Journal of Archaeological Science 55 (2015) 16–25

Contents lists available at ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Geographic scale and zooarchaeological analysis of Late Holocene foraging adaptations in western Argentina

Clara Otaola [a, *], Steve Wolverton [b], Miguel A. Giardina [a], Gustavo Neme [a]

[a] IANIGLA-CONICET, Museo de Historia Natural de San Rafael, Av. Ballofet s/n, Parque Mariano Moreno 5600, San Rafael, Mendoza, Argentina
[b] University of North Texas, Department of Geography, 1155 Union Circle #305279, Denton, TX, USA

ARTICLE INFO

Article history:
Received 16 July 2014
Received in revised form
3 December 2014
Accepted 6 December 2014
Available online 17 December 2014

Keywords:
Resource intensification
Zooarchaeology
Hunter–gatherers
Spatial scale
Nestedness
Species area curves

ABSTRACT

Previous research on intensification in hunter gatherer strategies from Central West Argentina *ca.* 2000 years BP states that human demographic packing and overhunting of guanacos (*Lama guanicoe*) may have caused resource depression of this large prey animal. As a result, people broadened their diet to include smaller prey animals. Evidence supporting this conclusion includes an increase in Shannon's Diversity Index and a decrease in the abundance of artiodactyl remains over time in southern Mendoza. However, these studies about change in diet breadth did not consider the importance of spatial scale on analysis of prey choice and diet breadth and used the entire region as a unit of analysis. This is problematic because southern Mendoza has a heterogeneous landscape. In this paper we analyze different faunal abundance indices considering different spatial scales and the representativeness of the zooarchaeological samples. The results of the analyses show distinctive patterns of resource use over time at the macro- and subregional scales. Some of the difference can be explained by environmental differences between subregions and others might relate to differences in sample representativeness between subregions.

1. Introduction

The concept of intensification has been used in archaeology to discuss topics in human ecology, such as the emergence of plant and animal domestication and the development of complex societies (Ames, 1994; Binford, 2001; Boserup, 1965; Flannery, 1969; James, 1990). Intensification of hunter-gathering strategies is thought to have been associated with the expansion of the southern limits of agriculture during the late Holocene in southern Mendoza province, central western Argentina (Neme and Gil, 2008a). Neme and colleagues (Neme, 2007; Neme and Gil, 2008a) noted that increasing human population density after 4000 years ago may have caused overhunting of large game, thus reducing its availability. This is thought to have led people to broaden their diet. As a result, more small game species were included in the diet over time within the region. Previous research shows an increase in faunal diversity and a reduction in the consumption of artiodactyls through time across southern Mendoza from 4000 to 2000 years ago with a reverse in the trend after 2000 years ago. It is important to recognize that these changes were observed at the space-averaged scale of the entire region. During the last decade, the archaeological record has improved substantially such that patterns in late Holocene foraging can now be assessed within Mendoza at the sub-regional scale (e.g., Neme et al., 2013).

In this paper we analyze variability in animal consumption during the late Holocene within southern Mendoza. This allows reassessment of the late Holocene intensification hypothesis framed by Neme and colleagues using multiple lines of zooarchaeological evidence. We subdivide the region into four subregions based on characteristics of physical geography: the mountains, piedmont, plains (lowlands), and volcanic Payunia. We focus on the mountain and Payunia subregions due to low numbers of excavated sites and small zooarchaeological samples in the piedmont and plains subregions. Regional and subregional zooarchaeological datasets are assessed for representativeness using two approaches: sampling to redundancy using visual inspection of species-area curves and nestedness analysis, which is followed by consideration of foraging and intensification at the subregional scale. Prior to introducing these approaches in the Materials and Methods

* Corresponding author.
E-mail addresses: claraotaola@yahoo.com.ar (C. Otaola), wolverton@unt.edu (S. Wolverton), mgiardina@mendoza-conicet.gob.ar (M.A. Giardina), gneme@mendoza-conicet.gob.ar (G. Neme).

http://dx.doi.org/10.1016/j.jas.2014.12.004
0305-4403/

section we discuss previous research on resource intensification in Mendoza. In the following section we present brief description of southern Mendoza physical geography, which is used to divide the region into subregions.

2. Study area

Southern Mendoza comprises a heterogeneous landscape and can be divided into four different geographic subregions: the mountains (Andean cordillera), the piedmont, the volcanic region (Payunia) and the plains (Fig. 1). The whole region has a semi-arid climate and consists of dry steppe and deserts (Norte, 2000); it is cut by three major rivers, the Diamante, the Atuel and the Grande Rivers, which would have been important water sources during prehistory. It is located in the "South American Arid Diagonal" (Bruniard, 1982), and precipitation varies in amount and seasonality from west to east. The western mountains (Andean cordillera) and piedmont exhibit winter precipitation, the western arid plains witness a majority of precipitation in the summer, and the southeastern volcanic plateau (called Payunia) is characterized by winter-dominant annual precipitation (Abraham, 2000; Capitanelli, 2005; Morales et al., 2009). The current long-term weather conditions have generally been in place for the last 3000–4000 years (Navarro et al., 2012; Zárate et al., 2010), though minor climate change occurred during the late Holocene (Navarro et al., 2012). We limit our analyses to the mountain and Payunia volcanic subregions because of the small numbers of excavated assemblages in the plains and piedmont subregions (Fig. 1, Table 1).

The mountain subregion comprises climate related to high elevation and glaciation spanning from approximately 1700 to 4400 masl. The subregion is dominated by shrub communities of Juncaceae and Cyperaceae at low and moderate elevations, which are replaced by grasslands at high elevations (Cabrera, 1976; Roig, 1972; Roig et al., 2000a,b). Zoogeographically this region corresponds to the Fauna de Montaña, consisting of large mammals such as *Puma concolor* and *Lama guanicoe* as well as migratory birds that live in small lagoons and creeks (e.g., *Anas* sp. and *Choelephaga picta*) and scavengers, such as *Vultur griphus*. The geomorphology and climate of this subregion impose conditions that would have made areas usable for hunter–gatherers only from November to March during the warm seasons of the southern hemisphere (Abraham, 2000).

The Payunia ranges from 1100 to 2000 masl with some volcanic cones that reach 3800 masl. The climate is cold and arid, with winter precipitation depending on the action of the Pacific anticyclone (Abraham, 2000; Capitanelli, 1972). This region lacks

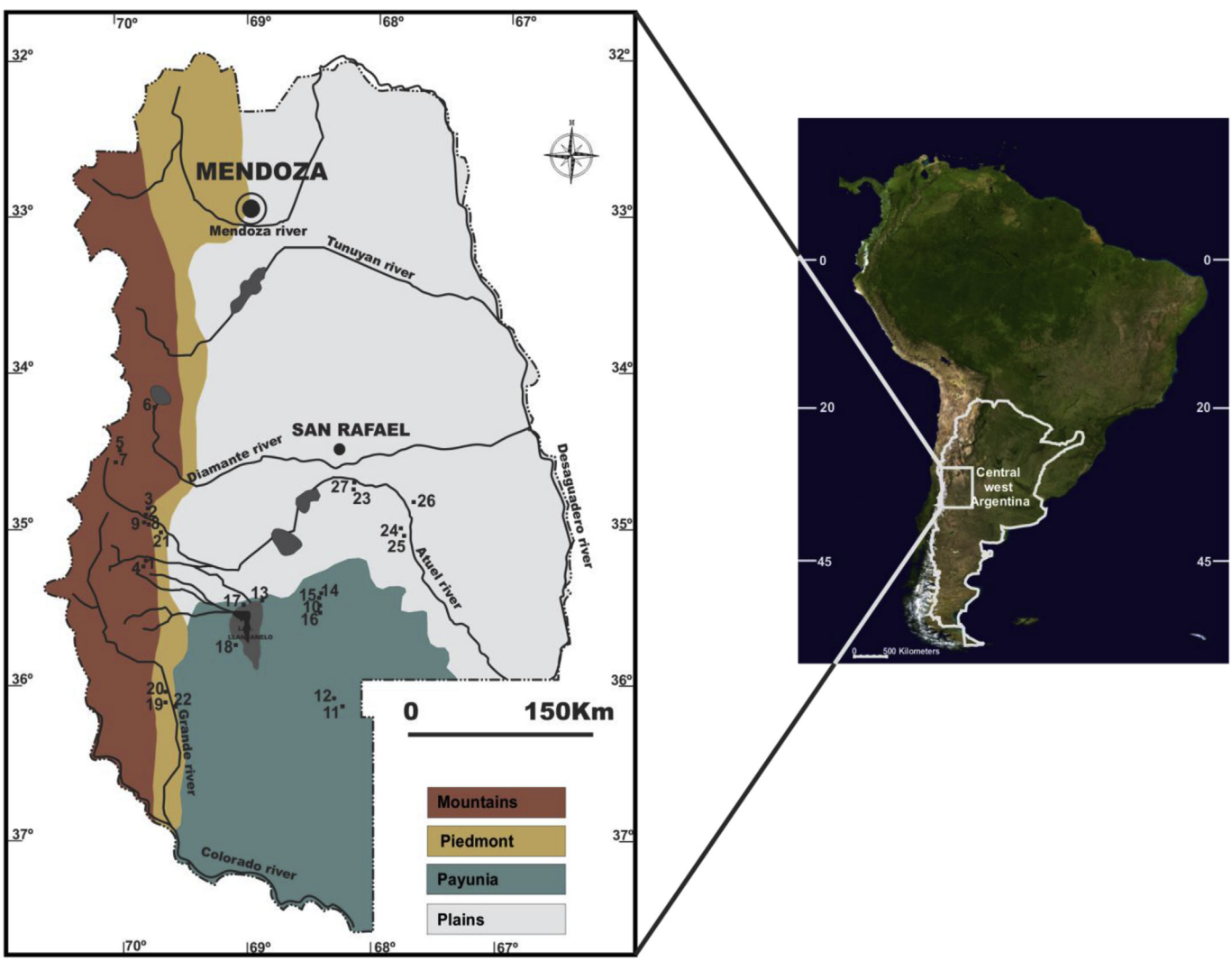

Fig. 1. Mendoza province with delineation of geographic subregions. Numbers indicate the archaeological sites with zooarchaeological assemblages studied in this paper.

Table 1
Zooarchaeological assemblages from Southern Mendoza. The sites were grouped according to subregion. NSP: Number of Specimens, NISP: Number of Identified Specimens.

Subregion	Assemblage	^{14}C date	NSP	NISP	NTAXA	Shannon H	p(GUA)	(pSA)	References
Mountains	El Indígeno	980 ± 90	204	53	1	0	1	0	Neme, 2007
	Panchino B	2793 ± 39	517	97	1	0	1	0	Otaola, 2013
	Panchino A	1048 ± 39	538	42	1	0	1	0	
	Palulo C	3970 ± 40	1144	1385	2	0.55	0.8	0.05	Otaola and Llano, 2014
	Palulo B	2228 ± 37	3428	923	2	0.12	0.97	0.02	
	Palulo A	130 ± 33	973	228	3	0.21	0.95	0.034	
	Los Peuquenes	280 ± 50	15363	1622	3	0.27	0.98	0.02	Neme, 2007
	Laguna El Diamante-4 I& II	782 ± 35	11,941	459	5	0.53	0.79	0.13	Durán et al., 2006
	L Diamante-4 III	1100 ± 40	3231	229	4	0.69	0.67	0.28	
	Cueva Ao. Colorado II	3190 ± 80	2981	960	2	0.04	0.99	0.01	Neme, 2007
	Arroyo Malo 3 B(I)	2200 ± 50	374	23	2	0.59	0.71	0.29	
	Arroyo Malo 1	560 ± 65	3034	25	1	0	1	0	
	Ao. Colorado cave I	1380 ± 70	8829	2603	5	0.15	0.97	0.02	
	AMA 3 C	3810 ± 100	709	18	2	0.44	0.67	0.33	
Piedmont	Cueva Luna c	3830 ± 160	106	81	2	0.67	0.58	0.41	Durán, 2000
	Cueva de Luna B	1490 ± 60	535	335	3	0.73	0.58	0.01	
	Cueva de Luna A	500*	829	525	3	0.66	0.74	0.02	
	Alero Puesto Carrasco B	2090 ± 80	48	48	3	0.87	0.35	0.57	Neme et al., 1999
	Alero Puesto Carrasco A	470 ± 90	2173	1492	4	0.64	0.8	0.1	
Lowlands	Rincon del atuel B–I	1520 ± 70	268	26	1	0	0	1	Gil et al., 2008
	Rincón del Atuel 1 AyK	980 ± 100	828	21	3	0.65	0.07	0.93	
	La Olla C1 & C2	1948 ± 46	4953	637	4	0.96	0.02	0.95	Gil and Neme, 2010
	La Olla A1 & A2	660 ± 26	1512	376	4	0.57	0.05	0.95	Giardina et al., 2014
	El Bosquecillo 5	903 ± 32	8	4	1	0	0	1	Corbat et al., 2009
	El Bosquecillo 3	886 ± 32	6	3	1	0	0	1	
Payunia	Puesto Ortubia	910 ± 40	6441	214	4	0.71	0.77	0.19	Gil, 2006
	Los Leones 5	870 ± 70	269	103	2	0.28	0.08	0.92	
	Los Leones 3	200*	45	7	1	0	0	1	
	La Peligrosa	640 ± 70	663	47	3	0.95	0.29	0.71	LP-1513/Salgán, 2012
	La Corredera	1930 ± 50	783	249	3	0.69	0.28	0.7	Gil, 2006
	Agua de los caballos	1240 ± 70	2941	212	5	1.22	0.55	0.45	
	Llan 50 sup	553 ± 34	850	811	3	0.22	0	1	Giardina et al., 2014
	Llan 50 Inf	3199 ± 38	570	553	4	0.36	0	1	
	Llan 29	3039 ± 28	219	219	5	0.99	0.54	0.97	
	Llan 17	990 ± 34	29	29	3	1.05	0.04	0.96	

significant permanent water sources (González Díaz, 1972), which is considered to have been a major constraint for human occupation (Capitanelli, 1972; Gil, 2006). The average annual rainfall is between 200 and 250 mm, with water scarcity between October and January (Abraham, 2000). This region is part of the Monte and Patagonian vegetation province (Abraham, 2000). The Monte–Patagonian transition is gradual at intermediate elevation, thus, some areas are ecotones. Zoogeographically the main species represented are those from the "Fauna de la Estepa Patagonica," which includes *L. guanicoe*, *Lagidium viscaccia*, *Lycalopex culpaeus*, *P. concolor*, *Dolichotis patagonum* and many birds species, such as *Rhea pennata* (lesser Rhea) *Chloephaga melanoptera*, and a numerous duck species (*Anas* sp.).

3. Intensification and archaeology in Southern Mendoza

Intensification is an increase in the production of one or more resources per unit of land, or per unit of labor, and intensification most often concerns responses to local or regional interactions between people and their habitats (Binford, 2001: 221; Boserup, 1965: 43; Johnson and Hard, 2008; Morrison, 1994; see recent summaries in Butler and Campbell, 2004; Gremillion et al., 2014; Zeder, 2012). An imbalance between resource availability and population size is one possible cause of intensification (Broughton et al., 2010; Cannon, 2000). The ways in which intensification occurred in the past varies by environment (Binford, 2001; Holly, 2005; Phoca-Cosmetatou, 2009; Zeder, 2012). Binford (2001) noted that in high latitude environments—the arctic and subarctic—intensification would have been expressed culturally as seasonal resource specialization with related increases in storage practices. In contrast, in arid environments it is expected that if population pressure occurred, which may cause a reduction in resource availability, the response will be a diversification in diet. Such expansion of diet breadth leads to an increase in the use of resources with low return rates and the use of lower ranked resource patches (Bettinger, 1991; Broughton, 1994; Cannon, 2000; Janetski, 1997; Nagaoka, 2001, 2002).

During the early Holocene, the most productive areas of southern Mendoza in terms of floral and faunal diversity—lowlands and cordillera valleys—were occupied first. By the mid-Holocene, the density of archaeological sites decreased (Neme and Gil, 2009), which has been attributed to an increase in aridity by 8000 years BP that was caused by a decrease in summer rains and an increase in average temperature between 8000 and 5000 years BP (D'Antoni, 1983; Markgraff, 1983; Stingl and Garleff, 1985; Zárate, 2002). At the beginning of the late Holocene, expansion into the lowlands, Andean valleys, and piedmont occurred. During the terminal late Holocene (after 2000 BP), there is evidence of human occupation in all the ecoregions of southern Mendoza (Borrero, 1989–1990), including those areas that had never been occupied before, such as some parts of Payunia volcanic region and the high elevations of the Andean Cordillera (Gil, 2006; Neme, 2007; Neme and Gil, 2008b).

Major changes associated with intensification in southern Mendoza concern mobility and subsistence, thought to relate to an increase in human population density in centuries leading up to 2000 years BP (Neme, 2007; Neme and Gil, 2008a; Neme et al., 2013). The precise timing of population growth is not clear, but generally is thought to have occurred between 4000 and 2000 BP.

By the end of this period, demographic packing is thought – based on previous studies – to have led to resource depression from overexploitation of high-ranked prey, such as guanaco (*L. guanicoe*) (Fig. 2A; Neme et al., 2012). A reduction in guanaco consumption and an increase in diet breadth, with the incorporation of plant and animal species with low return rates (e.g., small rodents, birds and fish) is thought to have occurred at the regional scale leading up to 2000 BP (Fig. 2B; Neme and Gil, 2008a). Indeed, evidence for new technologies (e.g., pottery and ground stone plant-processing tools) in addition to greater amounts of non-local raw materials indicate expansion into new environments, a decrease in residential mobility, and intensified use of resources (Neme, 2007). Archaeobotanical evidence indicates that high taxonomic richness of wild and domesticated plants was maintained in some areas after 2000 BP. There was a corresponding decrease in abundance of remains of high-return plant species, such as *Geoffroea decorticans*, *Prosopis* sp., *Schinus polygamous*, and an increase in remains of low-return species, such as *Pterocactus*, *Condalis* and *Ephedra*. This shift is particularly evident in the lowlands and piedmont (Llano, 2011). After 2000 BP, human populations became less mobile, may have incorporated domesticated plants into their diet, and generally occupied a greater diversity of environments (Neme et al., 2013) at the regional scale. During this time of higher population densities and intensification of plant-resource use, it is thought that resource depression of animal prey did not recover but that people were able to use guanaco through longer distance foraging bouts (Fig. 2; Neme and Gil, 2008a; Neme et al., 2013). Despite these regional patterns and interpretations, previous studies were not able to meet the data requirements of considering the heterogeneity of the spatial distribution of animal resources at the subregional scale.

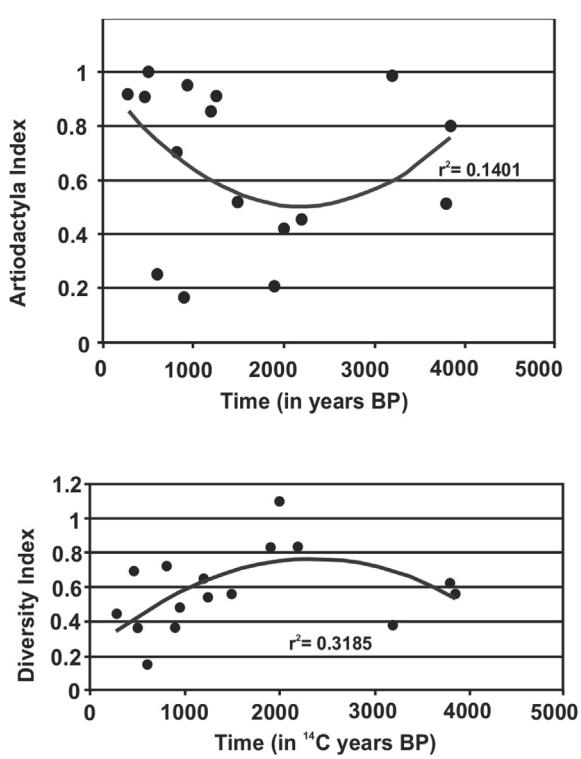

Fig. 2. Bivariate plots (after Neme and Gil, 2008a: 301–302, Figs. 3 and 5) illustrating a decrease in the Artiodactyl Index (upper) and an increase in Shannon Diversity Index (lower) centering on 2000 years BP for the southern Mendoza region during the late Holocene.

4. Materials and methods

We assess whether or not faunal communities are sampled representatively using two approaches, nestedness and visual inspection of species-area curves (Lyman, 2008; Peacock et al., 2012). Analyses are performed at two geographic scales; first, we analyze faunas aggregated at the regional scale of southern Mendoza (Fig. 1). Second, we analyze species-area curves and nestedness by subregion. All zooarchaeological assemblages are from projects that employed modern excavation and recovery methods, such as use of 2 mm sieving. Faunal samples with less than 50 NISP (number of identified specimens) are not included in these analyses. Twenty three of thirty five faunas in the region meet this sampling criterion (Table 1), producing 70,792 faunal specimens with 14,366 NISP. At the subregional scale we only consider the Payunia and Mountain subregions because there are very few sites represented from the plains and the piedmont. Our goal is to determine if representativeness improves at the finer geographic scale of subregion.

Using species-area curves, if the same animal community is sampled repeatedly in a set of faunal assemblages, the number of taxa (NTAXA) will increase as assemblages are added to the curve (as cumulative NISP increases). Using a bivariate scatter plot with NISP (sample size) as the independent variable and NTAXA as the dependent variable—assuming that encounter of rare species is more likely in large samples—the curve will asymptote once rare taxa have been sampled. This is termed "sampling to redundancy" (Leonard, 1987, 1997; Lyman and Ames, 2004).

The second approach we use for assessing differences in representative between regional and subregional scales is nestedness analysis (Lyman, 2008:167–170; Patterson, 1987; Ulrich, 2008). Beyond sampling to redundancy, use of this approach adds the ability to address similarity or dissimilarity in taxonomic composition among a set of assemblages. Nestedness graphs are constructed for the region and then for subregions using the logic that samples with lower NTAXA should nest within samples with higher NTAXA. Degree of nestedness is measured using a "heat of nestedness" measure, which varies from 0 (perfect nestedness) to 100 (no nestedness) (Lyman, 2008; Ulrich et al., 2009). Assemblages with lower NTAXA only have those taxa represented in those with higher NTAXA. Smaller samples should generally nest within larger ones in terms of taxonomic composition due to the propensity for taxonomic richness to increase with sample size (Grayson, 1981; Lyman, 2008).

Once we analyze species–area relationships and nestedness, we revisit expectations about prehistoric trends in late Holocene foraging in southern Mendoza in the Payunia and the Mountain subregions. For each subregion we analyze four measures that relate to taxonomic diversity and prey choice: taxonomic evenness and richness using Shannon Index of Diversity (H), taxonomic richness using NTAXA, proportion NISP of Guanaco remains (pGUA), and proportion NISP of small animal remains (pSA). "Small animals" are those that average less than 5 kg in body mass; this includes Dasypodidae (armadillos), rodents, anatids and small birds, turtles, and fish that are typically considered small-animal food sources in this region (Corbat et al., 2009; Giardina, 2010). Our goal is to determine whether or not the same trends in richness, diversity, and prey choice that were demonstrated by Neme and Gil (2008a,b; Neme, 2007; Neme and Gil, 2009) for the entire region exist at the subregional scale for the late Holocene.

Although it is not the focus of this study, attention has been paid to taphonomic analysis of these samples in another study (Otaola et al., 2012). Humans, carnivores, and owls commonly deposited remains in these sites, and differential preservation and destruction related to weathering, carnivore damage, chemical modification,

and human processing of bone were considered prior to deriving measures of taxonomic diversity, richness, and prey choice (see Corbat et al., 2009; Fernández, 2012; Fernández et al., 2009; Giardina, 2010; Otaola, 2013; Otaola et al., 2012, 2014). Remains included in these analyses are associated with evidence of human consumption, such as remains with butchering marks (Brain, 1981; Gifford-González, 1989; Lyman, 1994) and burned bones associated with artifacts.

5. Results

Zooarchaeological assemblages from the region and subregions are nested and paleoecological animal communities appear to be sampled to redundancy (Figs. 3–5). At the regional scale, assemblages are highly nested (Fig. 3), and remains of guanaco and Dasypodidae are ubiquitous. Six rare taxa occur in only one assemblage each. Guanacos and armadillos were likely to have been high-ranked prey, which would account for their ubiquity. Guanacos are large-bodied artiodactyls (100–120 kg) and would have offered high returns when hunted. In contrast, armadillos represent small, terrestrial prey (2.5–6.5 kg); among contemporary traditional ranchers (puesteros) they are commonly taken when encountered (Otaola et al., in press). Armadillos offer high net returns because of their low cost. Rheids and anatids are moderately ubiquitous at the regional scale; rheids are large terrestrial birds (15–28 kg) that are considerably larger than most prey animals with the exception of guanacos. Despite their large size, among modern puesteros, hunting of rheids requires coordinated, long distance hunts with substantial investment in search and pursuit time (Giardina, 2010); thus, we assume rheids were lower-ranked prey than guanacos and armadillos. Anatids (ducks) are highly diverse small prey that would have exhibited very patchy distributions near lakes, marshes, and some portions of rivers. The remaining rare species either occur in very specific habitats or would have been uncommon on the landscape in the mountains or Payunia.

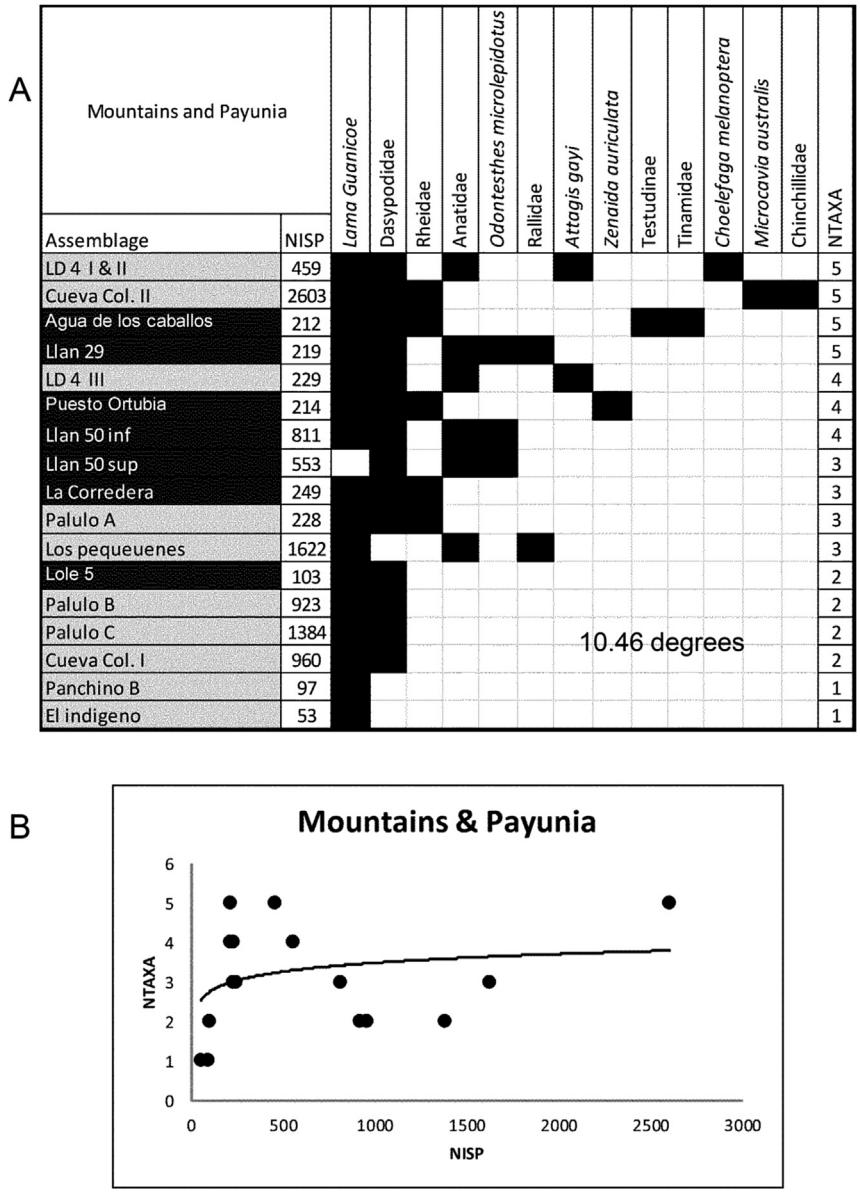

Fig. 3. Nestedness graph (A) and species area curve (B) for the southern Mendoza faunas for the late Holocene. See text for explanation.

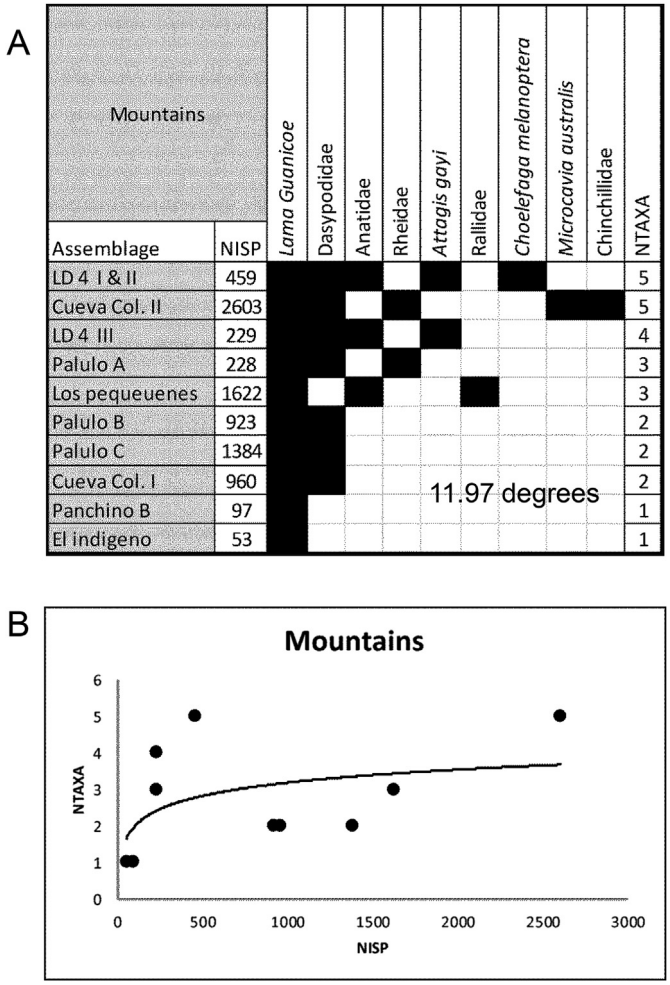

Fig. 4. Nestedness graph (A) and species area curve (B) for the mountain subregion of southern Mendoza for the late Holocene. See text for explanation.

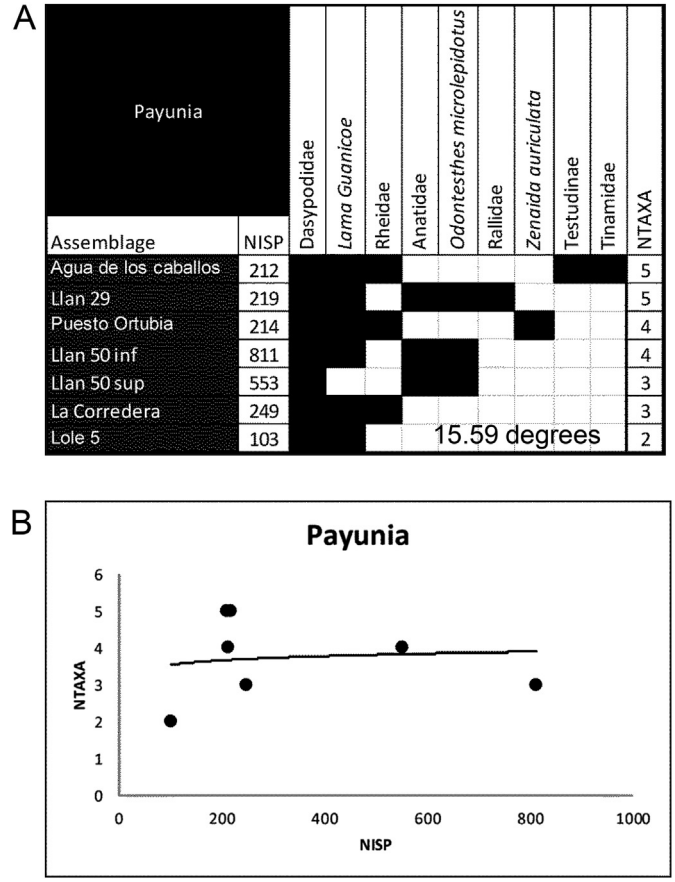

Fig. 5. Nestedness graph (A) and species area curve (B) for the Payunia subregion of southern Mendoza for the late Holocene. See text for explanation.

Assemblages from the mountain subregion are slightly less nested than for the region as a whole (Fig. 4A). Visual inspection of the species area curve indicates sampling to redundancy (Fig. 4B). Guanaco and armadillo remains are ubiquitous across the mountain subregion. Rheids and anatids are moderately ubiquitous, and four taxa of nine are rare, occurring in only one site each. Similar patterns of nestedness and ubiquity occur for the Payunia for guanacos, armadillos, rheids, anatids, and rare taxa compared to the mountains and the entire region. Nestedness for this subregion is the lowest of the three sets of assemblages (Fig. 5A). As with the mountain subregion, the species area curve indicates sampling to redundancy (Fig. 5B). The relatively high nestedness for the region indicates that zooarchaeological sampling is representative at that broader geographic scale, which seemingly supports results of previous studies (e.g., Neme and Gil, 2008a; Neme et al., 2013). In addition, high nestedness for the subregions indicates representative sampling at subregional spatial scales, suggesting that analysis of foraging adaptations at this smaller scale is warranted. We consider the implications of high nestedness at both geographic scales below in the discussion section.

In order to examine late Holocene foraging adaptations at the subregional scale, we analyzed taxonomic diversity and richness as well as prey choice for the mountain and Payunia subregions. Temporal trends for the mountain subregion for NTAXA and diversity exhibit low effect size (low r^2 values (Wolverton et al., in press), but there is a slight, gradual increase in NTAXA over time (Fig. 6A). In contrast to the pattern observed by Neme and Gil (2008a; Fig. 2) for the region, diversity is lowest at 2000 BP in the mountains (Fig. 6B). Guanaco remains (pGUA) are consistently a high proportion of faunal assemblages during the late Holocene (Fig. 6C), and pSA is consistently low (Fig. 6D), despite the ubiquity of Dasypodidae (Fig. 4A). These data indicate that late Holocene foraging adaptations in the mountain subregion were markedly different from the pattern observed for the region by Neme and Gil (2008a; Fig. 2).

Late Holocene foraging adaptations in the Payunia also differ from the trends observed by Neme and Gil (2008a; Fig. 2) and from those observed for the mountain subregion (Fig. 6). For example, NTAXA slightly decreases gradually during the late Holocene in the Payunia (Fig. 7A), and diversity peaks at 2000 BP (Fig. 7B). pGUA varies over time in the Payunia subregion and appears to peak at 2000 BP, in contrast to the pattern observed by Neme and Gil (2008a), but effect size is low for this trend (Fig. 7C). In contrast to the mountain region, small animal remains (pSA) are generally a higher proportion of assemblages in the Payunia than guanaco remains (pGUA).

Aggregation of the samples at the regional scale produces markedly different trends that mirror those in Fig. 2 from Neme and Gil (2008a). Space averaging of mountain and Payunia data creates an aggregate trend suggesting that guanaco decline in importance leading up to 2000 BP, which reverses after 2000 BP, and that NTAXA, diversity, and pSA increase and decline centering on 2000 BP. These regional trends appear to be an artifact of space averaging two distinctive subregional trends during the late Holocene.

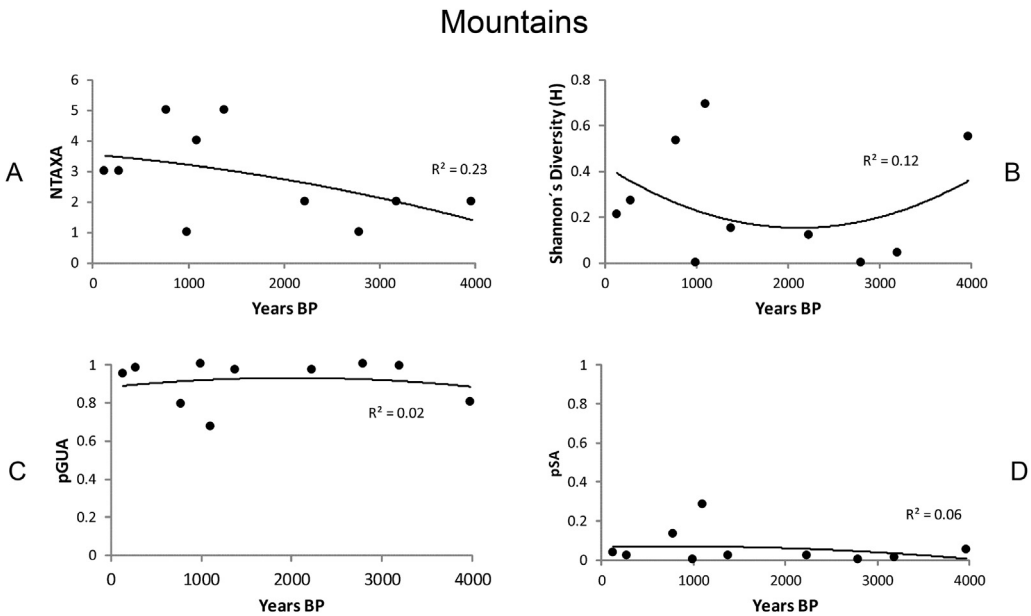

Fig. 6. Bivariate plots of NTAXA (A), diversity (B), proportional abundance of guanaco remains (C), and proportional abundance of small animal remains (D) over time for the mountain subregion of southern Mendoza during the late Holocene. Best fit second-order polynomial trend lines are for visual comparison.

In summary, nestedness analysis and visual inspection of species area curves indicate that southern Mendoza faunas are representative at regional and subregional scales. Consideration of multiple lines evidence indicates that the general trends observed at the regional scale by Neme and Gil (2008a) differ from those observed for Payunia and mountain subregions for the late Holocene. We discuss the potential meaning of these differences below.

6. Discussion

Nestedness analysis and visual inspection of species area curves support that zooarchaeologists have sampled to redundancy at regional and subregional scales. In fact, the lower temperature of nestedness for the regional assemblage suggests that it is highly representative. The question is "representative of what?" We surmise that though the regional assemblage is biogeographically representative of the late Holocene animal community at a large biogeographic scale, this scale may not relate closely to that of human foraging adaptations, which likely occurred in localized environments. Analysis at the subregional scale, at a minimum removes the space-averaging effect of zooarchaeological data across a heterogeneous environment in southern Mendoza.

Results of our regional and subregional zooarchaeological analysis of late Holocene foraging adaptations in southern

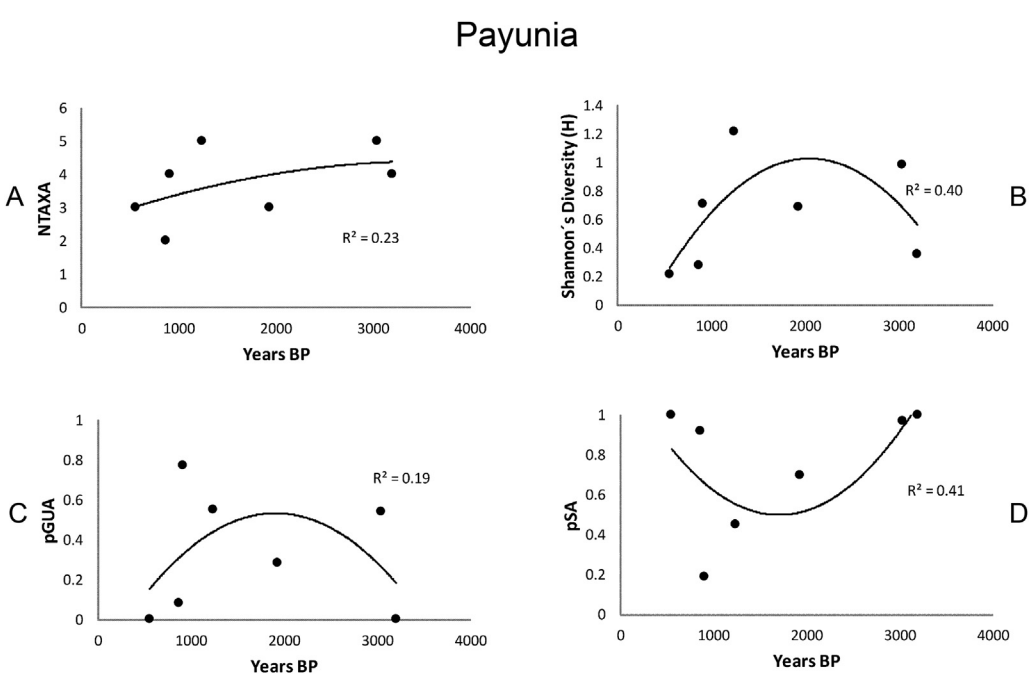

Fig. 7. Bivariate plots of NTAXA (A), diversity (B), proportional abundance of guanaco remains (C), and proportional abundance of small animal remains (D) over time for the Payunia subregion of southern Mendoza during the late Holocene. Best fit second-order polynomial trend lines are for visual comparison.

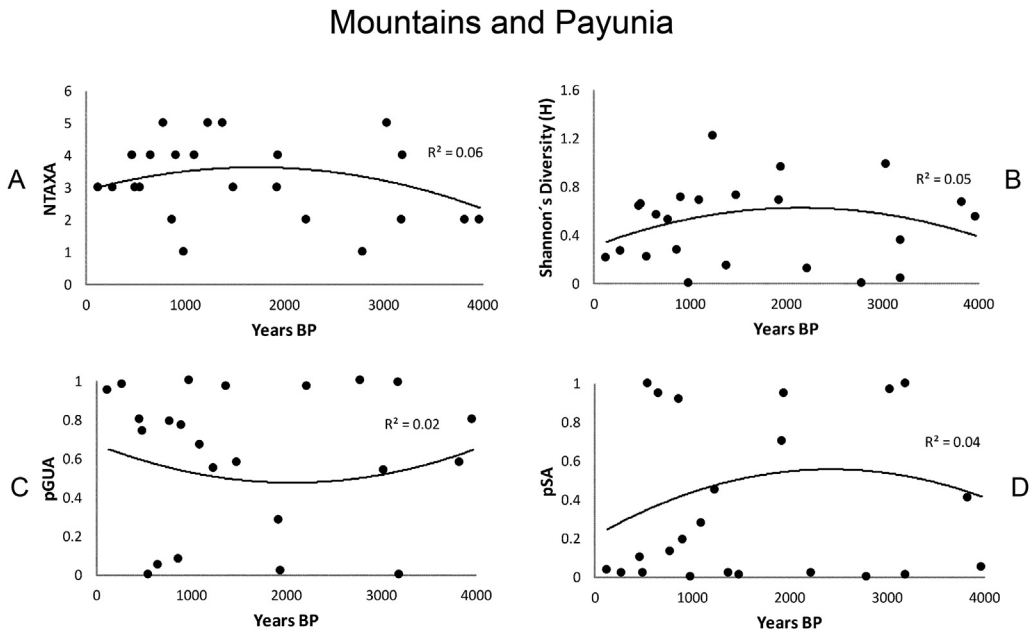

Fig. 8. Bivariate plots of NTAXA (A), diversity (B), proportional abundance of guanaco remains (C), and proportional abundance of small animal remains (D) over time for southern Mendoza during the late Holocene. Best fit second-order polynomial trend lines are for visual comparison.

Mendoza have important implications for understanding regional prehistory. At the regional scale (samples from the mountains and Payunia combined), patterns in taxonomic richness, diversity, and prey choice are similar to those described by Neme and Gil (2008a; Fig. 2). Although the removal of small samples and assemblages from the plains and piedmont has resulted in lower statistical power (Fig. 8), the shape of the trends are similar between these results and those for diversity and artiodactyl abundance reported in previous studies (compare Figs. 2–8B and C). When the regional assemblage is split by subregion, very different, stronger patterns emerge. Indeed, the patterns observed at the regional scale (Fig. 8) appear to be an artifact of spatial aggregation of two distinctive subregional patterns (Figs. 6 and 7).

There is no evidence for resource depression of guanaco and little evidence of substantial shifts in diet breadth during the late Holocene in either subregion. Rather, guanaco exploitation appears to have been important throughout the late Holocene in the mountains, and it varies over time and was consistently less important in the Payunia. Small animals were consistently of low importance in the mountain faunas and of variable but moderate importance in the Payunia. The mountain faunas may reflect seasonal, specialized exploitation of guanaco populations, and the Payunia faunas likely reflect a generalized, broader subsistence strategy. Isotopic analysis of human bone suggests that these two strategies may have been combined in different ways over time (Neme et al., 2013). During the early late Holocene (approximately 4000–2000 BP), there is much overlap in the $\delta^{13}C$ signal between the piedmont, lowland (including some sites from the Payunia subregion), and highland regions. Later in time, the signal differs between the piedmont and lowlands; no data have been reported for the highlands for the post 2000 BP period. Our data suggest that, despite subregional shifts in mobility (based on separation of $\delta^{13}C$ signals after 2000 BP; Neme et al., 2013), that foragers consistently and sustainably exploited highland guanaco populations. Clearly, understanding of late Holocene foraging in southern Mendoza will continue to improve as the archaeological records for the plains and piedmont subregions expand and as additional lines of evidence are incorporated.

7. Conclusion

The analyses presented in this paper reinforce the importance of considering finer scale spatial analyses in order to construct interpretations about past human subsistence from the perspective of human behavioral ecology (*sensu* Lyman, 2003). In southern Mendoza, if the broader regional scale is considered, finer-scale patterns in subsistence are muted by space averaging. Analyses related to diet breadth and prey choice indicate different trends at regional or subregional scales. The distinction of the different spatial scales, especially in cases such as southern Mendoza, where each subregion exhibits differences in environment, is particularly important in archaeological studies using foraging theory models, which have been constructed in “ecological time and space” and need to be translated to “archaeological time and space” (Grayson and Cannon, 1999; Grayson and Delpech, 1998; Lyman, 2003).

Ten years ago, when fewer archaeological data were available in southern Mendoza, archaeologists described a general pattern of resource consumption in central western Argentina. Currently, with a larger regional dataset and an improved archaeological record, new questions regarding finer scale analyses are being asked. Results of subregional analyses do not support intensification of resource use during the late Holocene (see also Neme et al., 2013). However, sampling of some subregions is relatively poor, thus subsistence patterns there are not as clear. Environment heterogeneity should be considered in places where the landscape offers diverse suites of animal resources, such as central western Argentina region. Our study demonstrates that in southern Mendoza a subregional approach is well-suited for understanding subsistence within a human behavioral ecological framework.

Acknowledgments

We thank Adolfo Gil for reading and commenting on this manuscript. We also thank CONICET and AGENCIA NACIONAL DE PROMOCION CIENTÍFICA y TECNOLÓGICA, for funding this

research as well as the University of North Texas, Department of Geography for supporting Clara Otaola during her post-doctoral research.

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