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FIRST RECORD OF NECROPHAGY BY PILLBUGS (*ARMADILLIDIUM VULGARE*) ON THE LINED TOLUCAN EARTHSNAKE (*CONOPSIS LINEATA*)

PRIMER REGISTRO DE NECROFAGIA POR COCHINILLAS (*ARMADILLIDIUM VULGARE*) EN LA SERPIENTE TOLUQUEÑA RAYADA (*CONOPSIS LINEATA*)

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Resumen.– La necrofagia involucra alimentarse de carroña. Como algunos de los principales promotores involucrados en el proceso de descomposición, los cadáveres son mayormente consumidos por artrópodos de los órdenes Diptera y Coleoptera, así como la subclase Acari, aunque algunas veces otras especies pueden cumplir tal función. Observamos una de aquellas instancias tras levantar una roca, encontrando una gran concentración de cochinillas (*Armadillidium vulgare*) consumiendo los restos de una serpiente Toluqueña Rayada (*Conopsis lineata*). Este es el primer reporte, hasta donde sabemos, de este tipo de comportamiento inusual en México. Las cochinillas son usualmente detritívoras; entonces, sugerimos que el cambio en la conducta proviene de un posible intento de complementar su dieta, y por lo tanto incrementar la supervivencia de los organismos al adquirir nutrientes difíciles de obtener encontrados en la carne descompuesta, especialmente durante la temporada de sequía, época donde tuvo lugar este evento.

Palabras clave.– Carroña, Colubridae, dieta, Estado de México, Oniscidea.

Abstract.– Necrophagy involves feeding upon carrion. As some of the main drivers involved in the process of decomposition, carcasses are mainly consumed by arthropod members of orders Diptera and Coleoptera, as well as the subclass Acari, though sometimes other species may carry out such a function. We observed one such instance after lifting a rock, finding a large concentration of pillbugs (*Armadillidium vulgare*) consuming the remains of a Lined Tolucan Earthsnake (*Conopsis lineata*). This is the first report, to our knowledge, of this type of unusual behavior in Mexico. Pillbugs are usually detritivores; thus, we suggest that the change in conduct stems from a possible attempt to complement their diet and increase the survival of the organism by acquiring hard-to-obtain nutrients found in decaying flesh, especially during the dry season, when this event took place.

Keywords.– Carrion, Colubridae, diet, Mexico State, Oniscidea.

Amongst the many feeding behaviors found in nature, necrophagy is perhaps one of the most peculiar. Necrophagy consists of the consumption of carrion biomass, in either a facultative or an obligate manner, which provides the organism with valuable nutrients (Trujillo et al., 2021). Though other animal groups, such as elasmobranch fishes (Rada et al., 2015), non-avian sauropsids (e.g., snakes; Smith & Rojas, 2023), as well as birds and mammals (Demo et al., 2013; Olivia-Vidal et al., 2021) feature this behavior, arthropod fauna are the most heavily involved in the process of carrion putrefaction (Sawyer & Bloch,

2020). Though the species composition may change depending on environmental factors, the process of decay involves distinct periods of arthropod succession, usually spanning eight waves of different species (Braig & Perotti, 2009). These waves are mostly composed of insect species of the Diptera and Coleoptera orders (Maisonhaute & Forbes, 2020), with members of the arachnid subclass Acari involved, including during the first stages of decomposition (Braig & Perotti, 2009).

As they are rare, decomposing bodies in the environment create microhabitats that provide for many different communities (Barton et al., 2013). Besides serving as sustenance for necrophagous organisms, carrion also functions as refuge for 'non-associated arthropods', which include detritivores (e.g., organisms that consume decaying organic matter, primarily vegetation), such as crickets and terrestrial isopods (Sawyer, 2017). According to Segura-Zarzosa et al. (2020), in Mexico we know of at least 86 species of terrestrial isopods belonging to 16 different families, with a significant portion of them being non-native to the country. Within the Armadillidiidae family, recognizable for the ability of its members to roll themselves into a ball (Mulaik, 1960), one of these exotic species may be found. The pillbug (*Armadillidium vulgare*) is perhaps the most ubiquitous terrestrial isopod on the planet (Schmalfuss, 2013). *A. vulgare* possesses a convex, smooth body, colored dark grey or black, occasionally featuring yellow or brown spots (Mulaik, 1960; Segura-Zarzosa et al., 2020). It is known as a generalist detritivore, with a preference for plant litter (Rushton & Hassal, 1983; Faberi et al., 2011; Sánchez-Chopa & Descamps, 2019). However, there is evidence that this isopod species has presented cases of carnivory (Edney et al., 1974), herbivory (Paris & Sikora, 1965), and granivory (Saska, 2008).

Mexico has the second highest reptile species richness worldwide, with the most diverse snake family being Colubridae, composed of 319 species (72.7 % of Mexican ophidian species; Suazo-Ortuño et al., 2023). Found within family Colubridae, is the Lined Tolucan Earthsnake (*Conopsis lineata*), a relatively small, viviparous snake with burrowing habits, easily identified by the brown scales of the dorsal region, which are broken by three to five black, vertical stripes; this coloration sets the species apart from other members of the genus (Goyenechea & Flores-Villela, 2006).

On May 6th, 2016 at 11:18 h, under a rock within the Parque de la Ciencia Sierra Morelos in Toluca, Mexico State, Mexico (19.3155° N, 99.6909° W; datum WSG84; 2,700 m a.s.l.), we discovered the carcass of a snake. We identified it as a specimen of the Lined Tolucan Earthsnake (*C. lineata*), which was being eaten by a large concentration of terrestrial isopods (*A. vulgare*), amongst piles of sticks, leaves and other decaying vegetation (Fig. 1). The individuals of *A. vulgare* seemed to be the main necrophagous organisms consuming *C. lineata*. Though a significant portion of the head and body were missing, fragments of clean bone were found, namely vertebrae and ribs, alongside desiccated scales and skin. Based on the condition of the remains, we determined that the snake was in the fourth stage of decomposition, according to the classification by Braig & Perotti (2009). It was due to these remaining features that we were able to positively identify the remains based on the size and the scale coloration pattern. Both features are unique to *C. lineata* and not seen in any other ophidian which inhabits the Parque de la Ciencia Sierra Morelos. Furthermore, we first identified *A. vulgare* through the photographs taken on May 6th, 2016 (Fig. 1) and using the guides written by Mulaik (1960) and Segura-Zarzosa et al. (2020). To confirm our findings, we returned to the exact discovery site on February 26th, 2024 with Gabriel Suárez Varón taking a sample of the available terrestrial isopods. We then analyzed them under a stereoscopic microscope to corroborate the species.

As previously mentioned, terrestrial isopods in general are detritivores which consume decomposing vegetal matter, such as fallen leaves, allowing for its nutrients to be reused in the ecosystem (Gerlach et al., 2014). Thus, a question remains: why resort to the consumption of carrion? In terrestrial isopods, there seems to be a tendency to shift from one type of food to another during the drought season. Some species cease being vegetarians and become scavengers, a behavior previously observed in *A. vulgare* (Paris & Sikora, 1967). These changes in diet are to some extent seasonal and are reflected in the fatty acid composition of the isopod (Zar & White, 1969). This coincides with the observation date, as the month of May is the peak of the dry season at the study site. Furthermore, Wenting et al. (2023), notes that carrion contains valuable nutrients, including vital elements difficult to obtain in nature, such as cobalt (Co), as well as selenium (Se), which are accumulated in larger quantities in dead organisms. Mattson (1980) also talks about the importance of nitrogen to animals, and indeed, determines that arthropod herbivores tend to select food items based on their respective nitrogen dietary needs. Survival of juveniles and adults of *A. vulgare* is likely related to the nitrogen availability in their diets (Faberi et al., 2011), and as bodily remains tend to contain a higher nitrogen concentration (6-12 %) than plant detritus (1-2 %; Parmenter & MacMahon, 2009), it is plausible that the individuals of *A. vulgare* could be complementing their nutritional needs, especially during the dry season, where appropriate food items might be scarce, by consuming carrion. With these points in mind, the answer is clear: acquisition of

Figura 1. Cochinillas (*Armadillidium vulgare*) consumiendo los restos de un espécimen de la serpiente Toluqueña Rayada (*Conopsis lineata*), en el Parque de la Ciencia Sierra Morelos, Toluca, Estado de México, México.

Figure 1. Pillbugs (*Armadillidium vulgare*) consuming the remains of a Lined Tolucan Earthsnake (*Conopsis lineata*) specimen, at Parque de la Ciencia Sierra Morelos, Toluca, Mexico State, Mexico.

these otherwise difficult to obtain alimentary sources would greatly enhance the fitness of *A. vulgare* specimens, ensuring their survival.

It is also important to note that *A. vulgare* represents an invasive species (Schmalfuss, 2013) that has become a predominant pest in some agricultural areas which employ no-tillage methods, consuming seeds and seedlings that significantly decrease crop density (Faberi et al., 2011). The presence of *A. vulgare* is also related to a decrease in native isopod diversity, that cannot compete against their anatomical features, which grant them an increased tolerance to dry conditions and allows them to settle in fragmented and open habitats (Vona-Túri et al., 2018). Our findings exemplify the aspects that allow *A. vulgare*, and other invasive species to be so successful, that is, their capacity to better employ and exploit the resources on the sites where they are introduced, compared to native species (Simberloff, 2010), as well as adapting to adverse conditions (Burgiel & Muir, 2010). This can be clearly seen in this instance, as by partaking in an opportunistic feeding event upon the snake's remains, *A. vulgare* individuals in the Parque de la Ciencia Sierra Morelos are able to occupy a new environmental niche.

As far as we are aware, this is the first report of this type of unusual behavior in *A. vulgare* in Mexico. There are very few studies analyzing the responses of terrestrial isopods towards food items, and their significance related to growth or reproduction. We hope that the information presented here may complement the current knowledge in this invasive species of terrestrial isopod that has near global distribution.

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