites in the North West, Central North, North East, and Eastern Tasmania. Of the 18 observations, six were at sites at which *S. australis* observations had previously been recorded in the *NVA*. Another six observations were recorded after investigating reports from botanists and orchid enthusiasts. The remaining six observations were found during the course of this study. Only two of the 18 sites were located within national parks (Douglas-Apsley and Freycinet national parks), both on the east coast. Four additional sites at which observations of *S. australis* had previously been recorded were visited, but no individuals could be found after a thorough search (Figure 2). Two of these sites had been burnt by a high intensity fire in late 2006 (Upper Scamander area, east coast) (personal observation). A third site had been logged in 1985 using a partial harvest system of advanced growth and seed tree retention (State forest southwest of Bicheno) (T. Leaman pers. comm. 2007). The remaining site is now remnant vegetation in a Crown land recreation park in the northeastern town of Scottsdale.

Habitat and host use of Sarcochilus australis *in Tasmania*

The climatic range for *Sarcochilus australis* in Tasmania was found to be broad (Table 1). The species was found growing from sea level, literally metres from the high water mark (northwest region), to an elevation of 250 m. Sites had an average yearly temperature range of between a maximum of 21.8ºC and a minimum of 1.9ºC. *S. australis* was found on slopes of 0 to 30º, and was seen growing in locations with average annual rainfall as low as 615 mm (east coast), and as high as 1609 mm (northwest). No specific aspect was seen to be favoured by populations of the species in this study.

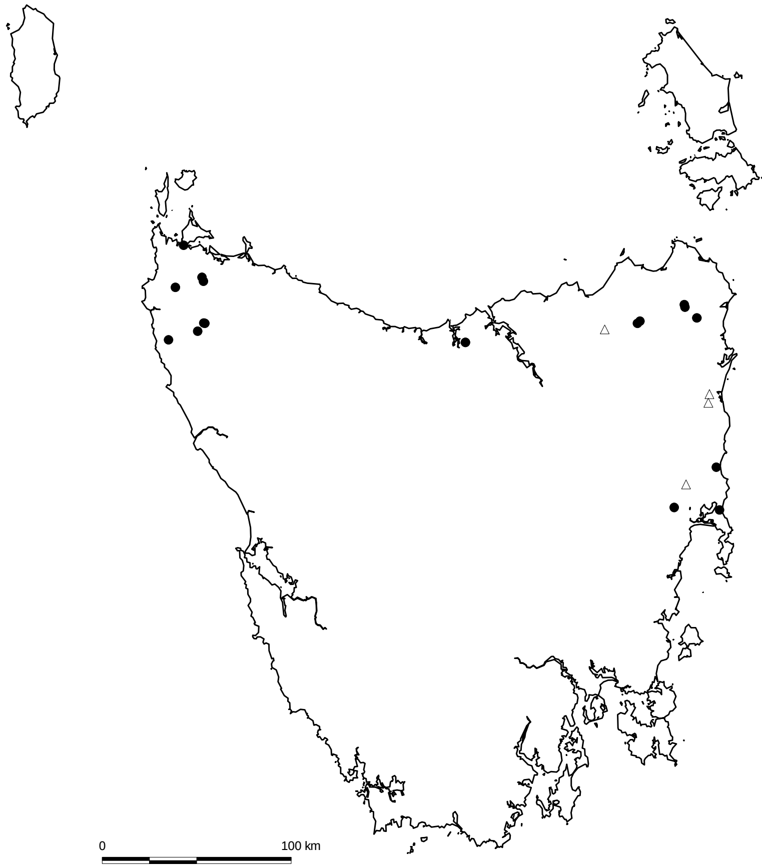

Figure 2. Distribution of observations of *Sarcochilus australis* in Tasmania made in the present study (filled circles – sites where species was observed; open triangles – sites where species could not be located and is possibly extinct).

Table 1. Climatic/environmental range (yearly means) across sites at which *Sarcochilus australis* was found in Tasmania. Source: ANUCLIM (Houlder *et al.* 2000).

Environmental parameter	min	max
Elevation (m)	0	250
Slope (degrees)	0	30
Max temp. (degrees C)	19.6	21.8
Min temp. (degrees C)	1.9	5.7
Annual precipitation (mm)	615	1609
Wettest quarter precipitation (mm)	170	582
Driest quarter precipitation (mm)	137	230

For epiphytes, water availability is the most important environmental factor limiting growth and survival (Zotz & Tyree 1996). Epiphytes have no direct access to soil held water, and water stress is characteristic of many epiphytic environments (Winter *et al.* 1983). The site of lowest rainfall in this study, 615 mm annual rainfall, is relatively low on the Tasmanian scale (Reid *et al.* 1999). Among other mechanisms for water conservation, it is estimated that 7000 species of orchid, mostly epiphytic, utilise the crassulacean acid metabolism (CAM) photosynthetic pathway (Zotz 2004), whereby they open their stomata at night to collect CO_2, and keep them closed during the day to reduce water loss through transpiration. Indeed, Winter *et al.* (1983) demonstrated that 22 of 46 Australian species of the orchid sub-tribe Sarcanthinae, including six species of *Sarcochilus*, use the CAM photosynthetic pathway. *Sarcochilus australis* was not included in their study, but given the relatively dry environments in which it is capable of occurring in Tasmania, future research may find the species is indeed utilising the CAM photosynthetic pathway.

During this study *S. australis* was found growing across four broad forest vegetation community types (Table 2). Using the Tasmanian vegetation mapping program classifications, these communities fell under the groupings of *Eucalyptus obliqua* wet forest (WOB/U), *Eucalyptus regnans* forest (WRE), *Melaleuca ericifolia* swamp forest (NME) and *Nothofagus-Phyllocladus* short rainforest (RMS) (Harris & Kitchener 2005). Some sites were borderline between two distinct classifications. No frequencies are given as communities were not visited at random. These vegetation types are all forms of wet forest, as may be expected for a plant for which water availability is a major limiting factor.

Table 2. Overview of the four broad vegetation community types at sites in which *Sarcochilus australis* was found in Tasmania.

Dominant canopy species	Dominant understory species	Dominat shrubs	TASVEG Classification
Eucalyptus obliqua *Acacia melanoxylon* *Acacia dealbata*	*Pomaderris apetala* *Olearea argophylla*	*Coprosma quadrifida*	WOB/U
Eucalyptus regnans *Acacia melanoxylon* *Acacia dealbata*	*Pomaderris apetala* *Olearea argophylla*	*Coprosma quadrifida*	WRE
Nothofagus cunninghamii *Acacia melanoxylon* *Eucalyptus obliqua*	*Pomaderris apetala*	*Mixed rainforest species*	WOU/RMS
Eucalptus ovata *Melaleuca ericifolia* *Busaria spinosa*		*Coprosma quadrifida*	NME

In the other States where *S. australis* occurs, the species is also found growing in wet forest, including rainforest (Dacy 1987; Upton 1992; Harden 1993; Walsh & Entwisle 1994), and estuaries in New South Wales (Dockrill 1992). Similarly, temperate epiphytic orchids in New Zealand occur predominantly in rainforest (Lehnebach & Robertson 2004).

In this study *S. australis* was seen using 10 tree and shrub species as hosts (Table 3). Host selection, however, was quite specific, with two host species, *Coprosma quadrifida* and *Pomaderris apetala*, used as hosts more than 80% of the time across the State. The other occasionally used host species seen in this study were *Acacia melanoxylon*, *Anodopetalum biglandulosum*, *Correa backhouseana*, *Eucryphia lucida*, *Melaleuca ericifolia*, *Nematolepis squamea*, *Olearia argophylla* and *Zieria arborescens*.

Field notes published by Barnett & Beattie (1986) recorded 16 host species for *S. australis* in Victoria along an 8 km section of habitat. No frequencies were recorded. Anecdotal evidence suggests that in New South Wales, *S. australis* exhibits a high preference for two species of host, *Backhousia myrtifolia* and *Tristania laurina* (Walsh 2001). Both this, and particularly, the present study, show that there are obviously some qualities exhibited by certain species within the habitat that make them the most frequently used hosts by *S. australis*.

Among other qualities exhibited by potential host species there can be a preference for a host with rough bark over those with smooth bark in epiphytic orchids (Migenis & Ackerman 1993; Otero *et al.* 2007). Not only may establishment of seedlings be inhibited by smooth bark, but such a substrate may also retain less water and nutrients (Migenis & Ackerman 1993). Nutritional content and allelopathic chemicals in the bark of a possible host may also affect suitability (Migenis & Ackerman 1993). *Coprosma quadrifida*, the primary host in this study, has relatively rough bark (Plate 1), with frequent corrugation-like channels that may retain water and increase the local humidity. While *Pomaderris apetala*, the second most frequent host, differs in that it has smooth bark, it often has moss and lichen growing on its surface, which may also act to retain water, increase humidity, and provide pockets in which seeds may settle.

Table 3. Total host use frequency of 909 *Sarcochilus australis* individuals at 12 sites across Tasmania.

Host species	Host freq. (%)
Acacia melanoxylon	**0.1**
Anodopetalum biglandulosum	**1.1**
Coprosma quadrifida	**50.0**
Correa backhouseana	**1.1**
Eucryphia lucida	**3.0**
Melaleuca ericifolia	**0.1**
Nematolepis squamea	**0.1**
Olearia argophylla	**5.4**
Pomaderris apetala	**32.2**
Zieria arborescens	**0.4**
Fallen to ground	**0.8**
Standing dead	**5.6**
No. *S. australis* sampled	**909**

Reproductive output of Sarcochilus australis *populations in Tasmania*

The flower-node to capsule ratios identified for *S. australis* in this study are low. The average for all sites across Tasmania was 0.77%, with individual sites ranging from 0% to almost 3% (Table 4). Thus on average, across the State, less than one flower in 100 results in the production of a mature fruit. While these rates are very low, it is important to compare this output with population structure.

Without going into too much detail on the population structure results, suffice it to say that the majority of populations sampled in this study exhibited stable, continuously-recruiting population growth (see Smith 2007, unpublished). That is to say, they were healthy and viable populations with large numbers of seedlings and juveniles, and gradually decreasing numbers of the larger size classed individuals (using length of longest leaf as an indicator of size). Three of the twelve populations sampled did present size-class structures that differed from this trend, some of which may be in decline.

Table 4. Total number of flower nodes to fruit success rates for *Sarcochilus australis* at each of 12 sites across Tasmania (E= East, N= North, NE= North-East, and NW= North-West).

Site	No. plants sampled from popln.	No. plants with remnant flower stalks	Total no. flower nodes	Total no. capsules	Flower node to fruit success rate (%)
E1	75	31	304	1	0.33
E2	125	40	452	7	1.55
N1	115	40	282	8	2.84
NE1	137	51	580	10	1.72
NE3	84	19	421	2	0.48
NE5	19	9	162	0	0
NW1	70	24	941	1	0.11
NW2	141	22	445	5	1.12
NW3	61	32	952	10	1.05
NW4	17	7	103	0	0
NW5	43	6	67	0	0
NW6	22	6	75	0	0
				Average	**0.77**

When the fruit rate is put in context with the population structures of *S. australis* around the State, it became apparent that although low, the fruit rates in these instances appear adequate to support stable population growth at most of the sites visited. As a single orchid fruit can produce millions of seeds (Arditti & Ghani 2000), a low fruit count may still provide enough seed for healthy recruitment.

Low flower to capsule ratios are typical of orchids (Snow & Whigham 1989; Ackerman & Montalvo 1990; Calvo 1993; Neiland & Wilcock 1998). For example, the tropical twig epiphytic orchid *Tolumnia variegata* has an average natural flower to capsule rate of less than 1% (Calvo 1993). Other rates for species of epiphytic orchid are 6.9% for *Dendrobium monophyllum* (Bartareau 1995), and 30%, 22.5%, 6.9%, and 4.1% for four temperate species in New Zealand (Lehnebach & Robertson 2004). Variation of fruiting rates within a species may occur across time and space, as was seen to some extent with *S. australis* across different sites.

CONCLUSIONS AND FUTURE STUDY

These results provide new insight into the ecology of *S. australis* in Tasmania. Both government organisations and community groups have expressed concern over the conservation status of this unique orchid in Tasmania, a species that has been the subject of few detailed scientific studies. Providing a heightened understanding of habitat use and reproduction, the results presented here will be indispensable to vegetation managers in Tasmania when dealing both with *S. australis* on its own, and the ecosystems in which it resides. This new data will also be of importance to management in the other States in which the species occurs.

While the importance of such a study as this is clear in a local context, wider commentary confirms the importance of such research. Worldwide, there is much concern about the future conservation of many orchid species (Zotz & Schmidt 2006). The need for detailed information on orchid population biology has been identified to assist conservation management in the face of increasing habitat changes (Zotz & Schmidt 2006). Ecological, demographic, and reproductive biology research on orchid species has been identified as a global priority for *in situ* conservation of orchid species by the Orchid Specialist Group of The World Conservation Union (Kell 1999).

The broad overview provided by this study on the habitat and climate in which *S. australis* may be found in Tasmania, as well as the detailed account of the species' fruiting rates, provides a firm basis for future research on the species. Future study is particularly important given the newly discovered populations and sites of local extinctions identified in this study. These findings raise the need for more distribution research to identify whether such local extinctions are common across the species' range. In addition, it is critically important to identify population responses to disturbance, most importantly those related to forestry operations, particularly given the species' association with moderate to high quality wood production forests.

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