

The Arboreal Foraging Behavior of the Frugivorous Monitor Lizard *Varanus olivaceus* on Polillo Island

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Abstract - Conjecture exists over the degree that arboreal frugivorous foraging is used by *Varanus olivaceus*. Here I present evidence from still camera traps, video camera traps, direct observations and spool and line tracking that indicate these monitor lizards take fruit directly from trees, rather than feeding exclusively on fallen fruit as suggested previously.

Introduction

The butaan, *Varanus olivaceus*, is an obligately frugivorous monitor lizard restricted to Luzon, Polillo and Catanduanes islands in the northern Philippines. Its diet consists almost entirely of fruit and snails. In his seminal work on the species, Auffenberg (1988) stated that butaan fed exclusively on fallen fruit from the forest floor and rarely, if ever, took fruit from trees. However, a ten year study of the species on Polillo Island in Quezon Province found no evidence to support his assertion that the lizards typically forage on fallen fruit. Direct observations and evidence from camera traps and spool and line tracking indicated that the animals normally climbed fruiting trees of all species and picked fruit directly from branches or syncarps.

Methods

All investigations were carried out in and around Sibulan Watershed Reserve, Polillo Island Quezon Province (14° 45' N; 121° 57' E) between July 1999 and May 2009. Habitat was primary and secondary lowland dipterocarp forest.

Spool and line tracking

Twenty one butaan of between 1 and 9 kg were released at the point of capture (or best guess) with 1-6 cocoon bobbins of polyester thread (Danfields, Leigh, UK) tied in color-coded series and wrapped in plastic, attached to the proximal third of the tail with duct tape.

Each spool contained about 240 m of thread and weighed 5 g. Total weight of the devices was between 12 and 55 g. Threads were followed and characteristics of trees climbed (species, fruit absent/present) were noted.

Camera trapping

Trailmaster 550 passive infrared camera traps (Goodman & Associates, Lenexa, Kansas) with Canon Sureshot A1 35 mm cameras (Canon Inc., Ota, Toyko) and Trailmaster 770 passive infrared video traps with Sony camcorders were set at fruit-bearing trees of species known to be locally important in the diet of *V. olivaceus* (Bennett & Clements, this volume).

Direct observation

Volunteers equipped with video cameras were positioned in camouflaged hides 4-8 m from fruiting *Pandanus*, *Canarium* and *Microcos* trees, usually from 0700 h until 1800 h. To reduce observer effects, individuals were deprived of mosquito repellent, food, cigarettes and music. All vertebrate visitors to the tree were recorded and filmed when possible. Footage obtained was examined and foraging behavior recorded.

Results

None of the thread trails from spool and line tracking suggested that lizards had foraged for fallen fruit below the canopy, although fresh digging suggested the animals often stopped to root around in decayed wood,

Table 1. Arboreal foraging events recorded by different methods.

Species	Observations	Spool and line	Video camera traps
<i>Micrococos stylocarpa</i>	9	1	4
<i>Canarium</i> spp.	7	4	5
<i>Pinanga insignis</i>	0	3	0
<i>Ficus</i> sp.	0	1	0
<i>Gnetum gnemon</i>	0	2	0
<i>Pandanus</i> spp.	19	3	10

apparently searching for snails. Spool and line data from 12 individuals indicated that lizards climbed *Canarium*, *Pandanus*, *Pinanga*, *Micrococos*, *Gnetum* and *Ficus* trees while they were in fruit (Table 1). In all cases the threads led to and from the trees in a more or less straight line.

Eighty four days of observations from hides between 2003 and 2009 recorded 35 visits by *V. olivaceus* to fruiting trees (Table 1 and Fig. 1). All lizards approached fruiting trees directly and climbed the trunk without foraging for fruit on the ground. During three of nine events at *Micrococos* trees the lizards appeared to show interest in fallen fruit (stopped walking, flicked tongue at fallen fruit), but were not observed to eat any of it. In all events observed, lizards climbed the fruiting trees and picked fruit directly from peduncles or syncarps, often selecting fruit from more than one branch.

All 19 sequences from infra-red triggered video traps all indicated that lizards climbed trees to obtain fruit and appeared to ignore any fallen fruit below the canopy.

Seven hundred and twenty nine events from camera traps indicated that lizards climbed fruiting *Pandanus*, *Canarium* and *Micrococos* trees and typically remained there for periods of 11 - 30 min depending on species. No lizard was recorded spending more than 111 minutes in a fruiting tree.

Discussion

Auffenberg (1988) made the following remarks about the foraging habits of the butaan (page 207): “*In spite of the fact that V. olivaceus* claw marks are often found on the trunks of trees whose fruits they eat, the scratches are also found on many other species whose fruits they do not eat. I have never seen any individuals feed in the trees, nor have any hunters stated so with any degree of conviction. Though adults can and do climb out onto terminal branches of some tree species, other species have slender terminal branches that

are not capable of supporting them. The butaan is not morphologically or behaviorally adapted to feed effectively in terminal branches, in spite of the fact that some of its fruit species have remarkably robust terminal twigs. Almost all food selection takes place on the ground. The only regular exception is *Pandanus radicans*; its drupes are evidently picked individually from the syncarp (see chapter 11). All fruits growing in trees are selected after the fruit have fallen”.

That peduncles are rarely ingested along with fruit is supported by an examination of nearly 2000 fecal samples from *V. olivaceus* on Polillo Island (Bennett, 2008 and field notes), only one of which contained identifiable twigs (from a *Canarium* tree). That butaan take *Pandanus* drupes directly from the syncarp is confirmed by this study. My observations suggest that *Pandanus* drupes do not fall from syncarps until they are overripe, and that butaan often ignore the lowest drupes (which detach easily) in favor of perfectly ripe ones higher up the syncarp that require considerable force to remove.

Auffenberg (1988; Table 9-12) gave terminal twig diameters of trees whose fruits are regularly eaten by *V. olivaceus*. Of the species listed, *Micrococos stylocarpa* (identified at *Grewia stylocarpa* in Auffenberg, 1988) has the slenderest terminal twigs (range 3-4.9 mm, mean 3.4 mm, SE 0.15). Footage obtained for a wildlife documentary at the Polillo study site in May 2005 (Mutual of Omaha’s Wild Kingdom, 2006; Fig. 2) shows a butaan estimated at 5 kg picking fruit from the terminal branches at the top of a *Micrococos* tree and indicates that Auffenberg underestimated the dexterity of the lizards in trees. It follows that if large butaan are able to forage in *Micrococos* trees, there is no morphological or behavioral impediment to their feeding in any of the tree species whose fruits are commonly consumed.

Data from camera traps do not provide direct evidence of lizards picking fruit from trees (except for *Pandanus* spp.) because the cameras were trained on



Fig. 1. *Varanus olivaceus* eating fruit in *Canarium* tree – from video taken by **Alice Clarke**. Polillo, 27 April 2005.



Fig. 2. *Varanus olivaceus* feeding in *Microcos* tree – Polillo, May 2005. From video by **Simon Normanton/Steel Spyda**.

tree trunks whilst the fruit was in the canopy. However, it is difficult to interpret the multiple short visits to fruiting trees made by many different individuals in any context other than arboreal foraging behavior. In the case of video camera traps, footage shows butaan approaching *Canarium* trees without making any obvious deviations to look for fallen fruit.

In his discussion of fruit availability and foraging behavior, Auffenberg (1988) makes it clear that, with the exception of *Microcos*, the number of fallen fruits available to butaan from individual trees is very low. Thus, although a lizard that climbs a fruiting tree would usually have access to far more fruits than it could possibly consume at one time, an animal restricted to fallen fruit might have to forage under a number of trees to fill its stomach.

The descriptions of feeding behavior in *V. olivaceus* given by Auffenberg (1988) all appear to have been recorded from captive animals and it is not clear whether any free living animals were observed taking fruit from the ground during his study. Elsewhere in the book he states that plans to watch animals from hides were abandoned early in the project because dense vegetation made it impractical. The fact that arboreal foraging was not observed is therefore not a reliable indication that it did not occur.

No observations were made of butaan feeding at *Caryota* or *Livistona* trees. Scratches that looked like butaan claw marks were recorded on *Caryota* trees, but such marks on the trunks of fruiting trees are not a reliable indication of feeding activity of *V.*

olivaceus because the sympatric monitor lizard *V. marmoratus* often climbs the same trees (particularly *Pandanus spp.*) in search of animal prey between leaf axils. Local guides on Polillo were skeptical about the butaan's ability to climb *Livistona* trees, and the possibility that the animals are obliged to take these fruits from the forest floor cannot be discounted. Fruits of both *Caryota* and *Livistona* are rare in the diet of *V. olivaceus* on Polillo and were also rare in Auffenberg's (1988) sample (on Polillo 6.1% of 1604 fecal samples contained *Caryota* seeds and 4.7% contained *Livistona* seeds; Auffenberg reported finding *Caryota* in 4.3% and *Livistona* in 0.5% of his samples).

There is no obvious reason why butaan would take fallen fruit in preference to fruit that is still attached to the parent tree, unless they were unable to reach fruit in the canopy or lizards perceived the fruit-bearing canopy as dangerous. My experience with the lizard suggests that they spend as little time on the ground as possible. That they never overnight in fruiting trees is probably due to the fact that these trees provide neither suitable hollows nor dense thickets in which to shelter. That they apparently spend as little time as possible in fruiting trees before returning to larger trees that provide greater protection from predators, and that they appear to approach fruiting trees directly without searching for fallen fruit below the canopy makes it unlikely that they would preferentially take fruit from the ground. In contrast, snails are probably found and consumed on the forest floor rather than in trees (Fig. 3). Spool and line tracking of the large (mean mass 46.0 g,



Fig. 3. *Varanus olivaceus* with snail. Polillo, 5 September 2004 – from camera trap.

mean length 69 mm, N = 29) *Helicostyla* species most common in the diet of the butaan on Polillo suggests that the snails are largely terrestrial, rarely climbing higher than 3 m in trees (unpublished data). Spool and line tracking of lizards indicates that they often dig under roots and rotting wood in search of snails, and that the shells are crushed and discarded on the ground (unpublished field notes).

The present study suggests that Auffenberg's (1988) posit about the terrestrial feeding habits of *V. olivaceus* was probably in error. Although butaan of all sizes do forage on the ground for animal prey (almost exclusively snails and hermit crabs in the case of animals > 2kg) and may collect fallen fruit (especially *Microcos*) when there is none left in the parent tree, the present study indicates that the animals preferentially take fruit directly from the canopy, and that they are adept at doing so.

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