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Intraspecific variation in opportunistic use of trophic resources by the lizard *Ameiva corax* (Squamata: Teiidae)

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Abstract. *Ameiva corax* is restricted to a small island (<2 ha), off the coast Anguilla. We present information on intraspecific variation in its diet, based on observations of 190 marked individuals. Larger individual were more likely to attempt to enter active seabird nests and only large males were observed to successfully enter a nest and break open an egg. Flower eating was commonly observed and its occurrence was not related to lizard size or sex. More than half the population was observed visiting areas where fisherman mixed their bait, a foraging strategy also unrelated to lizard size or sex. *Ameiva corax* is known to socially feed at large food items such as seabird eggs. The individuals that can initially access these food items may occupy key roles in the social network.

Keywords: diet, flower-eating, foraging, natural history, ovivory, seabird.

The lizard *Ameiva corax* (Censky and Paulson, 1992) is a diurnal, terrestrial, active forager endemic to a small island off the coast of Anguilla, British West Indies. Their diet includes a wide range of food types including seabird eggs, fish scraps, prickly pear fruit, invertebrates, and the leaves and flowers of a variety of plants (Hodge, 2000; Censky and Powell, 2001; Hodge et al., 2003; Eifler and Eifler, 2011). Social foraging has been observed at larger food items such as bird eggs and prickly pear fruit, where multiple lizards may feed simultaneously (Eifler and Eifler, 2014). The larger food items may be physically difficult for a lone individual to open, as efforts by a single lizard to bite into seabird eggs or break them open by rolling them into rocks usually fail; eggs are also defended by nesting birds (Eifler and Eifler, 2014). Feeding on, or the initial access to, eggs and prickly pear fruit could be limited to a subset of foraging *A. corax* (Eifler and Eifler, 2014). We investigated whether *A. corax* exhibited intraspecific variation in its use of key food sources, particularly the larger diet items associated with social foraging.

From 2-29 June 2014 we conducted a study of space use patterns for *Ameiva corax* on Little Scrub Island (18.30833°N, 62.9667°W), situated approximately 1.3 km NE of Anguilla in the British West Indies. Little Scrub is a small island (1.2 ha) and consists of approximately 60% bare rock; the remaining 40% is vegetated by moonvine (*Ipomoea violacea*), prickly pear cactus (*Opuntia dillenii*), various grasses and succulents, and a small amount of rabbit-bush (*Portulaca oleracea*). We captured lizards occupying the vegetated portion of the island by noosing, and then measured (SVL and mass), sexed by probing, and individually marked them with unique combinations of colored beads (Fisher and Muth, 1989). We determined lizard locations using Cartesian coordinates based on lizard distance and compass direction relative to a system of reference points. During the course of the study, we repeatedly traversed the study area as we surveyed for marked individuals and conducted focal observations. We recorded instances of resource use whenever they were encountered. Three potential food sources dominated our records: 1) bird eggs, 2) rabbit-bush flowers, and 3) fish scraps left by fishermen mixing chum.

Four bird species nested in our study area: Zenaida doves (*Zenaida aurita*), Brown Noddies (*Anous stolidus*), Bridled Terns (*Sterna anaethetus*), and Laughing Gulls (*Larus atricilla*). As we located bird nests, we recorded their position relative to our spatial reference system. Once located, we marked the nest, identified the bird species using it either by observing the attending adults, or by inspection of the eggs present, and recorded the status of the nest (active, egg(s) present, egg hatched, chick present, abandoned nest,

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etc.). Throughout the study we also recorded any changes in nest status, as well as the identity of lizards observed trying to enter nests and, when possible, whether they attempted to open eggs and eat them. We also recorded instances of lizards eating flowers from rabbit-bush (*Portulaca oleracea*), which is scattered throughout the vegetated areas of the island. Flowers open soon after sunrise and close by mid-to-late morning, corresponding with peak lizard activity (pers. obs.).

On 3-6 days per week during the study, local fishermen used a small part of our study area to mix sand into their bait (i.e., chumming), which facilitates dispersal when the bait is tossed into the water. Six small areas (approximately 1 m radius) were used by fishermen on a rotating basis, with two main areas in use once or twice each week, and the remaining areas in use only once or twice during the 4 weeks of our study. No more than two areas were used for chumming on a given day, and at most, chum was mixed twice in one day. After mixing their bait, bits of fish were left in the sand that provided easy access to food for the lizards, making chumming areas hubs for lizard activity. We recorded the identity of all individuals observed to have visited at least one of the chumming areas.

A fourth diet item, prickly pear, is potentially important to *A. corax* (Eifler and Eifler, 2014), but ripe fruits were not present in the study areas during most of our study. We examined intraspecific variation in diet by determining whether size or sex played any role in the likelihood of individuals entering nests, opening eggs, eating rabbit-bush or visiting a chumming area.

We captured and marked 190 lizards (102 males, 88 females), and observed lizards attempting to enter active nests 61 times (table 1). Some lizards managed to enter nests while others were repelled by attending adult birds. Lizard size (SVL) was a significant predictor of nest interest (Binary Logistic Regression; SVL: $\chi^2_1 < 4.25$, $P = 0.039$), with larger individuals more likely to have been observed trying to enter a nest; males are larger than females (mean ± SE, SVL: 94.6 ± 1.4 vs 84.7 ± 1.1 mm; T-test: $t_{184} = 5.73$, $P < 0.001$). Neither sex nor the interaction between size and sex was associated with the likelihood of an individual trying to access an active nest (Binary Logistic Regression; Sex: $\chi^2_1 = 0.461$, $P = 0.54$; SVL-Sex interaction: $\chi^2_1 = 0.50$, $P = 0.479$, table 1). Compared to the study population, there were proportionately more male lizards visiting bird nests than females ($\chi^2_1 = 13.04$, $P < 0.001$). We observed 10 eggs being opened by 7 male lizards, and 0 eggs being opened by females. Males that opened eggs were significantly larger than males that did not open eggs (SVL: 111.7 ± 4.6 vs 92.7 ± 1.3 mm; T-test: $t_7 = 3.98$, $P = 0.005$, fig. 1). In addition, we observed 109 instances of 46 lizards eating rabbit-bush flowers (table 1). The likelihood of eating rabbit-bush flowers was not related to lizard size (SVL), sex, or the interaction between size and sex (Binary Logistic Regression; SVL: $\chi^2_1 < 0.01$, $P = 0.970$; Sex: $\chi^2_1 = 0.01$, $P = 0.757$; SVL-Sex interaction: $\chi^2_1 = 0.17$, $P = 0.680$). We observed 108 individuals visiting at least one of the feeding areas (table 1). The likelihood of visiting a feeding area was not related to lizard size (SVL), sex, or the interaction between size and sex (Binary Logistic Regression; SVL: $\chi^2_1 = 0.47$, $P = 0.495$; Sex: $\chi^2_1 = 0.09$, $P = 0.769$; SVL-Sex interaction: $\chi^2_1 = 0.03$, $P = 0.863$).

Table 1. Distribution of feeding events by lizards of each sex. The study population included 102 males and 88 females; there were proportionately more occurrences of male lizards visiting bird nests than females ($P < 0.001$).

Foraging event	Number of		Number of occurrences by	
	Males	Females	Males	Females
Enter bird nest	19	9	47	14
Eat rabbit-bush flowers	24	22	59	50
Visit chum area	57	51	–	–

Ameiva corax diet reflects intraspecific variation with respect to accessing and opening seabird eggs, but not with respect to smaller items like scraps of fish at chumming areas or rabbit-bush flowers. Although an interest in seabird eggs was present throughout the population, the actual accessing of eggs was restricted to large males, which may be able to visit nests with greater impunity than smaller individuals. Our qualitative observations at nests provide some insight into the difficulties lizards must overcome to attain an egg meal. Lizards attempted to open eggs by rolling, scratching,

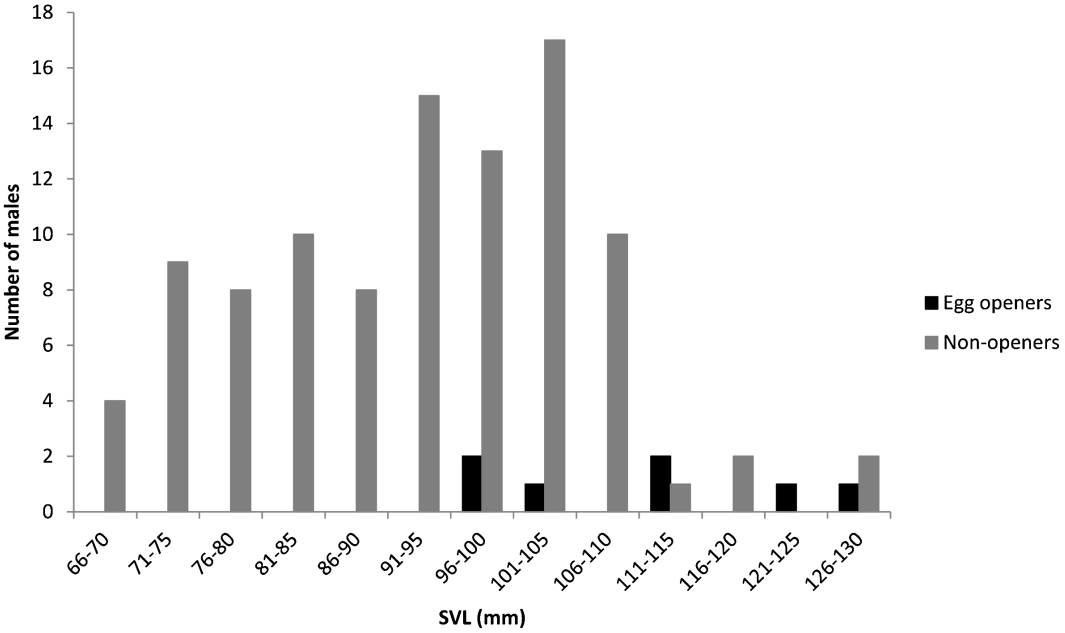

Figure 1. Size distribution of male *Ameiva corax* recorded as opening and not opening seabird eggs.

and biting the eggs; often, the eggshell appeared too thick or sturdy to be successfully opened by a lizard. On one occasion, over a period of 18 min, a single large male (SVL = 127 mm) rolled, scratched, and bit a tern egg. Several smaller lizards entered the nest during this time, but were chased away by the attending adult birds, while the large male attempting to open the egg was apparently ignored by the attending adults. In several other instances, we observed birds diving at lizards; smaller individuals typically scurried away from such attacks but large males continued their trajectories, seemingly unfazed by the birds. Once a large individual opened an egg, many other lizards shared the resulting food. During our study, we recorded several instances where up to five lizards were at a nest simultaneously. Observations at the chumming areas suggest that the number of individuals at a food source can exceed a dozen. How our observations translate into individual feeding success is the subject of future work.

Unlike obtaining an egg meal, eating rabbitbush flowers and scraps of fish at chum mixing areas have no entry barrier and present more diffuse food sources than bird eggs. Rabbitbush is dispersed throughout vegetated portions of the island, and individual flowers can be readily consumed by a single lizard. Similarly, the chumming areas contain bits of fish that are buried in the sand over a large enough area for multiple lizards to forage simultaneously, with ingestible pieces generally too small for more than one individual.

Social feeding observed in *Ameiva corax* may be linked to the characteristics of large, hard to access food items such as eggs and prickly pear fruit (Eifler and Eifler, 2014). Ripe prickly pear fruit was rare during the time of this study, but our observations suggest that social foraging at eggs is an opportunity made possible by a small segment of the population. Large males that open eggs may serve a unique role as suppliers. Among social feeding species, some animals serve unique roles and create situations where they then occupy pivotal roles in the social network (Giraldeau and Lefebvre, 1986; Stander, 1992; Pérez-Cembranos and Pérez-Mellado, 2015). The nature of the social

network in *A. corax* and the possibility of individuals occupying specific foraging roles merit further study.

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