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Tropical Hypogeous Fungal Sporocarp

Distribution in Time and Space.

Implications for an Endangered Specialist

Mycophagous Marsupial, *Bettongia tropica*.

Thesis submitted by

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in November 2008

For the degree of Doctor of Philosophy

in the School of Marine and Tropical Biology

James Cook University

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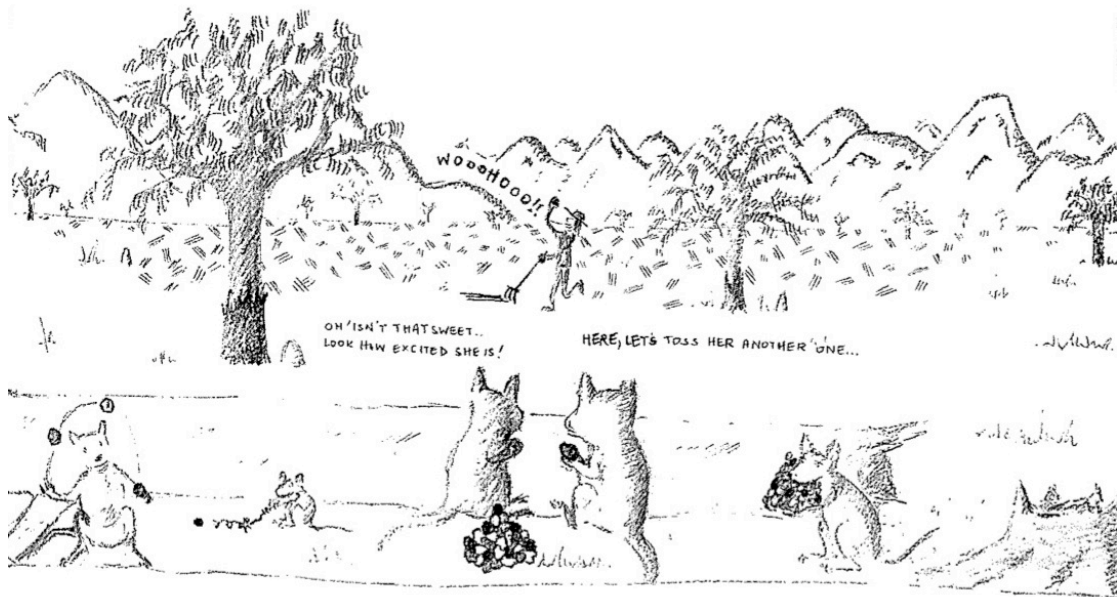
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OH ISN'T THAT SWEET...
LOOK HOW EXCITED SHE IS!

HERE, LET'S TOSS HER ANOTHER ONE...

THE BETTONGS WATCHED AS SANDRA SEARCHED AND SEARCHED FOR TRUFFLES...

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LIST OF PUBLICATIONS

Thesis Chapter Two

Abell, S. E., P. A. Gadek, C. A. Pearce, and B. C. Congdon. 2006. Seasonal resource availability and use by an endangered tropical mycophagous marsupial. *Biological Conservation* **132**:533-540.

Thesis Chapter Three

Abell, S. E., P. A. Gadek, C. A. Pearce, and B. Congdon. 2008. Reproductive cues and reproductive strategies of tropical hypogeous fungi. *Oecologia* (Berlin) **in review**.

Thesis Chapter Four

Abell, S. E., P. A. Gadek, C. A. Pearce, and B. Congdon. 2008. Nutrient levels determine the spatial distribution of hypogeous fungal sporocarps. *Ecosystems* **in review**.

Thesis Chapter Five

Abell, S.E., Gadek, P.A., Congdon, B., Pearce, C.A., 2009. Micro-spatial distribution of ectomycorrhizal fungi in tropical ecotonal sclerophyll forest. *Mycologia*. manuscript in final preparation.

Other publications in preparation

Abell, S.E., Gadek, P.A., Trappe, J.M., Lebel, T., 2009. New hypogeous fungal species descriptions and records. *Aust. J. Bot.* manuscripts in preparation.

Barker, M., Gadek, P.A., Congdon, B. and **Abell, S.E.**, 2009. Individual body condition response to seasonal availability of resources by an endangered tropical fungivore. *Wildlife Research*. manuscript in final preparation.

Mathams, S., **Abell, S.E.**, Latch, P. and Winter, J., 2009. Potential reintroduction sites for the endangered northern bettong, *Bettongia tropica*, determined by fungal and plant resource availability. *Wildlife Research*. manuscript in final preparation.

THESIS ABSTRACT

This thesis examines the relative importance of abiotic and biotic factors in determining the temporal and spatial distribution of tropical hypogeous fungal sporocarps along an altitude gradient of ecotonal sclerophyll forest. The implications of the fungal distribution on the habitat restriction within this ecotonal forest for an endangered specialist mycophagous marsupial, *Bettongia tropica* Wakefield, were subsequently investigated.

Fungal availability was quantified in the Early-Wet, Late-Wet, Early-Dry and Late-dry seasons within known *B. tropica* habitat in seven surveys over a period of two years. A total of eighteen sites within three vegetation types, including wet sclerophyll forest, *Allocasuarina* forest and *Eucalyptus* woodland, were examined using the time standardised raking method, in Far North Queensland, Australia.

Bettongia tropica is thought to be restricted to habitats where seasonal availability of hypogeous fungi, their principal food resource, remains high. In the first year of sampling a relationship was found between precipitation and fungal availability. The abundance of hypogeous fungi was significantly lower in the late dry season. Fungal availability correlated strongly with the seasonal rainfall pattern determined from 74-year monthly means. *Alloteropsis semialata* R.Br. (cockatoo grass) use by bettongs increased significantly during the period of low fungal availability. *Bettongia tropica* appear to be restricted to habitats where seasonal availability of hypogeous fungi, in synchrony with the availability of critical grass resources, remains high.

Temporal fruiting and availability of ectomycorrhizal hypogeous fungal species has previously been linked with both temperature and moisture (season) in temperate northern and southern hemisphere ecosystems. In contrast, the first year of data suggested that precipitation may be the sole factor influencing fruiting and diversity in tropical ecosystems. This hypothesis was tested using the data from all seven surveys. Season or temperature did not appear to be associated with fruiting of tropical hypogeous fungi. Instead, highly significant correlations between precipitation and abundance as well as biomass of sporocarps were detected. Precipitation also correlated with species richness and significantly influenced hypogeous fungal taxonomic assemblage. Availability of moisture appears to be the sole factor influencing the temporal distribution of fruiting and diversity of hypogeous fungi in this tropical ecosystem.

Spatial patterns of animal and plant diversity are used to infer mechanisms underlying community composition. Species distributions, associated with latitude and altitude gradients, are often positively correlated with moisture availability. Fungal taxonomic assemblage did not differ between the three contiguous vegetation types. Counter-intuitively, less fungal productivity occurred in one of the wettest forest types; wet sclerophyll forest. Higher sporocarp abundance and biomass were found in the *Allocasuarina* forest that had equivalent soil moisture levels. Fungal abundance and biomass appeared to be reduced by high inorganic nitrogen and phosphorous in the wet sclerophyll forest, while the effect of high nitrogen was counteracted by low phosphorous in the *Allocasuarina* forest.

The effects of soil phosphorous as well as other environmental variables on hypogeous fungal availability and richness were examined further at the micro-spatial scale of site. As predicted, negative correlations between phosphorous and fungal availability were also observed at this finer scale. However, phosphorous levels could not entirely explain the spatial patterns of fungal richness observed. Positive correlations were found for the mean number of *Allocasuarina* stems with the number of fungal genera as well as species. The most plausible explanation for the mean number of fungal species was an interactive effect between the number of *Allocasuarina* stems and a positive correlation with altitude. As well as strengthening the evidence that phosphorous levels affect the availability of hypogeous fungi, analysis at the micro-spatial scale allowed new information about fungal richness to be uncovered. An increase in host monodominance appears to increase fungal richness within this ecotonal sclerophyll forest.

These findings help to explain the habitat restriction of *B. tropica* within wetter sclerophyll habitats, increasing the temporal availability of their principal resource hypogeous fungi. The spatial distribution of fungal, as well as other important food resources, also explains *B. tropica* spatial habitat restriction within *Allocasuarina* forest and *Eucalyptus* woodland. The habitat restriction of the endangered *B. tropica* within a narrow band of ecotonal sclerophyll vegetation along the western margin of Wet Tropical rainforests in North Queensland Australia, can be attributed to the availability of their critical food resource hypogeous fungi, in both time and space.