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Depredación del cangrejo violinista, *Minuca osa* (Brachyura: Ocypodidae), por *Eudocimus albus* (Pelecaniformes: Threskiornithidae) en Ponuga, Veraguas, Panamá

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ABSTRACT

Numerous avian species prey on fiddler crabs, yet the ecological relationships involving *Minuca osa* crabs and their predators remain poorly understood. We report the first documented cases of *M. osa* predation by White Ibis, *Eudocimus albus*. Three distinct predation events were observed: June 3rd, 2021, November 10th, 2022, and November 25th, 2022, in the Gulf of Montijo, Veraguas, Panama. Examination of *E. albus* feces provided confirmation of such predator-prey interaction.

Keywords: White Ibis, Uca, mangrove, chela, camera trap.



RESUMEN

Muchas aves depredan cangrejos violinistas, pero las relaciones ecológicas entre *Minuca osa* y sus depredadores aviarios son poco conocidas. Se reportan los primeros tres casos documentados de depredación de *M. osa* por Ibis Blanco, *Eudocimus albus*: el 3 de junio de 2021, así como el 10 y el 25 de noviembre de 2022, en el golfo de Montijo, Veraguas, Panamá. Examen de las heces de *E. albus* confirmó la interacción depredador-presa.

Palabras clave: Ibis Blanco, Uca, manglar, quela, cámara trampa.

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INTRODUCTION

Fiddler crabs are semi-terrestrial decapod crustaceans that exhibit marked sexual dimorphism, with males possessing an extreme degree of cheliped asymmetry. Presently, there are 106 accepted fiddler crab species (Crane, 1975; Rosenberg, 2014), of which 28 are in Panama's Pacific (Crane, 1975; Rosenberg, 2014; Rosenberg, 2020) including *Minuca osa* (Lombardo, 2022). The first reports of *Minuca osa* from Costa Rica (Landstorfer & Schubart, 2010) and the Eastern Gulf of Montijo (Lombardo, 2022) in Panama revealed that there is no published literature on the ecological links between *M. osa* and its predators, activity patterns, or social interactions. Fiddler crabs are consumed by several avian predators, including shorebirds (Charadriiformes), rails (Gruiformes), and wading birds (Ciconiiformes); see Zwarts (1985) and Ens *et al.* (1993) for a comprehensive review. In Panama, known fiddler crab predators include three species of plovers, *Charadrius semipalmatus*, *C. collark*, and *C. wilsonia* (*Gelasimus panamensis*, *Leptuca inaequalis*, and *L. beebei*; Strauch & Abele, 1979), as well as Great-tailed Crackle (*Cassidix mexicanus*) (*L. terpsichores*; Kim *et al.* 2007). Other fiddler crab predators present in Panama include the Snowy Egret (*Egretta thula*), Herring Gull (*Larus argentatus*) (Crane, 1941), Cattle

Egret (*Bubulcus ibis*), and White Ibis (*Eudocimus albus*) (Kushlan, 1979; Christy, 1982; Christy, 1983); however, confirmed cases are unknown.

On the other hand, the White Ibis, *Eudocimus albus* (Pelecaniformes: Threskiornithidae), is one of the most abundant long-legged wading birds in southeastern North America (Kushlan, 1979; Frederick *et al.* 1996). They reside in freshwater and estuarine wetlands and subsist on small fish, crustaceans, and aquatic invertebrates. Their breeding habitat spans from coastal Colombia and northeastern Brazil to Virginia and possibly Cuba and Hispaniola (Frederick *et al.* 1996). White ibises are known to feed on a variety of fiddler crabs (Kushlan, 1979), including documented cases in *Leptuca pugilator* (Christy, 1982; Christy, 1983; Bildstein *et al.* 1989; Nomann & Pennings, 1998) and *Minuca pugnax* (Nomann & Pennings, 1998); however, there is no information on specific prey-predator interactions between *M. osa* and *E. albus*.

In the Eastern Gulf of Montijo in Panama, a colony of *M. osa* under study (since 2021) has been intermittently visited by *E. albus*; both juveniles and adults were observed exploring the substrate with their beaks, primarily over *M. osa* burrows. In view of the potential prey-predator interaction between *M. osa* and *E. albus*, the objective of this study was to document and clarify instances of predation by *E. albus*.

MATERIALS AND METHODS

The sampling site in the Ponuga River (07° 51' 51.3756" N, -081° 00' 52.6248" W) is located within the Eastern Gulf of Montijo, Pacific Panama. It is characterized by a long rainy season (April-December), mild flooding during spring tides and open understorey space bellow the canopy of *Prioria*

copaifera and *Avicennia germinans* trees (Lombardo & Rojas, 2022). A colony of *M. osa* (Fig. 1A) inhabits the site, where *E. albus* juveniles (Fig. 1B) as well as adults (Fig. 1C) search for food. The site was monitored for three days monthly to directly observe *E. albus* predation on fiddler crabs, from January to June 2021 and November 2022 to January 2023. Monitoring took



Fig. 1. Fiddler crab (*Minuca osa*) and White Ibis (*Eudocimus albus*) from Ponuga, Veraguas, Panama. A: Male (right) and female (left) *M. osa* in their natural habitat. B: White Ibis juvenile walking over burrow patch. C: Flock of adult and juvenile White Ibis. Scale bars: A = 35 mm, B = 20 mm, ♂ and ♀ = 10 mm

Fig. 1. Cangrejo violinista (*Minuca osa*) e Ibis Blanco (*Eudocimus albus*) en Ponuga, Veraguas, Panamá. A: *M. osa* macho (derecha) y hembra (izquierda) en su hábitat natural. B: Ibis Blanco juvenil caminando sobre parche de madrigueras. C: Congregación de Ibis Blanco, adultos y juveniles. Escala: A = 35 mm, B = 20 mm, ♂ y ♀ = 10 mm

place from the early morning to late afternoon (6:30 a.m. - 4:00 p.m.). All attempts to directly observe predation events were aided by using binoculars (Bushnell 10 x 42) fitted with a camera (iPhone 12 - $f/1.6$, 12MP) for photography and video. The November 2022–January 2023 monitoring period included five digital camera traps (UO-Vision UV-557, 5MP, CMOS-1.2s) distributed around the *M. osa* burrow patch to capture video of behavior without disturbance. Cameras were attached to surrounding trees at a minimum height of 1.2 m. To confirm *M. osa* consumption, ibis' droppings were examined for crab remains. Ibises were identified with [Angehr & Dean \(2010\)](#) field guide; crabs and their remains in ibis' droppings were identified with taxonomical keys ([Crane, 1975](#); [Landstorfer & Schubart, 2010](#); [Shih et al. 2016](#); [Rosenberg, 2020](#)).

RESULTS

White Ibis walked parsimoniously searching for food over burrows during low tide and visited the site only during rainy season months, an action we witnessed in 16 occasions. Out of these 16 occasions, predation on *M. osa* was observed three times: June 3rd, 2021, November 10th and 25th, 2022. The three events occurred in the early morning hours and were observed directly; the predation event from November 25th was captured

on video through binoculars (Fig. 2). When walking through burrow patches, ibises did so individually or in small groups (2-5) and targeted crabs outside their burrows. White Ibises also introduced their down curving beak into burrows, sometimes turning their head as to follow burrow curvature; only one instance of capture was observed with this approach (November 10th, 2022). Handling of prey took 9-16 seconds and likely broke the cephalothorax, which seemed to neutralize the major chelae of males. This was achieved by moving the crab from the tip of the beak to its base, where more pressure could be applied; then, they were ingested (Fig. 2, Appx. 1). Examination of *E. albus* droppings confirmed *M. osa* is among the prey items consumed, at least males as determined by major claw features (Fig. 3). The claw in Figure 3C (circle) may correspond to a Sesamid crab species that shares space with *M. osa*.

When approached by an ibis, *M. osa* males raised the major chela, displaying the merus while raising the body. Crabs briefly maintained this posture and waved by jerking the chela in an outward motion, then retreated inside the burrow. Female crabs extended their chelae forward, pointing downward, and lifted them while raising their bodies; then they dashed for the burrow. During December 2022 and January 2023, other potential avian predators were recorded.



Fig. 2. Photographic sequence of predation by a juvenile White Ibis (*Eudocimus albus*) on *Minuca osa* from Ponuga, Veraguas, Panama. Still images should be interpreted starting from the upper left frame to the lower right; see link (<https://youtu.be/JA8rjwRw-Zo>) for Appendix 1 video

Fig. 2. Secuencia de depredación por un juvenil de Ibis Blanco (*Eudocimus albus*) sobre *Minuca osa* en Ponuga, Veraguas, Panamá. Las imágenes fijas deben interpretarse desde el marco superior izquierdo hasta el inferior derecho; vea el vínculo (<https://youtu.be/JA8rjwRw-Zo>) para video del apéndice 1



Fig. 3. Crab remains on White Ibis (*Eudocimus albus*) droppings from Ponuga, Veraguas, Panama. A: Various crab exoskeleton fragments; the white circle represents a male *Minuca osa* major claw. B: Four morphological characters (black & white triangles) from the major claw corresponding to *Minuca osa* found in White Ibis droppings. C: Fragments of at least two crab species contained in White Ibis droppings; *Minuca osa* (lower right corner circle) and a Sesarmid crab (small circle and crop). Scale bars: A = 40 mm, B = 15 mm, C = 5 mm

Fig. 3. Restos de cangrejo en heces de Ibis Blanco (*Eudocimus albus*) de Ponuga, Veraguas, Panamá. A: Fragmentos varios de exoesqueleto de cangrejo; el círculo blanco representa la quela mayor de *Minuca osa*, macho. B: Cuatro caracteres morfológicos (triángulos negro y blanco) de la quela mayor correspondiente a *Minuca osa* encontrada en heces de Ibis Blanco. C: Fragmentos de al menos dos especies de cangrejos contenidos en heces de Ibis Blanco; *Minuca osa* (círculo inferior derecho) y un cangrejo sesarmido (círculo pequeño y recuadro). Escala: A = 40 mm, B = 15 mm, C = 5 mm

Camera traps captured Black Vultures (*Coragyps atratus*), Black Hawks (*Buteogallus anthracinus*), and Grey-necked Wood Rails (*Aramides cajaneus*) occasionally wandering over burrow patches, but no predation events were observed.

DISCUSSION

Cardisoma crassum juveniles, *Leptuca pygmaea*, *Minuca herradurensis*, and other unidentified Sesarmid crab species share space with *M. osa*; however, direct observation and ibis droppings examination confirmed, for the first time, that *M. osa* is also

preyed upon by *E. albus*. White Ibises visited our site intermittently throughout the year but were seen walking over burrows and probing only during rainy season. This is in line with previous studies on other fiddler crab species as temperature and humidity are limiting factors to their activity pattern (Kerr, 2015; da Silva *et al.* 2020).

Of the other three bird species observed in our study, *A. cajaneus* is known to heavily consume crab (Silva e Silva & Olmos, 2015; Villegas-Retana & Picado-Masís, 2021); however, we did not observe *A. cajaneus* preying on *M. osa* perhaps due to short camera deployment. More camera traps might be needed to determine if this bird species preys on *M. osa* as well. Interestingly, ibis droppings in this study consisted mainly of crab remains, confirming *M. osa* is a part of *E. albus* diet. However, quantitative analysis is required to further determine the importance of *M. osa* compared to other diet components across habitats and seasons in *E. albus* adults and juveniles (Kushlan, 1979; Zwarts, 1985; Heath *et al.* 2020).

M. osa response to predator approach was similar to other fiddler crab species, where major and minor claw, legs and body movements could serve the function of attracting a mate, deterring rivals or avoiding predators (Crane, 1975; Pope, 2005). Male fiddler crabs use their large, sexually-selected claws as weapons during

inter-male conflict and courting (Crane, 1975; Dennenmoser & Christy, 2013). The large claw on male fiddler crabs can be used as a weapon to dissuade predators. If these claws cause variation in prey preference by predators, this may influence their evolution (Bildstein *et al.* 1989; Backwell *et al.* 1998). In fact, sex specific and size differences in prey choice by birds have been reported in other fiddler crab species (Zwarts, 1985; Bildstein *et al.* 1989; Ens *et al.* 1993; Backwell *et al.* 1998; Koga *et al.* 2001). Along similar lines, *M. osa* individuals are larger relative to other *Minuca* species (Lombardo, 2022); thus, experimental manipulation of *M. osa* size in prey selectivity and predator avoidance behavior trials could be relatively easy due to a wider range of available size classes (Christy, 2007). This report paves the way to answering various questions regarding the ecology of *M. osa* and its predators and represents a first step for such behavioral ecology studies. The presented results further our understanding of the ecology, behavior, and natural history of *M. osa* and *E. albus* and add to the growing body of literature on fiddler crab predation, as evidenced by previous studies by Gruber *et al.* (2019), Ribeiro *et al.* (2019), and Takeshita & Nishiumi (2022).

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