



Depredation of eggs of threatened freshwater turtles by the short-beaked echidna (*Tachyglossus aculeatus* (Shaw, 1792))

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ABSTRACT

The echidna (*Tachyglossus aculeatus*) is documented as a new native predator of freshwater turtle eggs, particularly those of the vulnerable Fitzroy River turtle (*Rheodytes leukops*), and the critically endangered white-throated snapping turtle (*Elseya albagula*). This depredation has been identified in the Fitzroy, Burnett and Mary Catchments with echidnas recorded at traditional turtle nesting banks using direct observation of depredation of eggs, remote camera footage and identification of tracks. Echidnas were observed at traditional nesting banks for *E. albagula* and *R. leukops* nesting across eight months of the year. The presence of echidnas was more frequent during the *R. leukops* nesting season in spring. *R. leukops* is endemic to the Fitzroy Catchment and the depredation rate of eggs was significantly higher than for other species and catchments. The mean top egg depth of *R. leukops* nests was found to be the same depth as the echidna's beak length. There was a significant increase in depredation during the five-year study period, with 47.4% of *R. leukops* clutches depredated by echidna in the 2022 season. This substantial loss of eggs and recruitment of hatchling turtles poses a significant threat to the populations of this threatened species.

Keywords: Burnett River, critically endangered, depredation, echidna, eggs, *Elseya albagula*, Fitzroy River, freshwater, Mary River, nest, *Rheodytes leukops*, turtle, vulnerable.

Introduction

Australia's freshwater turtle populations are under continuous negative pressure due to environmental threats, changes to catchment flow and structure with construction of dams and weirs (Hamann *et al.* 2008; Limpus *et al.* 2011) and depredation of eggs by both native and introduced animals (Chessman 2021). The depredation of freshwater turtle eggs has been documented as a significant threatening process (Limpus *et al.* 2011; Campbell *et al.* 2020). A high proportion of freshwater turtle clutches succumb to depredation before they hatch (Chessman 2021).

Documented predators of freshwater turtle eggs in Australia include rakali (*Hydromys chrysogaster*) (Thompson 1983), goannas (*Varanus* spp.) (Hamann *et al.* 2008), dingo (*Canis lupus*) (Thompson 1983) and introduced predators including the European red fox (*Vulpes vulpes*) (Thompson 1983; Dawson *et al.* 2016) and pigs (*Sus scrofa*) (Chessman 2021). Clutches are also lost to livestock trampling, primarily by cattle (Flakus 2002).

The Fitzroy, Burnett and Mary Catchments are located in central and southern Queensland, Australia. The critically endangered white-throated snapping turtle (*Elseya albagula*) (Thomson *et al.* 2006) is found in all three catchments and the vulnerable Fitzroy River turtle (*Rheodytes leukops*) (Legler and Cann 1980) is endemic to the Fitzroy Catchment. Both species nest at traditional nesting banks in aggregations (Limpus *et al.* 2011). *E. albagula* lays one clutch each season with an average of 14 eggs (Thomson *et al.* 2006) and *R. leukops* lays up to two clutches each season with an average of 18 eggs per clutch (Legler and Cann 1980).

This paper describes egg depredation by the echidna (*Tachyglossus aculeatus*) in the Fitzroy, Burnett and Mary Catchments. Although multiple species have been recorded depredating nests, this paper will exclusively review the data directly related to the echidna collected from each catchment between 2018 and 2022. The percentage of clutches

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destroyed by echidna will be analysed for each catchment on an annual basis. This research forms part of an ongoing study of freshwater turtles in Queensland, Australia.

Methods

Study area

The lower Fitzroy, Burnett and Mary Catchments were surveyed annually during freshwater turtle nesting monitoring activities. Seasonal surveys were undertaken in the Burnett and Mary Catchments during May–July to monitor the nesting of *E. albagula*, and during May–December in the Fitzroy Catchment to monitor the nesting of *R. leukops* and *E. albagula*. Each individual predator species was identified and recorded on the nesting banks through tracks and depredation of eggs. The presence of echidna as a predator was identified during the surveys through tracks and clutch depredation. The echidna tracks were verified using Triggs (2004).

A remote camera (Swift Enduro 4G) was used to monitor the presence of wildlife at a significant traditional nesting bank (ACJ-14) for both *E. albagula* and *R. leukops* in the lower Fitzroy Catchment. The remote camera was in place from May to December 2022 and was positioned in the middle section of nesting bank ACJ-14 where the main nesting activity occurred. Foraging behaviours of the echidna were derived using the remote camera footage.

Results

The echidna is here documented as a new native predator of freshwater turtle eggs, particularly *R. leukops* and *E. albagula*. The depredation of freshwater turtle eggs by echidna has been observed and recorded in the lower reaches of the Fitzroy, Burnett and Mary Catchments at traditional nesting banks that were routinely monitored each nesting period. There were less frequent records of egg depredation of the listed least concern freshwater turtle taxa, Krefft's river turtle (*Emydura macquarii krefftii* (Gray, 1871)) and broad-shelled turtle (*Chelodina expansa* (Gray, 1857)), that nested on these monitored sections of riverbanks.

Direct observation of depredation

On the evening of 6 July 2019, an echidna was encountered partially buried into a known traditional freshwater turtle nesting bank (CC-10) within the lower Burnett Catchment (Fig. 1). The echidna was located at the end of a nesting turtle track and appeared to be feeding. The echidna was removed by rolling it sideways out from within its partially buried position in the loam substrate. A clutch of *E. albagula* eggs (BC2019110) was exposed inside the egg chamber directly below from where the echidna was removed. A clutch of 13 eggs was removed from the egg chamber and all were freshly punctured by the echidna's beak and the contents

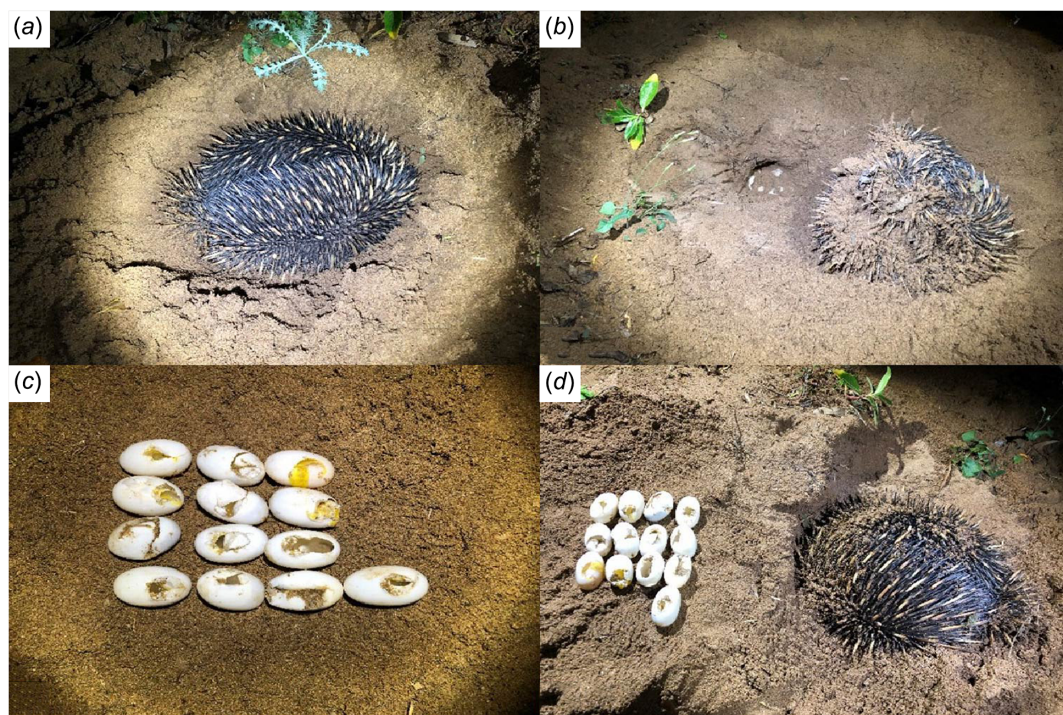


Fig. 1. Photographs showing (a) an echidna encountered *in situ*, (b) an echidna removed from where it was feeding, exposing an egg chamber of *E. albagula*, (c) *E. albagula* eggs depredated by echidna showing beak puncture, and (d) depredated *E. albagula* eggs and echidna.

consumed. There was only one puncture into each egg where the contents had been eaten. The echidna's beak was still moist with the contents of the eggs.

Foraging behaviour on nesting bank

Echidna foraging behaviour was interpreted from images recorded by a remote camera monitoring the presence of wildlife at the traditional nesting bank ACJ-14 frequented by *E. albagula* and *R. leukops* in the lower Fitzroy Catchment. The echidna appeared to wander in no fixed pattern over the sand/loam, moving its head from side to side with the beak probing the substrate (Fig. 2). When the echidna detected a potential food source, it would stop and push its beak vertically into the substrate to a depth of its beak length and anterior head, up to eye level. It would at times push its beak and head further into the sand/loam to beyond the eye position until it encountered freshwater turtle eggs. The echidna remained at the location of the nest until all the contents of each egg had been consumed. If the echidna found nothing at the site probed, it would continue this behaviour pattern in search of food as it wandered over the nesting bank. The echidna behaviour remained consistent each night it was documented, while it was foraging on the nesting bank.

Occurrence of echidnas on the Fitzroy River nesting bank ACJ-14

Echidnas have been observed both day and night on the traditional nesting areas along the riverbank, although the depredation was recorded at night. The remote camera recorded the foraging behaviour of echidnas at varying times between dusk and dawn.

During the *E. albagula* nesting season, which occurs during winter, echidnas were observed on 6 of 24 consecutive nights within the lower Fitzroy Catchment at nesting bank ACJ-14. During the *R. leukops* nesting season, which occurs in spring,



Fig. 2. Echidna foraging on nesting bank ACJ-14. It probed the substrate with its beak to detect freshwater turtle eggs.

echidnas increased activity and were observed on 19 of 32 consecutive nights at nesting bank ACJ-14.

At nesting bank ACJ-14 and other traditional nesting banks, the echidna traffic increased during peak spring nesting for *R. leukops*, with echidna tracks encompassing the entire extent of the nesting bank, preventing identification of tracks from nesting turtles and other species of animal on the following morning. The exact timeframe of foraging each night is not known, nor is it known whether it is dependent on the number of turtles nesting on that night and providing a food source.

Description of egg depredation

The depredated clutches were not always obvious, with few signs of a nest or visible eggshell at the surface after the echidna had visited the nest location. Each depredated egg within the egg chamber had a single puncture hole through the shell wall and the contents eaten. The clutches were destroyed from the substrate surface without the echidna digging down to the eggs within the nesting bank (Fig. 3). When a depredated nest was discovered, all eggs within the clutch had been consumed.

The chambers of previously depredated clutches were observed to be of interest to the echidna and were probed/dug into once more on subsequent nights. It has not been determined if this is due to the sand/loam being soft or if the scent of the eggs was sufficient to attract the echidna back to the same location again.

Comparison of probed depth to nest depth measurements

The individual beak depressions left in the sand/loam were obvious on the riverbank after rainfall and were measured at 14.0 cm in depth from the substrate surface, whereas the probing in dry sand did not leave prominent depressions that could be measured. The depth to which an echidna pushed its beak to eye level into the substrate while foraging was similar to the depth of the top egg measurement for *R. leukops* and just short of that to the top egg for *E. albagula*.

The depth to the top egg within the nest chamber from the substrate surface differed between freshwater turtle species. The mean depth was documented from intact nests for both species during the study. The mean top egg depth for *E. albagula* was 15.5 cm (range 8–23 cm, $n = 99$) and the mean top egg depth for *R. leukops* was 14.2 cm (range 4–21 cm, $n = 278$). Top eggs of *R. leukops* are located closer to the surface and within the probing range of the echidna's beak.

Depredation rates and species impacted within the Fitzroy, Burnett and Mary Catchments

Depredation of eggs by echidna has been identified in four turtle species: *R. leukops*, *E. albagula*, *C. expansa* and

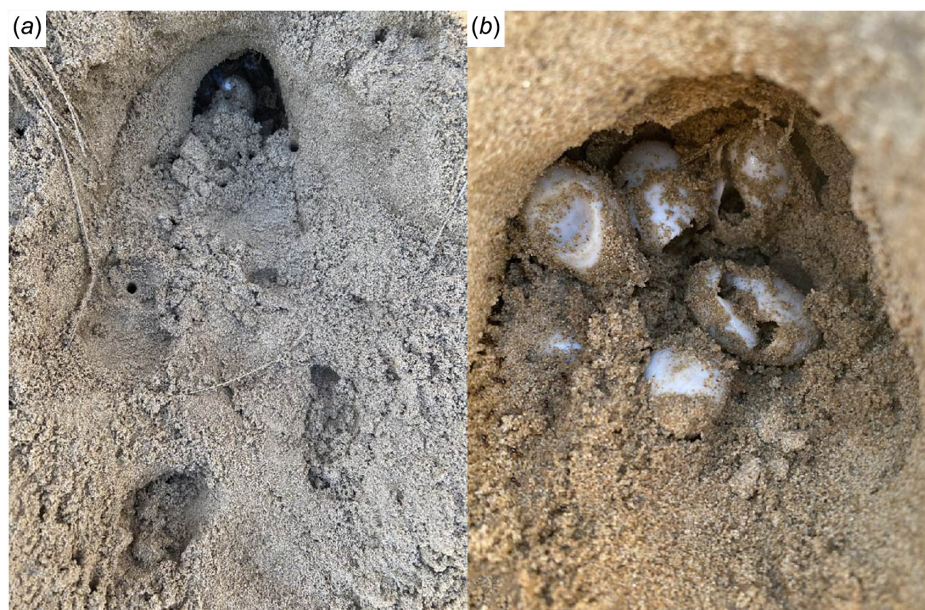


Fig. 3. Photographs of nests showing (a) depredated *R. leukops* clutch by echidna in damp sand, (b) close up of *R. leukops* depredated eggs in an egg chamber.

Table 1. Number of clutches and species impacted by echidna within the Fitzroy, Burnett and Mary Catchments.

	<i>R. leukops</i>		<i>E. albagula</i>		<i>E. m. krefftii</i>		<i>C. expansa</i>	
	TN	DN	TN	DN	TN	DN	TN	DN
Fitzroy catchment								
2018	178	5	*35	2	18	3	0	0
2019	98	13	199	4	11	1	2	0
2020	156	27	32	1	4	0	0	0
2021	139	21	49	4	2	0	0	0
2022	133	63	41	5	1	0	1	1
Burnett catchment								
2018			*0	0	*15	0	*0	0
2019			232	2	0	0	0	0
2020			87	0	33	0	1	0
2021			154	1	5	0	0	0
2022			55	0	0	0	2	0
Mary catchment								
2018			*1	1	*0	0	*0	0
2019			73	1	0	0	0	0
2020			*16	0	*1	0	*0	0
2021			141	4	0	0	0	0
2022			20	0	0	0	0	0

TN, total nests; DN, destroyed nests; * indicates incomplete survey.

E. m. krefftii (Table 1). The depredated clutches of *E. m. krefftii* and *C. expansa* were located at traditional *R. leukops*, and *E. albagula* nesting banks that were annually monitored.

As noted above, there was a consistently higher presence of echidnas on the traditional nesting banks in the lower Fitzroy Catchment. Echidnas were present during the peak of the nesting season for both *E. albagula* and *R. leukops*. As nesting increased, the echidna activity increased. Once frequency of nesting decreased late in the season, the presence of echidnas rapidly decreased.

R. leukops clutches were subjected to a higher rate of depredation by echidna than *E. albagula* clutches laid on the same banks in the lower Fitzroy Catchment (Fig. 4). For both species across the five years, there was a trend for an increasing proportion of clutches laid being depredated by echidna. The annual depredation of *R. leukops* clutches increased from 2.8% in 2018 to 47.4% in 2022 (Fig. 4).

Discussion

The diet of the short beaked echidna is reported to be insectivorous, consisting largely of ants, termites and scarab beetle larvae, with the diet varying in proportion depending on the locality (Sprent and Nicol 2012; Nicol 2022). No previously published records of echidna diet mention freshwater turtle eggs. Captive echidnas typically are fed a mixture of proteins including egg due to the limitations in providing them with enough ants and termites (Stannard *et al.* 2017). Nicol (2022) determined beak length and climate as contributing factors to the diet and foraging of each subspecies of short-beaked echidna. Echidnas are opportunistic feeders and use more foraging effort in areas where food source is more concentrated (Abensperg-Traun *et al.* 1991). The nesting activity of both *E. albagula* and *R. leukops* within

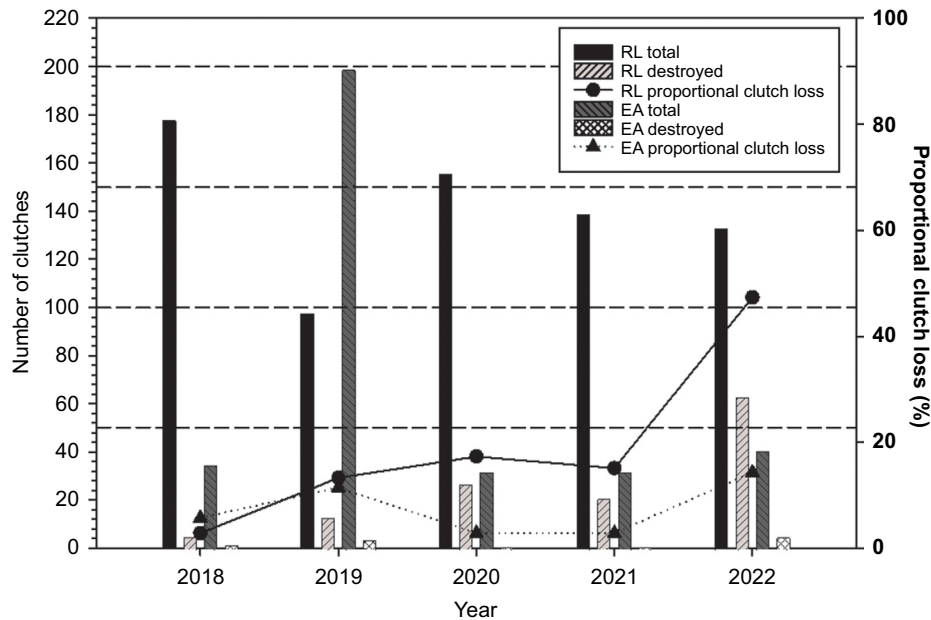


Fig. 4. Number of *R. leukops* (RL) and *E. albagula* (EA) clutches destroyed by echidna within the lower Fitzroy Catchment 2018–2022.

the lower Fitzroy Catchment provided a relatively consistent food supply at the traditional nesting bank locations for eight months of the year for the echidna. Winter depredation by echidna of *E. albagula* clutches was observed to be as high as 12.2%, whereas the frequency of depredation of *R. leukops* clutches during spring was as high as 47.4% in 2022. The rate of depredation for *R. leukops* is significantly higher than that for the other recorded turtle species. The echidna's beak allows the eggs to be depredated without removing them from the egg chamber. In contrast, other predators dig the eggs out of the chamber and chew or tear the eggshell to consume the contents. As observed during this study, the European red fox, varanid and rakali depredation typically leave eggshells scattered across the nesting bank with the egg chamber location visible where the contents have been dug out.

This research has established that the echidna, unexpectedly, is a significant native predator of freshwater turtle eggs. The Fitzroy Catchment supported a higher rate of depredation of turtle eggs by echidna than the Burnett and Mary Catchments. The depredation rate of *R. leukops* clutches by echidna has increased by 44.6% over five years. The increase of depredation was not due to an increase of survey effort as every clutch was documented each year of the study at these banks.

Within the lower Fitzroy Catchment, the depredation of turtle eggs by echidna was identified at traditional nesting banks of *E. albagula* and *R. leukops* that have been monitored across the last 20 years by the authors. Although depredation of turtle eggs by echidna had been identified prior to 2018, the data from the earlier years was not collected systematically.

The cause(s) of this increase in clutch loss have not been determined at present. However, there may be multiple

factors to consider. Recent changes in adjacent landscape to the riverbank, especially in the Fitzroy Catchment, may have impacted upon the foraging behaviour of the echidna due to areas being cleared of vegetation for bank restoration and agriculture. As a consequence of recent extreme flooding of the riverbanks since 2010, there may have been changes in the abundance of other predators competing with the echidna for the turtle eggs within the Fitzroy Catchment.

This study has shown a high depredation rate of the threatened freshwater turtle species that aggregate to nest at traditional nesting areas. Echidna depredation was highest for *R. leukops*, whose nests were shallower and whose eggs have a thinner shell that is easier to penetrate during the foraging. It is still to be determined if the foraging behaviour observed is a learned behaviour resulting in echidnas learning to utilise areas while there is an abundant/predictable food source. It is unknown if a single individual or multiple individuals are responsible for depredation at each nesting bank. This study identifies the potential for depredation of turtle eggs by echidna to be a significant threat to the survival of populations of at least two threatened freshwater turtle species, *E. albagula* and *R. leukops*, in the Fitzroy Catchment and possibly further afield. The high depredation rate, particularly for *R. leukops* eggs, requires further research to quantify the number of echidnas present at each nesting bank.

Permit and ethics

The study was conducted in accordance with Animal Ethics approvals SA 2021-11-812. Activities were undertaken with a

Collaborative Partner Authorisation issued by the Department of Environment and Science.

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Data availability. The data that support this study will be shared upon reasonable request to the corresponding author.

Conflicts of interest. The authors declare no conflicts of interest.

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