

Rapid development of tool use as a strategy to predate invasive land snails

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Abstract There are few examples of facultative tool use in animals under natural conditions. We provide the first description of tool use in great antshrikes (*Taraba major*), which were observed using stone anvils to break the shells of the land snail (*Achatina fulica*). This behavior is almost certainly of extremely recent origin given the lack of previous reports of tool use in *T. major* and the very recent (1980s) introduction of *A. fulica* into Brazil. Tool use in this particular population is probably a flexible behavioral trait that arose in response to the high density of exotic snails in this locality.

Keywords *Taraba major* · *Achatina fulica* · Exotic species · Facultative behavior · Anvils

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Introduction

Tool use is infrequent but taxonomically widespread among vertebrates (Bentley-Condit and Smith 2010; Seed and Byrne 2010; Shumaker et al. 2011), being found in three phyla and seven classes of animals (Bentley-Condit and Smith 2010). Among the taxa that most frequently use tools are birds, certain species of which have been observed to use tools for diverse activities such as food capture, food extraction, and agonism. Indeed, one of the first examples of tool use in animals was observed in thrushes (genus *Turdus*), who beat snails against stones (“anvils”) to extract them from their shells (Morris 1954; Goodhart 1958; Henty 1986). The use of anvils has subsequently been observed in many taxa, including a fish (Jones et al. 2011), and it has been intensively studied in species such as chimpanzees (Inoue-Nakamura and Matsuzawa 1997) and New Caledonian crows (Kenward et al. 2006).

Stereotyped tool use can evolve from pre-existing behaviors or, in cognitively advanced taxa such as birds and mammals, tool use can develop as a flexible behavior that incorporates a significant learning component (Hunt et al. 2014). Distinguishing these two origins in nature is often difficult, since specific tool-use behaviors may be ancient in origin. Here we report a new example of tool use that is very likely of a very recent origin: the use of stone anvils by great antshrikes (*Taraba major*) to break the shells of an introduced land snail (*Achatina fulica*). Our postulation of recent origin is based on: (1) the lack of previous reports of tool use in *T. major* (this species does not appear on the comprehensive list of tool-using species provided by Bentley-Condit and Smith 2010, nor in later publications), despite being an abundant and widespread species in South America, and (2) the recent (1980s) introduction of *A. fulica* in Brazil (Thiengo et al. 2007).

Fig. 1a–d Predation of *Achatina fulica* by *Taraba major*: **a** male *T. major* holds broken shell of *A. fulica* over anvil; **b** male *T. major* in the act of striking shell against the anvil; **c, d** examples of broken shells of *A. fulica*



Materials and methods

Observations and video footage (Fig. 1; Electronic supplementary material) were recorded by FNP and JM on August 29, 2012 at the edge of a secondary forest at the Sítio Monte Rey (505936E/9533989N), near the town of Guaramiranga in Ceara State, northeast Brazil. This particular site (a small farm) is infested with *A. fulica*, which can be easily located in open areas and in the understory of the forest.

Results and discussion

A male of *T. major* was observed to catch juvenile snails, bring them repeatedly to the same stone (roughly oval shape, $\approx 20 \times 10$ cm), and break the shell by repeatedly striking against the “anvil.” This same individual was observed engaging in this activity four times over several days. Two other large piles of broken shells (estimated fragments from >10 individual snails) were also observed: one next to a stone and the other next to the iron base of a broken plant pot in an open area between the farm residence and the forest. The breaking of the shell in these two anvils was heard simultaneously, indicating that this behavior was not restricted to a single individual. There was no evidence of shell-breaking behavior in adjacent forest sites, possibly due to the lower density of *A. fulica*.

Great antshrikes are strongly omnivorous, feeding on a wide range of taxa that include seeds, crustaceans, insects,

arachnids, mollusks, and small mammals (Beltzer 1987). However, these observations are the first documented account of tool use in this species. Given the ecological context, it is highly likely that this behavior is an example of flexible tool use, which developed in the absence of three key barriers (as defined by Hunt et al. 2014). First, there was a need to learn that an object can be used to facilitate solving a problem (extracting large snails from their shells) that would be difficult to solve without the tool. The smaller sizes of the majority of Brazilian snail species and their lower relative abundances may have reduced the selective benefits of this behavioral innovation in other sites. Second, there was an adequate working memory for adopting tool use. As an omnivore, *T. major* already had a broad repertoire of prey-capture behaviors and was thus a good candidate for tool-using behavior. Third, the practical difficulty of manipulating the object in a controlled way was low. As seen in other anvil-using birds, the physical act of breaking shells on rocks is relatively straightforward in terms of physical manipulation.

Giant African land snails were accidentally introduced into Brazil in the 1980s (Thiengo et al. 2007), and the snail-capture behavior documented here is likely to have developed at some time after this point. There is a small possibility that this behavior was already widespread in this species as a means to extract native mollusks. However, this is unlikely since mollusks typically make up a small fraction of the diet of *T. major*, with most populations specializing on arthropod prey (Beltzer 1987; Ridgely and Tudor 1994). Thus, the most parsimonious explanation is

that tool use in this particular population is a flexible behavioral trait that arose due to the high density of exotic snails in this locality. Such a rapid development of tool use as a strategy to optimally exploit this abundant food source provides a potentially interesting case study of the origins of tool use. Given the huge damage being caused by *A. fulica* in South America, predation at high levels by an abundant native species may also have practical implications in relation to controlling this highly problematic mollusk (Carlsson et al. 2009).

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