# How and why Aldabra giant tortoises hunt birds and other animals

**Georgia Miller[1], Mia Messenger[1], Anna Zora[2] and Justin Gerlach[1]***

[1]Peterhouse, Trumpington Street, Cambridge CB2 1RD, U.K.

[2]Frégate Island Foundation, Frégate, Seychelles

*Corresponding author: Justin Gerlach, email: jg353@cam.ac.uk

## Introduction

In 2021 we published a description of an Aldabra giant tortoise (*Aldabrachelys gigantea*) catching and eating a bird on Frégate Island, Seychelles, providing the first video evidence of this behaviour (Zora & Gerlach 2021). Prior to this, there were anecdotal reports of giant tortoises killing birds but these had not been properly documented. Since our publication a number of other observations of tortoises eating meat, and in a few cases catching animals, were reported to us. It is also well known that most tortoise species will opportunistically eat meat (e.g. when encountering carrion). However, the not infrequent sightings of predation on sea-birds on Frégate Island remains distinctive in having been observed on many occasions over several years, and involving many different individual tortoises (Zora pers. obs.).

The significance of the behaviour cannot be determined from the existing published evidence: it may be an occasional, opportunistic activity by a small number of individuals or a more systematic occurrence. It may be a new phenomenon, although it has been speculated to be a formerly normal part of giant tortoise and sea-bird interactions which had not been possible on most islands until habitat and species restoration became advanced (Zora & Gerlach 2021). Other questions can also be raised: how widespread is it in the tortoise population? Is it evenly distributed demographically, or is it more frequent in individuals with higher protein demands (e.g. juveniles and breeding females)? How often do individual tortoises hunt? What is the success rate and how important is it for them? What role do other species of animal play in the diet?

Following the publication of the video observation in 2021 we have started investigating the behaviour systematically. Here we report on the first results of these further studies.

## Study Site

Frégate island covers 219 hectares (Fig. 1). Naturally it was a wooded island but was largely converted to agricultural plantation in the 19th century. It is now managed for conservation and ecotourism and 30 years of habitat restoration have regenerated woodland over much of the island. Tortoises

  

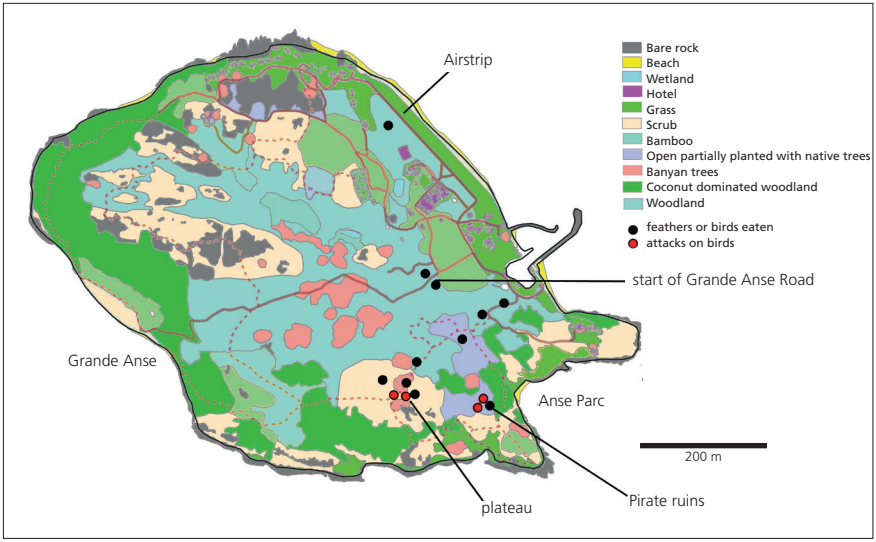


Fig. 1. Simplified habitat map of Frégate Island showing main study locations and the localities where tortoises were found consuming feathers or birds (observation and faecal analysis) or were recorded attacking birds.

were reintroduced to the island in the 1940s and some 3,000 animals are now present (Gerlach et al. 2013). Sea birds have recolonised, with the main tern breeding colony being in the Anse Parc area. There they nest in *Pisonia grandis* trees during June to September. High winds in this season frequently result in chicks being blown out of their nests. When on the ground these are rarely tended by their parents and fall victim to the abundant predators: snakes, lizards and crabs.

## Methods

Tortoise behaviour on Frégate Island was studied by two of the authors (GM, MM, with support and assistance from AZ) in July-August 2022. Four approaches were taken: camera traps, supplementary observation of focal tortoises and of fallen chicks, and faecal analysis. The main focus of research was on the tortoises within the lesser noddy (*Anous tenuirostris*) breeding colony above the Anse Parc area, where most predation events had been observed previously. Additional observations were also made elsewhere on the island, although not systematically.

Tortoises recorded interacting with birds were sexed and assigned an approximate age category based on size. Sexing was by means of tail length (when held to the side female tails reach less than half-way from mid-line to the base of the hind leg, whereas male tails make contact with the base of the hind leg) and age categories were: juvenile (approximately 30cm

straight carapace length), subadult (30-40cm) and adult (over 40cm). Terns were categorised as adult (full flying), large fledglings (able to flutter off the ground or to fly short distances), medium (at least half full size but flightless) and small (less than half full size, lacking any flight feathers). All terns observed in the interactions were lesser noddies, although white terns (*Gygis alba)* were also present.

### *Camera traps*

Four camera traps were initially set up in areas that contained nesting sites of the lesser noddy, principally in habitats classed as mixed woodland and open partially planted with native trees (Fig. 1). Initially the cameras were positioned to capture at least one lesser noddy chick that was on the ground or otherwise in reach of giant tortoises. Where possible, sites were selected where tortoises were active nearby to maximise the chance of recording an encounter. The camera traps were then left to run for approximately 20 hours before their SD cards were switched. If the original chick was no longer in view at this point the camera was repositioned. Camera traps were set up to record throughout the day and night, recording 30-60 seconds of video following motion detection, with a 60 second interval.

During the study two of the camera traps stopped working due to battery faults. This limited the areas that could be monitored simultaneously. After approximately a week, camera position was varied on a daily basis to cover more regions, still within the area of the lesser noddy colony. When no fallen chicks were observed on the floor, camera traps were instead positioned to cover a wider area to increase the chance of picking up fallen chicks and/or tortoise predatory behaviour. This included exotic scrub with banyan trees and native woodland habitats. Once tortoise-bird interactions were observed in an area, camera traps were placed there more frequently. The aim of this was to maximise the number of recorded observations, rather than to quantify the frequency of occurrences.

The footage from the SD cards was reviewed daily between 12:00 and 16:00 and clips with evidence of interactions were kept, and the nature of this interaction recorded. Interactions were separated into giant tortoises approaching chicks (walking directly towards a chick with the neck outstretched, but mouth not open), attacking (approaching with the mouth open, attempting to bite the chick), killing (live chick at start of observation but dead by the end) and eating (eating a dead bird, or with feathers in its mouth).

### *Observations*

Separate from camera trap observations, we noted down any interactions we saw across the island. This included the previously stated categories of observations as well as giant tortoises already in the process of eating birds – it is therefore unknown whether these had been hunted or were already dead and picked up from the ground. Other staff working on the island also noted down instances of tortoises in the process of eating birds, recording location, time and where possible the sex of the tortoise.

In addition to these casual recordings, focal observations were carried out on 50 occasions between 09:00 and 11:30 by locating one or more lesser noddy chicks on the ground and observing their behaviour and the behaviour of any nearby tortoises. Notable interactions here were recorded in both note form, and also via the use of mobile phones to record photos and videos of the interactions.

### *Fallen chicks*

Chicks that had fallen from their nests and were on the ground or otherwise potentially in reach of a tortoise (on top of rocks, branches and tree roots) were noted. The time, location, habitat, chick position, and species were recorded. We estimated the size of the chick visually (small, medium, large) and the distance between the chick and nearest giant tortoise in metres, as well as the presence of other nearby tortoises less than 10m from the chick. The behaviour of both the chick and tortoise was described.

### *Faecal data*

Faecal data was collected by dissecting individual tortoise faeces using sticks and tweezers to evaluate the frequency of consumption of birds. A visual estimate of the percentages of the main constituent items was made. These items were categorised as leaves, grass, seeds, giant millipede rings and bird remains, including single feathers. Seeds comprised large fruit seed; grass seeds were omitted from this category. Unidentifiable material was categorised as 'other'. Faeces were examined in 11 different locations, in the analysis these are grouped into 8 main areas.

## Results

### *Camera traps and observations*

Camera traps recorded 23 interactions, of which 22 were aggressive approaches by tortoises or tortoises eating birds (Fig. 2). The remaining observation was a chick standing on the back of a tortoise for over 4 hours. Of the aggressive interactions 11 were approaches, 3 attacks, 2 kills and 6 eating. Casual observations recorded 10 interactions: 4 approaches,

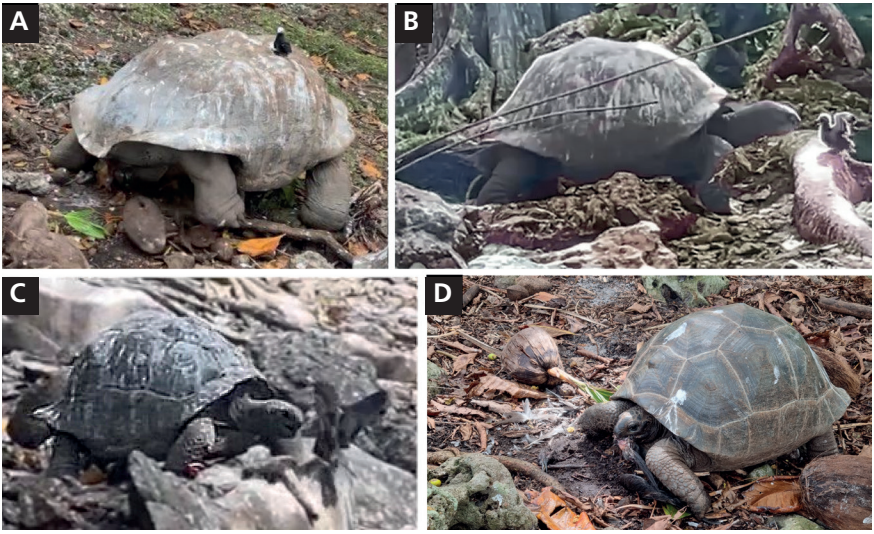


Fig. 2. Examples of interactions between tortoises and lesser noddies: (A) chick riding on tortoise; (B) tortoise approaching a chick; (C) attacking; (D) eating

2 definite attacks and 1 kill, in addition to 3 tortoises eating birds. The proportions of these behaviours observed at different times and categorised by sex are shown in Fig. 3.

### *Fallen chicks*

Observations of 143 fallen chicks (6 white terns, 137 lesser noddies, including 3 dead) recorded no interactions. In addition camera traps caught two cases of tortoises ignoring dead chicks (both near hydroponics) and 5 cases of tortoises ignoring live chicks within 3m (above Anse Parc, Anse Parc road, plateau) and 10 within 1m (plateau, above Anse Parc, Pirate ruins, Airstrip, clearing of tortoise trail).

### *Faecal data*

A total of 377 faeces were dissected from 8 main areas. In all cases leaves, grass and fruit predominated, comprising at least 95% of the faeces from all areas (Fig. 4). Excluding plant matter, the main animal component was found to be giant millipedes *Sechelleptus seychellarum*. Bird remains were recorded in only 5 localities, making up no more than 19% of non-plant diet (Fig. 4). 38% of samples with feathers contained a single feather, small numbers (up to 5) were found in a further 10 samples. Larger numbers were found in samples from the Pirate ruins (20 feathers and additional uncounted clumps of feathers) and plateau (3 feathers with an entire bird's head (Fig. 5)).

  

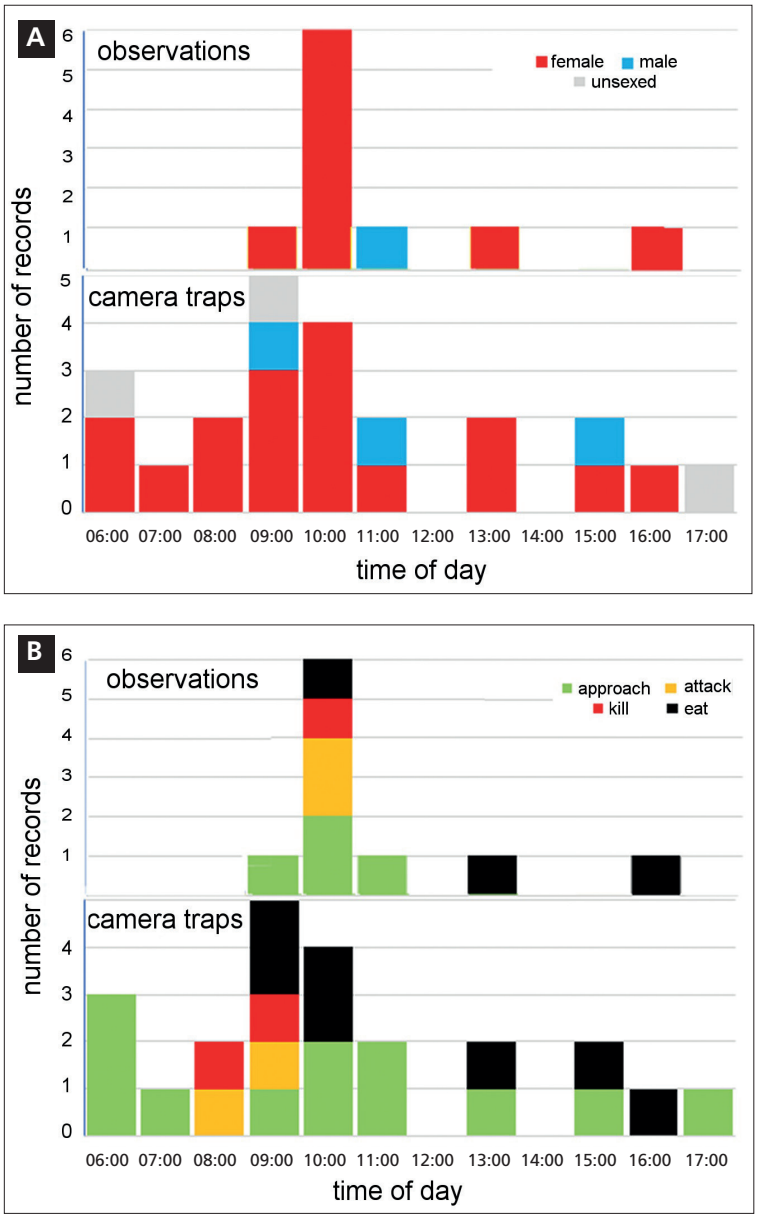


Fig. 3. Aggressive interactions between tortoises and birds at different times of day, comparing data from camera traps and observations categorised by (A) tortoise sex and (B) type of interaction, showing the peak of activity around 09:00-10:00 and the predominance of attacks by female tortoises.

  

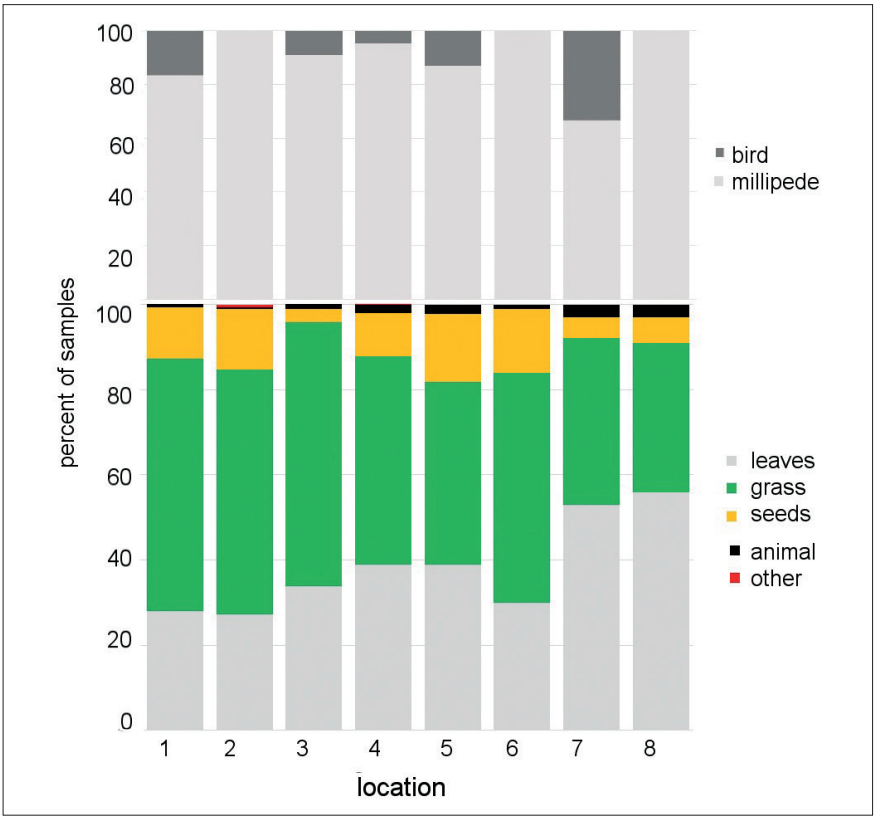


Fig. 4. Faecal analysis showing the percentage of faecal samples containing different items. Top**:** Animal material. Below: All material recorded.
Locations: 1: Airstrip (n=41), 2: near Airstrip (36), 3: start of Grande Anse road (20), 4: Anse Parc (139), 5: Pirate ruins (31), 6: tortoise trail near Anse Parc (21), 7: plateau (64), 8: Grande Anse trail (25)

## Discussion

Although the present study recorded a relatively small number of attacks by tortoises on birds (23 plus 10 records of tortoises eating birds) the interactions were sufficient to reveal some patterns to the behaviour. Hunts (including approaches, attacks and kills) were observed in five areas (plateau, Pirate ruins, above Anse Parc, tortoise trail clearing, start of Grande Anse road) and throughout the day, but with frequencies that depart from general activity patterns, showing a strongly bimodal pattern in the morning (06:00 and 09:30) but little afternoon activity. In contrast general activity recorded in this species on other islands has a main peak at 08:00 and a smaller one at 18:00 (Falcón et al. 2018). This may suggest that dawn (before the general rise in activity) represents a particularly attractive hunting time.


Fig. 5. Bird's head (two views) and fish skeleton found in tortoise faeces

Hunts (excluding eating, which may represent carrion feeding) were observed most on the plateau (4: 2 approach, 1 attack, 1 kill), with a single observation at the Pirate ruins (attack), above Anse Parc (approach) and tortoise trail clearing (approach). Camera traps recorded more hunts at the Pirate ruins (8: 4 approach, 3 attack, 1 kill) than on the plateau (6: 5 approach, 1 kill). The differences in the two survey methods probably reflect the differences in survey effort. Differences between the Pirate ruins and the plateau are impossible to evaluate as data collection was not standardised. Camera traps also recorded single approaches in the tortoise trail clearing and at the start of the Grande Anse road. In the behaviours recorded, casual observations and camera trapping seem to have been broadly comparable; casual observations recorded a slightly lower frequency of approach (0.4 compared to 0.5) and a slightly higher attack rate (0.2 compared to 0.13). This may suggest that the casual observations missed some of the approaches, which may be due to the majority of approaches recorded by camera traps being at times of day when observations were scarce.

Of hunts recorded to their end, 13% were successful (13% on the camera traps, n=16; 14% in casual observation, n=7). This is a high proportion and is in marked contrast to the large number of observations of tortoises ignoring chicks. This may suggest that hunting only occurs when tortoises have a high confidence of success, or a high level of motivation. The duration of hunts varied considerably, from 2 to at least 18 seconds, observation suggests that this was at least in part due to the ease or otherwise of moving over the rocky ground.

Attacks (excluding observations of just eating) were targeted at large fledglings (8) and medium chicks (8), with fewer attacks on adults (5) and small chicks (2). The highest successful kill rates were of fledglings (25%)

and medium chicks (14%). The camera recordings show that the majority of medium and small chicks were able to run away from the tortoises and were rarely pursued for more than a few steps. Despite having at least some flight, fledglings seemed to be more vulnerable to attack as they let the tortoises come closer than did smaller chicks and when taking avoiding action their fluttering wings made a large target for the tortoises. In all captures that could be seen clearly the tortoise first caught the bird by a wing-tip. One observation of two tortoises eating a dead chick is notable as the second tortoise had walked past the chick earlier and only approached once the first tortoise had started eating, this may suggest that they are not detecting carrion by scent.

Faecal analysis indicates that non-plant matter is a small component of the diet, but will be biased towards the least digestible components: cellulose in plant tissue and chitin and keratin in animal matter. Bird remains were scarce (up to 19% of non-plant diet in only 5 areas), and were most abundant on the plateau and Pirate ruins. Unexpectedly millipedes were present in faeces from all areas, forming 1-2% of the diet. They formed a substantial proportion (15-25%) of nine faecal samples from the Grande Anse trail (1), Pirate ruins (2), Anse Parc (3) and the plateau (3). This is a completely new addition to the food list for the Aldabra giant tortoise although it is known that live millipedes are consumed normally by *Kinixys* tortoises in Africa (Hailey et al. 2001). The Seychelles giant millipede is abundant on Frégate Island and potentially a significant source of protein for the tortoises. They do secrete defensive benzoquinones which would be expected to be a deterrent, however, not all individuals do this (Gerlach pers. obs.) and it is possible that the tortoises consume these more palatable animals. Alternatively, they may be consumed as carrion or accidentally in leaves, although observations suggest that at least some are consumed alive (Zora pers. obs.). Their presence as a notable dietary component is a significant new finding and needs to be examined in much greater detail in the future.

It is striking that the majority of interactions were made by female tortoises (0.82 of observations, 0.68 of camera traps). Excluding unsexed individuals the proportions are 0.88 female (0.9 observations, 0.84 camera), 0.12 male (observations 0.1, camera 0.17) (n=33). The sex ratio of adult tortoises on the island has been estimated to be slightly male biased at 45:55 (Gerlach et al. 2013), so these data indicate that hunting behaviour shows a strong sex bias, although it is not exclusively pursued by females.

Despite the frequency of bird hunting by giant tortoises on Frégate, they cannot be regarded as a threat to the terns as they are only catching flightless chicks on the forest floor. These chicks have almost no prospect of survival on the ground, facing predation from snakes, skinks and crabs.

The present study has expanded our base of information on this remarkable behaviour involving the hunting of birds, but also on the role that other animal matter may play in the natural diet of Aldabra tortoises. Although it is too early to evaluate its full significance it is now apparent that several giant tortoises on Frégate Island actively hunt birds and that it is a behaviour pursued predominantly by adult female tortoises. Further animal protein is consumed in the form of giant millipedes. Whether millipede consumption is also a female associated behaviour is at present unknown. Further studies will endeavour to quantify the rate of both hunting and carrion consumption in order to evaluate how important this behaviour is to individual tortoises.

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