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Short communication

Camera-traps detect the maned wolf preying on broad-snouted caiman eggs

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ABSTRACT

The maned wolf (*Chrysocyon brachyurus*) is a South-American canid of which conservation guidelines have been implemented due to its population vulnerability. Its trophic ecology demonstrates an omnivorous and opportunistic diet, and even flexibility in response to anthropogenic disturbances. Among the food items identified, the consumption of reptiles is scarce, and includes snakes and lizards. We monitored broad-snouted caiman (*Caiman latirostris*) nests during four nesting seasons through camera trapping, in savannas and grasslands areas, and recorded maned wolves feeding on caiman eggs during periods of drought. The consumption of an uncommon item, even at low frequency, suggests that camera trapping could become a complementary tool for studying the dietary habits of the maned wolf. Caimans have been a priority for conservation, while maned wolves are currently being released and reintroduced in order to reverse their vulnerable population status. This trophic interaction must be monitored in the long term, to project integral conservation strategies that include both emblematic species.

1. Introduction

The maned wolf (*Chrysocyon brachyurus*), a canid distributed throughout South America, is currently categorized by the IUCN Red List as near threatened (Paula and DeMatteo, 2015), and as vulnerable in Argentina (Cirignoli et al., 2019), due to the frequency of exposure to anthropogenic factors and increased hazards. These include habitat loss and degradation, persecution, illegal capture and hunting, roadkill and diseases associated with contact with domestic animals. However, the maned wolf is known to be widely distributed in northern Argentina, even with increasing areas of occupancy in the last decade (Orozco et al., 2023).

Maned wolves use open habitats including grasslands, savannas and scrublands (Soler et al., 2015a), all of which are well

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represented in northeastern Argentina (Biasatti et al., 2016). The increasing threats faced by the maned wolf have led to the enactment of a law for its categorization as a Natural Monument (Law No. 12,182/03), a strategic action to promote its conservation in the area (Biasatti et al., 2016; Lorenzón and Leiva, 2019). There are other conservation guidelines, such as the reintroduction of confiscated or rehabilitated individuals into natural environments that have an action protocol for their management prior to release (Pautasso, 2009; Orozco and González Ciccia, 2015), and national protection regulations (National Law for the Conservation of Fauna N°22.421/81; Lorenzón and Leiva, 2019).

The maned wolf is an opportunistic omnivorous species, and the composition of its diet varies according to food availability and season (Aragona and Setz, 2001; Soler et al., 2015a). To evaluate the food habits of the maned wolf, the highly effective and conventionally used non-invasive method is the collection of scat and subsequent identification of dietary items (Massara et al., 2012; Kotviski et al., 2019). Since this species is difficult to detect due to its solitary habits, evaluating its feeding behavior represents a challenge (Alves da Rosa et al., 2015). It's diet includes plants, arthropods, small mammals and, to a lesser extent, medium and large mammals, amphibians, birds, fish and reptiles (Aragona and Setz, 2001; Juarez and Marinho-Filho, 2002; Santos et al., 2003; Silva and Talamoni, 2003; Bueno and Motta-Junior, 2004, 2009; Amboni, 2007; Queirolo and Motta-Junior, 2007; Pautasso, 2009; Massara et al., 2012; Soler et al., 2015a; Kotviski et al., 2019). Among the reptiles identified in these studies are snakes and lizards, in addition to a record of freshwater turtle egg consumption in Brazil (Medel and Jaksic, 1988).

Among the reptiles whose distribution overlaps with that of the maned wolf is the broad-snouted caiman (*Caiman latirostris*), also preferring similar habitats — savannas and grasslands — and flooded and semi-flooded environments, for nesting (Larriera and Imhof, 2006; Montini et al., 2006). Nesting is considered one of the most vulnerable stages for the species, and an estimated 90–98% of caiman eggs laid in a season die during the incubation process or within the first year of life (Piña et al., 2004). The main causes of nest loss are extreme flooding and drought events, and predation (Larriera and Piña, 2000; Larriera and Imhof, 2006; Parachú Marcó et al., 2012).

Herein, we present recorded observations of predation events by the maned wolf on broad-snouted caiman eggs through camera-trap observations, which also makes it possible to assess the effectiveness of this indirect monitoring method as a complementary approach in diet studies. Understanding the food habits and feeding strategies of vulnerable species, such as the maned wolf, could strengthen the development of conservation programs for vulnerable species, highlighting that data obtained through natural history studies are valuable for planning those strategies (Nanglu et al., 2023). Furthermore, knowing and understanding interactions among species promotes comprehension of ecosystem dynamics, a relevant aspect for nature management (Heinen et al., 2020; Somaweera et al., 2020).

2. Materials and methods

The study was conducted in "El Fisco" Managed Nature Reserve, a protected area in Santa Fe province, Argentina (Fig. 1). The presence of maned wolves has been recorded in this area on numerous occasions (Pautasso, 2009; Pautasso et al., 2010), and confiscated and/or rehabilitated individuals are also being released within it. Furthermore, previous caiman population surveys in "El

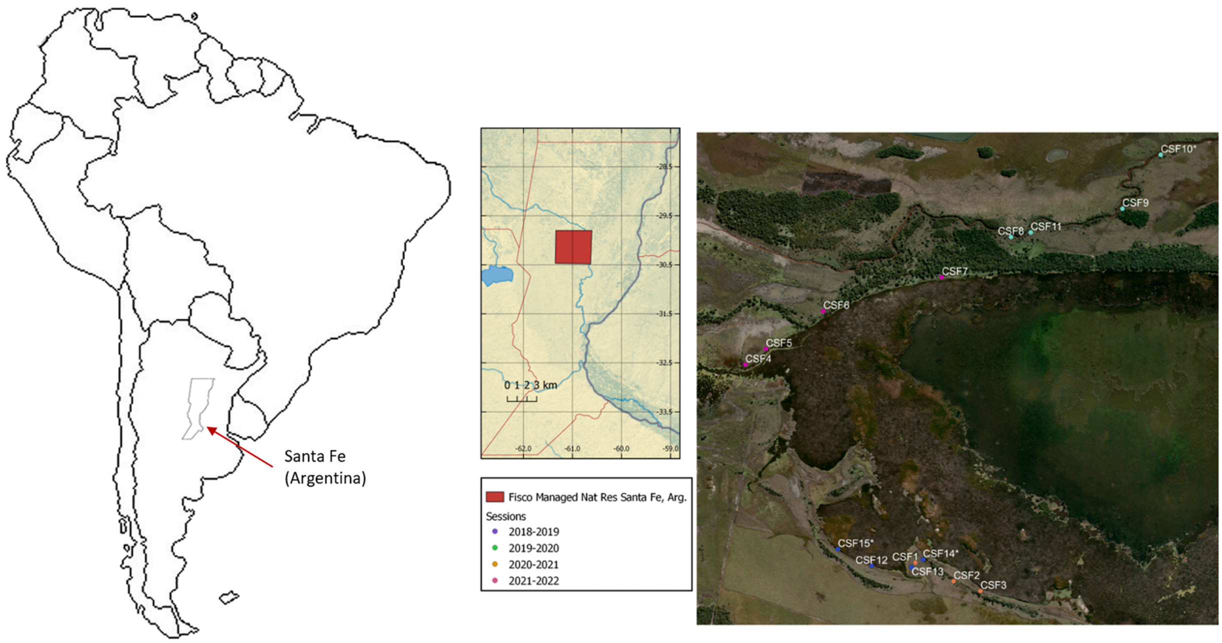

Fig. 1. "El Fisco" Managed Nature Reserve, Santa Fe province, Argentina, indicating the broad-snouted caiman nests where camera traps were deployed to detect the nesting visitors during 2018–2022. Cameras that detected the maned wolf interacting with the caiman nests are marked with an asterisk (CSF10, CSF14 and CSF15).

Fisco" reported a relative abundance of 472 caimans (Ciocan, 2023), of which 32% (151 individuals) are of classes III (70–89.9 cm Snout-vent length – SVL) and IV (≥ 90 cm SVL), corresponding to reproductive sizes based on Leiva et al. (2018). The sex ratio is 1 M:1.4 F, (Ciocan, 2023), i.e. 90 females and 61 males, and reproductive events are altered by extreme conditions such as drought (Simoncini et al., 2011, 2013). Records from *C. latirostris* egg harvest programs indicate that about 47 nests are located in the area annually during optimal reproductive times in the area, and about 20 nests in periods of extreme drought (Lorenzón and Leiva, 2019; Proyecto Yacaré database).

To determine whether the maned wolf preyed on caiman eggs, we searched for caiman nests throughout walks, horseback rides or boat trips in December, at the beginning of four consecutive nesting seasons (2018-2022), and installed a Bushnell Trophy Cam HD Essential camera trap on four nests per nesting season . Additionally, we monitored caiman nests in other regions within the distribution of the maned wolf during the same four nesting seasons: four nests in the Aguará Grande locality (30°8′5"S 60°46'9"O) in 2020–2021, and 10 nests in the Alejandra locality (30°02'46"S 9°58'29"O) in 2019–2022, both of which correspond to unprotected areas in Santa Fe, Argentina. For both protected and unprotected areas, we followed camera-trap installation guidelines on ethical standards, carefully removing the vegetation obstructing vision of the nest, and avoiding interference with the animal's activity (Díaz Pulido and Payán Garrido, 2012). We installed the cameras on a tripod of sticks at an average height of 1.60 m and focused them on the nest, at an average distance of 3 m from the site of interest (nest) to obtain an appropriate detection range, according to Ancrenaz et al. (2012) and Urbina Flores et al. (2022). The cameras remained active for 24 hours and we set them up to detect nest predators (mostly mammals), programming the capture of 1 photo every 1 minute when the passive infrared sensor (PIR) was activated, with a 10-second delay in activation. We also configured camera-traps to take 1 photo every 5 minutes to deal with other objectives related to the nesting behavior of caiman females. This setup was due to the limitations of PIR sensors in detecting ectothermic animals (Urbina

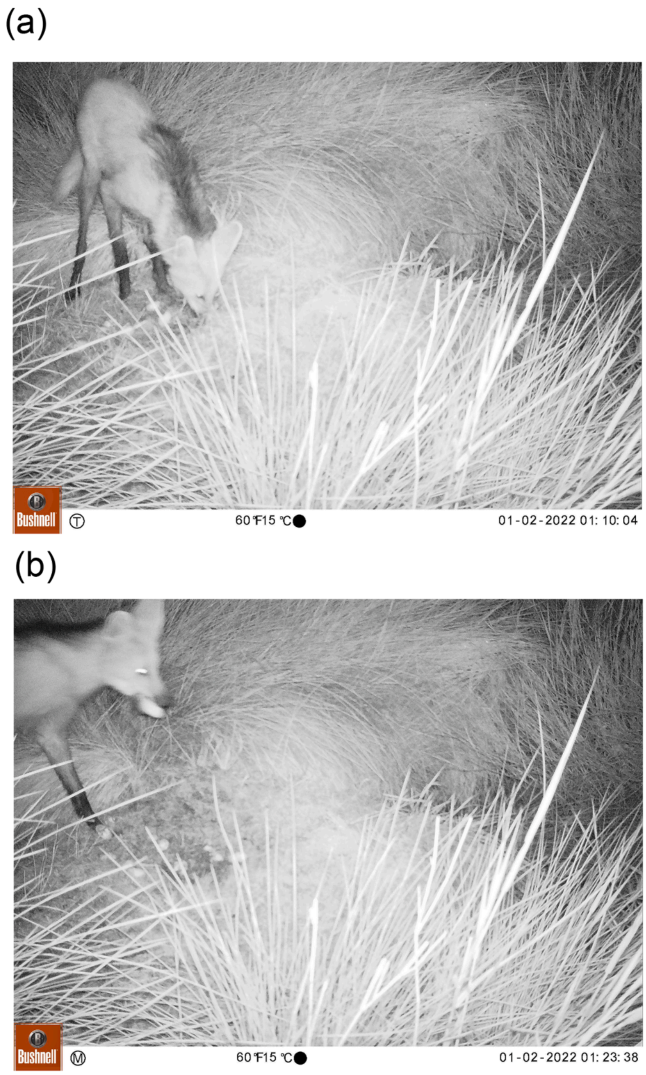

Fig. 2. (a) and (b) A maned wolf feeding on a few caiman eggs.

Flores et al., 2022). Cameras monitored each nest and its vicinity until the end of the nesting season (between March and April), and their changes of batteries and memory cards were replaced every 20–25 days. We identified and separated the maned wolf in the photos obtained. To analyze visits of maned wolves to the nests, we considered a 60-minute interval between photos to account for independent events.

3. Results

The sampling effort in the protected area was 1194 trap-nights, and we detected a single visit of a maned wolf per nest in 3/16 (19%) caiman nests monitored, where an individual is observed opening the caiman nests by digging the top off and feeding on eggs (2/3 events, Fig. 2, Supplementary Material 1), or scratching the nest (1/3 events, Supplementary Material 1). We also detected the maned wolf in the other monitored locations: sampling effort in Aguará Grande: 280 trap-nights; detection of a single visit of a maned wolf in 1/4 of caiman nests monitored; sampling effort in Alejandra: 677 trap-nights; detection of a single visit of maned wolf in 1/10 of caiman nests monitored. It was not possible to quantify the exact number of eggs eaten by the maned wolf in each event. However, it was not the complete clutch, as other predators (*Salvator merianae*, *Sus scrofa,* and *Cerdocyon thous*) continued to attend and feed on the eggs. Finally, the female caimans did not defend their nests against the approach of the maned wolf.

4. Discussion and conclusion

Among the indirect methods widely used to monitor wildlife, camera traps are a valuable tool for studying maternal care and crocodilian nest predation (Campos and Mourão, 2014; Merchant et al., 2018; González-Desales et al., 2020). Regarding the maned wolf, camera traps are considered effective tools because they have made it possible to assess aspects such as activity patterns, population density, and niche separation from other canids, providing valuable information to define priority conservation areas for the species (De Almeida Jácomo et al., 2004; De Souza et al., 2018; Souza et al., 2023). In addition, similar detection results of individuals have been reported through environmental DNA studies and camera trapping (Amavet et al., 2023). Even at low frequencies, the detection through camera trapping of maned wolves feeding on occasional prey appears to be an effective method that could complement the assessment of prey availability and consumption.

This is the first record of a maned wolf feeding on caiman eggs. The detection frequency of the maned wolf feeding on caiman eggs was low at all sites, as expected, since reptile consumption has been detected in a very low proportion and occasionally (Juarez and Marinho-Filho, 2002; Santos et al., 2003; Silva and Talamoni, 2003). In all cases, the interaction occurred between 2020 and 2022, corresponding to years with severe drought in the region, compared to the previous monitoring years (the Standardized Precipitation Index SPI ranged between −1.00 and −1.50, South American Drought Information System – SISSA, https://sissa.crc-sas.org/). Previous studies revealed that the diet composition of maned wolves varies according to food availability and the season (Soler et al., 2015a). Moreover, the consumption of reptiles, although infrequent, has been more frequently detected during dry seasons (Silva and Talamoni, 2003). Therefore, the consumption of caiman eggs—an aspect not previously reported but possible given the opportunistic habits of the maned wolf—might be due to the lower availability of preferred prey.

Drought could also have favored the accessibility of maned wolves to caiman nests. Previous studies reported that drought periods favor predators' access to crocodilian nests, possibly because wallows or water holes near the nests dry up, preventing females from attending to their nests (Larriera and Piña, 2000; Platt et al., 2008; Joanen and Merchant, 2018). We were not able to corroborate the reasons why female caimans did not defend their nests against the approach of the maned wolf or other potential predators, but we do not rule out that possibility.

Another eight predators, mammals and reptiles, besides the maned wolf, were detected consuming broad-snouted caiman eggs. Specifically, Fig. 2 reveals that the nest had been predated prior to the visit of the maned wolf —some eggs are visible outside the incubation chamber of the nest—. The predator species was the crab-eating fox (*Cerdocyon thous*) (Supplementary Material 2), which has already been detected feeding on caiman eggs in all monitored nests and on several occasions. Both species presented similar activity patterns in caiman nesting areas (Supplementary Material 3), and previous studies in the area indicate the coexistence of the crab-eating fox and the maned wolf (Lorenzón and Leiva, 2019; Pautasso et al., 2010). These two species are known to ocurr in sympatry (Soler et al., 2015b), although they present some trophic niche separation (Bueno and Motta-Junior, 2004; Soler et al., 2015a; Canesini et al., 2021).

It is also important to highlight that, although some detections of maned wolves involved scratching the nest, this activity, like predation, is harmful to the clutch. When manipulating the nest, the eggs could be rotated, resulting in embryo death (Larriera and Imhof, 2006). On the other hand, nest opening could be an attractive factor for the visit of other predators (Simoncini et al., 2016).

It is known that crocodilian nests constitute a food source for a large number of wild vertebrates (Larriera and Piña, 2000; Campos and Mourão, 2014; Merchant et al., 2014; Torralvo et al., 2017; Somaweera et al., 2020; González-Desales et al., 2020). In fact, predation is one of the main causes of caiman nest loss, with 50–80% of nests lost (Larriera and Piña, 2000), associated with extreme events such as floods or droughts (Larriera and Imhof, 2006; Parachú Marcó et al., 2012). Although the number of detected events of caiman egg consumption by maned wolves corresponds to a single record per nest—similar to the reported occasional consumption of other reptiles—currently and after decades of conservation efforts, caiman eggs may be considered to be widely available prey for the maned wolf, considering the number of nests in El Fisco. We are unaware of the exact population density of caimans in the other monitored areas.

The conservation of caiman populations was one of the priority objectives of the creation of "El Fisco" Managed Natural Reserve, through conservation and sustainable use strategies; the species is currently in a better state than in past decades (Larriera et al., 2008;

Prado et al., 2012; Siroski et al., 2020). However, the broad-snouted caiman, like other species, is not exempt from the negative effects of severe drought period impacts for reproduction (Macdonald et al., 2023). Since the presence of the maned wolf was documented in the protected area (Pautasso, 2009; Pautasso et al., 2010; Amavet et al., 2023), and that provincial government agencies, NGOs and researchers work together to achieve the release of individuals of the species, contributions involving the monitoring of trophic ecology could allow for a greater understanding of the impacts that drought or other disturbances might have on these processes.

CRediT authorship contribution statement

Sofía Evelyn Pierini: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Data curation. **Melina Soledad Simoncini:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Data curation. **Alejandro Larriera:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization. **Valentin Francisco Guarascio:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Leonardo Scarpa:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Carlos Piña:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization.

Declaration of Competing Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data availability

Data will be made available on request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.gecco.2024.e02916.

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