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Front Cover: Australian Brush-turkey *Alectura lathami* on its mound. Photo by G. Fulton

Brush-turkey incubation mound withstands partial inundation by floods

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Abstract

An Australian Brush-turkey *Alectura lathami* incubation mound built on the edge of a creek avoided destruction from the 2022 floods in Brisbane, Queensland, despite being partially inundated when the creek flooded. The mound was constructed around a group of saplings that probably helped to anchor it to the ground while a similar-sized mound of woodchips was washed away. The male owner continued to maintain the incubation mound for at least a year after the flood subsided. Although the eggs were not monitored, it is possible that embryos in the early stage of development survived due to their high tolerance of suboptimal temperatures, low oxygen demand and the presence of a water-repellent cuticle in the egg shell.

Introduction

The Australian Brush-turkey *Alectura lathami* is a megapode that incubates its eggs using heat from microbial decomposition, which is generated within the core of its nest mound by decaying plant material and soil (Jones 1988). The internal temperature of the mound is held constant by the addition of detritus or by opening the mound as required (Jones 1988). Females dig holes to lay the eggs but construction and maintenance including temperature control of the mound is undertaken solely by the male (Fleay 1937; Jones 1988). The mound serves as a continuous incubator; thus eggs can be laid while others develop and hatch (Seymour 1991). The incubation mound is constructed by raking litter (branches, leaves and soil) onto a suitable site, which is typically under tree canopies that provide the litter and has other vegetation present that help anchor the mound (Jones 1988). Adult Brush-turkeys roost in trees (Jones 1990) and would not be threatened by short-lived flooding.

Some authors have called for investigations into inundation of megapode incubation mounds suggesting they may be vulnerable to the effects of climate change (Radley *et al*. 2018). Coastal fringes and islands in the Pacific are considered vulnerable to increased sea-level rise and storm intensity due to climate change (Nicholls & Cazenave 2010). In particular, megapode mounds positioned on beaches and other coastal habitats are at risk of inundation due to amplified tidal activity and increased wave action (Nicholls & Cazenave 2010). Such inundation at Bramble Cay, a coral cay situated in the Gulf of Papua, caused the first extinction of a mammal, the Bramble Cay Melomys *Melomys rubicola*, due to human-induced climate change (Fulton 2016, 2017). At Oxley Creek Common, Brisbane, counts of birds before and after two separate floods (in 2011 and 2022) that entirely inundated the area showed negligible long-term impact on most terrestrial species, except a few ground-dwelling and ground-nesting species, e.g. Brown Quail *Synoicus ypsilophorus* and Fairy-wrens *Malurus* spp. (Possingham 2023). Smith & McAlpine (2014) modelled future precipitation and flooding events in the Brisbane River catchment, and predicted an increase in extreme rainfall events, which overall would be offset by lower annual total

precipitation. Nevertheless, short-term local flooding could still impact some birds such as the Brush-turkey on a more local scale.

This note describes a Brush-turkey's incubation mound that withstood destruction from partial inundation during widespread flooding of the Brisbane River catchment, and considers whether eggs within this partially inundated mound could survive such impact.

Observations

The Brush-turkey mound was located on the north bank of a narrow (c. 8-15 m wide) unnamed creek in Hickey Park, in suburban Brisbane (27°24'50" S, 153°01'10" E). This creek has been managed to retain trees of various ages from sapling to mature, shrubs and grass, creating a complex of riparian vegetation with a canopy cover c. 20-40 m wide along the entire length of the creek (Fulton *et al.* 2020). Coarse and fine litter has been left undisturbed for c. 5-20 m on either bank of the creek. The partially inundated mound was constructed around a group of saplings, and in the shade of mature trees.

The mound was partially inundated during the southeast Queensland floods that peaked at the site on 27 February 2022. Although the creek had broken its bank on 26 February, the water level was 20 cm below the base of the mound when checked. The water level rose on the following day, flooding slightly more than the lower half of the mound (Plate 1). The water then receded below the base of the mound on 28 February, when the mound appeared wet but well-drained. Maximum ambient temperatures on 27 and 28 February were 23.6°C and 29.9°C, respectively (Bureau of Meteorology 2024). The mound was thus partially inundated for approximately one day, although the number of hours and water temperature were not recorded. Notably, a mound of woodchips approximately equal in size and situated

Plate 1. Nest mound of Australian Brush-turkey during flood of 27 February 2022 (G. Fulton)

Plate 2. Same nest mound as in Plate 1, photographed 15 days after partial inundation. Note the live saplings growing through the mound and other nearby vegetation (G. Fulton).

c. 20 m from the Brush-Turkey mound was completely washed away by the same flood.

No attempt was made to check if the eggs survived as it was not possible to obtain a license to excavate the mound at short notice, nor was I prepared to dig out the eggs while the male continued to attend and maintain the mound after the flood waters subsided. The mound was maintained until at least 13 February 2023. The only other active mound at this site was maintained by the same male and situated 118 m away, on higher ground in the backyard of a suburban property immediately adjacent to the park.

Discussion

Brush-turkey nest mounds are often built around live saplings, stumps or other physical features that provide stability (Jones 1988), as they apparently did in this case (Plate 2). The saplings help stabilise the Brush-turkey's incubation mound by being rooted in the ground. The presence of tree saplings helped anchor the mound in the present study, enabling it to avoid destruction despite the physical force of the moving water during the flood. Future management in parks with waterways might consider promoting and retaining saplings along riparian zones to facilitate the conditions required by megapodes.

Two questions arising from this study are: Did the mound continue to function as an incubator and did the eggs survive the partial inundation. The best evidence demonstrating that the mound continued to function as an incubator was that the male did not abandon it and concentrate his efforts on the second mound. That he continued working the mound for a further year suggests that females continued to lay their eggs in it (D. Jones, pers. comm.).

The two main physiological factors that will most likely negatively affect the egg during embryonic development are hypoxia (low oxygen) and hypothermia (low body/ incubation temperature). The Australian Brush-turkey has a remarkable thermal

tolerance, with successful hatchings observed when mound temperatures ranged between 25°C and 40°C while eggs were present (Eiby & Booth 2008). Most remarkable is that all monitored Brush-turkey eggs experienced suboptimal temperatures for periods of days or weeks without detriment to the developing embryo (Eiby & Booth 2008).

When eggs are fully immersed in water, hypoxia seems more likely than hypothermia to kill the embryo. During the early stage of embryonic development (1-5 days), oxygen demand is low and it is obtained slowly by diffusion across the eggshell, albumen, amniotic fluid and embryonic tissues (Barret & Seymour 2021). Short-term inundation is unlikely to asphyxiate the embryo at this stage. However later in the embryo's development, during pulmonary gas exchange, the embryo would likely be asphyxiated if deprived of oxygen (Barret & Seymour 2021).

The shells of Brush-turkey eggs also possess a water-repellent cuticle, a barrier of small calcareous spheres over the pores that maintain the gaseous connection between the pores and the air. This is thought to be a hydrophobic adaptation to the moist environment within the mound and is hypothesised to limit egg-shell degradation and aid the diffusion of gases in an environment where the pores may become occluded with organic material from the mound (D'Alba *et al.* 2014; Grellet-Tinner *et al.* 2017). Even with this adaptation, total inundation of eggs would likely asphyxiate older embryos, so it is possible that some of the eggs in the present study did not survive.

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