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The ant, the butterfly and the bulldozer

A summary of baseline data for the 'pale form' of the sand-dwelling sugar ant *Camponotus terebrans* associated with the critically endangered Arid Bronze Azure butterfly *Ogyris subterrestris petrina* and recommendations for recovery

Members of the Mukinbudin Conservation Group with DEC Senior Officer Andy Williams photographing an Arid Bronze Azure butterfly.

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Baseline data for the sugar ant (*Camponotus terebrans* 'pale form') associated with the critically endangered Arid Bronze Azure butterfly (*Ogyris subterrestris petrina*) and recommendations for recovery actions.

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Summary

The only extant population of the critically endangered Arid Bronze Azure butterfly *Ogyris subterrestris petrina* is within Barbalin Nature Reserve in the northern wheatbelt of Western Australia. This report describes the monitoring program established for both the butterfly and the 'pale form' of the sugar ant *Camponotus terebrans.* The butterfly has an obligate association with the ant and hence its survival depends on the existence of large ant colonies. A clearing application within this remnant, currently under review, was the incentive for the monitoring program. The aim of the program is to better understand the habitat required for *C. terebrans* persistence and to detect any signs of decline of the ant colonies. Nests were mapped using transects traversing the reserve. Proximity to disturbance and the presence of eucalypts, principally Gimlet (*Eucalyptus salubris),* were critical to the presence of *C. terebrans* in the reserve. The largest eucalypts, measured by diameter at breast height, were less commonly associated with *C.terebrans.* We propose hypotheses for these results and make recommendations for ongoing research and recovery actions for the conservation management plan for the species.

Introduction

This report collates and analyses baseline data of a monitoring program established in April 2009 for the 'pale' or 'Goldfields' form the sugar ant *Camponotus terebrans*. This species is closely associated with the Critically Endangered Arid Bronze Azure Butterfly *Ogyris subterrestris petrina*. Until the rediscovery in 2006, it was unknown whether this subspecies was extinct, given that it had not been seen despite numerous surveys over the previous 13 years (Williams & Williams, 2005). The threats posed to this butterfly by a proposal for vegetation clearing in Barbalin Nature Reserve (BNR) have been documented previously (Williams & Williams, 2008). However, in summary, the area currently under application for clearing is within the only known breeding area of *O. s. petrina* (Fig. 1, Appendix). The impact has the potential to disrupt the breeding cycle of the butterfly and cause extinction of the colony. The permit has not been approved at present and is under review by the Native Vegetation Conservation Branch of the Department of Environment and Conservation. This remnant holds the only extant population of the butterfly. In order to reproduce, the Arid Bronze Azure butterfly has an obligate association with the pale form of *C.terebrans*. The larvae are obligate myrmecophiles, feeding on or being fed by the ants and living entirely within the ant's nest during their development (Field, 1999). The ants also protect the butterfly larvae from predators, while the ants are thought to be rewarded with secretions produced by the larvae (Williams, 2005). Thus the survival of this butterfly depends on the continued existence of strong colonies of its host ant (Williams et al, 2008). Large numbers of ants are required to support this butterfly. Similar ant-dependent species have ratios of ants to butterflies as high as 500:1 (Griebeler & Seitz, 2002). Establishment of a monitoring program at BNR to detect signs of decline of *C. terebrans* ant colonies and to better understand the environmental variables required for their persistence, was recommended as one of the critical recovery actions for the conservation plan for this species (Williams et al, 2008).

Methods

Study Site

Barbalin NR is situated in the northern wheatbelt of Western Australia, approximately 11 km west of Mukinbudin and 260km north-east of Perth at (S35°51.792′, E140° 27.532′). Remnant vegetation in this region is dominated by eucalypt woodland and the climate is semi-arid with an average annual winter rainfall of less than 350mm. The reserve is roughly square in shape with an area of 182ha.

Monitoring Design

A subset of the *C. terebrans* ant colonies were sampled at this site. A series of 10 transects that traversed the site was established with a GPS: 8 with a north/south orientation and 2 east/west (Fig 1). Data collection points (DCP) along the vertical transects were at 50 metre intervals for the first 300m metres then at 100 metre intervals. DCPs on the east/west transects were spaced at 100 metre intervals. The initial 50 metre spacing on the north/south transects and the implementation of two horizontal transects were designed to increase the number of DCP in the area where *C. terebrans* was known to be most numerous. This was based on prior knowledge of the site from a brief visit in 2007 and that *C. terebrans* are known as disturbance specialists (Hoffman and Anderson, 2003). The area with a large number of nests is located in the northern section of the reserve adjacent to the greatest disturbances, the Wyalkcatchem-Southern Cross road and railway (Fig 1).

Data Collection

Sampling was conducted in autumn (April) with typically cool mornings and clear warm days with a maximum temperature of 29-33C. At each data collection point several habitat variables were recorded, together with the presence or absence of *C.terebrans*. Presence or absence was verified by actively searching at the base of the nearest tree to the DCP, where the usually obvious nest entrances are found. The nearest tree was regarded as the closest tree to each DCP, often within 1-10 metres. *C. terebrans* was sometimes observed above ground on the tree trunks or limbs. If no specimens were observed, then the sand surrounding the entrance holes was carefully agitated which usually determined presence rapidly. Agitation was sometimes required since a number of species of *Camponotus* are nocturnal (Holldobler and Wilson, 1990) and retreat further under ground during the heat of the day (Williams & Williams, 2005). If the nests of any other ant species were present they too were recorded. The species of tree, number of stems and diameter at breast height (dbh) of the largest stem were recorded. The GPS coordinates were recorded and the tree was tagged with a corrosion resistant, metal, numbered tag. The GPS coordinates were imported into spatial software (Arc GIS 9.1) for analysis.

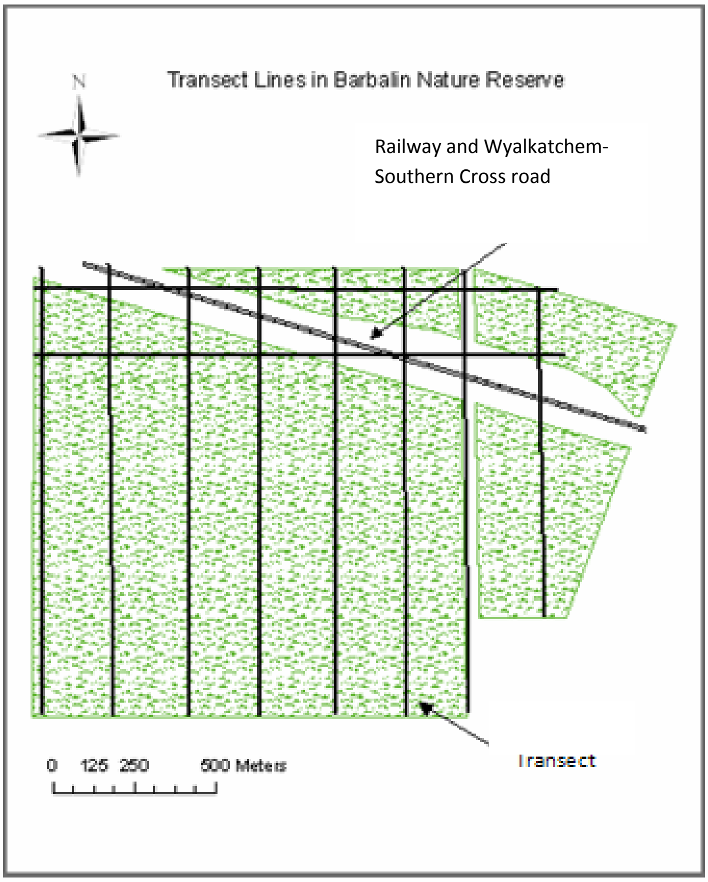

Figure 1. Monitoring design in Barbalin Nature Reserve for *C. terebrans* and *O. s. petrina* showing the 10 sampling transects.

Results

Data Collection points

The total number of DCPs on the transects was 168. At 3 DCPs there was an absence of data as the area was cleared and the nearest tree to record information from was the previous data collection point. There was also a single location where the horizontal and vertical transects met at the same DCP. *C. terebrans* was present at 54 (32%) of DCPs in the reserve (Fig 2).

Disturbance

The majority (85%) of DCPs with ants present were grouped in the north of the reserve within 250 metres of the railway and road. Only 2 DCPs with ants present were recorded outside of the area of this disturbance, and not associated with other obvious disturbances such as tracks, firebreaks or internal roads (Fig 2).

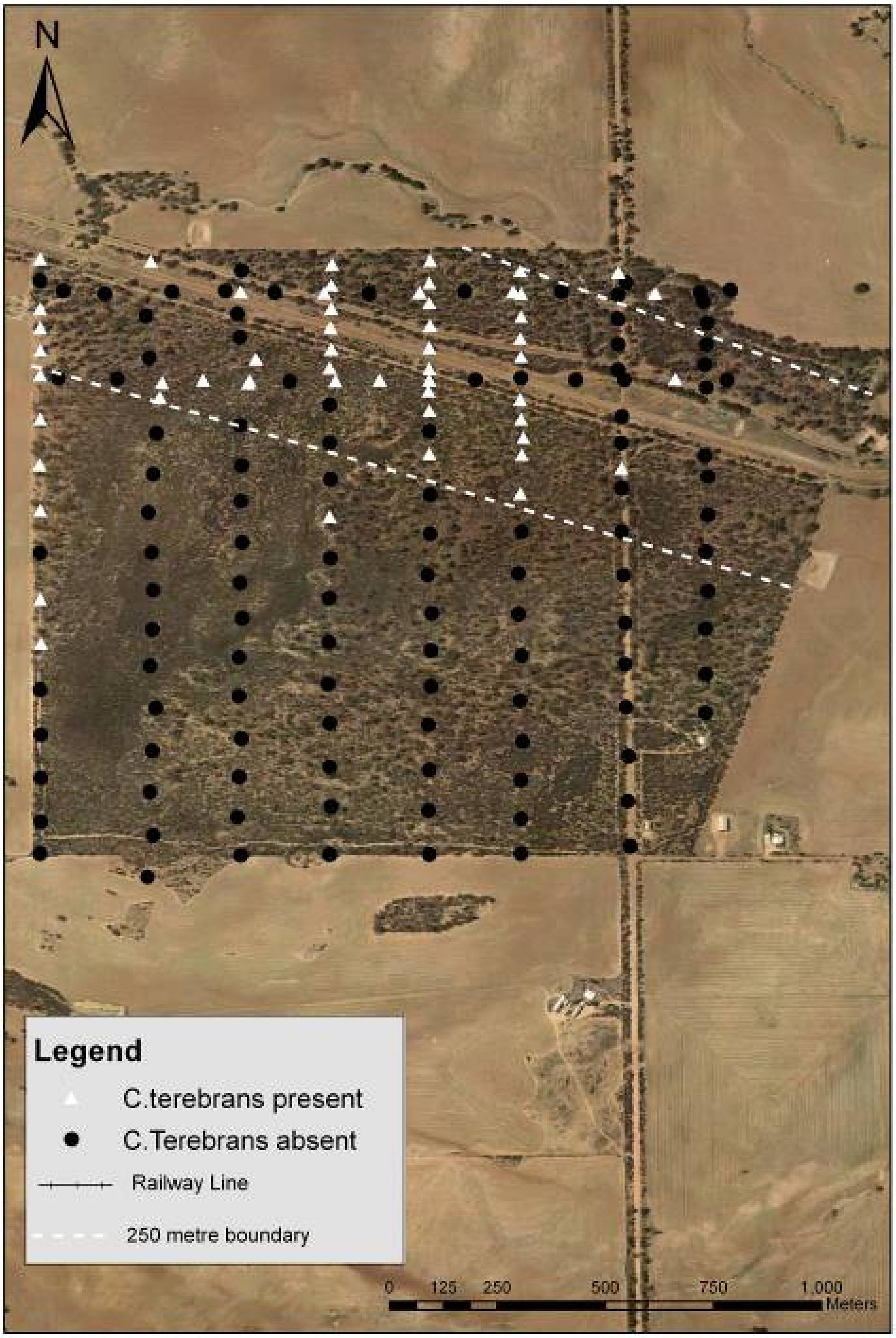

Figure 2. Occurrence of *C. terebrans* in Barbalin Nature Reserve. The area between the dashed lines is considered the 'area of disturbance' around the road and railway line.

Vegetation

At locations where disturbance was present but eucalypts absent, there was a corresponding absence of *C. terebrans* ants. Nests of *C. terebrans* were only found at the base of eucalypts: predominantly (83%) Gimlet *Eucalyptus salubris,* occasionally (9%) Wheatbelt Wandoo *E. capillosa capillosa* and rarely (4%) Salmon Gum *E. salmonophloia.* The majority of Gimlet and Salmon Gum were found in the northern section of the reserve within the 250m 'area of disturbance', whereas Wheatbelt Wandoo was more widespread (Fig 4). A small fraction of eucalypts (4%) could not readily be identified. There are large thickets of *Allocasurina campestris* in the southwestern section of the reserve (Fig 2, the dark patches) where the ants were absent. The most commonly encountered eucalypts were Gimlet (49%), Salmon Gum (13%) and Wheatbelt Wandoo (7%). The other commonly encountered plants were Acacia (9%) and Allocasurina (6%) (Fig 3).

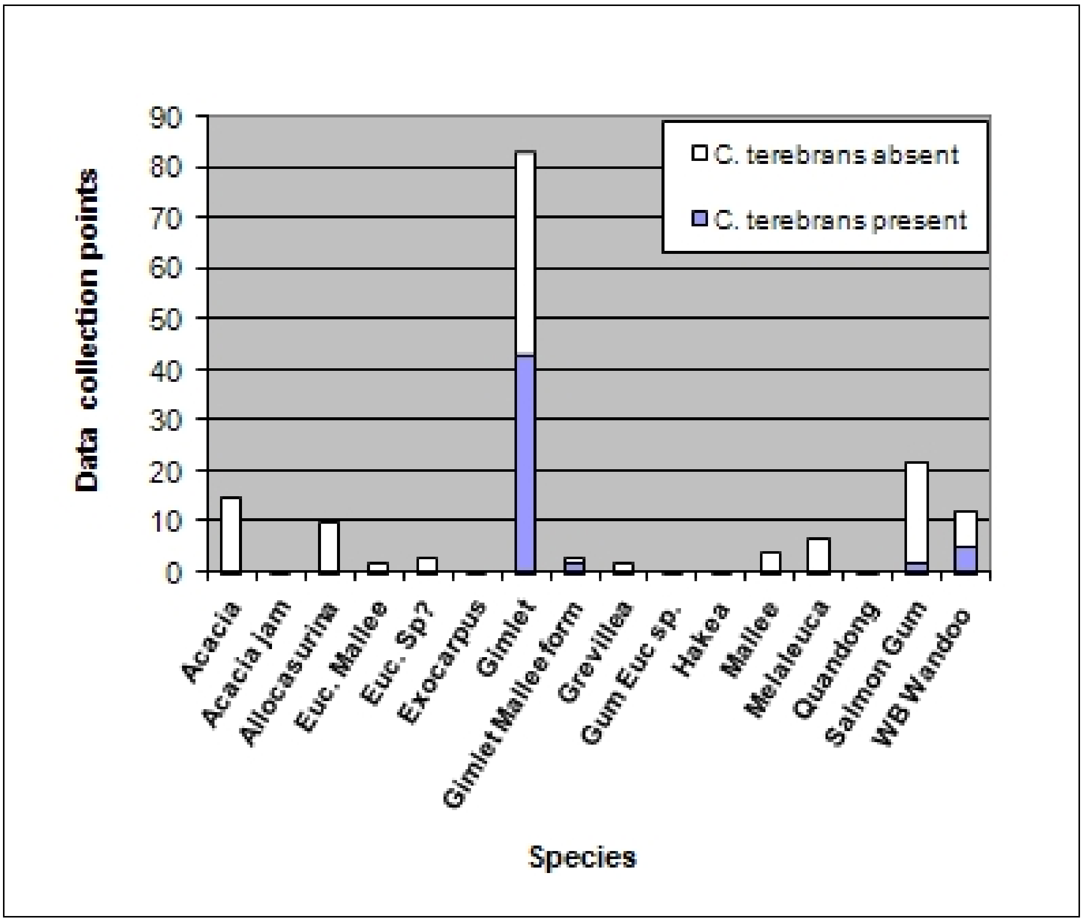

Figure 3. Presence of *C. terebrans* and associated flora recorded at 168 data collection points in Barbalin Nature Reserve.

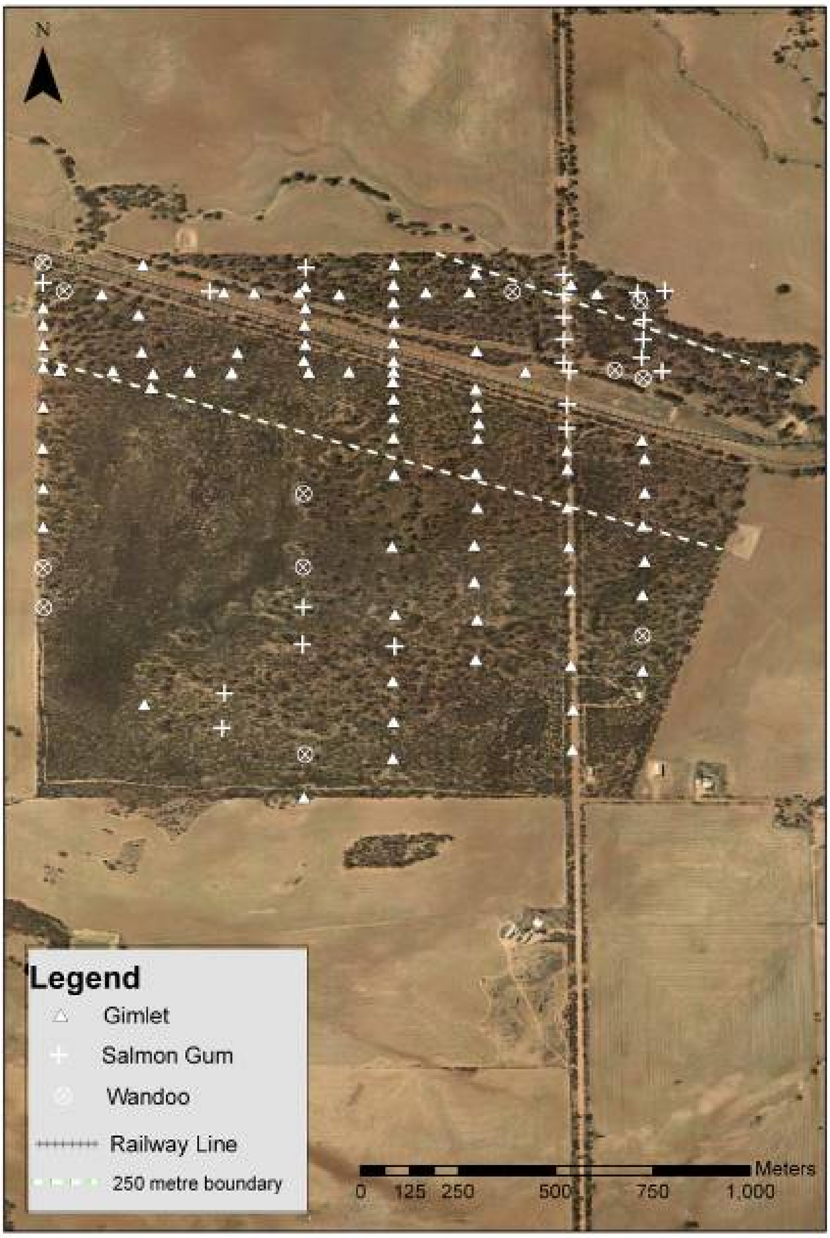

Figure 4. The distribution of eucalypts in Barbalin Nature Reserve.

Diameter at breast height (dbh)

From observations and a small sample*, C. terebrans* ants were most commonly associated with eucalypts between 0-40cm (Fig 5). This association was strongest below 20cm and declined with increasing dbh. However as a proportion they were most strongly associated with eucalypts between 41- 60cm. The average dbh of Salmon Gum and Wheatbelt Wandoo in the reserve were above the 40cm threshold, whereas the average dbh of Gimlet was 25cm (Table 1). Salmon Gums and Wheatbelt Wandoo made up 89% of trees with the largest diameters (>60cm).

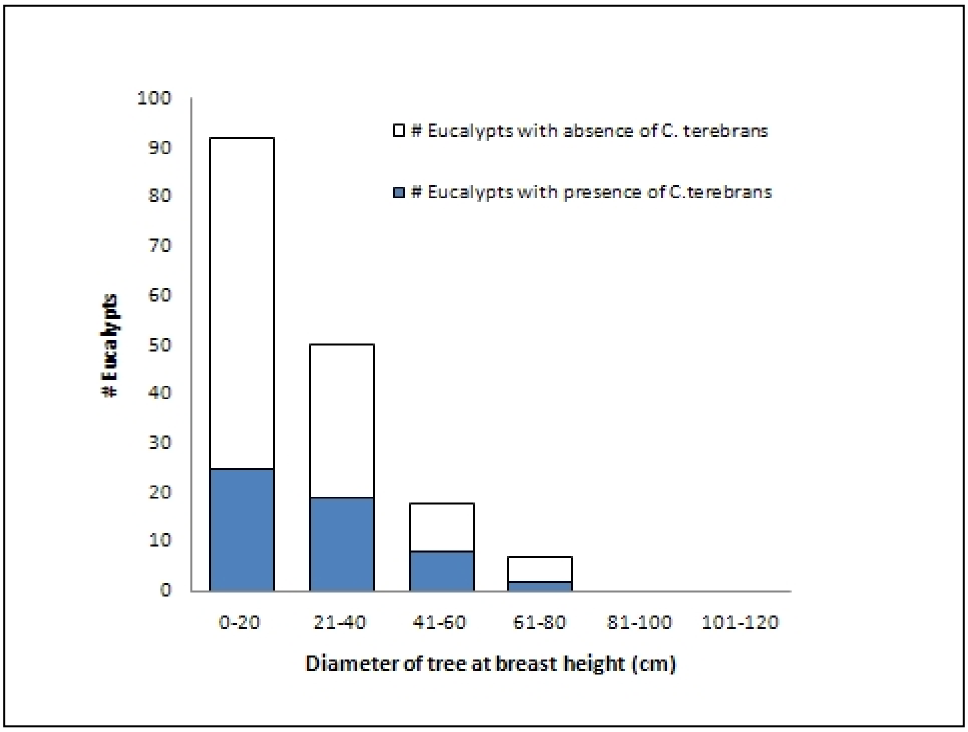

Figure 5. Presence of *C. terebrans* and corresponding diameter at breast height of the associated eucalypts.

Table 1. The average diameter at breast height (cm) of 3 eucalypts in BNR.

Species	Average Diameter at Breast height (cm)
Gimlet	25
Salmon Gum	42
Wheatbelt Wandoo	44

Diameter at breast height (dbh) of Gimlet

For Gimlet, ant presence was most frequent between 10 - 50 cm dbh peaking at 15-16cm dbh (Fig 6). Again the sample size was small.

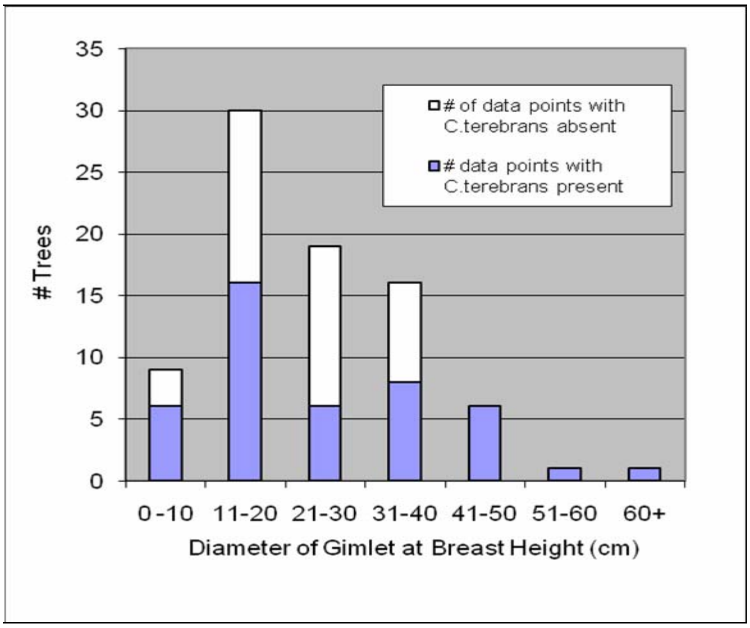

Figure 6. Presence of *C. terebrans* and diameter of Gimlet species at breast height.

Number of stems

Only 9 mallee eucalypts were recorded and of these only one was associated with *C. terebrans* presence. The ant's presence was therefore recorded most often with single stemmed (at breast height) eucalypt trees. However, cumulatively there were equal numbers of multiple and single stemmed trees with presence recorded (Fig 7).

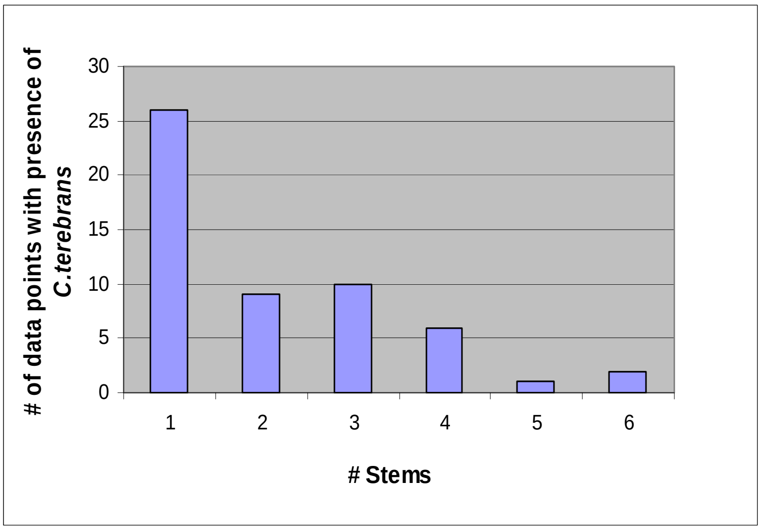

Figure 7. Presence of *C. terebrans* nests and the number of stems of associated tree.

Discussion

Proximity to disturbance and the presence of eucalypts, principally Gimlet, were critical to the presence of *C. terebrans* in BNR. *C. terebrans* is one of the first ant species to colonise disturbed sites (McArthur et al, 1997) and the highest concentration of *C. terebrans* colonies in BNR was within the area of significant disturbance consistent with this observation. Only 2 of 54 records of *C. terebrans* were in areas where there was no obvious disturbance such as firebreaks, tracks, roads or the railway line.

Though apparently strongly correlated, disturbance alone was not enough to ensure presence of *C.terebrans*. Data collection points situated where there is obvious disturbance but lacking in specific eucalypts also lacked *C.terebrans. C. terebrans* was exclusively associated with 3 eucalypts in BNR, principally Gimlet. The reason for this association with Gimlet is currently unknown. We propose two hypotheses. Firstly Gimlet could have more favorable root architecture for the ant's nest. However, no research has been conducted into differences in root architecture between Gimlet, Wheatbelt Wandoo and Salmon Gum (Pieter Poot, DEC Science Division, pers comm). Secondly the bias may be related to variation in the invertebrate fauna present on Gimlet that may be absent or in lower numbers on other eucalypts. Species of the suborder Sternorrhyncha (which includes the groups known commonly as jumping plant lice (Psyllids), aphids and scale insects) are a key resource for many ants including *Camponotus* species (Del-Caro & Oliveira, 1993; Moore, et al, 2003; Kondo & Gullan, 2004). The ants consume these insects and/or their honeydew, through 'farming' of the sugary excreta, in a mutualistic relationship whereby the ants provide protection from predators (Gullen, 1997; Delabie, 2001; Moore & Lohman, 2003). Some of these insects such as those of the Coccoidea are known to be 'host specific' to eucalypts (Janet Farr, DEC Science Division, pers comm) and possibly to Gimlet. If these wheatbelt eucalypts associated with *C. terebrans* indeed have unique insect assemblages, then there will also be energetic consequences for the ant. The preference for Gimlet may suggest an energetic advantage through predation and/or farming of these insect herbivores over those on other eucalypts. Further research is required to confirm this. Although it is unknown whether *C. terebrans* is entirely nectivorous, a study of a large foraging nectivorous ant illustrated that the high energetic costs for this feeding strategy compared with seed and insect prey foraging, leads to sensitivity to foraging costs (Fewell et al, 1996

The largest eucalypts were less commonly associated with *C.terebrans.* However a larger sample size is required to confirm this as few larger trees were in the sample. In a few areas of dense ant colonies close to disturbance it was observed that a number of large Salmon Gums, Wheatbelt Wandoo and Gimlet were without ant nests while ants were present on all of the smaller trees. Since Gimlet made up a high proportion of measured trees with *C. terebrans* ant presence, and the average dbh of Gimlet was less than Wheatbelt Wandoo and Salmon Gum, this trend is expected. This suggests that either *C. terebrans* has a preference for younger (smaller) eucalypts or is specifically favouring Gimlet, which on average is a smaller species. Within Gimlet the results are less conclusive. Results show an apparent association between the small to medium sized Gimlet (a dbh of 10-20cm) and *C.terebrans.* However, this may be a consequence of the high number of Gimlet trees of this size range in the reserve. Gimlet with a dbh of 10-20cm, had an almost an equal number of trees with and without *C.terebrans.* Since dbh is strongly correlated with tree height in eucalypts (Coppen, 2002) the preference for smaller trees could be for reasons of foraging energetics (Heteric, Environment and Biology Dept, Curtin University, 2009 pers comm.) That is, taller trees require longer foraging distances, incurring higher energy costs. A component of the mutualistic relationship between some ants and their sap-sucking associates is the transportation of them below ground for protection against cold weather in temperate areas (Poole & Poole, 1963). As a number of species of *Camponotus* are nocturnal and retreat further under ground during the heat of the day (Williams & Williams, 2005), *C. terebrans* may also carry their symbiotic associates. In South Australia coccids shelter in *Camponotus* nests during the day, emerging to suck on the tree sap by night (Moore & Lohman, 2003). Either way there are obvious transportation costs living on taller eucalypts than shorter. Plant nitrogen may also decline with plant age (Mattson, 1980) and soluble nitrogen levels will be particularly high at times of leaf growth (McNeil & Southwood, 1978). Hence younger or smaller trees may have a greater capacity to provide desired quantities of energy and nitrogen levels to insect herbivores than larger, more mature specimens. If correct, there would be a flow-on energetic benefit to *C.terebrans,* coupled with a shorter foraging distance. It can also be expected that younger trees would be more likely associated with disturbance and perhaps *C. terebrans* decline when the stand increases in height and maturity. Again, further research is required.

Presence of *C. terebrans* colonies under single or multiple stemmed trees in BNR concurs with what is already known of this genus, that it can be found beneath a range of tall vegetation including mallee (Shattuck & McArthur, 2002). Prior to the discovery of this population in BNR the previously known population near Kalgoorlie was located in mallee-dominated woodland on undulating country (Williams &Williams, 2005) which is different from the tree-dominated plains of BNR.

A key unknown is why areas of similar habitat surrounding BNR and up to 60km away have not returned positive results for presence of this sugar ant and hence the possibility of occupancy by the Arid Bronze Azure butterfly. These areas have what appears to be the principal variables required for this ant's presence: eucalypt woodland including Gimlet with a similar understorey, soils and presence of disturbance. Once all the biological requirements for *C. terebrans* are determined there will be better targeting of sites to search for new butterfly populations. Depending on the outcomes of further survey and research, translocations of the ant and/or butterfly from BNR to other suitable sites might be a conservation strategy. Human intervention may be required if no other new populations are found. This is due to the limited ability of the butterfly to disperse in this fragmented landscape. Typical dispersal distances are not known for females of *O. s. subterrestris*, but a study of a similar lycaenid butterfly in south-west Australia, *Hypochrysops halyaetus*, found that of over 1000 marked individuals the longest dispersal distance was 810 m for one female, but averaged less than 200 m (M. R. Williams, unpublished data). If left to disperse themselves the only available habitat within their range is at Wundolin Nature Reserve, adjacent to BNR. Although *C. terebrans* was found on the boundary of Barbalin NR and Wundolin NR, a thorough search of Wundolin NR revealed a lack of the ants. Perhaps this remnant is not suitable habitat in which case the Arid Bronze Azure Butterfly, may be truly marooned.

Recommendations for ongoing research and recovery actions

- The monitoring program for *C. terebrans* in BNR has only recently been established. Further surveys will assist in confirming the results and test hypotheses generated from the baseline data in this report. Surveying at different times of year will also measure seasonal variation in activity levels of the ant.
- Ongoing surveys for new populations of *C. terebrans* and *O. s. petrina* is vital. Areas close to Barbalin Nature Reserve have already been surveyed (Williams et al, 2008) however it would be useful to conduct:

  (i) A closer investigation into the vegetation and disturbance characteristics at Lake Douglas (near Kalgoorlie), the last known location of *O. s. petrina* prior to the discovery at BNR. This would allow comparisons of habitat variables with those at BNR.

  (ii) Targeted surveys for known populations of the pale form of *C. terebrans in WA* (from vouchered specimens).
- Other research could include: (i) An investigation into tree condition to measure any impact on the host tree from the ant colonies and their insect herbivore associates; (ii) Additional data such as vegetation and soil mapping may be useful to obtain a broader understanding of the habitat requirements for *C. terebrans*; and (iii) Research into *C. terebrans* association with species of the suborder sternorrhyncha.
- A Recovery Team and Recovery Plan should be established immediately to address the threats posed to this critically endangered butterfly. This should include actions to:

  (i) Provide information and advice, including maps, regarding the general location and management of both *C. terebrans* and *O. s. petrina* to landholders, land managers, community groups and other authorities;

  (ii) Provide rabbit control as *C. terebrans* nests may be negatively affected by grazing pressure and/or rabbit disturbance;

  (iii) Train relevant Department of the Environment and Conservation staff, community groups, local government authorities and other relevant parties, in the identification and seasonal activity of the butterfly and sugar ant; and

  (iv) To identify priority recovery actions so that they are ready for implementation, as resources become available.
- Translocations may be a possibility.

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Appendix

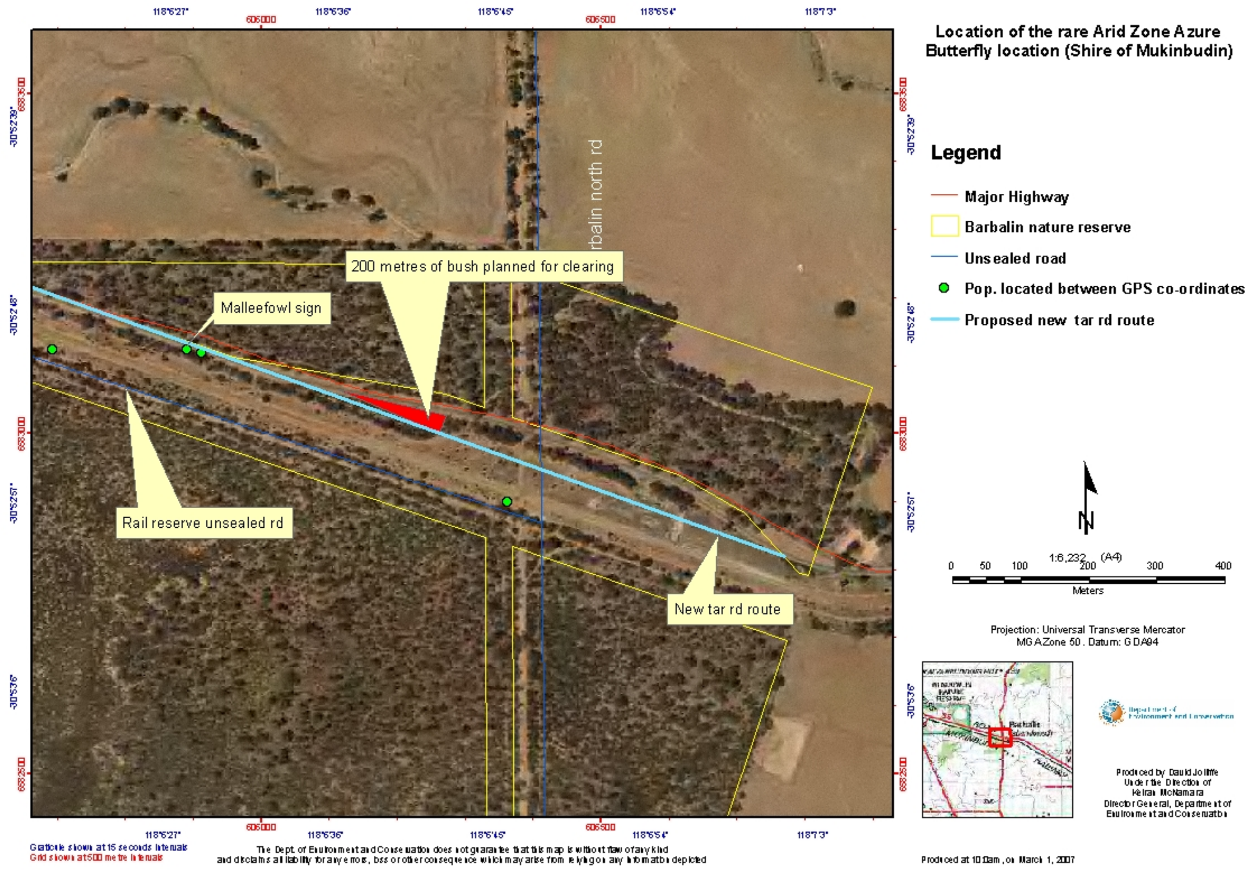

Figure 1. – Area of remnant vegetation under application for clearing adjacent to Barbalin Nature Reserve.