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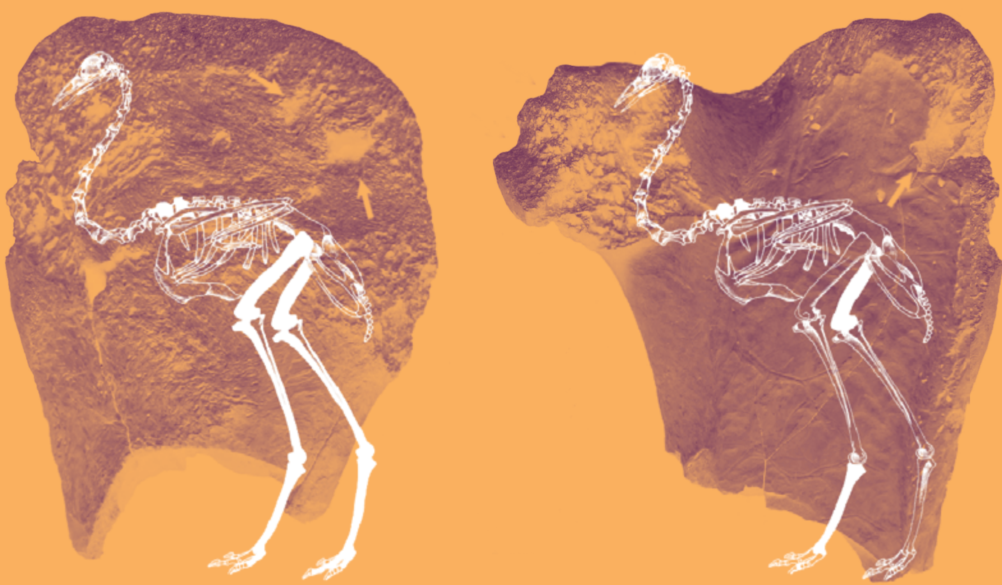

El rol de los pequeños animales en los estudios arqueofaunísticos de Argentina

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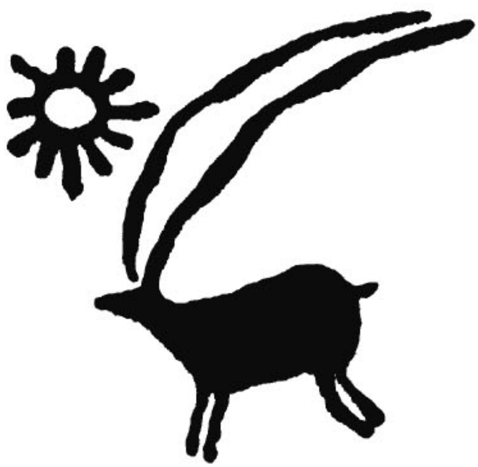

Archaeological applications of microvertebrate analysis. Reconstruction of natural and anthropic processes

DÉBORA M. KLIGMANN

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Archaeological applications of microvertebrate analysis: Reconstruction of natural and anthropic processes

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ABSTRACT: Microvertebrates recovered from archaeological and paleontological sites often provide paleoclimatic and paleoenvironmental information as well as information on the relative chronology of associated stratigraphic sequences. In general, microvertebrate specimens serve as reliable index fossils since they are often closely linked to specific climatic and environmental conditions. The fact that many microvertebrates are frequent prey of a great variety of animals and have very specific habitats, often results in large accumulations of certain groups at very particular places, as is the case of caves and rockshelters. Actualistic as well as taphonomic studies carried out in sites where there are accumulations of small vertebrates allow us to identify the agents involved in the formation and subsequent modification of the faunal assemblages.

In order to illustrate the archaeological applications of the recovery and analysis of microvertebrates, two Argentine case studies are presented in this paper: 1) the iguanid remains at an archaeological site located in the southern Puna of Catamarca province, which were interpreted as the result of a catastrophic death episode during a communal hibernation inside rodent burrows, and 2) the association of amphisbaenid remains inside a ceramic vessel recovered at an archaeological site located in the southern part of Salta province, which were interpreted as the result of intentional human action, with probable ritual-ceremonial purposes (*e.g.*, an offering). This is followed by a comparison of both case studies, illustrating the value of archaeological sediment samples as a source of information for past human activities.

KEYWORDS: GEOARCHAEOLOGY, MICROFAUNA, LIZARDS, AMPHISBAENIANS, NATURAL AND ANTHROPIC PROCESSES, NORTHWEST ARGENTINA

RESUMEN: La importancia e interés del estudio de microvertebrados proviene de sus aportes tanto a nivel paleoclimático y paleoambiental como a la cronología relativa de las secuencias estratigráficas de sitios arqueológicos y paleontológicos. En general, los microvertebrados son buenos indicadores ya que suelen estar muy ligados a un tipo de medio y condiciones climáticas particulares.

El hecho de que muchos microvertebrados sean presa frecuente de gran variedad de animales y que tengan hábitats muy específicos, da lugar a que usualmente se encuentren grandes acumulaciones de determinados grupos en ciertos lugares, especialmente en cuevas y aleros. Tanto los estudios actualísticos como los análisis tafonómicos realizados en sitios en los que hay acumulaciones de pequeños vertebrados permiten identificar los agentes involucrados en la formación y posterior modificación de los conjuntos faunísticos.

A fin de evaluar las aplicaciones arqueológicas de la recuperación y análisis de microvertebrados, en este trabajo se presentan dos casos de estudio: 1) el hallazgo de restos de iguánidos en un sitio arqueológico localizado en la Puna meridional catamarqueña, que fueron interpretados como el resultado de una muerte catastrófica de lagartijas durante una hibernación comunal en madrigueras de roedor y 2) la asociación de restos de anfisbénidos en una vasija proveniente de un sitio localizado en el sur de la provincia de Salta, que fueron interpretados como el resultado de una acción antrópica intencional, probablemente con fines rituales-ceremoniales (*e.g.*, una ofrenda). A continuación se presenta una comparación de ambos casos de estudio, ilustrando el valor de las muestras de sedimentos arqueológicos como fuentes de información de actividades antrópicas pasadas.

PALABRAS CLAVE: GEOARQUEOLOGÍA, MICROFAUNA, LAGARTIJAS, ANFISBENAS, PROCESOS NATURALES Y ANTRÓPICOS, NOROESTE ARGENTINO

INTRODUCTION

Microvertebrates recovered from archaeological and paleontological sites often provide paleoclimatic and paleoenvironmental information as well as information on the relative chronology of associated stratigraphic sequences (Avery, 1982a, 1982b, 1987, 1988; Holbrook, 1982; Sesé, 1986, 1991, 1994; Denys, 1987; Sesé & Gil, 1987; Gil & Sesé 1991; Sesé & Sevilla, 1996; Vigne & Valladas, 1996; Denys *et al*., 1997; Fernández-Jalvo *et al*., 1998; among others). In general, microvertebrates serve as reliable index fossils since they are often closely linked to specific climatic and environmental conditions (*e.g.*, Avery 1982a, 1988; Fernández-Jalvo *et al*., 1998).

The fact that many microvertebrates are frequent prey of a great variety of animals (such as carnivores and predatory birds) and that they have very specific habitats (*e.g.*, burrows, dens, lairs, holes), usually results in large accumulations of certain groups at particular places, especially in caves and rockshelters. Actualistic (*e.g.*, analysis of scats and pellets) as well as taphonomic studies carried out in sites where there are accumulations of small vertebrates allow us to identify the agents involved in the formation and postdepositional modification of the faunal assemblages (Brain, 1981; Andrews, 1990; Fernández-Jalvo *et al*., 1998; Smith *et al*., 2013, among others).

The recovery and subsequent analysis of microvertebrate remains in Argentine archaeological sites is rare, and the few papers published deal with the analysis of rodents. As far as reptiles are concerned, we can mention the following publications: Mengoni & Silveira (1976); Van Devender (1977); Cione *et al*. (1979); Donadío (1983); Salemme & Tonni (1983); Salemme *et al*. (1985); Tonni *et al*. (1985), Salemme (1987, 1990); Gordillo (1988, 1990); Madrid & Politis (1991); Miotti & Tonni (1991); Capparelli & Raffino (1997); Rodríguez Loredo (1997-98); Albino (1999, 2001); Brunazzo (1999); de la Fuente (1999); Lezcano & Fernández (1999); Onaha *et al*. (2001); Albino *et al*. (2002); Paleo *et al*. (2002); Quintana *et al*. (2002, 2003, 2004); Salemme & Berón (2003); Kligmann, 2003, 2009; Albino & Albino (2004); González (2005); Tobisch *et al*. (2005); Aldazabal *et al*. (2007); Campos & Gasco (2007); del Papa *et al*. (2007); Recalde & Srur (2007); Medina (2008); Santini (2009); del Papa (2012) and Moro & del Papa (2013). In all these cases, a few isolated individuals (corresponding to lizards, amphisbaenians, snakes and turtles) are mentioned. Significant accumulations, however, are absent. In most of these publications, and due to the scarcity of the recovered remains, the origin of the faunal materials is not discussed. Also, most of these faunal remains are macroscopic. This means that it was not necessary to employ special recovery methods (such as flotation or sieving) or analytical techniques (e.g., use of binocular microscopes) (Kligmann *et al*., 2013).

In order to illustrate the archaeological applications of the recovery and analysis of microvertebrates, two Argentine case studies consisting of accumulations of reptile bones and teeth are presented in this paper: 1) the finding of iguanid remains at an archaeological site located

in the southern Puna of Catamarca province, which was interpreted as the result of a lizard catastrophic death during a communal hibernation inside rodents burrows, probably corresponding to *Ctenomys*, and 2) the association of amphisbaenid remains inside a ceramic vessel recovered at an archaeological site located in the southern part of Salta province, which was interpreted as the result of an intentional human action, with probable ritual-ceremonial purposes (*e.g.,* an offering). Thus, interpreting the taphonomy of microvertebrate fossil assemblages (in our cases reptile remains) found in archaeological sites is relevant for understanding the relationship between indigenous groups and their environment.

CASE STUDY 1: ALERO 12 (CATAMARCA PROVINCE, NW ARGENTINA)

Introduction

Archaeological surveys and excavations in the Chaschuil area, a high altitude desert located in the Andes of northwest Argentina, have been carried out since 1994, funded by the National University of Catamarca, The University of Buenos Aires and the FONCyT (*Agencia Nacional de Promoción Científica y Tecnológica, Ministerio de Ciencia, Tecnología e Innovación Productiva*). So far, several sites have been found, including both open-air sites and rockshelters. The goal of the general interdisciplinary research project, directed by Dr. Norma Ratto, is to understand how humans adapted to the Puna environment (Kligmann, 2003, 2009).

Excavation of Alero 12 (*Rockshelter 12*) provided the following material remains: 1) lithics, 2) sherds, 3) camelid bones, and 4) a large number of small vertebrate bones, mainly of lizards plus some birds and rodents. Only the small vertebrate specimens will be considered here. Microfaunal remains were analyzed to distinguish how they entered the rockshelter deposits, that is, whether the bones were deposited naturally or by humans, as well as to explore site usage through time and to discuss the intensity of human occupation. We examine here the significance of the lizard bones, as well as of other geoarchaeological information, for inferences about past human behavior in this highly challenging region (Kligmann, 2003, 2009).

Caves and rockshelters are unique, complex and dynamic depositional environments, characterized by their constrained living space (Farrand, 1985; Waters, 1992; Sherwood & Goldberg, 1997). Geologically, they can be described as effective sediment traps where deposition exceeds erosion (Collcutt, 1979; Butzer, 1982; Farrand, 1985; Straus, 1990; Waters, 1992). Sediments can be both exogenous (sediments from outside the rockshelter and deposited by a variety of agents including water, wind, animals and humans) and endogenous (sediments from within the rockshelter, deriving from the ceiling and walls, as well as from chemical precipitates and human activities) (Schmid, 1970; Butzer, 1982; Farrand, 1985; Straus, 1990; Waters 1992). Since caves and rockshelters provide refuge and protection from predators and hostile weather conditions, they tend to be reused much more than open-air sites (Schmid, 1970; Straus, 1990). This means that layers with evidence of occupation frequently constitute palimpsests, resulting from the activities of several processes and agents.

Site and site setting

Alero 12 is a rockshelter located at 3980 m asl in the Puna region, SW of Catamarca province, NW of Tinogasta Department, NW Argentina (68°07' W and 26°55' S) (Figure 1) (Kligmann, 2003, 2009; Kligmann *et al.*, 1999). This region is characterized by cold and dry weather, low precipitation and low atmospheric pressure. Vegetation is sparse and salt-lakes, which are the outcome of reduced moisture and high evaporation rates, are quite common.

This archaeological site stands out by the presence of an unusual abundance of lizard remains. Bones and teeth were recovered from an excavation block of 4 m^2 (*i.e.,* four 1 x 1 meter units) out of a total site size of 44 m^2, representing approximately 9% of the site (Kligmann, 2003, 2009; Kligmann *et al.*, 1999).

Four stratigraphic layers were distinguished during excavation (Figure 2): I (sandy sediments), II (archaeologically sterile volcanic sediments), III (sandy sediments with some rodent burrows), and IV (muddy sediments). Given its thickness, layer III was subdivided into six spits (or artificial levels) of about 10 cm each. The four layers had a

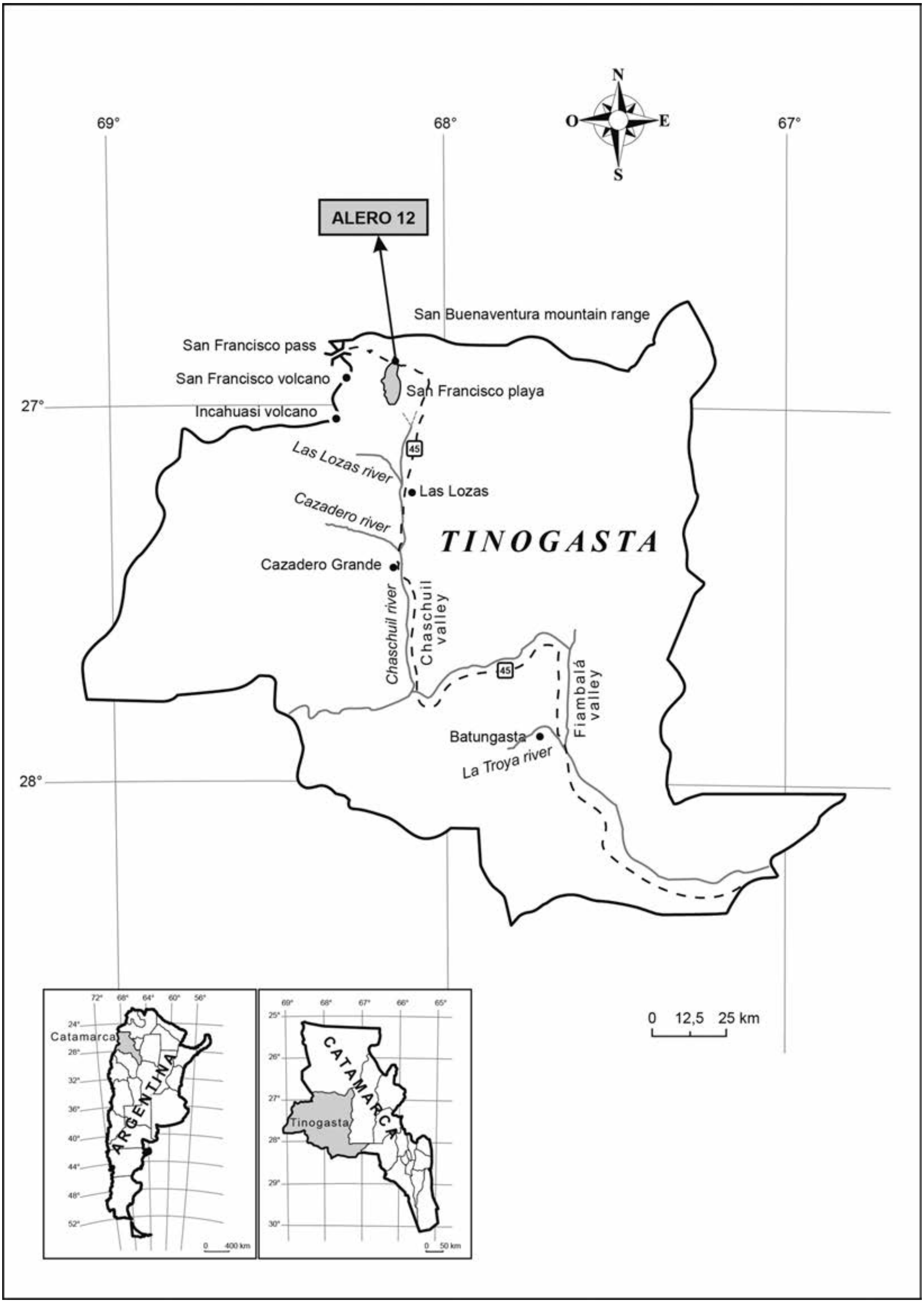

FIGURE 1
Location of the study area (Alero 12) (adapted from Kligmann, 2003, 2009).

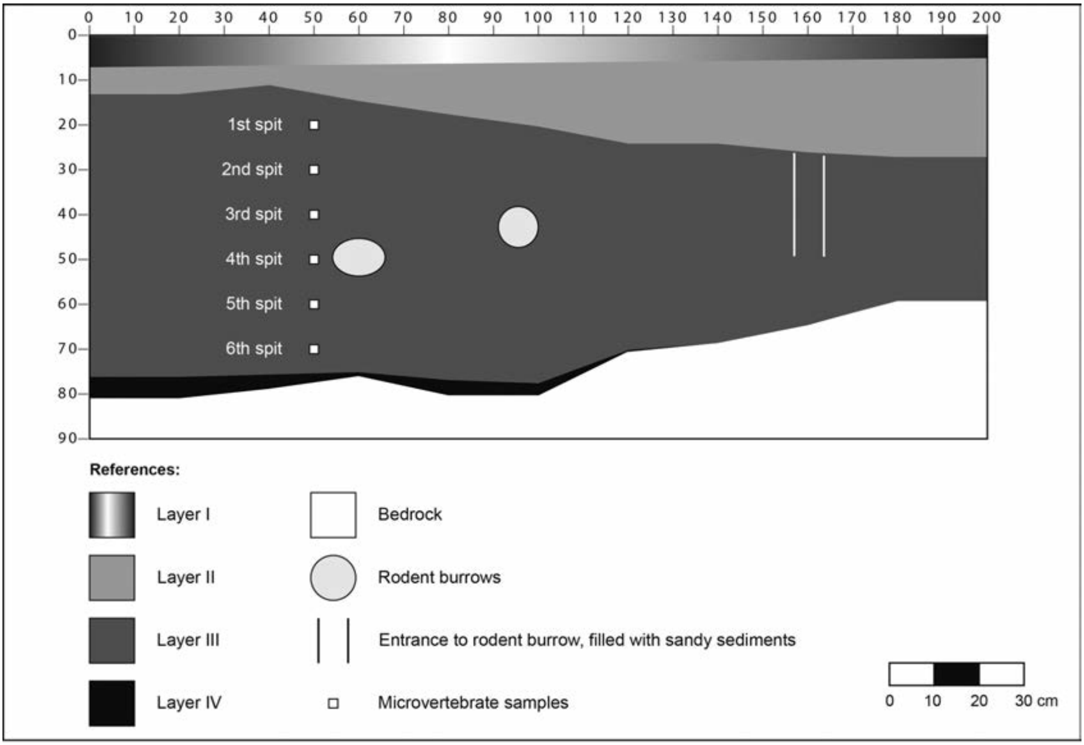

FIGURE 2
West profile, Alero 12 (adapted from Kligmann, 2003, 2009).

total maximum thickness of 80 cm (Kligmann, 2003, 2009; Kligmann *et al*., 1999).

The only radiocarbon date available for the site (590 ± 45 BP, LP-880, Ratto, 1997, 2000) comes from the same stratigraphic layer where the microvertebrates were found. Volcanic sediments are widespread in the research area and have been found in other archaeological sites (Kligmann, 2003, 2009) as well as in a local lake profile (Valero Garcés, 1997).

Expectations

We have considered four possibilities for accumulation of the lizard bones recovered at Alero 12 (Kligmann, 2003, 2009; Kligmann *et al*., 1999): 1) humans, 2) carnivores, 3) predatory birds (both diurnal and nocturnal), and 4) natural or catastrophic death assemblages (lizards lived and died in the rockshelter).

A summary of the expectations often mentioned in the literature for each of these possible agents and / or processes of accumulation of faunal remains in archaeological sites can be seen in table 1 (based on Chaline *et al*., 1974; Mayhew, 1977; Dodson & Wexlar, 1979; Brain, 1980, 1981; Avery 1982a, 1988; Levinson, 1982; Andrews, 1983, 1990; Andrews & Nesbit Evans, 1983; Payne, 1983; Hoffman, 1988; Whyte, 1988; Kusmer, 1990; Crandall & Stahl, 1995; Stahl, 1996; Borrero *et al*., 1997; Denys *et al*., 1997; Martín & Borrero, 1997; Andrews & Fernández-Jalvo, 2012; Smith *et al*., 2013, among others).

The problem arises when these expectations, generated for big animals, are applied to small vertebrates. For example, what happens with cut marks and other signs of prey preparation before consumption when the animals are so small that they can be eaten raw and whole? In this case, signs of consumption may not be visible in the archaeological record (Kligmann, 2003, 2009; Kligmann *et al*., 1999).

	POSSIBLE AGENTS AND / OR PROCESSES OF ACCUMULATION OF FAUNAL REMAINS			
EXPECTATIONS	**Humans**	**Carnivores**	**Predatory birds (1)**	**Natural and / or catastrophic death**
Burned bones	X (2)			
Cut marks	X			
Gnawing marks	X	X		
Digestion damage	X (3)	X	X	
Punctures	X	X	X	
Fractured bones	X	X	X	X
Presence of human feces including bones and / or teeth	X			
Presence of carnivore scats including bones and / or teeth		X		
Presence of bird pellets including bones and / or teeth			X	
Biased representation of skeletal parts	X	X	X	X
Skeletal parts in proper anatomical order				X
Variety of taxa represented	X	X	X	

Legend:

(1): Majority of diurnal preys for diurnal predatory birds and majority of nocturnal preys for nocturnal predatory birds. However, some diurnal and nocturnal predatory birds overlap and hunt crepuscular species. In addition, there are exceptions owing to seasonal behavior. Therefore, species *per se* do not necessarily reflect the predator (Fernández-Jalvo pers. com.).

(2): But it depends on the size of the prey: small animals may not require any prior preparation for consumption. In other words, the absence of burned bones does not necessarily rule out human consumption, as some animals can be eaten raw. However, the presence of burned bones is not always equivalent to human consumption, since the bones can get burned postdepositionally.

(3): Crandall and Stahl (1995) and Stahl (1996) mention that human digestive acids are similar to, or even stronger than, those of carnivores. So low representation of skeletal parts, high corrosion of faunal remains, broken bones and loss of teeth should be observed. Bones so fragile can hardly be recovered outside coprolites.

TABLE 1

Expectations for each possible agent and / or process of accumulation of faunal remains (adapted from Kligmann, 2003, 2009; Kligmann *et al*., 1999).

Another problem encountered is that these expectations do not take postdepositional alterations into account although they can mask original traits, being superimposed on the primary modifications. While secondary modifications occur after death, they are unrelated to the cause of death (Andrews, 1990). For example, as far as natural or catastrophic death is concerned, one would not normally expect fractures although it depends on the nature of the catastrophe (*e.g.,* the collapse of a cave roof will probably crush bones). Also, one would not expect a biased representation of faunal assemblages, although this can be observed if bones had been transported (*e.g.,* by water). This selection occurs when bones are already disarticulated. Finally, one would expect skeletal parts in proper anatomical order only if bones have not been transported or otherwise disturbed. This also depends on the fragility of the bones and soft tissues, differential destruction and sediment grain-size (Kligmann, 2003, 2009; Kligmann *et al*., 1999).

Finally, there is a problem of equifinality with most of the attributes. That is, one single attribute (*e.g.,* gnawing marks, digestion damage,

punctures, fractured bones, biased representation of different skeletal parts and variety of taxa represented) can be assigned to more than one agent of accumulation. The only non-ambiguous attributes are human feces, carnivore scats and predatory bird pellets. This is why the identification of the natural or cultural origin of a faunal sample cannot be based on just one attribute. Only the combination of several attributes will allow us to understand how the sample was deposited (Kligmann, 2003, 2009; Kligmann *et al*., 1999).

Methodology

For the microfaunal analysis, six sediment samples of approximately 150 cm^3 (one from each spit) were collected in stratigraphic column –*i.e.*, from the top surface to the base–, from layer III. Samples were taken because some microvertebrate bones could be seen in the field but not recovered with the screen apertures available during excavation (3 mm) (Kligmann, 2003, 2009; Kligmann *et al*., 1999).

Once in the lab, each sample was dry sieved using three superimposed sieves of 2.5, 1.5 and 0.5 mm respectively. Bones and teeth were separated from sediment grains using a binocular microscope and then analyzed. The materials were classified into skeletal parts within big systematic groups (reptiles, rodents and birds). The NISP was calculated for all groups, and the MNI just for the reptiles. Taxonomic analyses were followed by taphonomic analyses, including: spatial location (both horizontal and vertical) of the faunal remains, state of preservation of the bones and teeth and faunal representation (diversity). Finally, we carried out ethological analyses of the taxa recovered as well as an analysis of the probable agents of accumulation of the microvertebrate assemblage (Kligmann, 2003, 2009; Kligmann *et al*., 1999). The following sediment attributes were measured: color, pH, available phosphorus, organic matter, grain-size and microartifacts.

Results

As table 2 illustrates, lizard remains, unlike those of birds and rodents, are present in every single sample. Table 3 shows that the NISP for lizards significantly exceeds the number of specimens identified for other microvertebrates and accounts for 99% of the recovered sample. The number of rodent bones is very low while the number of bird bones is only slightly higher. The MNI established for the lizard remains, based on the number of preserved right dentaries, is 74 (Kligmann *et al*., 1999).

	SPIT					
VERTEBRATES	**First**	**Second**	**Third**	**Fourth**	**Fifth**	**Sixth**
CLASS: REPTILIA						
*** Subclass: Lepidosauria**						
*** Order: Squamata**						
*** Suborder: Iguania**						
*** Family: Tropiduridae**						
*** Subfamily: Liolaeminae**						
*** Genus: *Liolaemus***	X	X	X	X	X	X
CLASS: AVES						
*** Aves indet.**	X	X		X		X
CLASS: MAMMALIA						
*** Order: Rodentia**						
*** Rodentia indet.**			X		X	X

TABLE 2

Presence of lizards, birds and rodents in each sample (adapted from Kligmann, 2003, 2009; Kligmann *et al*., 1999).

VERTEBRATES	NISP	PERCENTAGE
Lizards	1732	99.2%
Birds	9	0.5%
Rodents	5	0.3%
TOTAL	1746	100.0%

TABLE 3
Number of identified specimens by taxon (adapted from Kligmann, 2003, 2009; Kligmann *et al*., 1999).

Kligmann *et al*. (1999) preliminarily assigned the entire assemblage to the iguanid genus *Liolaemus*, and Albino & Kligmann (2007) were able to discuss the generic and species-group level systematic position of the lizard remains found at Alero 12. Characters of the preserved bones suggest that a minimum of two species of the *Liolaemus* genus is represented. One of them is undoubtedly attributed to the *montanus* group, probably *L. poecilochromus* or *L. andinus*. A second genus (*Phymaturus*) is also possibly represented.

Liolaemus is the most species-rich lizard genus in South America, with more than 160 described species (Schulte *et al*., 2000). In fact, a search of the Reptile Database (http://www.reptile-database.org.) yielded 242 currently recognized species. This genus ranges from the high Andean mountains of Peru and Bolivia in the north to northern Tierra del Fuego Island in the south, and from the Pacific beaches in the west to the sandy Atlantic beaches of Argentina, Uruguay, and Brazil in the east (Donoso Barros, 1966; Cei, 1993).

As can be seen in table 4, the number of lizard remains decreases dramatically with depth, being more abundant directly beneath the layer of pyroclastic sediments. The majority of the lizard remains recovered belong to mature individuals, although juvenile specimens are also present. Bone preservation is very good: almost all the skeletal parts are represented, specimens are not burned and do not present cut marks, gnawing marks, digestion damage or punctures (Figure 3). Most of the bones, even the smallest and most fragile, are complete. The presence of fragile specimens like those recovered would indicate minimal or no transport at all, because transport would surely cause breakage or disappearance of delicate specimens (Kligmann, 2003, 2009; Kligmann *et al*., 1999).

Interestingly, some bones display manganese oxide staining, which implies that the site was intermittently saturated with water (Rapp & Hill, 1998). The texture of sand-sized sediments facilitates water circulation in the deposits due to its permeability.

Discussion and interpretation

As described in the expectations, four possible agents or processes of accumulation were considered: humans, carnivores, predatory birds and natural or catastrophic death. The characteristics of the microvertebrate assemblage (*i.e.,* large accumulations of bones from a limited range of species with minimal bone damage and almost all parts of the skeleton represented), allow us to reject humans, carnivores and diurnal predatory birds as accumulators. Some nocturnal birds do not affect bones much, but what made us reject them too is the fact that about 99% of the bones recovered correspond to lizards. It is difficult to explain how nocturnal birds have eaten almost exclusively lizards, which have diurnal habits. Besides, predatory birds tend to consume a variety of different taxa and not just one taxonomic group (Kligmann, 2003, 2009; Kligmann *et al*., 1999).

As a consequence, the only possibility to explain such an assemblage was natural or catastrophic death. Natural death does not produce a great accumulation of bones of several individuals concentrated together in one particular context, but usually only isolated cases. Thus, we finally came to the conclusion that the lizards probably died as a result of a catastrophic event, such as extreme weather conditions (*e.g.,* a winter colder or drier than usual), while hibernating. This idea is further supported by the fact that bones

	SPIT						
SKELETAL PART	First	Second	Third	Fourth	Fifth	Sixth	TOTAL
SKULL							
Parietal	10	3					13
Pterygoid	1						1
Frontal	12	9					21
Jugal	20	13					33
Quadrate	12	7					19
Neurocranium			1				1
MAXILLAE							
Right	22	12					34
Left	20	16	2				38
Premaxillae	6	5					11
Indeterminate fragments	4	4					8
DENTARIES							
Right	42	28	3		1		74
Left	37	22	3		1		63
Coronoid and mandible fragments	18	21					39
Indeterminate fragments	9	5					14
VERTEBRAE							
Axis	9	1					10
Presacral	180	64		2			246
Sacral	13	12					25
Caudal	102	41	2			1	146
Intercentrum caudal	1						1
LONG BONES	533	286	22	1	5	1	848
PECTORAL GIRDLE							
Coracoid	16	10		1			27
PELVIC GIRDLE	36	16	1				53
METATARSALS	1	5					6
PHALANGES						1	1
TOTAL	1104	580	34	4	7	3	1732

TABLE 4

Classification of lizard remains by skeletal part (adapted from Kligmann, 2003, 2009; Kligmann *et al*., 1999).

show no traces of subaerial exposure. Other probable causes of death can be mentioned such as an epidemic illness or an increase in the rate of deposition, closing the entrance of the rodent burrows, and thus entrapping the lizards. These three hypotheses cannot be distinguished in the archaeological record (Kligmann, 2003, 2009; Kligmann *et al*., 1999).

High mortality rates are frequent during hibernation, the lack of humidity being a serious

Figure 3.a. Modern lizard (probably *Phymaturus*) from the study area.

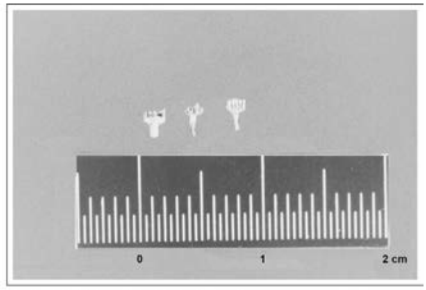

Figure 3.b. Lizard premaxillae, first spit.

Figure 3.c. Lizard dentaries, first spit (Scale: 2,5 cm).

Figure 3.d. Lizard bones, first spit (Scale: 2,5 cm).

FIGURE 3 (part I)
Lizard bones I (adapted from Kligmann, 2003, 2009).

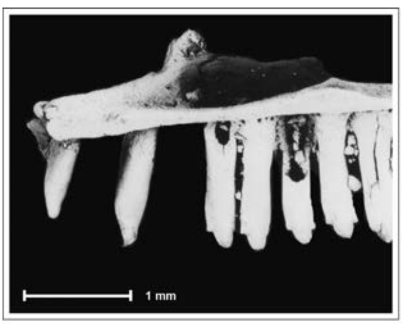

Figure 3.e. Lizard right maxilla (magnified 24 times).

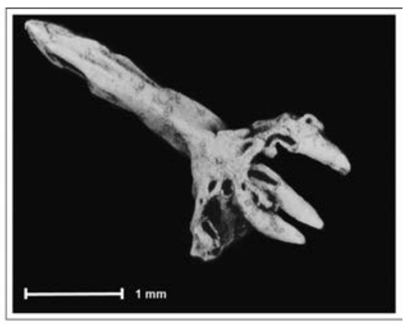

Figure 3.f. Lizard premaxilla (magnified 22 times).

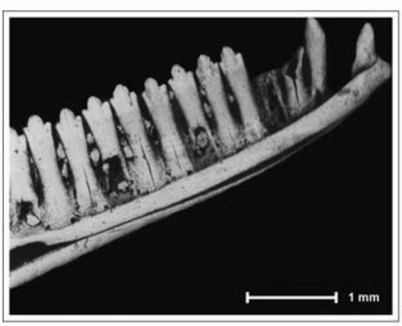

Figure 3.g. Lizard left dentary (magnified 20 times).

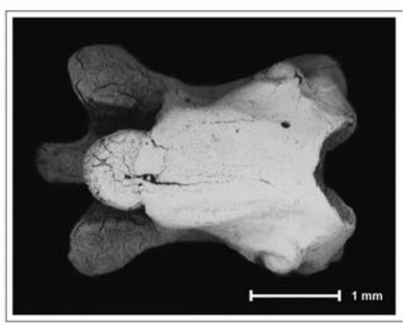

Figure 3.h. Lizard presacral vertebra (dorsal view)

FIGURE 3 (part II)
Lizard bones II (adapted from Kligmann, 2003, 2009).

problem. Mortality increases during severe winters, very dry and hot summers and / or heavy rains (Gregory, 1982). Lizards do in fact hibernate in groups, they tend to use the same place year after year and they also tend to use empty rodent burrows (Gregory, 1982; Walker, 1983; Contreras, 1984). We have already mentioned that there are some tunnels in the rockshelter deposits. In the beginning we thought that lizards could have died while hibernating due to a volcanic eruption. However, we have discarded this hypothesis based on the fact that lizard bones and pyroclastic sediments are not associated. This means that the burrows were filled with sandy sediments before the eruption took place. Therefore, the volcanic event is not directly related to the lizards' death (Kligmann, 2003, 2009; Kligmann *et al*., 1999).

The use of rodent burrows as shelter has been recorded for some iguanian species living in the Argentine and Chilean Puna (Donoso Barros, 1966; Cei, 1993; Etheridge, 1993). In particular, *L. ornatus* and *L. multicolor,* two common lizards in high altitude sites, exploit sandy soils where there are abundant rodent burrows that both species share to protect themselves from predators (Etheridge, 1993). The high concentration of individuals (both adults and juveniles), accumulated in a surface smaller than 1 m^2 located on the SW sector of the excavation, suggests an aggregational behavior during hibernation of at least two *Liolaemus* species that exploited the same refuge simultaneously or quasi-simultaneously. This finding of *Liolaemus* bone remains in the Argentine Puna region represents the first record of this genus in an archaeological site of South America (Albino & Kligmann, 2007).

The lack of articulated skeletal parts observed in the field can be explained by the fragility of small animal soft tissues, which are quickly destroyed. Besides, the existence of moisture conditions in the rockshelter, inferred from manganese oxide staining, could have accelerated the decomposition of carcasses (Stahl, 1996; Kligmann, 2003, 2009).

Animal and human occupations generally alternate in cave and rockshelter deposits. Since lizards and humans do not exploit the same places at the same time, recovering lizard remains in an archaeological site (if it can be shown that they were not consumed by people) points to its seasonal occupation. The data revealed that humans were only one of the several agents who used the site as a refuge and allowed us to propose a model of alternate site usage through time (Kligmann, 2003, 2009). The fact that available refuges are scarce in the study area surely contributed to the exploitation of specific places by several agents at the same time, including individuals of different species, as well as to the reutilization of the same place by certain species at different moments.

The results of the sediment analyses showed values expected for high altitude sites in arid environments (*i.e.,* alkaline sediments with low organic matter and low available phosphorus). There is no evidence to support the idea that humans contributed in a significant way to the formation of the site, although it was certainly used by people. This may be explained as a consequence of just a temporal occupation of the site or by the fact that only a few number of people inhabited the site at a time. Besides, evidence of a catastrophic event (*i.e.,* a volcanic eruption) has been recorded. This probably implied the abandonment of the area until the local fauna and flora recovered (Kligmann, 2003, 2009).

In summary, our analyses allow us to propose that the reptile remains constituted a food resource neither for people nor for other predators (e.g., carnivores and predatory birds). Also, we can acertain that their origin is not due to other human activities unrelated to food consumption (*e.g.,* medicinal or ritual purposes or provision of raw materials for the manufacture of artifacts). Thus, their presence is due to catastrophic causes (death during group hibernation inside a rodent burrow) and points, at least temporarily, to the abandonment of the site by people. The remains would be the result of one or a few occupational events related sequentially but in a relatively short temporal span (Kligmann, 2003, 2009). Therefore, the identification of catastrophic death as the cause of accumulation can be described as a «process of elimination», whereby only one unfalsified hypothesis remains at the end.

CASE STUDY 2: TOLOMBÓN (SALTA PROVINCE, NW ARGENTINA)

Introduction

An accumulation of thousands of small amphisbaenian (Squamata, Amphisbaenidae)

reptile bones was found during the geoarchaeological analysis of the sediment contents of a ceramic vessel from the archaeological site of Tolombón (Fi-gure 4). The Santamariano style vessel, which had a human face modeled on the outer surface, was covered by a Famabalasto style bowl (Kligmann *et al*., 2013).

Amphisbaenians are small snake-like reptiles. Snake-like designs are extremely popular in the iconography of at least two ceramic styles of northwest Argentina. Up to now, however, only isolated bones of amphisbaenians have been mentioned (although not described) for just two archaeological sites. Even though the recovery and subsequent study of microvertebrates is becoming more common in Argentine archaeology, the record of reptile remains is still scarce (Kligmann & Díaz País, 2007; Kligmann *et al*., 2013). In this paper we present this rare assemblage and discuss the importance of the finding, which can be described as unusual given the size of the bones as well as by the amount of faunal remains recovered.

Site and site setting

Tolombón is located in the Yocavil Valley, Department of Cafayate, southern Salta Province, northwest Argentina (26° 11' 50" S and 65° 57' 41" W), at approximately 1800 m asl (Figure 5). Eight radiocarbon dates are available for Tolombón. They range between 800 and 350 years BP, indicating an occupation during the Regional Developments, Inka and Hispanic periods. During the Inka Period, this site became an administrative center (Williams, 2002, 2002-2005, 2003).

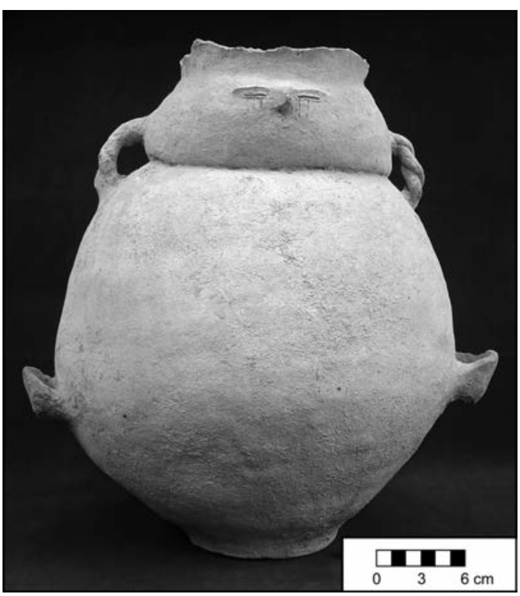

FIGURE 4
Ceramic vessel containing the amphisbaenian remains (taken from Kligmann *et al*., 2013).

The main goal of the Tolombón archaeological project was to understand the social, political and economic transformations carried out by the Inka Empire during the occupation of the Yocavil Valley (Williams, 2002, 2002-2005, 2003). Under the direction of Dr. Verónica Williams, the site was first excavated between 2000 and 2003 with financial support from Fundación Antorchas. Since 2004, the research project was funded by two grants awarded by FONCyT and CONICET (*Consejo Nacional de Investigaciones Científicas y Técnicas*) (Williams, 2002, 2002-2005, 2003). During fieldwork, Dr. Williams and her team collected the sediment contents of a ceramic vessel for further analysis in the lab, including geoarchaeological studies and flotation.

Iconography

Argentine archaeologists use the word amphisbaenian as a synonym of a two-headed snake. Amphisbaenians and snakes, however, are quite distinct groups. A more detailed study of the iconographic repertoire of northwest Argentine art shows that not all these reptiles look the same. While some of the images probably correspond to snakes, others are more difficult to identify because they lack precise attributes. Thus, they could be snakes (especially poisonous snakes), amphisbaenians or even worms. The first can be distinguished by their triangular heads, clearly separated from the body, and their big eyes. Some even show a tongue. In the latter, on the other hand, head and body are not distinct. All these representations, however, share one common characteristic: both the extremes look exactly the same. The bodies of probable snakes present geometric designs that simulate the skin patterns of these animals. The bodies of probable amphisbaenians or worms, on the other hand, show segmentation marks. Segmentation is merely apparent in amphisbaenians (given the particular arrangement of the scales) but real in worms.

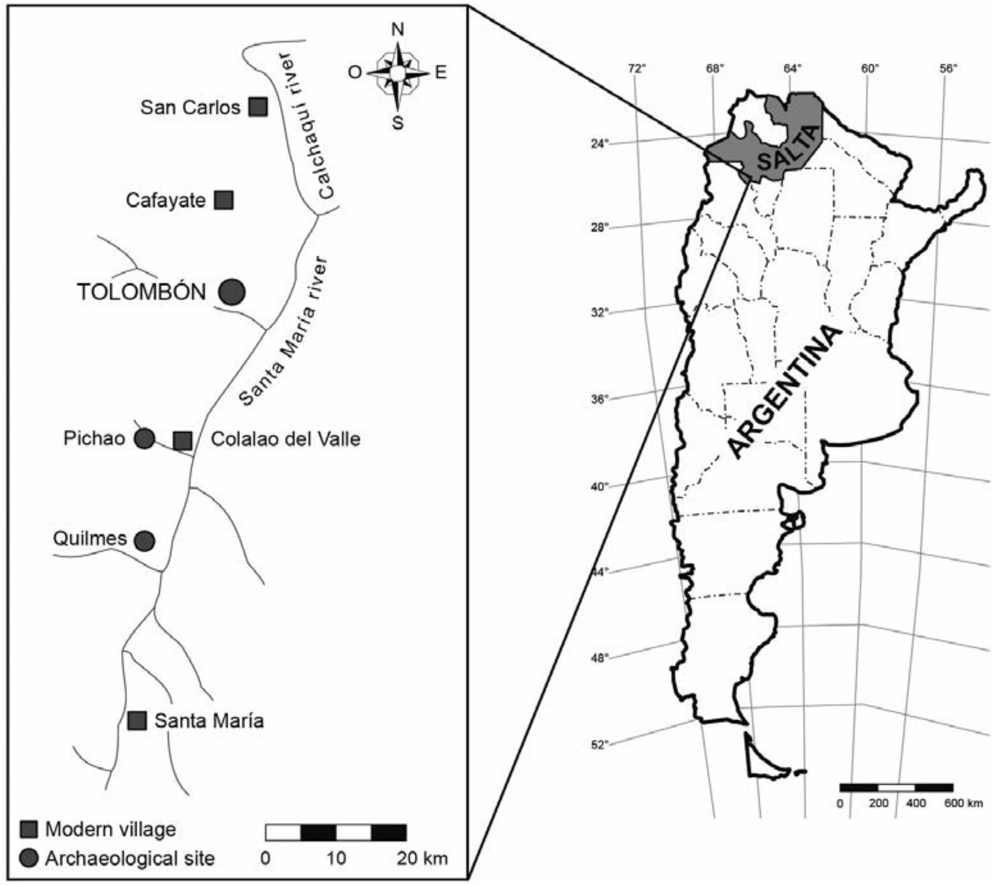

FIGURE 5
Location of the study area (Tolombón) (adapted from Kligmann *et al*., 2013).

Snakes with one head at each end of the body (as depicted in the indigenous art) do not exist in nature. Exceptionally, some snakes are born with two heads (located one next to the other at the front end of the body) but this is a malformation and the animals do not survive for very long (Kligmann *et al*., 2013).

Unlike lizards, two-headed reptile designs are very common in the iconography of northwest Argentina. Representations of these animals appeared in the Middle Period, flourished during the Late Period (also called Regional Developments) and became scarce in the Inka and Hispanic Periods. They have been depicted on a wide variety of raw materials, including fire-engraved gourds, pottery, basketry and metallurgy (Kligmann & Díaz País, 2007; Kligmann *et al*., 2013).

Methodology

All the sediments recovered from inside the ceramic vessel (approximately 9,4 kg) were dry sieved using three different superimposed mesh sizes (-1 Ø, 0 Ø and 1 Ø, equivalent to 2, 1 and 0.5 mm respectively). The sediments retained in all three sieves were examined under a binocular microscope (10x to 30x). All bones and teeth were separated from the mineral grains and classified according to skeletal part, followed by NISP and MNI determinations. Taxonomic identification at low taxonomic levels (genus and species) was followed by a taphonomic analysis. We discuss issues such as: 1) density of specimens/kg of sediment analyzed, 2) number and diversity of taxa represented, 3) relative abundance, 4) degree

of skeletal articulation, 5) marks and modifications (e.g., burned bones, cut marks, gnawing marks, digestion damage and fractures), and 6) size variation within the different skeletal parts as a result of ontogeny (Kligmann *et al*., 2013).

We then carried out a bibliographic search for information on the ecology and ethology of the identified taxa. We address questions such as: Do these taxa currently live in the study area?, What are their climatic requirements?, What are their feeding habits?, What animals feed on them?, How many individuals are born at a time?, What are their life habits? In other words: Do they aggregate?, Do they share shelters?, Do they constitute family groups including male, female and juveniles?, Is there evidence of parental care? These are key questions for accurate interpretation (Kligmann *et al*., 2013).

Animals can be consumed or used as a source of raw materials (such as leather, fur, wool, tendons, feathers, bones, antler, ivory and shell) for a variety of purposes, including medicinal, ritual or technological. Thus, it also became necessary to understand the use of amphisbaenians in indigenous communities (both ancient and modern) of northwest Argentina. Finally, a detailed analysis of the possible processes and agents of accumulation of the faunal remains was carried out. The following sediment attributes were measured: color, pH, available phosphorus, organic matter, grain-size and microartifacts (Kligmann *et al*., 2013).

Results

The MNI is 21 (based on the number of preserved occipital complexes), the NISP is 6884, and the density of specimens/kg of sediment analyzed is almost 732.

In Tolombón, the number and diversity of taxa are restricted to only one vertebrate family: the Amphisbaenidae (a member of the order of Squamata together with snakes and lizards), which comprises more than 18 genera and over 160 species. Specifically, the genus *Amphisbaena* includes around 70 species (Gans, 2005). Amphisbaenians, also named «worm lizards», are limbless reptiles adapted to a burrowing life style. They possess an elongated body, a short tail and a unique modification of the inner ear that allows them to detect low-frequency sounds. Their small heads are not differentiated from the body and their eyes, which are scarcely developed, can hardly be distinguished. Amphisbaenians prefer loose or sandy soils and only rarely come to the surface. Many species are found by chance after heavy rains or when plowing or moving the soil. These solitary animals feed on ants and termites. Amphisbaenians do not aggregate, but they exploit nests of ants and termites. They do not tolerate water or sun very well so they can drown or desiccate easily if their galleries are flooded or if they are exposed on the surface. So far, we have not been able to find references that show that more than 2 or 3 individuals at a time live in the same place (Gallardo, 1977; Albino & Kligmann, 2009; Kearney, 2003; Kligmann *et al*., 2013).

Amphisbaenians inhabit Baja California, Florida, the Caribbean, Central and South America, sub-Saharan Africa, parts of the Mediterranean and the Middle East. The majority of amphisbaenian species diversity is concentrated in Africa and South America (Kearney, 2003) and some herpetologists have specifically studied the current distribution of these animals in Argentina (*e.g.,* Montero, 1996; Ávila *et al*., 2000). Their ecology and life history are poorly known due to their fossorial lifestyle and to the scarcity of researchers studying this group (Albino & Kligmann, 2009; Kligmann *et al*., 2013).

The species identified in Tolombón is *Amphisbaena heterozonata*. Both mature and juvenile individuals are present in the assemblage. Different skeletal elements have been recovered, including occipital complexes, parietals, maxillae, dentaries, vertebrae and ribs. It is important to notice the scale drawn on some of the photographs, equivalent to 1 mm or even smaller (Figure 6). Vertebrae and ribs are, by far, the most abundant elements in the assemblage (Table 5). This was expected since, as already mentioned, amphisbaenians have elongated bodies and no limbs. Although most of the bones are disarticulated, there are some examples of articulated skeletal parts such as occipital complexes with stapes, occipital complexes with parabasisphenoids, frontals with parietals and dentaries with compound bones (Kligmann *et al*., 2013).

As far as taphonomy is concerned, we can mention that almost all parts of the skeleton are represented. This suggests that the animals entered

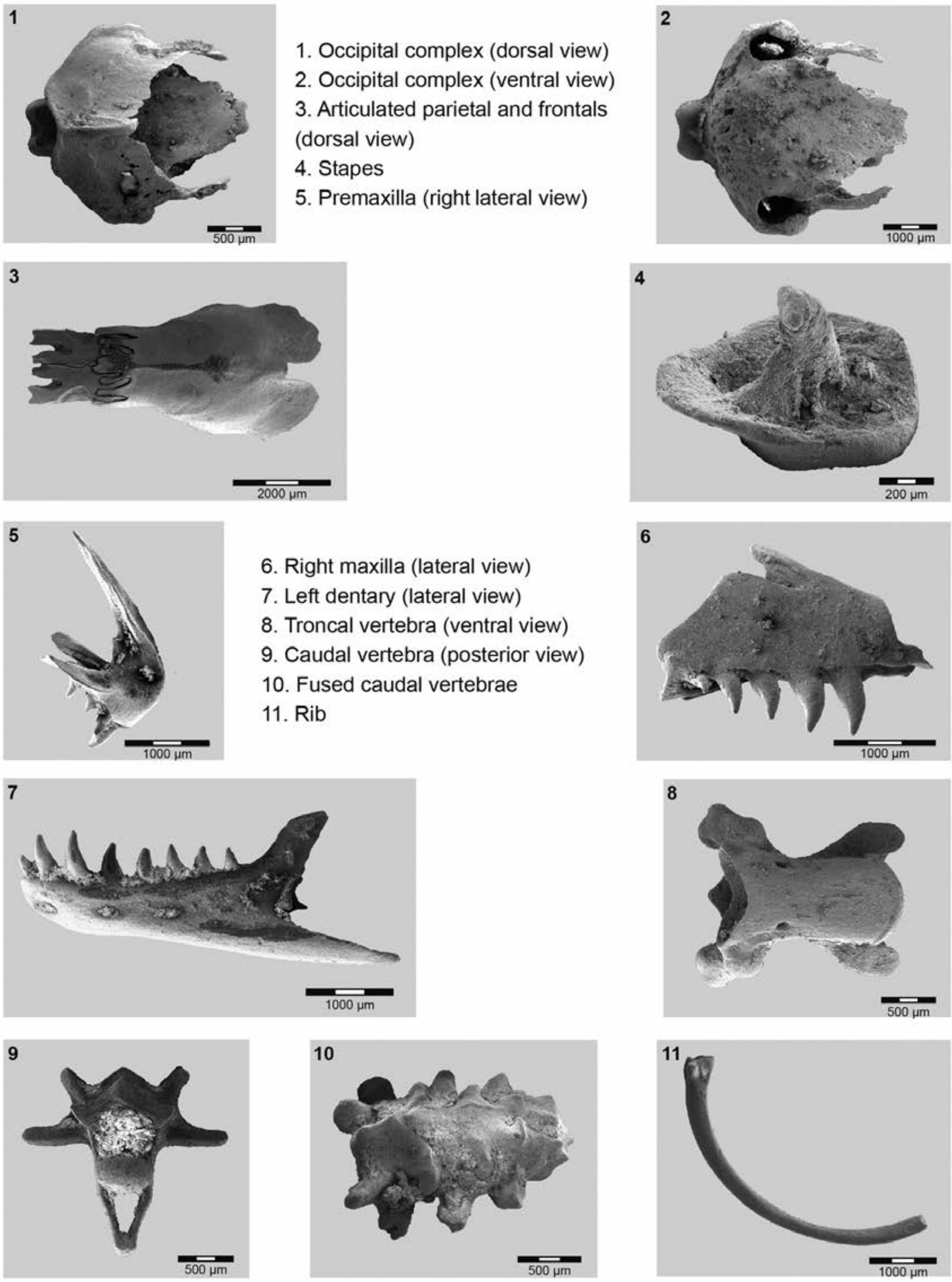

FIGURE 6

Amphisbaenid bones (adapted from Kligmann *et al*., 2013).

	SKELETAL PART	NISP	SUBTOTAL
CRANIUM	Ectopterygoid	17	355
	Frontal	34	
	Right maxillae	18	
	Left maxillae	16	
	Nasal	22	
	Occipital complex	21	
	Palatine	30	
	Parabasisphenoid	18	
	Parietal	13	
	Parietal fragments	3	
	Prefrontal	12	
	Premaxillae	19	
	Pterygoid	35	
	Quadrate	38	
	Stapes	31	
	Tabulosphenoid	16	
	Vomer	12	
MANDIBLE	Angular	3	91
	Compound bone	29	
	Coronoid	19	
	Right dentaries	19	
	Left dentaries	20	
	Indeterminate dentaries	1	
POSTCRANIUM	Atlas neural arches and axis vertebrae	44	2599
	Precloacal vertebrae	2192	
	Cloacal and caudal vertebrae	344	
	Fused caudal vertebrae	19	
	Ribs	3839	3839
	TOTAL	**6884**	

TABLE 5

Classification of amphisbaenian remains by skeletal part (adapted from Kligmann *et al*., 2013).

the vessel whole and that their skeletons disarticulated *in situ*. Also, the presence of so many fragile and well-preserved small bones would indicate minimal or no transport at all. In some of the bones, even skin pieces and skin impressions are observed. Specimens are not burned and do not exhibit cut marks, gnawing marks, digestion damage or punctures. Specific anatomical parts were not selected. The percentage of fractured bones is very low and the amount of indeterminate elements is lower than 8% (Kligmann *et al*., 2013).

Discussion and interpretation

Lyman (1994) suggests that the challenge taphonomy presents to zooarchaeologists can be simply phrased as: what are these bones doing in this site? This rare accumulation of small reptiles could have been either taphonomic or the result of human action. Our main goal was to figure out how the animals entered the ceramic vessel since this was crucial for understanding the relationship between indigenous peoples and their environment. Examination of both the faunal remains and the sedimentary matrix shed light on this issue.

In order to correctly interpret this finding, four complementary and independent lines of evidence were followed: 1) analysis of the possible agents and / or processes of accumulation of the reptile remains, 2) the context of the microvertebrate assemblage (*i.e.,* the vessel, the circular structure where it was deposited and the archaeological site as well as the faunal remains found in other structures of the same site), 3) the papers published by the first Argentine archaeologists at the beginning of the twentieth century dealing with the meaning of reptiles in NW Argentina belief systems, and 4) the iconography of snake-like designs in ceramic vessels corresponding to the Regional Developments Period. Just one line of research would not have been enough and the assemblage could have easily been interpreted in the wrong way (Kligmann *et al*., 2013).

The following arguments allowed us to propose not only an anthropic origin for this accumulation but also that it was not related to nutritional, technological or medicinal purposes: 1) only one vertebrate taxon was represented in the vessel although there are different taxa living in the area, pointing to an intentional selection of amphisbaenians, 2) the MNI was too high for such a small space, given that these solitary animals do not aggregate in nature, 3) they lay just a few eggs at a time, 4) the bones are very small and delicate, 5) the state of preservation of the faunal remains was excellent and there were no signs of natural or anthropic damage, 6) these animals live underground and are rarely seen on the surface, 7) because of their size, they have a very low economic yield, 8) the amphisbaenid bones were not associated with any other remains except the ceramic vessel itself, 9) the vessel was filled with sediments and covered by a ceramic bowl, 10) amhisbaenids do not appear in any other sample of the site and other species recovered in different structures of Tolombón are absent in the circular structure (e.g., mammals –such as Artiodactyla, rodents, and carnivores– and birds), 11) snake-like designs are very popular in the iconography of the Regional Developments Period, 12) a similar assemblage was recovered in another site of NW Argentina (amphisbaenians inside a ceramic vessel, filled with sediments and covered by a ceramic bowl, although in this second case, the bones were associated with the bones of an infant and the vessel was decorated with snakes), and 13) remains of amphisbaenians and snakes have been found inside ceramic vessels –filled with sediments and covered by ceramic bowls– in other parts of the world such as Peru or the Near East (see for example Bailon, 1997; Potts, 2007 and Goepfer *et al*., 2013), and they have been interpreted as animal sacrifices (Kligmann & Albino, 2007; Kligmann *et al*., 2013).

The presence of almost all the skeletal parts of the reptiles as well as their excellent state of preservation is surprising, given the extreme fragility of these bones. The results of the analyses (taxonomic, ecologic, ethologic, taphonomic and contextual), together with a detailed study of the possible processes and / or agents of accumulation, show that this assemblage of small vertebrates was the result of an intentional human action, probably related to ritual activities such as an offering. Given the fact that in local ethnographic narrations reptiles are associated with climatic phenomena, and that amphisbaenians live underground and only come to the surface after heavy rains, we can propose that the accumulation of several individuals of only one species inside a ceramic

vessel could have been related to a propitiation for rain (Kligmann *et al*., 2013).

The sediment analyses included samples coming from both inside and outside the ceramic vessel. The differences between the two sets of samples can be appreciated particularly in two of the attributes chosen: phosphorus and organic matter. For the samples coming from inside the vessel, an average value of 180 ppm of phosphorus was recorded while the percentages of organic matter obtained ranged between 1.3 and 2.1. The samples taken outside the vessel, on the other hand, showed an average value of 33 ppm of phosphorus and percentages between 0.6 and 0.9 of organic matter. While we cannot yet explain why higher values of both phosphorus and organic matter were recorded inside the vessel, this could be related to some organic substances deposited together with the amphisbaenians (e.g., floral remains with hallucinatory properties, fermented beverages or body fluids such as blood, saliva or urine) or even an infant, later removed and deposited somewhere else. In any case, these should have decomposed through time, thus changing the characteristics of the natural sediments of the study area (Kligmann *et al*., 2013).

To sum up, during the Regional Developments period it was common to bury small children in funerary urns. Although it looks like the vessels used as funerary urns in NW Argentina, the vessel recovered at Tolombón did not contain human remains. When no human bones are found inside the urns, archaeologists believe that these are «empty». This leads to a fascinating archaeological problem: how really «empty» are funerary urns? Maybe the offering was the vessel itself or maybe the offering consisted of different items such as animals, seeds and flowers placed inside the vessels. Given that for many years sediment samples were not collected, if these items were small or decomposed very easily, they might have gone unnoticed (Kligmann *et al*., 2013).

DISCUSSION AND CONCLUSION

This paper provides examples of how similar signatures (*e.g.,* skeletal completeness) can be separately interpreted as accumulations of natural or cultural origin using multiple lines of corroborating evidence, based on the faunal analysis as well as on contextual details.

This paper also demonstrates the importance of collecting and analyzing sediment samples from archaeological excavations. The recovery and interpretation of these assemblages was made possible because geoarchaeological studies were carried out in both research projects. One of the attributes considered during routine sediment analysis was microartifacts. In order to achieve this goal, sediments were examined under the microscope, the material remains found were separated from the mineral grains and then analyzed.

As table 6 illustrates, these two sites share some common characteristics, including the chosen methods for the recovery and further analysis of microvertebrates as well as the attributes of the sedimentary matrices and the vertebrate classes recovered. On the other hand, they have some particular features that make them unique, such as the genus and species identified and the meaning of the faunal assemblages. This is why we thought that they were perfect case studies to showcase the potentialities of microfaunal studies recovered from archaeological sites.

The physical and chemical analysis of the sedimentary matrix of the first case study, as well as a detailed study of the microvertebrate remains, allowed us to propose a model of site occupation: the highest peak of human activity was identified at the base of layer III, showing high values of phosphorus and organic matter and low values of pH (close to neutral). The rockshelter was later abandoned by humans and occupied by other inhabitants such as rodents and lizards.

The analysis of both sediments and faunal remains in the second case study presented here, allowed us to assign a possible function to a circular structure at Tolombón. By comparing the micro and macrofaunal assemblages, we could infer a differential use of the fauna and of the landscape. Some animals were regular components of the diet (*e.g.,* camelids), whereas others were used exclusively for ritual purposes (*e.g.,* amphisbaenians). Also, both faunal assemblages come from structures of different size and shape, located in distinct parts of the landscape. Thus, we can hypothesize that rectangular structures were used as dump areas while circular structures were chosen as ceremonial areas.

		ALERO 12	TOLOMBÓN
WHAT DO THESE ASSEMBLAGES HAVE IN COMMON?	DOMINANT CLASS	Reptilia	
	ANIMAL SIZE	Small animals, do not have an equivalent version in larger sizes	
	RECOVERY METHOD	Dry sieving of sediment samples	
	SEDIMENTARY MATRIX (GRAIN-SIZE)	Sand	
	LOCATION	Northwest Argentina	
	ENVIRONMENT	Arid / Semi-arid	
	TAPHONOMY	Excellent state of preservation, almost all parts of the skeleton represented, specimens are not burned and do not present cut marks, gnawing marks, digestion damage or punctures, most of the bones are whole, even small and delicate ones	
WHAT ARE THE DIFFERENCES BETWEEN THESE ASSEMBLAGES?	DOMINANT TAXA	Reptiles (Lizards)	Reptiles (Amphisbaenians)
	OTHER TAXA	Birds and mammals (rodents)	Absent
	ETHOLOGY	Gregarious animals, hibernate	Solitary animals, live beneath the surface
	NISP	1732	6884
	MNI	74	21
	RECOVERED FROM	Natural sediments	Sediments inside a ceramic vessel
	SITE TYPE	Rockshelter	Open air site with site structures
	LOCATION	Puna (Catamarca province)	Yocavil Valley (Salta province)
	CHRONOLOGY	590 ± 45 BP	Regional Developments Period, according to the style of the ceramic vessel where the assemblage was found, although it could have been used or reused in a later period (Inka)
	ORIGIN	Natural	Anthropic
	INTERPRETATION	Communal hibernation of individuals of different genus, species and age inside rodent burrows	Ritual, possibly related to animal offerings asking for rain

TABLE 6

Comparison between the two case studies presented in this paper.

As both case studies presented in this paper show, sediments should be considered as a source of information of past human activities. Even though in some cases microartifacts can mirror macroartifacts, in some other cases they offer complementary information that cannot be obtained otherwise.

Ideally, each layer represents a well-defined time unit. The definition of stratigraphic layers and their boundaries is important for the definition of assemblages. We have to make sure that all the items found in close spatial association do, in fact, belong to the same assemblage. In too many cases, however, all the artifacts in an assemblage cannot be referred to a single activity of a single group of people. They are aggregates of items resulting from different site occupation events and possibly from different modes of site use by the same or different groups of people or other agents. Since vertical migration of artifacts across layers is fairly common in archaeological sites, horizontally associated items in a layer may result from the mixing of different events of site use (Villa & Courtin, 1983; Kligmann, 1998).

Far too little has been done systematically to use archaeological sediments when reconstructing site formation processes. At best, sediment samples are collected by archaeologists and then sent to geologists for further analyses. The results are often published as appendixes of site reports and seldom incorporated into archaeological interpretation. Artifacts have been the traditional concern of archaeologists. They are, however, only one category among the wide variety of particles contained in a deposit. Artifacts, ecofacts, their spatial relations and sediments are related in such a way that studying only one of them may result in a great deal of lost information (Kligmann, 1998). For example, if sediments had not been taken into account for these particular case studies, microvertebrate bones would have not been recovered. Also, if bones had not been analyzed in

relation to their depositional context (artifacts, ecofacts, structures and the sedimentary matrix), the meaning of both accumulations would have not been fully understood. Thus, if the deposit is considered the analytical unit, inferences about past cultural phenomena, such as site use and abandonment, can be constructed.

Research in multiple lines of analysis such as experimental archaeology, ethnoarchaeology, refitting studies, taphonomy and geoarchaeology, has increased our understanding of both natural and cultural formation processes of archaeological sites. An integrated approach that uses data provided by different yet complementary procedures can contribute to a better assessment of the research potentials of stratified sites (Kligmann, 1998).

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