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Utilisation of Anvils by the Trinidad Motmot (*Momotus bahamensis*) in Tobago, Trinidad and Tobago

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ABSTRACT

In June 2012 the remains of terrestrial snail shells were found next to rocks on forest paths in several locations in north-eastern Tobago, W.I. It was surmised that an avian predator had been responsible. In June-July 2013 camera trapping and direct filming revealed that a Trinidad Motmot (*Momotus bahamensis*) was using the rocks as anvils to break open snail shells and other hard-bodied prey items.

Key words: predation, feeding behaviour, anvil, *Plekocheilus glaber.*

INTRODUCTION

Birds have evolved a wide variety of techniques to catch and process different types of prey. One of these techniques is to use a rock or other hard surface as an anvil to either kill or break open hard-bodied prey. The hard remains of the prey are then discarded next to the anvil. Over time a small midden is formed, leaving valuable clues as to the behaviour of the anvil user and to the range of predated species.

Anvil use has been recorded in several bird species around the world (for summaries see Boswall 1977, 1978, 1983; Allen 2004; Lefebvre *et al.* 2002). Perhaps the best known of these is the Song Thrush, *Turdus philomelos*, which has been studied extensively over many decades by a number of researchers (e.g., Goodhart 1958). Other species reported to use anvils include the Chestnut Rail, *Eulabeornis castaneoventris* (Woinarski *et al.* 1998) and the Noisy Pitta, *Pitta versicolor* (Andrade *et al.* 2011). Lefebvre *et al.* (2002) gathered papers showing that a total of 39 species from 11 families have been observed battering prey on a hard surface. Anvil use is an example of borderline tool use, as the rock remains part of the substrate rather than true tool use, in which an object independent from the substrate is manipulated (Boswall 1977).

Like all motmots, the Trinidad Motmot is an adaptable feeder and enjoys a varied diet including berries, large invertebrates such as beetles, centipedes, millipedes, cockroaches and scorpions, and vertebrates such as frogs, small lizards, and small birds (ffrench 1991). Motmots have been observed striking live animal prey items against tree branches or other hard objects to stun or kill the animal before consumption (Sandoval *et al.* 2008; Skutch 1971), but there are no reports in the literature of the Trinidad Motmot, *Momotus bahamensis,* habitually using a rock as an anvil to extract food.

This paper presents two recorded incidents of Trinidad Motmots using rocks as anvils to break open terrestrial snail shells, information on the content of the remains found around 10 anvils, and information on the characteristics of the anvils used by the motmots.

METHODS AND RESULTS

In June 2012, one of us (MGR) was undertaking fieldwork in Tobago, W.I., surveying for terrestrial molluscs. During this work, aggregations of broken snail shells were found on trails in forests in the northeast of the island. The shells were always close to a prominent rock, normally a few centimetres high, in the middle of a trail. Several of these rocks or "anvils" were found along a trail heading north from Pirate's Bay, Charlotteville. A second anvil was found alongside a stream next to a Water and Sewerage Authority (WASA) station on the Coast Road just south of Cambleton. A third was found on the Gilpin Trail in the Tobago Forest Reserve. These sites ranged in altitude from 53m to 313m and were a mixture of primary and secondary forest and recently abandoned agricultural land (Table 1). At the time of the first discovery of an anvil, no sightings were made of any animal utilising them.

It was assumed from the prey remains that an avian predator was involved because the shells showed a similar type of damage to shells found next to anvils used by thrushes in Europe – namely the spire or the body whorl

Table 1. Locations of anvils.

Anvil No.	Site Name	Altitude (m)	Latitude, Longitude (Datum: WGS84)	Notes
1	Trail above Pirate's Bay	53	N 11.32832°, W -60.54832°	Site of filming by GB
2	Trail above Pirate's Bay	75	N 11.33086°, W -60.54916°	
3	Trail above Pirate's Bay	72	N 11.33049°, W -60.54947°	Site of camera trap
4	Trail above Pirate's Bay	95	N 11.33014°, W -60.54961°	Remains collected (UWIZM.2012.33.32)
5, 6	Trail above Pirate's Bay	82	N 11.33116°, W -60.54939°	
7	Trail above Pirate's Bay	117	N 11.33163°, W -60.54995°	
8, 9	Trail above Pirate's Bay	118	N 11.33182°, W -60.54998°	
10	Trail above Pirate's Bay	120	N 11.33220°, W -60.55024°	
11	Stream near WASA station	124	N 11.30988°, W -60.55873°	Remains collected (UWIZM.2014.3.1)
12	Gilpin Trail	313	N 11.28562°, W -60.61939°	

of the shell was damaged but the lip remained intact. There was no sign of tooth marks on the shells, which would indicate predation by a mammal. A search of the literature was conducted, but no references to anvil use by birds in the Caribbean was found.

Anvils in use

To ascertain which species was responsible, further research was conducted in June 2013. A time-lapse camera trap (Wingscapes Timelapse Camera 8.0) was set up by MGR on a tree trunk overlooking Anvil 3. It was programmed to take a photograph every minute during daylight hours. The camera was set out for three days from the 9 -12 June. Three photographs taken at 1625 h, 1626 h, and 1627 h on 10 June, 2013 showed a Trinidad Motmot, *Momotus bahamensis,* standing on the anvil and engaging in a vigorous head-banging movement against the rock (Fig. 1). Freshly broken snail shells were found near the rock after the incident, adding to the evidence that the motmot was the predator.

To gain video footage of the behaviour, GB observed an anvil for several hours on most days from late June through to the end of July 2013. Chosen as the study site was Anvil 1 (Fig. 2), situated in the middle of a trail above Pirate's Bay, Charlotteville, in a fairly open area of secondary forest that provided suitable cover for GB to hide. A Sony Handycam® was used to record events. On 16 July, 2013 at 1345 h, approximately three minutes of footage was recorded showing a motmot breaking open a land snail. The film clip started after the bird had arrived at the rock with a snail in its beak. For the first 2 minutes and 17 seconds, the bird held the snail by the spire of the shell. Each time the motmot struck the shell against the anvil, the snail flew out of the bird's grasp. The bird

Fig. 1. Motmot at Anvil

repeated this action 13 times; each time the motmot had to retrieve the snail from the surrounding leaf litter. At 2 minutes and 18 seconds, the bird changed its grip, now holding onto the aperture; it then smashed the spire of the snail shell nine times against the rock until it broke at 2 minutes and 25 seconds. The bird then took a few seconds to extract and eat the snail before flying to a nearby tree, where it wiped its beak several times on a branch and then flew away. The recording of the incident can be seen at: http://youtu.be/HUC35Rtbqo0

Fig. 2. Anvil 1 surrounded by broken shells.

During one earlier observation made by GB on the 26 June, 2013, a motmot cracked open a snail shell on an anvil after only four or five attempts. After eating the snail, the bird wiped its beak against a tree branch. The entire incident took around one minute but was not recorded.

Prey species found at anvils

The majority of remains found at all anvils were shells of a single species of land snail, *Plekocheilus glaber* (Gmelin 1791) ([Stylommatophora]: Orthalicidae). This is a fairly large species with an average shell length of approximately 44 mm (Robinson *et al.* 2004). It is common in the forests of Tobago and has been observed on the ground, in low vegetation, and higher up in the canopy and has been found to be active during both day and night (MGR, pers. obs.). The pattern on the shell varies from nearly entirely cream coloured to having dark brown stripes; examples of both types were found at the anvils. All specimens collected from the anvils were adults, indicated by the presence of a thick lip around the aperture as opposed to juveniles which have a thin lip.

The middens around the anvils varied from containing less than ten snail shells and other remains to containing more than 60 different items. All specimens from the middens surrounding Anvils 4 and 11 were collected for analysis. Middens at Anvil 4 contained 41snail shells; of those, 40 had an intact lip around the aperture. Those at Anvil 11 contained 58 snail shells, 42 with intact lips and 16 with broken lips. The shells from Anvils 4 and 11 were deposited in the University of the West Indies Zoology Museum (UWIZM), Saint Augustine, Trinidad, accession numbers UWIZM.2012.33.32 and UWIZM.2014.3.1, respectively.

The broken remains of several non-snail taxa were also found in the middens. The elytra of at least two different species of beetles (*Passalus* sp. [Coleoptera: Passalidae] and *Neoptychodes* sp. [Coleoptera: Cerambycidae]) were found at Anvils 8 and 9. These are fairly large beetles with body lengths ranging from 30mm to 50mm. The chelae and broken pieces of the carapace of the manicou crab, *Eudaniela garmani* (Decapoda: Pseudothelphusidae) were found at two anvils. The size of the chelae indicated that the carapace width of the crab had been around 35mm. Body segments from large snake millipedes (Diplopoda: Spirostreptidae) were found at Anvils 5 and 6; these millipedes can reach around 150mm in length. A single unbroken specimen of the predatory marine snail *Plicopurpura patula* (Neogastropoda: Muricidae) was found next to Anvil 9; however, it is not known if its presence was a result of being collected by a motmot.

Anvil characteristics

Ten anvils along the Pirate's Bay trail were measured. Most anvils were more than 50m apart, but some (Anvils 5 & 6 and 8 & 9) were within one metre of each other. Anvils varied in size from 66cm to 17cm long by 28cm to 11cm wide and from 6cm to 12cm high (see Table 2). Most were near the middle of the trails in which they were found, with the surrounding area containing leaf litter and smaller rocks but no vegetation.

Table 2. Anvil characteristics.

Anvil Number	Length (cm)	Width (cm)	Height (cm)
1	31	25	11.5
2	29	15.5	8.5
3	17.5	16.5	6.5
4	41	24	11
5	19	15	6
6	17	13	9
7	21	15	12
8	21	11	5
9	23	21	8
10	66	28	11
Average	**28.55**	**18.4**	**8.85**

DISCUSSION

Utilisation of anvils to feed on snails by *M. bahamensis* in Tobago is an interesting behaviour as it provides evidence of borderline tool use in a species and a family in which it has not been recorded before, and it highlights a potentially important method of exploiting food sources that might otherwise not be available to the predator.

The wide area over which anvils were found during this study indicates that the behaviour is fairly common among individuals of *M. bahamensis*. It is still to be determined if all motmots in Tobago utilise anvils or if only certain individuals in certain areas utilise them. Differences in rates of anvil utilisation between sexes and between adult and juvenile motmots could also provide valuable data. It would also be interesting to see if different species of motmots in other countries exhibit this behaviour. Haverschmidt (1968) mentioned that the stomach contents of a *Momotus momota* from Suriname included molluscs but provided no information on how the molluscs were obtained.

The method by which the motmot held the snail shell seemed to make a significant difference in the effectiveness of the hammering. In the filmed incident, when the bird gripped the shell by the spire, the shell was likely to be dislodged from the beak when hammered, whereas when the bird gripped the shell by the lip, the shell was held securely and could be broken after a few hammers. A motmot consistently grasping the shell by the lip would decrease shell handling time and thereby develop a more efficient feeding strategy. The majority of shells found in the middens had intact lips but broken spires, suggesting that in the majority of cases the snail had been held by the lip while the spire end of the shell was being struck against the rock.

The use of a surface against which to batter prey has been noted before in motmots, which are well-known to feed on beetles and other large insects. Skutch (1971) observed Broad-billed Motmots*, Electron platyrhynchum,* and Rufous-capped Motmots, *Baryphthengus ruficapillus,* battering insects against tree branches for consumption both by themselves and by their chicks. Regarding a *B. ruficapillus* that he observed feeding on a large millipede, he wrote that, "standing on the ground, the bird beat its prey until it broke, and swallowed it piecemeal." However, Skutch never mentioned utilisation of an anvil or of middens being formed.

One of the common features of the anvil sites was that they tended to have little vegetation around them and generally only a thin layer of leaf litter in the immediate vicinity; a condition that could possibly make it easier for a motmot to retrieve a prey item lost during the beating process and thus to decrease the time needed for it to extract the food.

It is currently unknown what percentage of the diet of *M. bahamensis* consists of snails and other species whose edible parts they can access by means of anvil utilisation. Also unknown is how the use of anvils and rates of predation upon snails varies throughout the year, from wet season to dry season. Predation upon terrestrial gastropods by birds is not all that common, except for species in the family Turdidae, many species of which prey heavily upon snails. This is possibly a result of the long handling time for minimal return (Allen 2004) but incidents have been recorded of birds consuming snails during migration events (Shachak *et al.* 1981) when choices of food may be limited. Several species of birds such as Limpkins, various species of oystercatchers, and Snail Kites feed almost exclusively on molluscs, but these are mainly freshwater and marine molluscs, and the birds do not utilise anvils to extract their prey.

Although several different species of snails were present as remains at the anvils, the vast majority were those of the land snail *P. glaber*. Despite the presence of at least three other similar-sized species of snails (*Drymaeus vincentinus*, *Orthalicus undatus*, and *Megalobulimus oblongus*) in the surrounding forest habitat, it is unknown why no remains of these species were discovered in anvil middens.

Many questions await answers regarding this behaviour, including: Do motmots consume snails all year round or is there seasonal variation? Do young motmots learn the behaviour from watching adults or is it to some degree innate, as in Song Thrushes (Henty 1986)? Does prey handling time vary among individuals and is this a factor of the age of the individual? What percentage of a motmot's diet is made up of snails predated in this way? Does a motmot use the same anvil each time or does it vary depending upon where the prey is collected? Are motmots territorial around the anvils? If all remains around an anvil are removed, does this affect the motmot's ability to find or relocate the anvil? We hope that this paper stimulates more research into this fascinating behaviour.

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