Crotalus aquilus in the Mexican state of México consumes a diverse summer diet

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ABSTRACT – We report observations of the summer diet of *Crotalus aquilus* (Querétaro dusky rattlesnake) from an agricultural region near San Pedro de los Metates, municipality of Acambay, state of México, Mexico. We recovered the remains of 12 individual prey items from 11 different snakes. Eleven of 38 (29%) snakes observed contained prey remains, including 6 mammals, 3 lizards, and 3 snakes. These observations suggest that *C. aquilus* consumes a diverse diet and that they may be more ophiophagous than many other rattlesnakes.

BASIC information describing the natural history and ecology of most Mexican snakes remains fragmentary, particularly for species endemic to the country. Despite recognition of the importance of dietary studies to both conservation efforts and snake evolutionary ecology, relatively few detailed studies of snake diets have been published (Holycross *et al*., 2002). In the absence of detailed studies, most available dietary information is anecdotal. Available dietary surveys often provide little information beyond a list of prey items consumed across the range of a species. While valuable, these studies provide little information about the dietary preferences of specific populations. In the case of many snakes endemic to Mexico, even less information is available (Campbell & Lamar, 2004). For example, we are aware of only one author who has provided information concerning the diet of *Crotalus aquilus*: Klauber (1997) mentioned a preponderance of lizards, particularly *Sceloporus* sp. among a group of *C. aquilus* (exact number of snakes unknown). Here, we provide detailed records of the summer diet of *C. aquilus,* a moderately small rattlesnake endemic to the central Mexican Plateau (Campbell & Lamar, 2004).

We collected snakes from an agricultural region near Acambay, state of México (*ca*. 2500 m elevation). The population of *C. aquilus* at this site occurs near the southern range limit for this species (Meik *et al*., 2007), and individuals in this population may achieve larger sizes than those in more northern populations (Mociño-Deloya *et al*., 2007). The climate is cool, subhumid, and relatively aseasonal, with rainfall concentrated in June–September. Most vegetation in this valley has been converted to agricultural use, and *C. aquilus* persists along margins of crop fields, in pastures, and remnants of more natural vegetation (Meik *et al*., 2007).

We obtained faecal samples from *C. aquilus* encountered during June, July, and August of 2006. Most snakes were found in the morning or early afternoon, and were processed the same day that they were found. All snakes were anesthetized with isoflurane (Setser, 2007), sexed, weighed, measured, and marked with subcutaneous PIT tags. We obtained faecal samples by expressing faeces during processing, and from snakes which naturally voided faeces. Additionally, we palpated some snakes with recent food boli; food items were gently pushed to the snake's mouth for identification, and when possible, pushed back to the snake's stomach following identification. We preserved faecal samples in 96% ethanol for subsequent identification. We identified lizard and snake remains to the greatest resolution possible using morphological (remains from palpated snakes) or scale (remains from faeces) characters. We identified mammal remains based on a microscopic examination of hairs (Moore *et al.,*

1974), and by examination of tooth and bone characters (Whorley, 2000).

We obtained prey remains from eleven adult or subadult (346–618 mm SVL) snakes (five females and six males). These snakes constituted 29% of the 38 *C. aquilus* which we captured, and 39% of adult and subadult snakes. We did not detect prey remains in any of the 10 neonates (164–193 mm SVL) we examined. We found mammal hair and/or bones in six samples; four of these samples were identified as *Microtus mexicanus*, one was identified as a *Sylvilagus sp.*, and one was too completely digested to be identified. All three lizards consumed were *Sceloporus torquatus*, the only lizard we have observed alive at the site. We encountered three snakes that had consumed other snakes. Of these, one snake contained a medium-sized, partially digested *Pituophis deppei* (Fig. 1). Two other snakes contained *Thamnophis sp*. scales. We have observed *T. eques, T. melanogaster* and *T. scaliger* at this site, however we do not rule out the possibility that the prey items may have been *T. scalaris* (not observed, but possibly present based on known range; Rossman *et al*., 1996).

In only one case were we able to obtain a precise measurement of a prey item's mass, a *S. torquatus* weighing 25.5 g (37% of the snake's mass). In four other instances, it was possible to roughly estimate prey mass by subtracting the snake's post-defecation mass from its initial mass (Table 1). In these cases, prey items weighed ca. 37% (*P. deppei*), 31% (*M. mexicanus*), 16% (*S. torquatus*), and 10% (*M. mexicanus*) of each snake's post-defecation mass. Other prey items were too digested to allow estimation of their original masses.

A single snake contained more than one prey item, a small (346 mm SVL) female contained a freshly ingested *S. torquatus*, and also deposited faeces containing *M. mexicanus* hairs. We recovered pieces of arthropod exoskeletons from one snake's faeces; however, like Prival *et al*. (2002), we consider it likely that these were secondarily ingested as the gut contents of a lizard prey item.

Mammals represented a much higher proportion of our sample than they did in the sample reported by Klauber (19 lizards and 2 rodents; 1997). Many

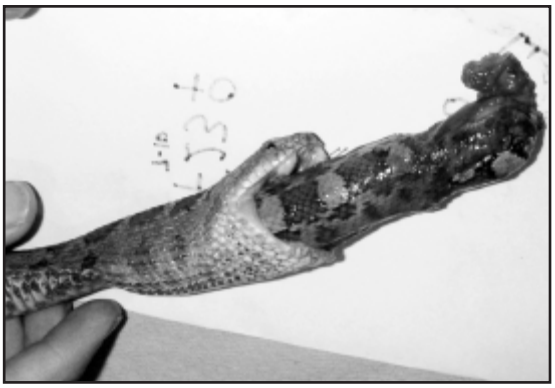

Figure 1. Adult male *Crotalus aquilus* from the state of México regurgitating the partially digested remains of a *Pituophis deppei*.

smaller rattlesnakes increasingly consume rodents at larger sizes (Holycross *et al*., 2002 and citations therein). Although Klauber did not itemize the sizes or localities of the snakes from which he obtained records, we suggest that it is likely that his samples were taken from smaller individuals from more northern populations. Snakes in the population we discuss may attain larger sizes than do snakes from more northern populations (Mociño-Deloya *et al*., 2007), and may also consume higher proportions of rodents. Despite this conjecture, we point out that the smallest (346 mm SVL) animal from which we recovered prey remains had consumed a *M. mexicanus*, and that many rodent species smaller than *M. mexicanus* are present in this area.

Perhaps most intriguingly, we encountered repeated evidence of ophiophagy by *C. aquilus*. All three *C. aquilus* that had consumed other snakes were large (524, 556, and 618 mm SVL) adult males. Ophiophagy is rare among rattlesnakes, although numerous anectodal reports exist (Campbell & Lamar, 2004). Although our data are limited, the frequency of ophiophagy in our small sample is notable and suggests that snakes may be an important element of the diet of this population during summer months.

Despite the inclusion of relatively large prey species in their diets (e.g. *Pituophis*, *Sylvilagus*, *Microtus*), none of the prey items we report constituted an unusually high proportion of the snake's mass (Pough & Groves, 1983). This reflects that *C. aquilus* is a relatively stocky snake,

that larger prey items were taken by large snakes, and that most prey items found were already partially or nearly completely digested. In particular, the *Sylvilagus* was likely a large meal for the snake which consumed it. While we were unable to directly estimate the size of the cottontail, it is possible to infer a minimum size based on hair characters. Based on the presence of identifiable guard hairs, the cottontail ingested had attained juvenile or adult pelage. Negus (1958) asserts that the molt from nestling fur to juvenile pelage in eastern cottontails in Ohio occurs when rabbits are at least 7.5 weeks old and weigh a minimum of 241 g. Cottontails occurring near Acambay may molt at younger ages or lighter masses, nonetheless, it is probable that the rabbit eaten was of equal or greater mass than the snake that ingested it (154.6 g). Pough and Groves (1983) mention that viperid snakes can swallow and digest prey nearly three times larger than themselves; hence it is not unreasonable that a large *C. aquilus* could swallow a juvenile cottontail.

All of the prey species recovered exhibit diurnal or crepuscular habits. Relatively cool summer night temperatures at this high elevation site may limit nocturnal foraging during the summer (rainy) season, although *C. aquilus* may forage more extensively at night at other sites or during warmer seasons at our study site.

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