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Ocelot (*Leopardus pardalis*) Predation on Agouti (*Dasyprocta punctata*)[1]

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ABSTRACT

We collected details on the predation of four agoutis (*Dasyprocta punctata*) by ocelots (*Leopardus pardalis*). All kills were made outside of the typical agouti activity period (<0500 h). Agoutis were captured from behind and killed with a bite through the back of the skull. The kill sites for two female agoutis were significantly closer to their den sites than expected, while kill sites for two males were not. All carcasses were completely covered by leaves during the day and were fed on during night hours. Predation by ocelots can be a significant cause of mortality for agoutis at Barro Colorado Island (BCI).

RESUMEN

Colectamos detalles en la depredación de 4 agoutis (*Dasyprocta punctata*) por ocelotes (*Leopardus pardalis*). Todas las depredaciones fueron fuera del periodo típico de actividad (<0500 h). Los agoutis fueron capturados por detrás y muertos con una mordida en la parte trasera del cráneo. Los lugares de muerte en las dos hembras fueron significativamente cerca de sus guaridas, mientras que los machos no. Los cadáveres fueron completamente cubiertos con hojarasca durante el día y fueron consumidos solamente durante la noche. La depredación por ocelotes puede ser una causa significativa de mortalidad de los agoutis en BCI.

Key words: agouti; *Dasyprocta punctata; Leopardus pardalis;* Neotropics; ocelot; Panama; predation.

DIETARY STUDIES OF OCELOTS (*Leopardus pardalis*) from North America and South America have documented more than 50 prey species across their range (Sunquist & Sunquist 2002), and support their characterization as generalist predators. Although they typically eat small prey, such as rats and birds, ocelots occasionally also feed on medium-sized prey, including agoutis (*Dasyprocta spp.*) that are one of the largest preys that ocelot capture. This was especially true in central Panama where medium-sized prey made up *ca* 60 percent of their diet, and agoutis were found in *ca* 20 percent of ocelot scat samples (Moreno *et al*. 2006).

Little is known, however, about the importance of this predation on agouti populations. Few records exist of ocelots killing larger prey (Sunquist & Sunquist 2002), and none of these describes ocelot kills or the way they handle their prey. Recognizing and describing the details of ocelot predation will help understanding the complex predator–prey community interactions in the tropics, and the role of ocelots as possible agents of natural selection and agouti population regulation. Here we describe the predation of four agoutis by ocelots.

This work was conducted in the tropical moist forests of Barro Colorado Island (BCI), 9°9′N, 79°52′W (for detailed descriptions of the area see Leigh *et al*. 1996). Agoutis were captured in Tomahawk traps (Tomahawk Live Trap Co., Tomahawk, WI, USA) and were immediately anesthetized with Telazol© which is a combination of Tilamine HCl and Zolazepam HCl (Aliaga-Rossel 2004). They were fitted with Telonics© radio collars (Telonics, Inc., Mesa, AZ, USA) that were equipped with activity and mortality sensors. The faster "mortality pulse" was set to trigger after 4 h of immobility by the collared animal. Animals were tracked by hand and with one automated telemetry receiver that sent live-activity data back to the laboratory through a 900-mHz freewave radio link (see http://www.princeton.edu/~wikelski/research/index.htm). On two occasions, we monitored recently killed agoutis with a motion sensitive Sony Night-shot video camera (CamTrak South, Inc., Watkinsville, GA, USA) with an Infra red light source.

We measured the distance between kill sites and the nearest den used by that agouti. We then compared these values with 1000 random points within each individual's home range (95% minimum

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convex polygon) and recorded the location of all ground dens and other potential refuges (*i.e.*, areas with low tangled vine areas) with a GPS (Aliaga-Rossel 2004).

From January to December 2003, eight agoutis were monitored with radio collars. Here we describe the circumstances around the predation events on four of the study animals, the forensic evidence from predator tooth marks on two additional agouti skulls, and the observation of two failed agouti hunts attempted by a young ocelot.

The carcass of agouti (F-Mu) (3 kg female) was discovered at 0600 h, on February 10, 10 m from her den. The collar changed to the mortality pulse at 0910 h, indicating that the animal was left by the predator at 0510 h (*i.e.*, 4 h of inactivity). The carcass would not have been found if not for the radio collar, as it was totally covered with leaf litter and hidden near a fallen tree. We examined the body with minimal disturbance of the area. The predator had already eaten parts of the neck, thorax, forefeet, heart, and lungs; the head was severed from the body. There were no visible scratches or cuts on the animal's back or flanks. We recovered the body with leaf litter, set up the video camera, and continued to monitor the pulse rate of the radio collar from 50 m away, a distance too great to be detected by the ocelot.

The video recorded an adult female ocelot arriving at the carcass at 1930 h. It picked up the headless body and carried it out of view, leaving the head and the collar in view of the camera. The same female (recognizable by her spot pattern) returned and was again recorded by the camera together with a female cub, and later a male cub arrived. The female cub carried the head out of view, but both mother and cubs were recorded walking around sniffing some hours after the head was removed. The next morning we found the agouti's skull in a vine tangle 7 m from where it had been in front of the camera; there were no other remains in sight. The skull was chewed, with the nasal bone missing, and clear marks of the upper canine teeth pierced the agouti's frontal and parietal skull bone. We left the agouti's skull and camera in the same place for 2 weeks, but did not register the return of the ocelot or any scavengers.

The body of agouti (M-Si) (3 kg male) was discovered at 1000 h, on April 21, after we detected the mortality signal. Again the body was completely covered by leaf litter and hidden, this time between the buttresses of a tree. It was lying 35 m from the agouti's nearest den. Time of death was estimated to be about 0500–0600 h, based on the collar signal. The neck had been partly consumed leaving the head attached to the body by one layer of skin. The chest wall had been eaten; there was a deep cut that ran from the scapula close to the rump, which appeared to be caused by claws of a predator. Again we left a motion-sensitive video camera at the site. At 1900 h the video registered the arrival of the same adult female ocelot as seen at the previously killed agouti, judging from her spot pattern. She slowly dragged the carcass away from the camera and out of site (Fig. 1). At 0600 h she returned to the area and sniffed around it during a heavy rain. Later, the remains of the agouti were found 5 m away in a clearing. The skull was mostly destroyed, with the frontal area eaten, and clear marks of canines puncturing though the frontal and the parietal areas. The lower mandibles were broken, and the radio collar had been partially chewed. Agouti hair and a piece of skin were found nearby, but the rest of the carcass was not recovered.

FIGURE 1. Female ocelot dragging the body of a killed agouti (M-Si) after unburying it.

The remains of depredated agouti (M-Ca) (2.75 kg male) were discovered at 0900 h on May 14, one day after the radio collar signaled that death had occurred. The only remains left at the site were some hair and the bones of hind leg. Evidence from the placement of these remains, and the disturbance to the leaf litter indicated that the predator buried the prey under leaves for one day and then carried the remains away to a different area. The collar and the visible remains were on the top of a large fallen log covered by vines, 20 m from this agouti's nearest den. The collar showed the same bite marks as observed during the other events. The predator did not eat part of the bones of the shoulder area, and there were fresh remains of ligaments and fragments of muscular tissue still adhered to the bones. We were not able to use the video camera in this case, but the marks and scratches in the collar and treatment of the carcass were similar to the other events so we concluded it was an ocelot attack.

The carcass of agouti (F-Shak) (2 kg female) was found at 1600 h on May 29. The timing of the start of the mortality signal indicated that this agouti was buried and left by the predator at 0600 h. We were unable to set the video camera. The agouti carcass was covered with leaves and lying in a vine tangle 15 m from her nearest den. Once again, part of the neck and chest were eaten, leaving the rest of the body intact. The collar changed from inactive signal to active signal at 1900 h, indicating that the carcass/collar was moved at that time. The next morning we found the collar and the remains 7 m from the initial location. The collar had bite marks as found in the previous cases; the skull was

broken and the nasal bone destroyed with sharp and deep punctures caused by canine marks in the base of the skull and the occipital bone. The only other remains observed were the femur and pelvis, both showing few scratches from the predators' teeth and little muscular tissue remaining. The tooth marks in the skull and on the bones lead us to conclude that this agouti was killed by an ocelot.

Agouti kill sites were 10–35 m from the nearest den. Compared with random points within their home range, these sites were closer than expected for the two females, but did not show attraction to dens for males (Table 1). There was no statistical significant effect when comparing these kill sites with the total area commonly used by each individual.

All the agoutis killed had minimal overlap in their home ranges (two overlapped by *ca* 20%, Aliaga-Rossel 2004). All the agoutis were known to live inside the home range of one adult male and two female ocelots (R. Moreno and R. Kays, pers. comm.).

Two other agouti skulls were opportunistically found at the study site. Both had bite marks similar to those created by ocelots on the collared agoutis they killed. These appeared as deep punctures the size of an ocelot's canines when they passed through the right side of the parietal bone and through the occipital bone. Based on tooth wear patterns, one agouti was an adult and the other a young adult. In the younger animal's skull the nasal bone was absent and there were cuts in the lower mandible.

Not all ocelot hunts are successful. Three of 14 agoutis live-trapped as part of this study had recent wounds apparently made by predators, and three others had similar healed wounds. Only one of these was deep enough to reach muscular tissue. The cuts were generally in the upper part of the shoulder or in the rump, suggesting that they were attacked by a predator from which they escaped. The patterns of the scratches and shape of the cuts were similar to each other and to that observed on the dead agoutis, leading us to conclude that they were caused by the claws of ocelots.

In addition, we visually observed a juvenile (*ca* 1 yr old) radio-collared male ocelot attempt unsuccessfully to capture an agouti. The ocelot's signal was first detected at 2100 h, as it approached a low tangled vine area where an agouti was sleeping. The ocelot approach caused the agouti to run to another low tangled vine area after it emitted a typical agouti alarm bark. The ocelot quickly followed the agouti, and the process of chase was repeated again, with short periods of fast activity, minutes of stalks toward the agouti and the escape, finally at 2125 h the ocelot moved to a different area. These alarm barks from other agoutis were heard often late at night or at dawn.

All agoutis were observed the day before their predation, and were left by the predator just before dawn. Therefore, it appears that all of these ocelot attacks occurred at night. Agoutis are thought to be strongly diurnal, typically leaving their nocturnal refuge and beginning their activity early in the morning (Smythe 1978, Aliaga-Rossel 2004). Although ocelots are primarily nocturnal, they are opportunistic predators and are known to hunt by day and night (Emmons 1987, Konecny 1989, Moreno 2002). Thus, it is surprising that these predation events all occurred during the active period for ocelots and what should have been the inactive period for the supposedly strictly diurnal agouti.

The two female agoutis were killed near a known den, suggesting that the animals were either pulled from the hole or caught resting just outside of the den. Since we found no evidence of a struggle in the dirt by the den, and ocelots are not known to pursue prey into burrows, we suspect the agoutis were outside of their den when caught. The kill sites of the two males were not significantly close to their dens, suggesting that they were active at the time. A possible explanation for the agouti activity at nighttime is that hunger drives them out to find fruit that has fallen during the night before their other food competitors do.

Judging from the position of holes in the agouti skulls, and cuts on the flanks of two of the carcasses, it appears that the ocelots caught the agoutis by grabbing their flanks or chest with their forepaws, and then dispatched the animals by biting the head and piercing the skull with their canine teeth. This is typical hunting behavior exhibited by many felids attacking medium-sized prey (Leyhausen 1979).

The ocelots apparently began to immediately feed on the kill, starting with the chest and the neck, followed by the abdominal area and limbs. They eventually eat part of the head, starting with the nose, but do not penetrate the cranium or orbits. Some muscles and bones are also eaten, such as the hind limb areas and the ribcage. Pieces of skin sometimes remained on the carcasses. We did not find evidence that the ocelot returned to eat the remains after more than 24 h, by which time there was little edible remains left. However, since ocelots moved the carcasses it is difficult to find remains. In the case of the three agouti carcasses found soon after dawn, the ocelot had already stopped eating, covered the body with leaves, and did not return until after sunset. Given that ocelots are reported to be active both day and night (Sunquist & Sunquist 2002), it is surprising that they did not return to feed sooner.

After their initial feeding, the ocelots hid the carcasses by dragging them to a tree buttress or vine tangle, and covering them with leaf litter. Although the leaf litter hid the carcasses amazingly well, and we would not have been able to find the fresh kills without radio telemetry, the female ocelot in both cases was observed to snatch up the carcass from under the leaves without any searching or hesitation. Carcass burying behavior is well known in other

TABLE 1. *The distance of kill sites from the nearest agouti den compared with random locations within the individual's 95% Minimum convex polygon.*

Animal ID	Sex	Kill site distance from den (m)	Random points in home range closer to den (%) range
F-mu	f	10	4.0
F-shak	f	15	7.0
M-ca	m	20	19.3
M- Si	m	35	43.8

felids, but we do not know of any previous description of it for ocelots (Labiski & Boulay 1983). Once the sun sets, the ocelot returned to retrieve the body and dragged it out of the sight of the camera.

Our video showed that the female brought her *ca* 7 to 8-mo-old cubs to the kill site, a behavior not previously recorded for ocelots, but common in other felids (Sunquist & Sunquist 2002). Because the adult immediately moved most of the carcass out of the view of the video, we have few details concerning their interactions here. However, the male cub was observed sniffing at and picking up the agouti's head and carrying it out of view, presumably to eat it. The carcass of the killed agouti was fully consumed after one day and night, which also could explain why it was not possible to find other remains of ocelot prey (Moreno 2002).

On BCI, agoutis are abundant (84.3–100/km^2 Wright *et al.* 1994, Aliaga-Rossel 2004) and are the most frequent prey item for ocelots throughout the year (found in 22% of 190 scats, Moreno *et al.* 2006). The predator population of BCI is typical of the region with resident populations of native mid-sized predators (*i.e.*, tayra, jaguarundi, margay) resident puma (Moreno *et al.* 2006), but infrequent visits by jaguar in the past 25 yr. There are no wild dogs and no human hunting. Ocelot populations were especially robust, with 21–25 individuals identified annually through camera-trap monitoring from 2000 to 2003 (J. Giacalone and R. Moreno, pers. comm.). Predation may have reduced agouti density since strip census counts of agoutis returned sighting rates of 2.15 agouti/km of trail in January 2003 (before our observations) and 1.38 in January 2004, which was the lowest sighting rate of agoutis since the mid-1990s (Milton *et al.* 2005).

Until now, however, the relative importance of ocelot predation for agouti populations was not appreciated, merely suggested by two studies of *D. leporina* in Brazil, which provided less detail on the individual predation events themselves. Silvius and Fragoso (2003) report that three of six agoutis with radio collars were probably depredated by ocelots over 3 mo, based on teeth marks on the collar (similar to those found in this work, Silvius, pers. comm.). Jorge (2000) reported high predation rates (six of ten collared animals over 4 mo), but this study did not determine the cause of death. Thus, in three studies that radio collared a combined total of 26 agoutis, at least 13 were killed within 4 mo of being monitored, probably all by felids. Although our sample size is small, the data suggest that predation by ocelots can be a significant cause of mortality for agoutis.

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