




Femoral fracture in a wild ocelot *Leopardus pardalis* resolved in natural conditions

*Fractura femoral resuelta en un ocelote *Leopardus pardalis* salvaje en condiciones naturales.*

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Recibido: 04 de abril de 2025 - **Aceptado:** 21 de mayo 2025

ABSTRACT

We report the case of a femoral fracture resolved under natural conditions in an ocelot, *Leopardus pardalis*, in northeastern Argentina. The femur belonged to an adult male that died after being hit by a vehicle. The fracture resulted from the loss of continuity in the cortical areas of the middle third of the diaphysis, causing a complete transverse fracture with displacement of the proximal and distal fragments of the femur. The fracture resolved by forming a large bony callus that encircled the fracture site and firmly joined the two fragments, although it resulted in shortening of the bone. While this likely caused locomotion difficulties, judging by the physical condition of the ocelot at the time of its death, it did not prevent it from leading a relatively normal life. Although information on resolved fractures in wild mammals is scarce, evidence suggests that they do not inevitably lead to the death of the individuals, who can survive under favorable circumstances.

Keywords: Felidae, fracture resolution, wildlife injuries

RESUMEN

Reportamos el caso de una fractura femoral resuelta en condiciones naturales, en un ocelote *Leopardus pardalis*, en el nordeste de Argentina. El fémur pertenecía a un macho adulto, que murió atropellado por un vehículo. La fractura se produjo por la pérdida de la continuidad de las áreas corticales del tercio medio de la diáfisis, lo que ocasionó una fractura completa transversa, con desplazamiento de los fragmentos proximal y distal del fémur. La resolución de la fractura se produjo mediante la formación de un gran callo óseo, que rodeó el foco de la misma y unió firmemente los dos fragmentos, aunque ocasionó el acortamiento del hueso. Aunque probablemente esto provocó inconvenientes en la locomoción, a juzgar por el estado físico del ocelote al momento de su muerte, no impidió que llevara una vida relativamente normal. A pesar de que la información sobre fracturas resueltas en mamíferos silvestres es escasa, la evidencia indica que las mismas no conducen inevitablemente a la muerte de los individuos, que pueden sobrevivir en circunstancias favorables.

Palabras clave: Felidae, resolución de fracturas, lesiones en animales silvestres

INTRODUCTION

The ocelot *Leopardus pardalis* is the third-largest feline in the Americas, following the jaguar *Panthera onca* and the puma *Puma concolor*, with a body mass of up to 16 kg (Murray and Gardner, 1997). Its geographic distribution extends from southern Texas in the United States to northern Argentina, southern Brazil, and Uruguay (Murray and Gardner, 1997; Castelló, 2020).

It is a generalist and opportunistic predator that consumes a wide range of prey, with body masses ranging from 10-20 g, such as lizards, mice, and marsupials, to others exceeding 10 kg, such as deer (*Mazama* spp.) and juvenile capybaras *Hydrochoerus hydrochaeris*. Although they primarily hunt on the ground (Emmons, 1988), they are excellent climbers and capture strictly arboreal prey such as monkeys (*Alouatta* spp.), squirrels (Sciuridae), and opossums (Didelphidae) (Murray and Gardner, 1997; Wang, 2002; Bianchi and Mendes, 2007; Santos et al., 2014).

Ocelots are solitary; they do not form social groups or lasting pairs (Murray and Gardner, 1997), making it unlikely that an injured individual or one unable to hunt would receive food obtained by others, except for cubs or juveniles still being fed by their mothers. As with other solitary carnivores, adult individuals would be expected to have a very low probability of survival in the face of injuries or fractures that impair or restrict their ability to capture prey (King, 2021). Therefore, it is of great interest to document cases of resolved fractures in wild individuals and their ability to survive severe physical traumas. The aim of this study is to report the case of an adult ocelot killed by a vehicle, which exhibited an old femur fracture resolved under natural conditions.

MATERIALS AND METHODS

On December 17, 2022, an ocelot recently hit by a vehicle was found on National Route 14, in front of Establecimiento Las Marías (28°06'46" S; 56°02'42" W), Santo Tomé department, northeastern Corrientes province, Argentina. It was an adult male, weighing 14.3 kg, whose skin and skeleton were deposited in the mammalogical collection of the Argentine Museum of Natural Sciences "Bernardino Rivadavia" (Buenos Aires), under the number MACN-Ma 30866. During the skeleton preparation, it was observed that in addition to recent fractures resulting from the collision, the left femur exhibited an anomaly in its normal shape and structure, resulting from an old bone trauma.

The femur was measured using a vernier caliper (accuracy = 0.05 mm). The following measurements were taken: total femur length, and diaphysis diameter, in areas with and without bone overgrowth. Additionally, radiographs were performed using a high-frequency portable radiology unit, DINAR PAF-100 TP.

RESULTS

The femur clearly belonged to an adult individual, as no epiphyseal line was observed in the radiographic projections, showing complete epiphyseal and metaphyseal fusion in the bone structure (Fig. 1A). The total length of the femur was 153 mm; the width of the unremodeled portion of the diaphysis above and below the bony callus was 18 x 12 mm and 17.1 x 12.2 mm, respectively. Meanwhile, the width of the bone overgrowth area was 42 x 33 mm.

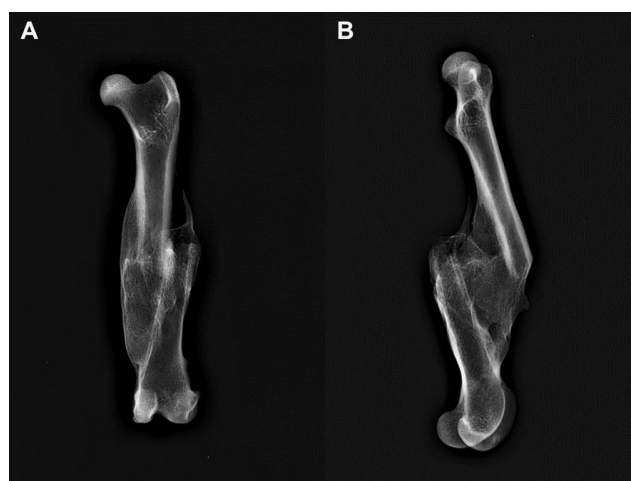


Figure 1. Radiographs of the left femur of the ocelot *Leopardus pardalis* (MACN-Ma 30866): (A) caudocranial projection; (B) lateromedial projection. Note the axial displacement of the two fragments of the femur, and their union by means of the bone callus.

The fracture occurred due to the loss of continuity in the cortical areas of the middle third of the diaphysis, resulting in a complete transverse fracture with excessive displacement of the proximal and distal femur fragments, forming an acute angle, which must have caused damage to the overlying musculature. The fracture was resolved by secondary intention, given the large amount of bone material (the bone callus) surrounding the fracture site in a disorganized manner, a result of bone consolidation under natural conditions (Figures 1 and 2).

In the caudo-cranial projection (Fig 1A and 2A), the distal fragment is laterally displaced relative to the midline, displaying an overlap of the cortical areas near the fracture. This results in a disruption of the medullary canal continuity. However, the "bridge" formed by the new bone material and subsequent remodeling has restored stability and functionality to the pelvic limb. In the latero-medial projection (Fig. 1B and 2B), there is a significant displacement (~20 mm) between the two bone fragments, with the proximal fragment positioned cranially over the distal fragment.



Fig. 2. Left femur of the ocelot *Leopardus pardalis* (MACN-Ma 30866) with transverse fracture of the middle third of the diaphysis: (A) caudal view; (B) medial view. The shortening of the bone and the bone overgrowth can be observed in detail.

DISCUSSION

Although the exact circumstance of the fracture in this ocelot is unknown, there are three possible causes, common to many predator species. They can sustain skeletal injuries from physical contact with larger prey; as a result of falls from trees, for those with arboreal habits; and even from collisions with vehicles, either while crossing roads or feeding on animals killed on them (Argyros and Roth, 2016). Once a fracture occurs, the resolution process in mammals is divided into four stages: an initial inflammatory stage, followed by the formation of soft callus (fibrocartilage), then a stage involving the formation of hard callus (bone), and culminating in the bone remodeling stage (Schindeler et al., 2008). In this final stage, the bony callus undergoes smoothing of its surface, and depending on the fracture characteristics, it may even restore the bone's original shape (Resnick et al., 1995; Schindeler et al., 2008). However, when the parts of the fracture are highly displaced from each other, it would be very difficult, if not impossible, to restore the previous bone morphology without surgical intervention, as was the case with the ocelot reported here.

Although limb shortening might seem a serious handicap for a carnivore, it is known that domestic cats *Felis catus* can adapt to the shortening of a hind leg following a fracture, as long as it is not excessive, so that the deformity has little or no consequence (Ormrod, 1966). Similarly, in this case, the shortening of the limb evidently did not prevent the ocelot from hunting and leading a normal life, as at the time of its death it was in good general condition and had a body mass near the upper limit cited for adults of the species (Murray and Gardner, 1997; Castelló, 2020). This contradicts the claim that the resolution of fractures in long bones is characteristic of social carnivores, who survive thanks to food provision by other members of the pack (Heald, 1989). There are other records of solitary carnivores with severe healed fractures in their limbs (e.g., Iberian Lynx *Lynx pardinus* [García-Perea, 2000]; Bobcats *L. rufus* [Argyros and Roth, 2016]; Stoats *Mustela erminea* [King, 2021]), demonstrating that this argument is based on premises not properly substantiated, and even goes against the evolutionary pressure for rapid bone healing (McCall et al., 2003).

Unlike canids, which can regurgitate ingested food to feed injured or incapacitated group members (Macdonald et al., 2010), felids completely lack this ability (McCall et al., 2003; Macdonald and Sillero-Zubiri, 2010). This implies that a socially habituated felid that has suffered a fracture restricting its hunting ability would need to move to the site where its pack members have secured prey, or, in the case of solitary felids, fast until they are again able to hunt (Argyros and Roth, 2016). Supporting this latter hypothesis, domestic cats have demonstrated a remarkable ability to recover from such traumas, sustaining themselves solely on their metabolic reserves (McCall et al., 2003), which likely occurs with wild species as well.

CONCLUSION

Although reports of resolved fractures in long bones in wild mammals are scarce, published cases show that these do not inevitably lead to the death of the individuals, who can survive under minimally favorable circumstances (Kierdorf et al., 2012). It is highly advisable for researchers to document and report such records, which contribute to increasing understanding of the recovery and survival of the species involved. This information could be useful for future studies on fracture recovery without veterinary assistance in carnivores and other wild mammals, and beneficial for use in zoos, veterinary centers, and wildlife rehabilitation (Argyros and Roth, 2016).

ACKNOWLEDGMENTS

We would like to thank José L. Anchetti for report the finding of the ocelot; María G. Villordo, Carlos Costa and Laura Comparin, for their collaboration in processing the carcass. We thank Establecimiento Las Marías for its support of our research. We would also like to thank the Dirección de Recursos Naturales of the Province of Corrientes for authorizing the collection of the animal. Mariel Lockett and Carolina Repetto, from the Radiology Service of the Faculty of Veterinary Sciences (UNNE), were kind enough to take the radiographic images.

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