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Crowned solitary eagle (*Buteogallus coronatus*) as accumulator of armadillo osteoderms in the archaeological record? An actualistic taphonomic study for central Argentina

Claudia I. Montalvo [a, *], Fernando J. Fernández [b, c], Maximiliano A. Galmes [d, e], Miguel A. Santillán [e], Joaquín Cereghetti [a]

[a] Facultad de Ciencias Exactas y Naturales, Universidad Nacional de La Pampa, Uruguay 151, 6300 Santa Rosa, Argentina
[b] Cátedra de Anatomía Comparada, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Calle 64 s/n (entre diag. 113 y calle 120), 1900 La Plata, Argentina
[c] Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina
[d] Centro para el Estudio y Conservación de las Aves Rapaces en Argentina (CECARA), Universidad Nacional de La Pampa, Avda. Uruguay 151, 6300 Santa Rosa, La Pampa, Argentina
[e] The Peregrine Fund, 5668 West Flying Hawk Lane, Boise, ID 83709, USA

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ABSTRACT

To distinguish whether the presence of osteoderms of armadillos (Xenarthra, Dasypodidae) in the zooarchaeological and paleontological record can be assigned to anthropic action or predators is an interesting topic. The Crowned solitary eagle (*Buteogallus coronatus*, Accipitriformes, Accipitridae) is among the predators that usually consume armadillos. It is one of the largest South American birds of prey, inhabiting southern Brazil to northern Patagonia in Argentina. Prey remains of the armadillos *Zaedyus pichiy*, *Chaetophractus villosus* and *C. vellerosus* were collected in 13 breeding areas from two biogeographic regions including La Pampa and Mendoza provinces, central Argentina, during 2010–2012. The significant amount of carapaces, osteoderms, and cranial elements of armadillos accumulated in nests is a distinctive feature of the Crowned solitary eagle. These accumulations are taphonomically characterized by the presence of: 1) complete or almost complete flattened, depressed or book-shaped folded carapace; 2) scarce caudal armors and cephalic shields; 3) flexible bands, and scapular and pelvic shields well represented; 4) anterior region of scapular shields usually broken; 5) many isolated osteoderms broken, crenulated or with irregular borders; 6) posterior regions of skulls often with crenulated, broken or missing borders; 7) skulls with beak marks in the dorsal and posterior parts of the braincase, and in the palates; 8) some mandibles with the posterior part broken; 9) scarce, but well preserved limb bones; and 10) beak marks on scapulae and pelves. In addition, the information obtained from abandoned nests showed that these taphonomic features could have been altered by weathering. These observations can be used in subsequent studies of armadillo bone accumulations from open-air archaeological or paleontological sites from central Argentina, and other parts of America, inhabited by the Crowned solitary eagle, as well as in future revisions of samples.

1. Introduction

Armadillos (Xenarthra, Dasypodidae) are mostly distributed in South America. They are semi-fossorial mammals that use burrows for shelter, nesting, parturition, hibernation or torpor (e.g., Superina and Loughry, 2012; Superina et al., 2014). Their fossorial activities produce archaeological and sedimentological disturbances by moving and destroying lithic and bone materials while digging (Mello Araujo and Marcelino, 2003; Frontini and Escosteguy, 2012). Armadillos are the only mammals covered by a flexible carapace composed of numerous osteoderms or bony dermal scutes (~800) (Wetzel et al., 2007; Superina et al., 2014 and references therein). Therefore, the presence of only few individuals would be sufficient to produce an osteoderm accumulation.

* Corresponding author.
E-mail address: cmontalvo@exactas.unlpam.edu.ar (C.I. Montalvo).

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Armadillos were first recorded in the Late Paleocene of Brazil (Krmpotic et al., 2009), and in the Early Eocene of Argentina (Ciancio and Carlini, 2008). They have been described as prey of different predators such as mammalian carnivores and birds of prey inhabiting different environments of South America (e.g., Montalvo et al., 2007; Ballejo et al., 2012; Frontini and Vecchi, 2014 and references therein). Hunter–gatherers have also hunted them since prehistory. For these reasons, exoskeletal (osteoderms) and endoskeletal bones of armadillos are frequently recorded in archaeological and paleontological sites of Argentina (e.g., Vizcaíno and Bargo, 1993; Vizcaíno et al., 1995; Ciancio and Carlini, 2008; del Papa, 2012; Loponte and Acosta, 2012; Otaola et al., 2012; Soibelzon et al., 2013; Frontini and Vecchi, 2014; Hammond et al., 2014; Fernández et al., in this volume).

The osteoderms recovered from archaeological sites have drawn the attention of zooarchaeologists, who treated them as a problem of taphonomic equifinality, using actualistic models (e.g., Frontini and Escosteguy, 2012; Frontini and Vecchi, 2014; Hammond et al., 2014; Muñoz, 2015). From a taphonomic point of view, it is crucial to distinguish if raptor birds, carnivore mammals, or humans accumulated the remains of armadillos, in order to evaluate natural action (death *in situ* and predation) vs. human subsistence (Binford, 1981; Andrews, 1990; Lyman, 1994). Cut marks, thermal alteration patterns, and skeletal anatomical representations are the main taphonomic evidence to infer that these animals could have been hunted and consumed by humans (e.g., Frontini and Vecchi, 2014 and references therein). Although several mammals and raptor birds consume armadillos (Massoia and Pardiñas, 1986; Hiraldo et al., 1995; Saggese and de Lucca, 2004; Trejo et al., 2006; Foster et al., 2010; Sarasola et al., 2010; Zanón et al., 2012), little is known about the taphonomic modifications of bones and osteoderms produced by them (Montalvo et al., 2007; Ballejo et al., 2012). Most actualistic studies of diurnal raptors (Falconiformes and Accipitriformes) were focused on small mammals and small birds (e.g., Mayhew, 1977; Hoffman, 1988; Andrews, 1990; Hockett, 1995; Bochenski et al., 1999; Gómez, 2007; Lloveras et al., 2008; Montalvo and Tallade, 2009, 2010; Souttou et al., 2012; Montalvo et al., 2014).

In this contribution, we present a taphonomic analysis of the modifications produced by the Crowned solitary eagle (*Buteogallus coronatus*, Accipitriformes, Accipitridae) during capture and handling on armadillos recovered from several accumulations of prey remains from central Argentina. In addition, we compared active and abandoned nests of the Crowned solitary eagle in order to evaluate the differential preservation in the accumulations. The taphonomic data presented here may be used as actualistic model for the zooarchaeological record.

2. Crowned solitary eagle (*Buteogallus coronatus*) as armadillo accumulator

The Crowned solitary eagle (*Buteogallus coronatus*) is among the largest South American birds of prey (~3 kg) (Fig. 1), inhabiting southern Brazil to northern Patagonia in Argentina (Fergusson-Lees and Christie, 2001; Sarasola et al., 2010). This species inhabits semi-open, arid and semi-arid areas, mainly in lowlands, but also at intermediate altitudes (Collar et al., 1992). Historically its distribution was wider, reaching central Patagonia (see Maceda, 2007; and references therein). The fragmentation and loss of habitat due to deforestation was proposed among the causes of low population numbers of this species (Collar et al., 1992; Maceda, 2007). For this reason, the Crowned solitary eagle is listed in the IUCN Red List of Threatened Species (2012), as well as in the Argentinean list of threatened birds (Chébez et al., 2008; López-Lanús et al., 2008). Studies on wild populations of this species are scarce. Many aspects of its biology are still unknown, including habitat use and selection, and feeding ecology. This raptor is mostly solitary and crepuscular; its nests are a large platform of sticks placed on top of trees or occasionally in abandoned human constructions, such as metallic towers (Maceda, 2007). The hunting techniques of the Crowned solitary eagle include perching and waiting for prey, as well as performing circular low-altitude flights approximately 100 m above the ground (Pereyra Lobos et al., 2011). Knowledge about its food habits increased in the last 10 years, mainly in central Argentina (Maceda et al., 2003; Maceda, 2007; Chébez et al., 2008; Sarasola et al., 2010; Pereyra Lobos et al., 2011). In these works, the Pichi or Dwarf armadillo (*Zaedyus pichiy*) was the most important prey in terms of number and biomass, and a trophic selection was suggested for this prey. Armadillos represent about 50% of the Crowned solitary eagle diet [48.6% in Sarasola et al. (2010) and 57.9% in Pereyra Lobos et al. (2011)], while small mammals, reptiles, birds and fish constitute the remaining diet. The hunting activity pattern of the Crowned solitary eagle seems to be consistent with the daily activity patterns of its prey (M. Galmes unpubl. data).

The family Dasypodidae includes 21 living species of armadillos, distributed from the southern United States to the Strait of Magellan [Argentina and Chile; Wilson and Reeder (2005)]. Three species were identified in the samples analysed here. *Chaetophractus villosus* (Hairy armadillo) and *Chaetophractus vellerosus* (Screaming hairy armadillo) inhabit the Gran Chaco of Bolivia, Paraguay, Argentina and Chile. Both species extend south to Santa Cruz Province in Argentina and Magallanes in Chile. *Chaetophractus vellerosus* also inhabits central Argentina, and a small population was found in the coast of Buenos Aires Province (Abba and Superina, 2010). The third species recovered is *Zaedyus pichiy*, which ranges from central Argentina and eastern Chile south to the Strait of Magellan (Superina and Abba, 2014). *Chaetophractus vellerosus*, C. *villosus* and Z. *pichiy* are omnivorous and are threatened by human persecution (Abba and Superina, 2010; Abba et al., 2011; Superina and Abba, 2014).

There is scarce information about predators of *C. vellerosus*, which was reported only as prey of Crowned solitary eagles (Sarasola et al., 2010). *Chaetophractus villosus* was described as prey of crowned solitary eagles, but also of *Geranoaetus melanoleucus* (Black-chested buzzard eagle), and mammals such as *Lycalopex culpaeus* (Andean fox), and *Puma concolor* (puma) (Hiraldo et al., 1995; Zapata et al., 2005; Zanón et al., 2012; Superina and Abba, 2014). *Zaedyus pichiy* is predated by Black-chested buzzard eagles, Crowned solitary eagles, Andean fox, puma, and *Lycalopex griseus* (South American grey fox) (Zapata et al., 2005; Zanón et al., 2012; Superina and Abba, 2014).

3. Regional setting

The studied breeding areas of the Crowned solitary eagle are located in central-western La Pampa Province, in an area of 15.000 km^2, and central-eastern Mendoza Province in the protected "Ñacuñan Biosphere Reserve", in an area of 123 km^2 (Fig. 1, Table 1). These areas include the southern limit of the distribution range of this eagle, corresponding from east to west to the Espinal and Monte Desert ecoregions, respectively (Burkart et al., 1999). The Espinal has a warm and semi-desert climate, sandy soils, and the vegetation is mainly characterized by deciduous xerophytic forest with "Caldén" (*Prosopis caldenia*) as the dominant tree. The Monte, coincident with the South American Arid Diagonal, has warm-desert climate, sandy soils, and the vegetation is mainly composed of xerophytic shrubs such as *Larrea* spp. and isolated trees such as *Prosopis* spp. and *Geoffroea decorticans* (Burkart et al., 1999; Abraham et al., 2009).