

The Consumption of Dead *Incilius luetkenii* (Anura: Buffonidae) by *Ctenosaura similis* (Squamata: Iguanidae)

Lucía I. López¹ and José Manuel Mora^{2*}

¹Unidad de Ciencias Básicas e Ingeniería en Tecnología de Alimentos, ²Carrera de Gestión Ecoturística, Sede Central, Universidad Técnica Nacional, Alajuela, Costa Rica.

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Abstract: The Ctenosaur or Black Iguana (*Ctenosaura similis*) occupies xeric habitats in Mesoamerica from southern México to Panamá. Juvenile individuals consume mainly invertebrates, but they present an ontogenic change to herbivory as adults. Moreover, the species is highly omnivorous and consumes several types of organisms including young Ctenosaurs. However, the consumption of carrion is rare in this species with only one case of consuming a giant toad (*Rhinella horribilis*) reported. The current study reports the consumption of a dead Yellow Toad (*Incilius luetkenii*) by a young adult Ctenosaur at the dry forest of northwestern Costa Rica. This toad species is common in the dry forest of Santa Rosa National Park where it breeds explosively at the beginning of the rainy season. At this time, several individuals are killed by cars while crossing the roads, and the young adult Ctenosaur, it seems, took advantage of this situation for an easy meal.

Key Words: Black Iguana; Carrion eater; Omnivore; Tropical dry forest.

Introduction

Iguanidae is a Squamata family that contains forty-four species of mostly large herbivorous lizards, eight of which are critically endangered (Buckley *et al.*, 2016). The most diverse iguana genus is *Ctenosaura* with fifteen species (Uetz *et al.*, 2020). Among these, the Black Iguana or Ctenosaur (*Ctenosaura similis*) has the widest distribution ranging from the Isthmus

of Tehuantepec, Mexico, south to central Panama on the Pacific slope, and in several isolated populations along the Atlantic slope, from 0 to 1320 m elevation (Köhler, 2008). However, phylogeographic studies have found considerable variation within this wide-ranging taxon (Buckley *et al.*, 2016). As recognized at the moment, *Ctenosaura similis* is a large locally abundant iguana with no crest on the head, and a cylindrical tail that bears whorls of distinctly enlarged and heavily keeled spiny scales that are separated by rows of small scales (Mora, 2010). The standard length of adult males is 489 mm reaching up to 400 mm in females, and the total length is 1300 mm and 800 mm respectively (Leenders, 2019).

The *Ctenosaura* species generally occupy dry terrains with cacti or rocks, or dry forests with hollow trees and many rock crevices, which they use as refuge (Mora, 2010). The *Ctenosaura* is found in various types of habitats; for example, on the Pacific versant of Mesoamerica, it occurs primarily in wooded or semi-forested habitats in xeric environments (Mora, 2010), mainly in dry forests where it prefers open areas (Mora, 1989).

Ctenosaurs consume a wide variety of vegetal and animal food. Juveniles feed mainly on insects, but at the end of the first year of life, the proportion had decreased to only 6% (Mora, 2010). Adults have been considered herbivorous or omnivorous, carnivorous, or opportunists (Mora, 2010). However, frogs and toads are not common items that are consumed mainly because the Ctenosaurs have a diurnal activity with some exceptions (Mora, 1986).

*Corresponding author: jomora@pdx.edu;
josemora07@gmail.com

The Neotropical Yellow Toad (*Incilius luetkenii*) is an explosively breeding species, in particular, when males rapidly shift from a cryptic brown to conspicuous lemon yellow (Rehberg-Besler *et al.*, 2015). The very brief mating event coincides with the first rain of the year in their dry forest habitat (Doucet and Mennill, 2010). Right after the amplexus, males return to their cryptic coloration until the females complete the egg-laying and disperse (Rehberg-Besler *et al.*, 2015). The Yellow Toad is found across areas from Chiapas, Mexico, to northwestern Costa Rica on the Pacific slope, and in Guatemala, Honduras, and Nicaragua on the Caribbean slope, from sea level to 450 m (Leenders, 2016). This common toad is nocturnal and can be seen in a variety of open areas, including streambeds, disturbed pasturelands, and man-made bodies of water (Leenders, 2016).

Materials and Methods

Ctenosaurs are common at Santa Rosa National Park, Guanacaste Conservation Area, Costa Rica (Mora *et al.*, 2015), a UNESCO World-Heritage Site in northwestern Costa Rica (10°40' N, 85°30' W; WGS84; 297 m elevation). Tropical dry forests dominate the landscape of Santa Rosa where the rainy season lasts from May to November and the dry season from December to April in average years (Campos and Fedigan, 2013). However, the dry season extends sometimes for some more months, mainly due to El Niño phenomenon (Mora *et al.*, 2015).

The researchers conducted observations of the activity of amphibians and reptiles in Santa Rosa from 11 to 21 September 2015. They looked for amphibians and reptiles on the main entrance road to Santa Rosa and saw them feeding on termites on 12 September. The researchers checked for dead herps on this road in the morning of 13 September. On 18 September at about 10.00 p.m., the researchers drove to the main entrance gate and back to the headquarters area of the park (14 km) to look for anuran activity on the road after a heavy rain.

Results

The transition from the wet to the dry season in 2015 in Santa Rosa was delayed until mid-September was well passed with some few showers on the previous days. On 12 September 2015, there was a big storm with heavy rains in Santa Rosa. Termites reproductive caste emerged to mate, and there was a frenetic feeding activity of nocturnal creatures near the headquarters area including toads such as *Rhinella horribilis*, *Incilius luetkenii* and *Rhinophrynus dorsalis*. In the morning of 13 September, there were several dead amphibians in the main entrance road to Santa Rosa. The researchers counted fourteen toads, mainly giant toads (*Rhinella horribilis*) and yellow toads (*Incilius luetkenii*) and three small snakes in a section of 1.5 km of this road. The night before, the researchers observed many toads and frogs (mainly *Rhinella horribilis* and *Lithobates forreri*) on the road feeding on termites (up to 15 individuals/100 m). At 07:44 a.m., they found a young adult Ctenosaur feeding on a yellow toad. The iguana took it from the paved road. The toad, which was a big adult, was dead but basically with no damage. The iguana took the toad from the road and went to a rock where it swallowed it (Figure 1). The whole event took nearly two minutes.

In the afternoon of 18 September, it rained (approximately a twenty-minute shower) in Santa Rosa. The researchers only observed one frog *Lithobates forreri* (at 2220h) after driving 7 km to the main entrance gate and 7 km back to the headquarters area of the park. However, the researchers counted five *Incilius luetkenii* dead on the road on the first 200 m from the Santa Rosa headquarters area on the next morning.

Discussion

Extended dry seasons have a big impact on Santa Rosa organisms mainly due to food shortage. Even though Ctenosaurs are highly omnivorous and very opportunistic, some uncommon behaviors can be observed such as cannibalism during these periods (Mora *et al.*, 2015).



Figure 1. Young male Black Iguana (*Ctenosaura similis*) swallowing an adult yellow toad (*Incilius luetkenii*) at Santa Rosa National Park, Costa Rica.

Although the Black Iguana was documented consuming a post-mortem *Rhinella horribilis* (Pasachnik and Corneil, 2011), to the researchers' knowledge, this is the first report of this species consuming yellow toads. *Incilius luetkenii* and *Rhinella horribilis* have two parotid glands that secrete poison, although these glands are small in the first species (Savage, 2002). The researchers could not observe the condition of the glands when the male Ctenosaur took the Yellow Toad from the pavement.

Some organisms take advantage of amphibians that are dead on roads to feed on them, including snakes especially the cat-eye snake (Mora, 1999). *Incilius luetkenii* was the most registered species in 53% of the observations (695 individuals) in a five-month study conducted in the same conservation area (Monge, 2018). On the day following the termite caste emergence, several animals were observed feeding on

termites (including Ctenosaurs) or on herp carcasses (including some birds such as caracara falcons –*Caracara cheriway*, and roadside hawks –*Rupornis magnirostris*).

Ctenosaura similis is a true omnivore and a highly opportunistic predator. Juvenile individuals feed mainly on insects (Mora, 2010), and other arthropods including adult tarantulas *Aphonopelma crinitum* (Dion and Porras, 2014) and *Brachypelma vagans* (Avilés-Novelo *et al.*, 2019). However, they are mainly plant-eaters as adults (Mora, 2010). Large individual adults feed on leaves, buds, and fruits, but occasionally they consume lizards such as *Aspidoscelis*, *Sceloporus*, *Marisora unimarginata*, and *Basiliscus vittatus*; frogs, rodents, birds, eggs of other lizards and snakes, and bats (Fitch *et al.*, 1971; Henderson, 1973; Fitch and Hackforth-Jones, 1983; Mora, 1987; Cedeño-Vázquez and Beutelspacher-García, 2016; Avilés-Novelo *et al.*, 2019).

They even consume juvenile individuals of their own species (Mora, 1991; Mora *et al.*, 2015; García-Rosales *et al.*, 2020), and they have been observed taking recently hatched hawksbill marine turtles (*Eretmochelys imbricata*), while the hatchlings consume feces of adult individuals (García-Rosales, 2020). Scavenging of vertebrate carcasses is a less common dietary behavior in iguanas (Pasachnik and Corneil, 2011). There are observations concerning this behavior in *Ctenosaura pectinata* (Grant, 1967) and *Iguana iguana* (Loftin and Tyson, 1965). The consumption of *Rhinella horribilis* (Pasachnik and Corneil, 2011), and *Incilius luetkenii* reported here by Ctenosaurs supports an ontogenetic shift to an omnivorous diet in this species. It may be suggested also that carnivory in Ctenosaurs might be more prevalent than what was previously thought (Pasachnik and Corneil, 2011). Also, these observations show that the Black Iguana is one of few opportunistic scavengers of vertebrate carcasses in Iguanidae (Pasachnik and Corneil, 2011).

The Black Iguana is the *Ctenosaura* species with the widest distribution range and it is under the least concern category by the IUCN (Mora, 2010). However, this species is a model organism from the ecological point of view. Its interactions in the dry forest of Costa Rica such as the communal nesting behavior (Mora, 1989), cannibalism (Mora *et al.* 2015) and carrion eater (Pasachnik and Corneil, 2011) are examples of this condition. Besides, this species consumes fruits of several dry-forest plant species, mainly during the dry season, including *Vachellia farnesiana* whose seeds were found in the feces of this iguana which makes it an important seed disperser in this tropical forest (Traveset, 1990), which is one of the mostly threatened tropical ecosystems (Janzen, 1988).

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