

the devastating end-Cretaceous mass extinction, a sudden event primarily caused by the impact of a 10-kilometer asteroid and the ensuing environmental destruction. Pterosaurs, however, should not be seen as evolutionary failures. They were highly adaptable and absurdly diverse, thriving in many environments for over 150 million years. They were the first vertebrates to achieve the nigh on impossible feat of flight, and achieved it with a style unlike that of any bird or bat.

Pterosaurs lack contemporary analogues and therefore captivate us with their baffling anatomy. Their aerial prowess even inspires research in areas outside of palaeontology, like engineering. The US Army Research Laboratory is currently collaborating with pterosaur researchers to develop new pterosaur-inspired aircraft. For better or worse, pterosaurs may rise from extinction in this way, and become an agent of extinction themselves. But more than anything, pterosaurs are proof of nature's versatility and innovation, and show that the fossil record can surprise and inspire with creatures so fantastic that, had they not been turned to stone millions of years ago, we would have never conjured their existence.

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# Giant tortoises hunt and consume birds

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Tortoises (land turtles) are familiar animals and are generally assumed to be strict herbivores. Their ecological roles are most obvious in giant tortoise species which, due to their size and local abundance, play major roles as keystone species and ecosystem engineers<sup>1–3</sup>. In the Galápagos and Seychelles islands these species are known to play major roles as the islands' largest herbivores, with exceptionally high biomass and consuming up to 11% of primary production<sup>1</sup>. In addition they act as ecosystem engineers, dispersing seeds, breaking vegetation and eroding rocks<sup>2</sup>. However, as slow-moving poikilotherms most people assume their behaviour to be simple. Here we present video evidence of a Seychelles giant tortoise (*Aldabrachelys gigantea*) attacking a tern chick and pursuing it along a log. Finally the tortoise killed the chick and was observed to eat it. Other tortoises in the same area have been seen making similar attacks, although those were not fully documented. We believe that the exceptional combination of a tree-nesting tern colony with a resident giant tortoise population has created conditions leading to systematic hunting of birds by several individual tortoises; an entirely novel behavioural strategy for any tortoise species.

Tortoises are known to be not strictly vegetarian. Opportunistic carrion feeding has been observed<sup>3</sup>, they consume bones and snail shells as calcium sources<sup>4,5</sup> and in captivity the semi-aquatic *Manouria emys* eats frogs<sup>6</sup>. However, studies of wild animals have not recorded any active predation by any tortoise species. There are reports of Galápagos giant tortoises squashing birds under their carapace<sup>6</sup> and we have heard of tortoises on Aldabra squashing crabs, but these are anecdotal and although it is implied that the act is deliberate, this is unclear. Our observation is the first documentation of deliberate hunting in any tortoise species.

The hunting tortoise was observed on 30th July 2020 on Frégate Island, a

privately owned island in the Seychelles group managed for ecotourism. The observation was made at 'Anse Parc' a restored mixed woodland that is one of the areas on the island most densely populated by tortoises<sup>7</sup>. The 2021 tortoise census on Frégate island recorded about 3,000 individuals<sup>8</sup>. These are a mixture of animals believed to have been introduced from Aldabra atoll in the 1950s, animals released from captivity from other islands and those wild bred on Frégate<sup>7</sup>. The extensive habitat restoration that has taken place on Frégate has enabled seabirds to recolonise, with a colony of 265,000 noddy terns *Anous tenuirostris* (10,000 nests) in an area of 1.9 hectares (last census conducted in June 2020<sup>9</sup>). The ground under the colony is littered with dropped fish and chicks that have fallen from their nests.

While returning from censusing seabirds on 30th July 2020 we observed several tortoises in the tern colony at 16:58 hrs. An adult female, approximately 50 cm in straight carapace length, was noticed approaching a tern chick on a log. The tortoise walked directly to the tern at a normal walking pace and reached out with its mouth open when the chick was in reach (Figure 1A and Video S1, published with this article online). The chick retreated along the log and was pursued by the tortoise, which continued to attempt to bite. The chick tried to defend itself by pecking at the tortoise without making contact, and fluttering its wings (Figure 1B). At the end of the log the chick stopped retreating, enabling the tortoise to close its jaws directly on the head of the chick (Figure 1C). The chick, now dead, was dropped and the tortoise had to climb off the log to retrieve it. Once retrieved, the chick was swallowed whole. From first approach to the death of the chick, the interaction took 7 minutes in total; the pursuit along the log to the killing of the chick took 92 seconds.

Although this is the only videoed hunting and killing of a bird by a tortoise, it was not an isolated event. Other tortoises on Frégate have been observed eating birds (Figure S1) and several individuals have been seen hunting as described above, but these were not recorded and consumption of the bird was not observed. Birds being pursued on these occasions were





**Figure 1. Adult female giant tortoise hunting and killing a lesser noddie tern chick.** (A) Tortoise first attacking the tern, out of range. (B) Tern attempting to defend itself. (C) Tortoise successfully seizing tern by the head, killing it (stills taken from Video S1).

chicks of the lesser noddie and fairy tern *Gygis alba*.

In this first documented observation of a tortoise deliberately attacking and consuming another animal it is notable that during the attack the tortoise approached the chick with its jaws wide open and the tongue retracted. This is typical for aggressive tortoise behaviour and is in contrast to feeding behaviour where the tongue is protracted in all chelonians feeding on land<sup>10</sup>. The direct approach to the chick on the log suggests that the tortoise had experience of being able to capture a chick in such a situation,

where it was likely to try to remain on the log, above ground-level (as is typical of tern chicks that have fallen from nests in trees). This indicates that this type of interaction is not infrequent for this individual. The observation of other tortoises hunting and consuming birds suggests that this behaviour has been adopted by several individuals.

In most ecosystems potential prey would be too fast or agile for giant tortoises. For birds, only flightless chicks that will not attempt to run away would be vulnerable. Ground nesting common noddie *Anous stolidus* or sooty terns *Sterna fuscata* would be able to avoid

predation, or the adults would defend nests or chicks on the ground. Predation by tortoises has not been reported from the islands where such species and tortoises coexist. Chicks of tree-nesting terns are extremely unlikely to survive on the ground due to predation by lizards and crabs. This means that predation by giant tortoises is unlikely to exert any selective pressure on the terns. At present we do not know how extensive the behaviour is on Frégate; future studies will determine whether it develops further or expands more widely in the tortoise population. Even if Frégate's combination of tree-nesting terns and giant tortoise populations may be exceptional, the present observation considerably expands the known behavioural repertoire of tortoises.

#### SUPPLEMENTAL INFORMATION

Supplemental information includes one figure and one video and can be found with this article online at <https://doi.org/10.1016/j.cub.2021.06.088>.

A video abstract is available at <https://doi.org/10.1016/j.cub.2021.06.088#mmc3>.

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