Nonspecific coprophagy of a free-ranging neonate *Gopherus flavomarginatus* LEGLER, 1959

During a field study aiming on mule deer movement ecology in the UNESCO Biosphere Reserve of Mapimí (BRM), State of Durango, northern Mexico; ≈103º45'/103º43'W; ≈26º40'/26º39'N) in June, 2015, the authors observed a neonate *Gopherus flavomarginatus* LEGLER, 1959 (age estimated by its size, according MORAFKA et al. 1989) feeding on two plant species (*Baileya multiradiata* and *Portulaca oleracea*) and droppings of the desert cottontail rabbit (*Sylvilagus audubonii*). The tortoise was followed for 40 minutes to identify its purpose, however, no definite direction was observed.

The Bolson Tortoise (LINER & CASAS-ANDREU 2008), *G. flavomarginatus*, is endemic to the central region of the Chihuahuan Desert. This region known as the Mapimí Bolson is characterized for low relative humidity and precipitation, high evaporation and temperature fluctuation, and a high solar radiation (MORAFKA et al. 1981). The BRM was decreed in 1979 to the protection of the Bolson tortoise due to its endangered status (CONANP 2006; SEMARNAT 2010). There are various studies of the Bolson Tortoise including ecological (MORAFKA et al. 1981; AGUIRRE et al. 1984; TOM 1988, 1994), reproduction (AGUIRRE et al. 1987; ADEST et al. 1989; GONZÁLEZ et al. 2000) and diet studies (AGUIRRE et al. 1979).

Gopherus flavomarginatus is an exclusively herbivorous species and its feeding is based on grasses, shrubs and annual herbaceous plants which include more than 20 species (MORAFKA et al. 1989). Herbivorous species lack digestive enzymes to break down ingested plant fiber, so they have developed a symbiosis with complex communities of microorganisms to aid digestion of cellulose and hemicellulose and get nutrient available (YUAN et al. 2015). Herbivorous reptiles are no exception, they need that vegetable fiber to be degraded by cellulase which is produced by intestinal bacteria (BJORNDAL 1987), a process that has evolved independently in tortoises (KING 1996).

Coprophagy in reptiles is rare (YUAN et al. 2015), but has been reported in some species of Testudinidae (FRYE 1991). Faeces intake is more important during the neonatal period when there is greater physiological feasibility of establishing microbiota (TROYER 1982), and once established, the intake volume increases to provide the high calories and protein requirements of growth (MORAFKA et al. 2000; MORAFKA 2002). For the genus *Gopherus*, it has been suggested that coprophagy from conspecifics occurs to acquire intestinal microbiota in the neonatal or juvenile stages (MORAFKA et al. 2000; MORAFKA 2002; LANCE & MORAFKA 2001), as in the case of *G. agassizii* (COOPER, 1861), ingesting conspecifics faeces to establish *Clostridium bifermentens* for cellulase production (DEZFULIAN et al. 1994).

Coprophagy is frequently observed in young *Gopherus* sp. tortoises under one year of age (BJORNDAL 1987; LANCE & MORAFKA 2001; MOORE & DORNBURG 2014). However, there are reports of nonspecific coprophagy in which faeces of other *Gopherus* species were ingested (LANCE & MORAFKA 2001; HENEN 2002), as well as rodents and lizards faeces (HENEN 2002), Black-tailed Jackrabbit (WALDE et al 2006), Rabbit droppings (AUFFENBERG & WEAVER 1969), and Peccaries faeces (MARES 1971).

Nonspecific coprophagy in some tortoises has been given with, for example, faeces of cat, dog and cow (COSTA et al. 2005), wild carnivores (SOLER & MARTINEZ-SILVESTRE 2011), and wild herbivores (MARES 1971; JOSHUA et al. 2010). These observations suggest that coprophagy aims to obtain microorganisms to break down plant fiber and absorb the available nutrients (BJORNDAL 1987) or micronutrients such as calcium necessary for growth of the shell or the development of eggshells in gravid females (MOORE & DORNBURG 2014). Nonetheless, it has also been suggested that coprophagy acts as a nutritional supplement in seasons when vegetation is scarce (SOLER & MARTINEZ-SILVESTRE 2011).

The rabbits' droppings are nutritious (WALLI DEVRIES 1996) and their fiber can serve as a source of trace elements or some other nutrients, and may be, though small, water (WALDE et al. 2006). The present ob-

servations suggest that nonspecific coprophagy by *G. flavomarginatus* could have these objectives, since the discovery was made in June when the average monthly rainfall was 2.9 mm and the average monthly temperature of 22.43 °C (CONAGUA 2015). On the other side, although *G. flavomarginatus* is endemic to the central Chihuahuan Desert (VAN DIJK & FLORES-VILLELA 2007), the Bolson Tortoises have not developed a local adaptation to arid environments since the Quaternary when they lived in non-desert grasslands (MORAFKA 1988; AGUIRRE et al. 1997). This could suggest that their nutritional requirements are still adapted to these former temperate environment and now, at the present arid conditions, render necessary the intake of mutualistic microorganisms through non-specific coprophagy.

Finally, another hypothesis might suggest that the coprophagy in *G. flavomarginatus* neonates is to obtain carotenoid pigments to the yellowing of the marginal scutes of the carapace, which is the main characteristic of the species (LEGLER 1959; MORAFKA et al. 1981; GONZÁLEZ-TRÁPAGA & AGUIRRE 2006). Egyptian Vultures (*Neophron percnopterus*) eat ungulate feces to obtain carotenoid pigments for their characteristic yellowing of the skin of the head (NEGRO et al. 2002). Carotenoid pigments, in addition to its pigment function, are considered micronutrients for their antioxidant and immunostimulant properties (BRITTON 1995). However, although in the Mapimí Bolson Mule Deer (*Odocoileus hemionus*) and other little herbivores (e. g., *Lepus californicus*) were present in the study area, the authors did not observe that the tortoise ingested faeces of these species.

The probability of encountering a *G. flavomarginatus* neonate is low to verify whether or not the nonspecific coprophagy is frequent in this stage of development, or seasonal (COSTA et al. 2005). However, the authors suggest that this behavior is to obtain anaerobic microorganisms (TROYER 1982) and small amounts of some micronutrients (SOLER & MARTÍNEZ-SILVESTRE 2011; MOORE & DORNBURG 2014), including some water-soluble vitamins (e.g., B-complex vitamins) and essential amino acids (GÁLVEZ 1985; SANTOMÁ 1989; MAIANI 1990; ROMERO 2008), small amounts of water, and probably pre-digested fiber (ROMERO 2008) due to the nutritional demands during the growth stage of tortoises (ANDREWS 1982).

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