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Eat Or To Be Eaten

I have always considered myself a calm, collected person, occasionally excitable but rarely in panic, the kind of panic that causes the vocal cords to explode and the heart to go into spasm. But that was before my face-off with a snake. This was on a pitch dark night a few months ago outside my garden gate. With keys in my right hand and a small LED flashlight in my left, I was reaching up for the padlock at eye level to open the gate. Smack in the middle of the two inch-diameter spotlight, I caught the movement of an undulating rope, one end of which appeared to be going straight for my nose. In that split second, *every* muscle of my body seized, not just those of the vocal cord and heart. Captured in my visual field, I saw the snake froze also. So there we were, practically rubbing noses, both rigid with terror (I know I was). Then a funny thing happened. My mind started to assert itself. It took stock of the size, shape, color, markings, head shape (two feet long, finger-thin, alternating brown and white, ragged rings, pronounced jaw, blunt head, very large red eyes). In a mere fraction of a second, my neurons quickly searched the mental database, found a match, and determined that it was non-poisonous. Then and only then did the mind "reconnect" itself to the body to render the latter functional again. I slowly backed away with my flashlight still focused on the snake's head. The snake responded by moving toward me! My feet stopped moving. My arms waved the light to the left, the snake head moved left. I waved the flashlight right, the snake moved right. Aha, it was tracking the light! I slowly inched sideways away from the lock and sure enough, the snake slowly unwrapped itself from my padlock, obediently followed the path of the moving light and eventually headed off in the direction of the trees with a bit more coaxing. Had it been a venomous snake staring back at me, I suspect my mind would have been paralyzed as well.

As result of that experience, one that was accentuated by my being in complete darkness, I learned several things about my own "involuntary" reactions. First, the mental paralysis came *before* I knew clearly that it was a snake. Second, the intensity of the fright was disproportional to the size of that snake. Had my mind been in a normal thinking mode, absolutely nothing that size could have elicit a similar response. Third, it was the horizontal S-shape coupled to the side-to-side motion that triggered the terror. If it were a piece of stiff wire swinging in the wind, I would still be terrorized. Fourth, this knee-jerking reaction was unexpected, as I consider snakes beautiful, worthy of respect and have worked to destigmatize them through public education. I had played with non-poisonous snakes, and would not hesitate to go near poisonous ones behind cages. True, I feared them during my childhood, but I believed I had overcome the phobia after years working at Nectandra. It appears now to be a more profound, more primal fear than I would have guessed.

I suspect I share this deep-seated phobia with at least two thirds of our cloud forest visitors, many with no personal exposure to actual snakes. Their reactions to our snakes range from fascination, curiosity, dislike, disgust, fright and outright ophidiophobia (abnormal fear of snakes). Many would shrink away from photographs or run out of the room when shown snake images. Innate fear of legless, slithery animals appears to be nearly universal.

In the last decade, snake phobia of humans and non-human primates has been the subject of many investigations by herpetologists, psychologists, physiologists, anthropologists and more recently, by neurobiologists. They believed that fear of snakes is very ancient (>75million years) and rooted in evolution. Early hominids lived in an environment dominated by dangerous reptiles, whose presence are well documented by existing fossil collections. Modern humans have evolved from ancestors with survival skills that include an ability to rapidly detect dangerous predators in the environment. More to the point, this reaction appears specialized for snakes. For example, psychologists have found that humans and primates react quickest to visual stimuli containing snakes compared to other visually similar images. In addition, human test subjects with ophidiophobia reacted statistically the fastest. Is this preferential ability to detect the subject of fear a learned response to environmental danger, or is it a physiological reaction?

The answer to the former has now been partially answered through a report from a multi-disciplinary scientific team consisting of herpetologists, anthropologists, psychologists and neurobiologists (Le, Isbell, Matsumoto *et al*, 2013). They used the combination of brain imaging (MRI) and probe sensors to study Japanese macaques bred in captivity and never exposed to snakes. The scientists were able to home in on the pulvinar region of the brain. They mapped, down to single neuron level, the neurons that respond preferentially to visual images of snakes shown to the

animals. These neurons reacted both faster and more intensely when the monkeys were shown photos of snakes under controlled conditions, compared to visual stimuli of other objects.

We fear reptiles for at least two likely reasons. They can harm or kill us via their venomous bites (snakes), but also because some of them may want to turn us into food (think crocodilians, pythons, boas). With respect to the first reason, death and serious injuries from reptiles are decreasing in modern times because of advanced technology (weapons, transportation) and medical intervention. For example, there are in Costa Rica 133 species of snakes, 19 of which are poisonous (5 coral snakes and 14 vipers). In the last decade, snake bites averaged about 500 a year, of which half needed treatment for microbial infections. A number of bites left residual tissue damage from the destructive and digestive enzymes of snake venoms, but deaths from venom intoxication were rare (0.2 per 100,000 inhabitants). There has been a 25 fold drop in the death rate since 1950. Elsewhere in the world, however, there are an estimated 20,000 annual deaths from venomous snake bites, most because the victims could not get medical support in time. If modern humans are still threatened by snakes, our ancestors must have had it worse, much worse, with only primitive weapons for self-defense.

The more intriguing source of fear—that of being preyed upon—is harder to substantiate. So little is known of the actual conditions and human predation by serpents in prehistoric time. Boas and pythons are more primitive, in an evolutionary sense, than the vipers, with lineages going back 100 million years ago. They are also the largest among snakes. While there are no known fossilized records of reptilian predation on primates, there are ample field observations of modern boas and pythons consuming monkeys and other non-human primates.

All snakes swallow their prey whole. Venomous snakes subdue and partially predigest their prey with a startling array of potent substances injected through their hollow, piercing fangs. These toxins cause rapid multi-organ destruction. In contrast, the larger non-venomous boas and pythons simply bite, coil around and squeeze their prey to death before swallowing them whole. Fig. 1 illustrates radio-graphically what happened to two macaques after being consumed by a python.

But is there evidence for humans being part of the reptilian food chain? Most herpetologists do not think so. An intriguing glimpse that they may wrong was revealed in a recent report of an anthropological study, circa 1960-70's, of an indigenous tribe in Luzon, Philippines. Anthropologists Thomas Headland and his wife Janet, lived and worked for several decades as lay missionaries among the Agta tribes. They collected meticulous ethnographic and census data of some 650 tribe members, who lived in small kin-related groups, had no permanent shelters, subsisted on wild meat. The pre-literate Agta tribesmen were short-stature, nomadic hunter-gatherers in the mountainous old-growth forest. The average adult Agta male weighed only 44.2 kg (97 lbs) and stood 1.4 m (4.5 ft) tall. At that time, 5-7m (16- 22 ft) long , 20-75 kg (44-165 lbs) reticulated pythons roamed throughout much of Southeast Asia and Indo-Australian Archipelago. The Headlands documented, at times with photos (Fig. 2 & 3), regular python attacks on the hunters as they foraged for wild meat, which often included that of the pythons. In interviews of 58 Agta men and 62 women, 15 men and 1 woman reported being ambushed by pythons. All of the attacks were successfully fought off with metal knifes or guns, although all sustained scarring bites, most to the lower limbs, some on arms and torsos. There were also 15 python invasions at dusk into their small huts, during which two children were killed, both were coiled by the snake, one was being swallowed headfirst. The Agta men interviewed knew of 6 more fatal, historical (1934 -1973) victims, one of whom involved an adult male whose body was recovered from the eviscerated snake. The Headlands were intrigued by their data, but filed them away where they remained for several decades.

Meanwhile, herpetologist Harry Greene at Cornell University was penning a book on the natural history of snakes, to be published in 2012. He recalled seeing a photo taken by the Headlands a decade before and finally tracked down the anthropologists at the Summer Institute of Linguistics in Texas. When shown the unpublished data, Greene was stunned by the significance of mutual Agta/python predation. Among the many aspects of the human-snake relationships discussed in their joint publication (Headland & Greene, 2011), several stood out. 1) Counter to current belief, large boas and pythons did attack and prey on humans regularly, 2) Conversely, humans also preyed on the boas and pythons for daily sustenance, and 3) Attacks by large snakes resulted in lasting injuries but could be successfully fought off with modern weaponry. The authors concluded that this dangerous ecological relationship between large reptiles and primates, including humans, went far back in evolutionary history. If living members of the human hunter-gatherers and large snakes compete for food and preyed on each other regular, it is likely that their ancestral counterparts also share this reciprocal persecutive and predatory relationship. It is therefore not surprising that we stand in terror of each other.

Note: I eventually identified the small snake at the gate as an uncommon, non-poisonous, nocturnal snail and slug-eating snake (*Sibon annulatus*, Fig. 4) of montane wet forest of Costa Rica. It has specialized sharp teeth to seize snails and jaws designed to pry the prey from their shells. Its prehensile tail is able to anchor the snake, almost fully stretched out to hold its position in space for many hours.

1. QV Le, LA Isbell, J Matsumoto et al., 2013. Proc Nat Acad Sci 110:47.
2. TN Headland, HW Greene., 2011. Proc Nat Acad Sci 108:1473.

—— *The Editor* —

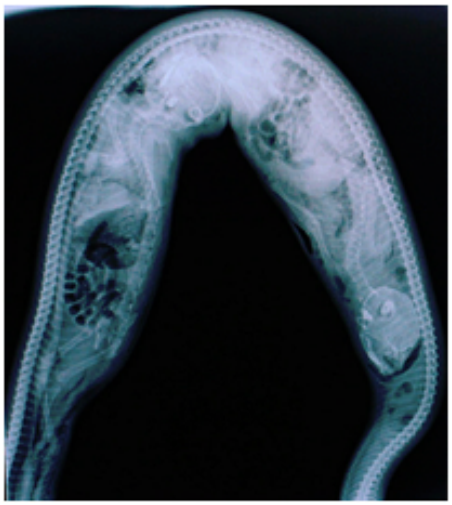

Fig. 1 Radiographs of two macaques swallowed headfirst inside the stomach of a python in Singapore (photo by A.Devan-Song, published in Headland & Greene, 2011)

Fig. 2 Python shot by two male adult Agta tribesmen. Note the relative size of snake to the men. (Photo by J Headland)

Fig. 3 Stretched skin of snake in Fig 2 after T Headland and the two tribesmen butchered to yield 25kg of meat. (photo by J Headland)

Fig. 4 *Sibon annulatus*, similar snake to the one wrapped around the lock to my gate.(photo by ET Lennette)

Other News Highlights 2013

*** *Reported by Luis Villa* ***

Jul 2013 Nectandra Institute staff and a group of local youths continued their semiannual biomonitoring of the waterways in the upper Balsa River Watershed. The participants were previously trained on a stream water quality assessment method that looks at the presence (or absence) of indicator aquatic macroinvertebrates to obtain qualitative contamination levels. Preliminary evaluation of the 23 sampling points indicated that worst water quality rating were all found to be in close proximity to agricultural lands with regular use of chemical pesticide. In fact, one of these points was located downstream from another point of better water quality rating located within an eco-loan financed property undergoing restoration. In

between the two points are a cattle ranch and potato fields.

Aug 2013 Bird monitoring, initiated with the communities of Angeles Norte and San Antonio, expanded to include the community of Pueblo Nuevo. Through a series of workshops, Nectandra Institute's staff biologist instructed the newest participants on the proper use of binoculars and sighting techniques, avian morphology, local species, feeding and mating habits, and migration patterns. Classroom learning is then followed by bird watching sessions in the field. Birding results are entered into eBird, a real-time, online checklist program launched in 2002 by the Cornell Lab of Ornithology and National Audubon Society. eBird receives, tracks, integrates global bird sightings into a managed central database. The stored data are accessible to anyone. With access to eBird, our local data can also be analyzed in the context of global avian distribution and movements. Tracking birds in and around eco-loan financed restoration properties is important because avian variety is a useful indicator of restoration progress.

Sept 2013 Nectandra Institute and its partners in the Balsa River Watershed celebrated the 6th annual New Culture of Water Month, a 30-day long festival hosted by a different community each year that shines a spotlight on watershed protection and environmental conservation. This year's edition included popular holdover events from prior festivals, including the Water Soccer Championship, the New Culture of Water Queen Pageant, and the second annual CRECER competition, which saw teams of students from several of the watershed's different grade schools answering environmentally-themed questions in an academic decathlon-type format and competing for the title of "Eco-Superstars". During the inauguration, we were treated to a wonderful speech by a young watershed resident in which she expressed the urgency with which we need to reboot our way of thinking about the natural world and live up to our reciprocal relationship with it.

Oct 2013 Twice each year, in March and October, a series of photos is taken from fixed points within each eco-loan financed property in order to visually document the advancement of ecological restoration. For the earliest property acquired under Nectandra Institute's land acquisition and protection program, we now have 12 sets of photos depicting the changes that have taken place over six years.

Oct 2013 Nectandra Institute staff members were invited to participate in the 5th World Conference on Ecological Restoration in Madison, Wisconsin, USA. The event hosted several hundred experts and collaborators who work on a variety of restoration programs and projects around the world. Nectandra's delegation had the opportunity to present on our eco-loan financing model both during a plenary session and a panel discussion titled "Economics, Human Communities, & Livelihoods in Restoration Ecology".

Nov 2013 Nectandra Institute organized a presentation by Dr. Pedro Arrojo to residents from our partner communities. Dr. Arrojo is an economics professor at the University of Zaragoza, Spain. He is a leading advocate for sustainable water use and management. Considered the founder of Europe's "New Culture of Water" movement, he pushes for a holistic view of water and its associated ecosystems. Arrojo reasons, for example, that a river is more than just a channel with flowing H_20; it is an entire ecosystem that supports a diversity of living organisms and provides an array of very real, although not always so apparent, services to humanity that are high in economic, social, cultural, and environmental value.

Dec 2013 Nectandra Institute co-sponsored the fourth annual "Conteo Navideño del Bosque Nuboso de Occidente" (Christmas Bird Count in the Cloud Forests of the Western Region). Nectandra Institute is a founding organizer of this yearly event. This year, approximately 65 birdwatchers participated, breaking out into groups of five to six people each and spread out over 14 different routes, one of which passed through Nectandra Cloud Forest Preserve and another which traversed the first community-owned restoration property purchased with eco-loan financing. The results for this year are still being tabulated, but last year, 351 species and 7131 individuals were spotted along 17 routes by approximately 80 participants. It's worth mentioning that the role of birds as seed dispersers is a very important part of forest restoration projects.

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