Title

Determining host plant preferences for the critically endangered Lord Howe Island Stick Insect (*Dryococelus australis*) to assist reintroduction

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Abstract

The Lord Howe Island Stick Insect (*Dryococelus australis*) is one of the world's rarest insects. However, the opportunity to reintroduce the species to Lord Howe Island, and commence the path to recovery, may occur within the next five years. Understanding the insect's host plant and habitat preferences on Lord Howe Island is critical to maximising the likelihood of reintroduction success. However, very little ecological information was documented before the species became extinct on the island in the 1930s. Here we examine the Lord Howe Island Stick Insect's preference for potential host plants, a key aspect of habitat suitability. We conducted preference trials using 15 common plant species found on Lord Howe Island. Both nymphs and adults consumed some but not all of these plant species. Nymphs were able to survive on seven of these 15 plants for the duration of the 26-day trials although failed to survive on some of the plants most preferred by adults. Overall, these data reveal that there are numerous plants on Lord Howe Island that the stick insect can consume, though their suitability varies with different developmental stages of the insect. These data are encouraging for any future reintroduction attempts and would greatly aid the selection and monitoring of release sites.

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Introduction

The reintroduction of individuals sourced from captive and other wild populations has been a common strategy to help prevent the extinction and promote recovery of numerous threatened species (Knisley et al. 2005; Armstrong et al. 2007). However, these programs are time-consuming (Thatcher et al. 2006), expensive (Seddon et al. 2005; Thatcher et al. 2006) and historically have often been unsuccessful in terms of establishing self-sustaining populations (Griffith et al. 1989; Beck et al. 1994; Fischer and Lindenmayer 2000). Numerous factors can affect the outcome of reintroduction programs (Wolf et al. 1996, 1998; Fischer and Lindenmayer 2000), but suitability of habitat at the release site is crucial (Griffith et al. 1989; IUCN/SSC 2013; Batson et al. 2015). For example, studies have demonstrated that introductions and reintroductions of birds and mammals have had higher success rates when habitat quality of the release area has been classified as excellent compared with good or fair/poor (Griffith et al. 1989; Wolf et al. 1996). Changes in habitat can occur while the species is absent, so it cannot be assumed that the former range will provide suitable habitat (IUCN/SSC 2013). Consequently, knowledge about habitat suitability and the ecological requirements of a species is essential in the selection of appropriate reintroduction sites as this will influence the likelihood of success (Griffith et al. 1989; IUCN/SSC 2013).

The critically endangered Lord Howe Island Stick Insect (*Dryococelus australis*, LHISI) is a large, nocturnal, flightless stick insect (Lea 1916). It was first described by the missionary Jean Xavier Hyacinthe Montrouzier in 1855 from specimens collected on Lord Howe Island (Gurney 1947), which is situated 700 km off the coast of New South Wales, Australia (Honan 2008). The Lord Howe Island Group supports high biodiversity with a large proportion of endemic species and communities (Department of Environment and Climate Change (NSW) 2007). Indeed, recent genetic work indicates that the LHISI is likely to have diverged from its nearest ancestor at least 22 million years ago (Buckley et al. 2009). The species was once abundant on Lord Howe Island (Honan 2008), but following the beaching of a ship in 1918, and the subsequent accidental introduction of the Black Rat (*Rattus rattus*), it was thought to have become extinct by the 1930s (Gurney 1947). However, three live specimens were discovered in 2001 on Balls Pyramid (Priddel et al. 2003), a rocky island located 23 km southeast of Lord Howe Island (Auld and Hutton 2004). These individuals were found at night, feeding on the endemic shrub *Melaleuca howeana* (Priddel et al. 2003). Since that discovery, more extensive surveys conducted between 2002 and 2005 reported findings between nine and 35 adults (Carlile et al. 2009). In 2003, two breeding pairs were collected and transferred to mainland Australia to establish a captive breeding program (Honan 2008), which has been maintained since that time (Cleave et al. 2013). In captivity, females reach up to 150 mm and males up to 120 mm (Cleave et al. 2013). Individuals gradually change in colour with each moult, from green to black until they reach maturity at approximately seven months, and then may live up to another 18 months (Honan 2008).

There is a well-advanced plan for the eradication of rodents, from Lord Howe Island (Lord Howe Island Board 2009, 2017). In addition to the Black Rat, there is also the introduced House Mouse (*Mus musculus*), but no endemic rodents (Lord Howe Island Board 2009, 2017). This plan provides the first opportunity for the reintroduction of the LHISI to Lord Howe Island if the rodent eradication is successful. However, invertebrate reintroductions occur much less frequently than vertebrates (Beck et al. 1994; Stanley Price and Soorae 2003; Knisley et al. 2005; Seddon et al. 2005), so our understanding of such programs is generally very limited. Critically, the habitat use and food requirements of the LHISI on Lord Howe Island are poorly understood, because virtually no information was collected before it became extinct from the island (Carlile et al. 2009). There were reports of the LHISI being found in the hollows of tree trunks in significant numbers in all life stages (e.g. 68 removed from one hollow; Lea 1916), thought to be *Ficus macrophylla columnaris* (Rentz 1996), but their host plants on Lord Howe Island are not known (Carlile et al. 2009). At Melbourne Zoo, the captive LHISI have been reared successfully on a number of plants, including Moreton Bay Fig *Ficus macrophylla* (the subspecies *Ficus macrophylla columnaris* occurs on Lord Howe Island), as well as *M. howeana* found on Lord Howe Island (Honan 2008). *Melaleuca howeana* has been used because it was consumed by the population on Balls Pyramid (Honan 2008), though it is unlikely to have been an important host plant on Lord Howe Island because it is typically found in exposed areas, such as on cliffs, ridges and along the coastline (Hutton 2010a).

The LHISI has been reared in captivity on plants from a number of Families (Honan 2008), which suggests that the species may have been polyphagous (ability to utilise a variety of Families as host plants) when on Lord Howe Island. Across the Order Phasmatodea, diet varies considerably, with some species having restricted diets, while others are highly polyphagous (Blüthgen et al. 2006). The degree of polyphagy in herbivorous insects depends on various physiological, ecological and morphological factors, and in many species the range of plants consumed changes throughout development (Schoonhoven et al. 2005). Furthermore, studies on stick insects demonstrate that different host plants affect the longevity, growth rate, reproductive success (Boucher and Varady-Szabo 2005), length of time to maturation and the proportion of nymphs surviving to adulthood (Hsiung and Panagopoulos 1998). Understanding the host plants preferences of the LHISI on Lord Howe

Island, and how these preferences may change over the course of development, is therefore important information to aid in the planning of any reintroduction. Consequently, this study aims to determine the preferred host plants of both LHISI adults and nymphs, and also document the impact of different host plants on the development and survival of the nymphs. These data would help guide and improve the likelihood of a successful reintroduction in the future.

Methods

Study area

Our experiments were conducted in a nursery shed in the lowland region of Lord Howe Island (159°05’E, 31°33’S) in September and October 2013. The shed had windows to allow ambient light, temperature and humidity. Lord Howe Island has a subtropical climate, with monthly average maximum temperature ranging across the year from 19°C-25°C and minimum temperatures from 14°C-21°C, whilst average humidity ranges between 60%-70% year-round (Australian Government Bureau of Meteorology 2017).

Adult preference trials

For the host plant preference trials, we used 30 LHISI sub-adults that had been transferred from the Melbourne Zoo population, and 30 adults/juveniles sourced from a captive population on Lord Howe Island. These two groups were housed separately in large (67 × 67

× 122 cm) enclosures and fed on *F. macrophylla columnaris* and *M. howeana* inside the Lord Howe Island Research Station. Individuals used in the host plant preferences trials were drawn from these stock populations. Any individuals showing clear signs of stress or illness were not used in any trial.

We selected potential host plant species for the preference trials by first documenting diets of stick insects worldwide (Bedford 1978; Tay and Seow-Choen 1996; Seow-Choen 2005; Blüthgen et al. 2006) and grouping these plants by Family (as described in Tay and Seow-Choen 1996). Plants from these Families were then identified from flora lists of Lord Howe Island (Green 1994; Hutton 2010a; J. Bruhl and I. Telford personal communication). This list was then reduced to a shortlist of 15 species (see Table 1) by excluding species that were either uncommon or restricted to the higher regions of Lord Howe Island (I. Hutton personal communication).

The preference trials involved placing two different plant species in a 40 × 40 × 76 cm enclosure. There were 105 possible plant combinations from the shortlist of 15 plants, with each combination placed in one of 24 enclosures over a nine-day period. The 105 combinations were repeated three times (315 trials in total) over 27 days. Each enclosure contained: (1) an equal-sized cutting from the two plant species, with each cutting placed in a 350 ml water bottle, and the vegetation touching the top and sides of the enclosures; (2) one half of a six-inch plastic plant pot as a retreat; and (3) one water dish. The plants were sprayed with water each morning and evening. We randomly selected 24 LHISIs from the Melbourne Zoo stock population, and noted the age-class and gender of each individual. One insect was randomly allocated to each enclosure and was placed into the retreat in the early evening. The trial was conducted for the following two nights.

The next morning, we recorded which of the two plants had been eaten and also estimated the amount of plant consumed according to a subjective five-category ‘consumption score’ ranging from none (0) to extensive (4). Since adults can eat more than sub-adults and juveniles, we scaled the score with respect to the age-class of the individual. For example, ‘extensive’ for juveniles, would be ‘moderate’ for sub-adults and ‘little’ for adults. While this measure is clearly imperfect, it does not create a source of bias because individuals were randomly allocated to plant combinations, and there was no *a priori* expectation of host plant preferences.

We then removed the partially consumed parts of the plant cuttings, so that foliage eaten the following night could be assessed, and switched the position of the two plant cuttings within the enclosure. The amount eaten after this second night was again estimated and recorded in the following morning. Individuals were then returned to their source population, and the enclosure was cleaned and prepared for the next set of trials using individuals from the other Lord Howe Island stock population. This procedure continued for 27 days, alternating between using individuals from the Melbourne Zoo and Lord Howe Island stock populations, ensuring that individuals did not go without a host plant of known suitability for more than two nights in a row.

Nymph survival trials

The survival of nymphs on different plant species was investigated in trials conducted using nymphs hatched from a stock of 1,092 eggs sourced from the Melbourne Zoo captive population. We used the same 15 plant species (Table 1), with each enclosure (40 × 40 × 76 cm) containing cuttings of a single plant species, with two replicate enclosures for each plant species. For the first replicate, we placed a group of six, one-day-old nymphs on each plant species in a random order, as these groups became available from the source population of eggs. We repeated the procedure for the second replicate, but reversed the order in which the group of nymphs was added to the different plant species. The two replicate enclosures for each plant species were placed in different areas of the shed and randomly positioned within those areas.

Each enclosure contained a small water dish and a 350 ml bottle of water that supported the plant cutting, which touched the enclosure’s roof. Every second day we recorded the number of individuals that remained alive. We then replaced the plant cuttings with new cuttings collected that day. Enclosures were checked in the morning and evening for any deceased nymphs, which were weighed and their length measured. Each of the 30 enclosures were monitored for a maximum of 26 days or until all six individuals had died. For trials with nymphs surviving to 26 days, we placed the surviving nymphs in a freezer for one hour, thawed them for 45 minutes, and then recorded their weight and length.

Nymph preference trials

We conducted host plant preference trials for LHISI nymphs using the five plant species that yielded the highest nymph survival rates (see above). We used 100 nymphs, with an estimated age of between three and seven weeks, from the Lord Howe Island captive population, which had been feeding on *M. howeana*. We acknowledge that this familiarity with *M. Howeana* may have influenced the nymph’s preference for this species. These insects were placed into one of two enclosures (40 × 40 × 76 cm) that contained *M. howeana* cuttings and water dishes.

The nymph preference trials provided a choice between two different plants. Each two-plant combination was randomly assigned to one of ten cylindrical enclosures (25 cm diameter × 35 cm height), which had two small vials filled with water for the plant cutting (which touched the side of the container), and a small water dish at the bottom. For each trial, we placed five randomly chosen nymphs into an enclosure, placing two on each cutting and one on the underside of the mesh lid. In the morning following the second night, we assigned the amount of leaf eaten into one of five categories, as described above. The enclosures were cleaned and the nymphs returned to their original enclosure. This procedure was then repeated for the second replicate of each two-plant combination, using the remaining 50 nymphs. In total there were 20 trials with two replicates for each of the 10 two-plant combinations.

Vegetation map

We combined unpublished plants species distribution data provided by the Lord Howe Island board with the results of our preference trials, to create a map of Lord Howe Island using ArcMap 10.2.2 (ESRI 2011) that highlights the distribution of the moderately to highly preferred plant species (mean consumption score > 1.5 – see below) and/or plant species that yielded high nymph survival. The map identifies areas where particular plants are considered dominant species in plant communities (Pickard 1983; Sheringham et al. 2016). These distributions are conservative because there were no data indicating areas in which these species occur but are not considered dominant.

Data analysis

For the adult preference trials, we derived an averaging consumption score for each of the 15 plant species. This score was derived by first averaging the consumption scores over the two nights within each trial, and then average across the three replicate trials for each unique plant combination. This provided 14 values for each of the 15 plant species, and these data were used to calculate the average consumption score and perform the statistical comparison of leaf consumption across the 15 plant species used in the experiment. This variation in consumption scores was analysed using a Standard Least Squares linear regression model. Nymph preference trials were conducted only on the five plants species that the nymphs were known to consume and survive on, based on the nymph survival trials. The average consumption score for each of these five species was derived from averaging the eight consumption scores of each plant when paired with the other four plants (two replicates of each two-plant combination) and the variation was analysed using a Standard Least Squares linear regression model.

Variation in the number of surviving LHISI nymphs was assessed by first identifying the plant species treatments that had at least one surviving insect in at least one of the two replicates after the 26-day trial period. Differences in the number of survivors between plants in this sub-group of plant species were then analysed using a Standard Least Squares linear regression model, with host plant as a fixed effect. Variation in the weight of these survivors was analysed using the same model.

Relationships between plant consumption scores for the adult preference trials and (i) number of survivors and (ii) weight of survivors in the nymph survival trials were determined using a Standard Least Squares linear regression model. The same model was used to determine the relationship between the number of surviving nymphs and their average weight.

All data analyses were performed using statistical program JMP version 13 (JMP 1989-2007).

Results

Adult preference trials

In the adult preference trial, there was significant variation in the amount of plant eaten across the 15 species ($F_{14,209}$ = 49.82, p < 0.001). *Ficus macrophylla, S. fullagarii, B. inophylla, S. howinsula, and C. triplinervis,* were consumed in the greatest quantities, while *L. patersonius, S. australis, C. conferta, M. pustulatus, O. paniculata, and P. cissodendron* were consumed very little (Fig. 1).

Nymph survival trials

The survival of nymphs to 26 days varied across the host plants ($F_{6,13}$ = 8.03, p = 0.007). Of the seven plants on which nymphs survived, *L. patersonius*, *M. howeana*, *B. inophylla* and *S. fullagarii* had a significantly greater number of survivors than *F. macrophylla* and *S. howinsula* (Fig. 2a). Additionally, the weight of survivors differed between host plants ($F_{6,47}$ =

3.15, p = 0.012). The average weight of *B. inophylla* survivors was greatest and differed significantly from those on *M. howeana*, *S. howinsula* and *S. fullagarii* but not those on *C. triplinervis*, *L. patersonius* and *F. macrophylla* (Fig. 2b).

Nymph preference trials

The amount eaten by the nymphs in the nymph preference trials varied across the five plant species treatments ($F_{4,39}$ = 7.86, p < 0.001). *Syzygium fullagarii, M. howeana, B. inophylla* and *C. triplinervis* were all consumed in higher quantities than *L. patersonius* (Fig. 3).

Relationships between adult plant preferences and nymph survival and weight

There was no correlation between the adult plant consumption score and the number of surviving nymphs on the same host plant species, though there was a positive trend (r^2 = 0.23, $F_{1,14}$ = 3.82, n = 15 plant species, p = 0.07). Similarly, adult plant consumption score was unrelated to the weight of surviving nymphs on that same plant species (r^2 = 0.11, $F_{1,6}$ = 0.62, n = 7 plant species, p = 0.47). There was also no relationship between the mean weight and number of survivors across the different plant species on which at least some nymphs survived (r^2 = 0.14, $F_{1,6}$ = 0.84, n = 7 plant species, p = 0.40).

Vegetation map

The distribution on Lord Howe Island of five plants (*L. patersonius, S. fullagarii, C. triplinervis, M. howeana* and *F. macrophylla*) that were among the most preferred by adults and/or nymphs (preference score of > 1.5), or on which nymphs survived for 26 days is shown in Figure 4.

Discussion

This study provides several lines of evidence that provide optimism for the successful reintroduction of the LHISI to Lord Howe Island. The host plant preference trials revealed a number of plant species that were consumed by the insect and are abundant and/or widespread on the island. The nymph growth and survival trials revealed considerable variation across the 15 host plants examined, but nymphs were able to survive and grow on seven of these plants.

A key element of habitat suitability for reintroduction is the availability of adequate food resources. All of the plant species tested in this study are common on Lord Howe Island, particularly in the lowland area. The vegetation on Lord Howe Island has been extensively surveyed, allowing the construction of vegetation distribution maps that will be helpful in identifying appropriate release sites and potentially predicting the subsequent distribution of the LHISI on the island.

The vegetation distribution map derived for this study, whilst conservative as it highlights only areas where favoured species are dominant, illustrates that the LHISI can consume plants that are distributed widely across the island. For example, the preference of both adults and nymphs for *S. fullagarii*, suggests that much of the low to mid-altitude forest in middle of the island, where this plant is dominant, may be suitable for establishment of the stick insect. Lowland *F. macrophylla* forest may also be suitable for reintroduction, provided that adequate host plants are available for the younger stage of development. However, more specific information on the distribution of some preferred host plant species would be desirable to help select specific reintroduction locations. For example, *B. inophylla* was a preferred species for both adults and nymphs but as it is not considered a dominant species in any plant community it was not possible to map its distribution. Other factors would also need to be taken into account to identify reintroduction sites, such as land tenure and proximity to dwellings. Nevertheless, our findings were generally encouraging for the prospects of successful reintroduction, as suitable foraging habitat appears to be widespread.

Our experiments confirmed that the LHISI is polyphagous, with both nymphs and adults consuming, and nymphs surviving on, a variety of plant species from different plant Families. Polyphagy in the LHISI was not unexpected, as flightless stick insects typically have more generalised diets compared with the more specialised diets of stick insects with fully developed wings (Bragg 2001; Junker et al. 2008). However, while polyphagous insects may consume a wide array of plant species, these species are not indiscriminate (Schoonhoven et al. 2005). Similarly, this study demonstrated that the LHISI actively discriminates between host plants, as some species were rarely eaten in the adult preference trials. Nevertheless, polyphagy clearly increases the prospects of survive for the LHISI when returned to Lord Howe Island because it increases the likelihood of locating suitable host plants.

The location of oviposition is also associated with the capacity to fly: fully winged species often deposit eggs on particular host plants, whereas flightless stick insects frequently scatter their eggs on the forest floor (Bragg 2001). Many of the studies investigating host plant preference of herbivorous insects have examined the relationship between oviposition and feeding preference and offspring performance. These studies typically report positive correlations between offspring survival and plant preference of the ovipositing female (Craig and Ohgushi 2002; Gripenberg et al. 2010). However, similar to other flightless stick insects, the LHISI is thought to oviposit onto the forest floor. Lea (1916) describes regularly finding fresh and recently hatched eggs amongst frass at the base of trees where the LHISI takes daytime refuge in the hollows of tree trunks. Therefore, the first host plant species encountered by recently eclosed nymphs may not be the same species where the female was ovipositing.

Our study highlights the importance of investigating host plant preferences at different developmental stages. Both LHISI adults and nymphs consumed *S. fullagarii, B. inophylla, C. triplinervis, M. howeana* and *L. patersonius*, though among these the latter was least preferred. Whilst host plant preference trials provide vital information regarding the range of plants that the LHISI will consume, it is also necessary to examine the relative performance of the insect on the different plant species. For example, *F. macrophylla* would be regarded as a preferred host plant, based on the adult preference trials alone. However, in the nymph survival trials, less than 10% of individuals survived for the 26 days. The poor performance of the nymphs on *F. macrophylla* may be associated with the plant's tough leaves. Leaf toughness increases mandibular wear (Raupp 1985) and affects development of herbivorous insects, by decreasing growth rates and increasing developmental time through lower nutrient intake (Clissold et al. 2009). However, the size of the head and mandibles increase with each moult, thereby increasing mandibular power (Bernays 1986), with studies showing that later instars consume tougher leaves more frequently than early instars (Bernays and Chapman 1970; Malishev and Sanson 2015). This may explain the contrasting findings for nymphs and adults in relation to *F. macrophylla*, though the factors influencing host plant preference and ability of nymphs to survival and grow on different host plants were not a focus of this study.

The ability of the LHISI to survive on a plant does not necessarily imply a preference for that plant species. LHISI nymphs were unable to survive on eight of the 15 plant species they were offered, yet there was no correlation between adult host plant preference and number of surviving nymphs. A higher proportion of nymphs survived on *M. howeana*, relative to other plant species, but this species was not strongly preferred by the adults. Similarly, despite a high nymph survival rate on *L. patersonius*, this plant was among the least preferred plants in both the nymph and adult preference trials. The final weight of surviving nymphs varied between plant treatment groups, and the proportion of survivors was not associated with their mean weight. In other words, while individuals may survive on a particular host plant species, they may not necessarily achieve optimal growth. Nevertheless, there was some concordance between nymph survival and adult preference as nymphs were unable to survive on five of the six plants least preferred by adults. Combined, our experiments suggest that *B. inophylla* and *S. fullagarii* would be the most suitable host plants at any developmental stage of the LHISI. However, it is very likely that adults and nymphs may favour different hosts from among the variety of plant species available on Lord Howe Island.

This study contributes valuable information to aid a future reintroduction of the LHISI by demonstrating that this species can utilise a range of host plants that are widely distributed on the island and identifying some areas that may be suitable. Reintroduction of the LHISI to Lord Howe Island could occur within the next five years, with the rodent eradication program set to commence in mid-2018, pending final approvals. To aid in the identification of specific reintroduction sites, we recommend that additional vegetation surveys are conducted to improve resolution about the distribution of some preferred species, such as *B. inophylla,* and also identify locations where preferred host plants for both adults and nymphs are common. Prior to widespread reintroduction, we also recommend that trial releases be conducted into one or more large (rodent-proof if necessary) enclosures of potentially suitable forest on the island. This would allow behaviours, including host plant use and preferences, and rates of survival and population growth to be examined in a natural, but contained environment. Finally, we hope that this approach to assessing host plant use and preferences may be of value to other conservation programs that are investigating the reintroduction or introduction of herbivorous invertebrates.

Conflict of Interest The authors declare that they have no conflict of interest.

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Table 1 The biology of the 15 native plant species selected for the adult preference and nymph survival experiments on Lord Howe Island (Hutton 2010a, b).

Species	**Biology on Lord Howe Island**
Melaleuca howeana (Tea tree)	This small shrub to tall bush has small linear 10 mm x 2 mm leaves and is commonly found, particularly in open areas such as on the seashore, ridges and cliffs.
Celtis conferta subsp. amblyphylla (Cotton wood)	Common in the lowland forest, this tree reaches 16 m and has leathery elliptical 8 cm x 3.5 cm leaves.
Syzygium fullagarii (Scalybark)	A tall tree commonly found from sea level to approximately 400 m, reaching up to 20 m high with obovate 9 cm x 3 cm leaves.
Ficus macrophylla subsp. columnaris (Banyan)	Growing to 20 m high, this tree has broad-ovate 16 cm x 10 cm leaves, which are glossy on one side and contain latex. Commonly found in the lowlands, although sometimes to 500 m altitude.
Howea forsteriana (Kentia Palm)	A tall palm tree with a trunk that reaches 15 m. Leaves are 3-5 m in length and form a crown; leaflets are 30-60 cm x 3 cm. It is common in the lowlands but favours flat areas with sandy soils.
Olea paniculata (Maulwood)	Up to 14 m high, this tree has ovate-lanceolate glossy 7 cm x 3.5 cm leaves. Widespread and common in the lowland forests to 500 m.
Cryptocarya triplinervis (Blackbutt)	Reaching up to 16 m high, with somewhat glossy broad-lanceolate 7 cm x 3 cm leaves. This is one of the most commonly found lowland trees and can be located up to 400 m.

Lagunaria patersonius (Sallywood)	Growing to 15 m, this tree has elliptic-rhomboid 8 cm x 3.5 cm leaves with white scales on the underside. It is common in the lowlands.
Baloghia inophylla (Bloodwood)	Reaches 7 m high and has leathery and stiff round-elliptic 7 cm x 4 cm leaves. This tree is common on exposed ridges to 400 m high.
Drypetes deplanchei (Greybark)	Up to 16 m high with elliptic 6 cm x 3 cm leaves. It is one of the most commonly found lowland trees, but sometimes can be found up to 500 m.
Sophora howinsula (Lignum vitae)	Growing up to 13 m, this tree has compound pinnate leaves with up to 11 pairs of soft elliptic 20 mm x 8 mm leaflets. It has a scattered distribution on the hills in the lowland, but is locally common such as on Transit Hill.
Polyscias cissodendron (Island pine)	This tree grows up to 12 m and has 10-35 cm compound pinnate leaves, consisting of usually 11, 7 cm x 4 cm ovate leaflets. Relatively common from sea level up to approximately 400 m, usually in sheltered forest areas.
Smilax australis (Lawyer vine)	This climber has small prickles on its stem and stiff round leaves reaching 10 cm in diameter. Most likely is the most common vine within the lowland forest.
Trophis scandens subsp. megacarpa	A climber common in the lowland forests that has stiff oblong-elliptic 13 cm x 5 cm pointed leaves. In the same family, Moraceae, as *Ficus macrophylla subsp. columnaris*.

Microsorum pustulatus subsp. howensis	It has dark green glossy fronds 15-35 cm long, which are lobed with blisters on the top-side. This fern is widespread across the island, found from sea level to the tops of mountains.

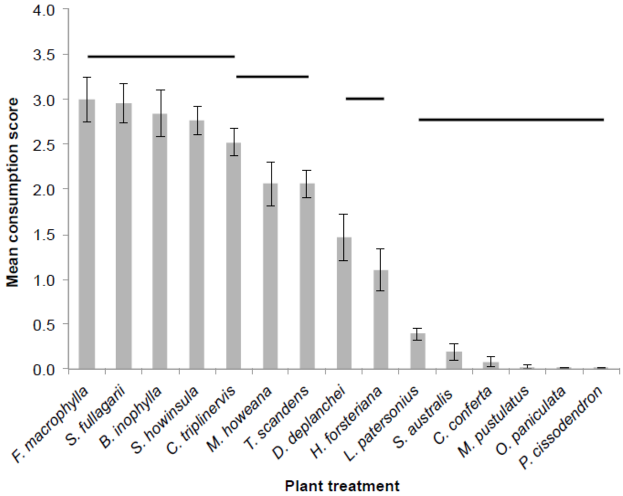
Figure Legends

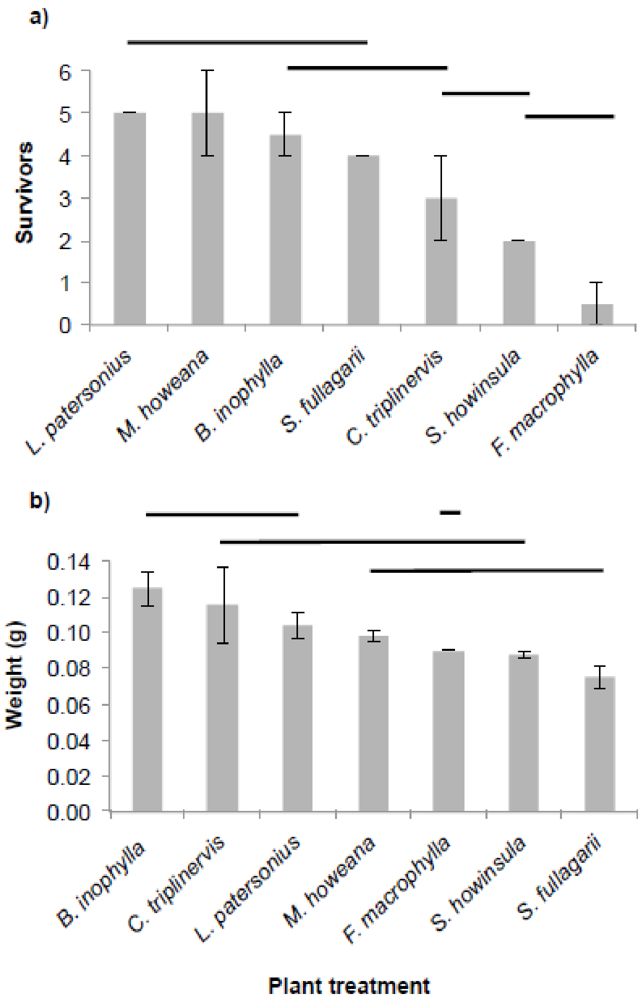
Fig. 1 Mean (±SE) leaf consumption score (none (0) to extensive consumption (4)) by adult LHISIs for each of the 15 Lord Howe Island plant species assessed in preference trials. The mean for each plant species was derived by averaging across the 14 consumption scores for that species when paired with each of the other 14 plants. Mean values not connected by a horizontal bar are significantly different ($\alpha = 0.05$).

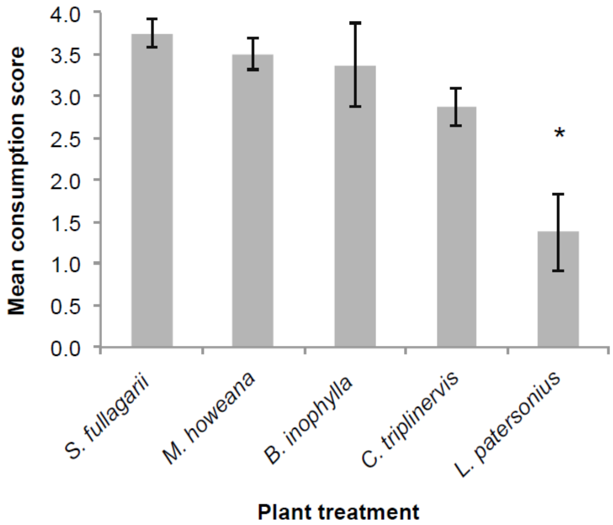
Fig. 2 Plant species treatment in relation to (a) mean number (±SE) and (b) mean weight (±SE) of nymphs surviving to 26 days. Only the seven plant species that supported at least one nymph for 26 days in at least one of the two replicates are shown. The mean number of surviving nymphs for each plant species is the mean across the two replicates (each replicate started with six individuals on day one). The number of individuals that contributed to the mean nymph weight for each plant species is twice the mean number of survivors for that plant species. Plants not connected by a horizontal bar are significantly different ($\alpha = 0.05$).

Fig. 3 The mean (±SE) leaf consumption score (none eaten (0) to extensive consumption (4)) by nymphs for each of the five Lord Howe Island plant species assessed in preference trials. The mean for each plant species was derived by averaging the consumption scores for that species across the total of eight replicates with the four other plant species (two replicates per species combination). * indicates a significant difference in consumption score compared to all other plant treatments ($\alpha = 0.05$).

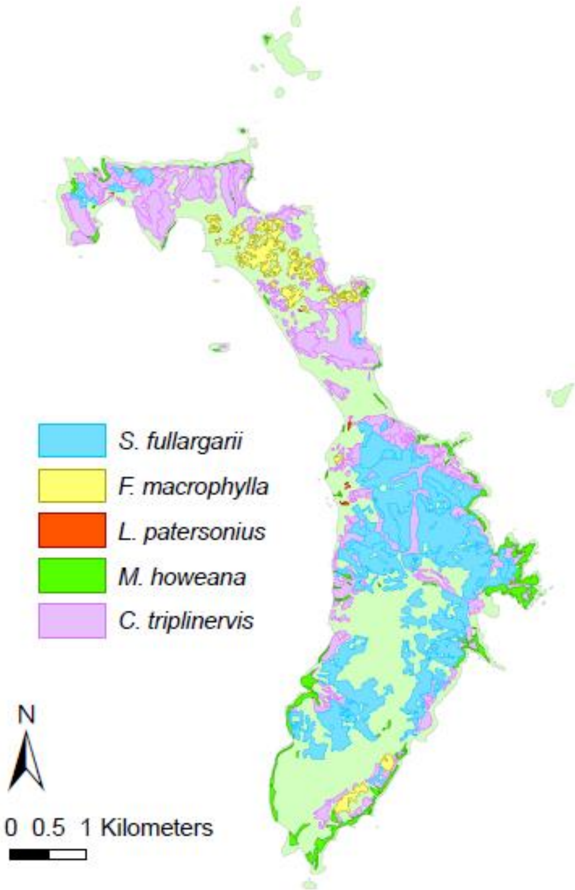
Fig. 4 Distribution on Lord Howe Island of host plant species preferred by adults and/or nymphs, or on which nymphs survived for 26 days. The distributions are conservative as they show only areas where these species are considered dominant in the community. The map was created from unpublished vegetation data supplied by the Lord Howe Island Board.


4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Mean consumption score
F. macrophylla
S. fullagarii
B. inophylla
S. howinsula
C. triplinervis
M. howeana
T. scandens
D. deplanchei
H. forsteriana
L. patersonius
S. australis
C. conferta
M. pustulatus
O. paniculata
P. cissodendron
Plant treatment


a)
Survivors
6
5
4
3
2
1
0
L. patersonius
M. howeana
B. inophylla
S. fullagarii
C. triplinervis
S. howinsula
F. macrophylla
b)
Weight (g)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
B. inophylla
C. triplinervis
L. patersonius
M. howeana
F. macrophylla
S. howinsula
S. fullagarii
Plant treatment



4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Mean consumption score
*
S. fullagarii
M. howeana
B. inophylla
C. triplinervis
L. patersonius
Plant treatment


S. fullargarii
F. macrophylla
L. patersonius
M. howeana
C. triplinervis
N
0 0.5 1 Kilometers