

# The use of animals in Northern Mesoamerica, between the Classic and the Conquest (200-1521 AD). An attempt at regional synthesis on central Mexico

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## ABSTRACT

Zooarchaeology of Northern Mesoamerica has often been restricted to major archaeological sites and few regional syntheses are documented. Based on the original analysis of animal bone remains from ten archaeological assemblages and their confrontation with iconographic, historic and ethnographic data, this paper aims to propose a synthesis on the use of animals in central Mexico, from the Classic period to the Spanish Conquest. We selected sites from a similar environment but two cultural regions: Central Mexico and Western Mexico. The methodology used to compare the results from each assemblage is adapted to a particularly heterogeneous corpus and small-sized samples. The identification of 35 different taxa shows the use of a restricted and rather homogeneous spectrum. However variations are observed considering their proportions in each site. Only two domestic animals are recognised, the dog (*Canis familiaris* Linnaeus, 1758) and the turkey (*Meleagris gallopavo* Linnaeus, 1758), but none of the studied societies specialised in the breeding of these species. We then address the cases of hunting or garden-hunting and the exploitation of aquatic animals. Finally, hypotheses are presented about how the animals were used by the populations of Northern Mesoamerica. Although a larger number of sites need to be studied to enhance the impact of our interpretations, this paper establishes a first attempt at regional synthesis on central Mexico.

## KEY WORDS

Zooarchaeology,  
subsistence economies,  
Mesoamerica,  
hunting,  
herding,  
Trans-Mexican Volcanic  
Belt.

## RÉSUMÉ

*L'utilisation des animaux dans le nord de la Mésoamérique entre le Classique et la Conquête (200-1521 apr. J.-C.). Essai de synthèse régionale sur le centre du Mexique.*

L'archéozoologie du nord de la Mésoamérique s'est souvent restreinte aux sites archéologiques principaux et il existe très peu de synthèses régionales. En se basant sur l'analyse inédite des os animaux issus de dix assemblages archéologiques et leur confrontation aux sources iconographiques, historiques et ethnohistoriques, cet article vise à proposer une synthèse sur l'exploitation des animaux dans le centre du Mexique, du Classique à la Conquête espagnole. Si les sites analysés sont implantés dans un même environnement, ils se rapportent à deux régions culturelles : le Centre du Mexique et l'Occident du Mexique. La méthodologie mise en place pour comparer les résultats des différents assemblages est adaptée à un corpus particulièrement hétérogène et à des échantillons de petite taille. L'identification de 35 taxons différents montre l'utilisation d'un spectre de faune réduit et relativement homogène. Des variations sont cependant observées quant à leurs proportions dans chacun des sites. Deux animaux domestiques seulement ont été reconnus, le chien (*Canis familiaris* Linnaeus, 1758) et le dindon (*Meleagris gallopavo* Linnaeus, 1758), mais aucune des sociétés étudiées ne s'est spécialisée dans l'élevage de ces espèces. Les cas de la chasse ou du garden-hunting ainsi que l'exploitation des milieux aquatiques sont ensuite abordés. Enfin, on présente quelques hypothèses sur la manière d'utiliser ces animaux parmi les populations du nord de la Mésoamérique. Bien qu'un plus grand nombre de sites doivent encore être étudiés afin de préciser la portée de nos interprétations, cet article constitue un premier essai de synthèse sur le centre du Mexique.

## MOTS CLÉS

Archéozoologie,  
économies de  
subsistance,  
Mésoamérique,  
chasse,  
élevage,  
axe volcanique  
transmexicain.

## INTRODUCTION<sup>1</sup>

Mesoamerica is a cultural area, extending from central Mexico to western Nicaragua and Costa-Rica (Fig. 1). Even if numerous archaeological investigations have been achieved since the beginning of the 20<sup>th</sup> century, allowing to describe the details of societies organisation (Nichols & Pool 2012: 4-6), animal remains are hardly ever studied and few regional syntheses are documented (Emery 2013: 607). Archaeozoological studies of “complex” societies are yet a real asset to testify to status differences, interethnic variations or trade networks (Crabtree 1990). But if archaeological bone remains have been under-exploited, many ethnographic or ethnohistoric records can illustrate the integration of animals in Mesoamerican economy during more recent periods. Although these data must be regarded with care, considering the time distance between observations and prehispanic period, their precision and richness allow to propose interesting hypotheses about the exploitation of animal supplies.

Based on the study of animal remains from nine archaeological sites of central Mexico and their confrontation with published zooarchaeological, iconographic, historic and ethnographic data, this paper aims to address a regional synthesis of material and symbolic use of animals in Northern Mesoamerica, from the Classic period to the Conquest (200-1521 AD).

## ENVIRONMENTAL AND CULTURAL CONTEXT

The geography of central Mexico is mostly structured by the Trans-Mexican Volcanic Belt. This mountain range spans across

the country from East to West and is composed of some of the highest mountains of North America. Various waterways drain the region, many of them belonging to the Lerma catchment basin. Until the beginning of the 20<sup>th</sup> century, it was covered with large wetlands and various large endorheic basins, such as the Mexico Basin. Climate is tropical, divided into a dry season and a rainy season. But because of the altitude – as the valleys are located over 1000 m above sea level – temperatures might be cool. During the 16<sup>th</sup> century, the region represented the northern limit for maize dry farming due to low precipitation as well as winter frost (Braniff 1989).

According to López Austin & López Luján (2012: 72), Mesoamerica stands out from neighbouring regions as soon as 2500 BC, through the development of first ceramic productions, early settled societies and the adoption of agriculture, in particular the cultivation of the domestic triad: maize (*Zea mays* L.), beans (*Phaseolus* spp.) and squash (*Cucurbita pepo* L.). Unlike other regions such as the Middle-East, Europe or the Andes, the role of animal domestication appears completely insignificant – or neglected – in the process of Neolithisation in Mesoamerica (see for example the opinion of Weigand 2000). Only dog (*Canis familiaris* Linnaeus, 1758) and turkey (*Meleagris gallopavo* Linnaeus, 1758) are commonly admitted as domestic animals in prehispanic Mesoamerica (e.g., West 1998; Valadez Azúa 2003b). However, the conditions and timing of their domestication or adoption by Mesoamerican societies is still not clear. Dogs have been firstly domesticated in Eurasia and were then introduced in the Americas by human populations (Leonard *et al.* 2002; Witt *et al.* 2015). They appear in Mexican archaeological contexts before the beginning of Preclassic although the increasing number of dog remains seems related to the transition from nomadic populations to sedentary groups (Flannery 1967). Temporal and geographic origin of domestic Mesoamerican turkeys is still uncertain but these birds – domestic or wild – appear in archaeological contexts as soon as the Middle Preclassic (Thornton & Emery 2015).

1. This paper is a summary of A. Manin's doctoral dissertation, «Aspects matériels et symboliques de l'utilisation des animaux dans le nord de la Mésoamérique entre le Classique et la Conquête (200-1521 ap. J.-C.)», carried out between 2012 and 2015 in the Muséum national d'Histoire naturelle (Paris) under the supervision of C. Lefèvre (Manin 2015).



FIG. 1. — Topographic map of Mesoamerica and details of the studied area: 1, Central Mexico; 2, Gulf Coast; 3, South-Eastern Mesoamerica; 4, Oaxaca; 5, Western Mexico; 6, Northern Mesoamerica. Map: CC SEMHURS.

This paper focuses on central Mexico, which is composed of two cultural areas: Central Mexico and Western Mexico. The Classic period (200-650 AD) confirms the differentiation between urban and rural settlements initiated during the Preclassic (López Austin & López Luján 2012: 122). In Central Mexico, the city of Teotihuacan centralises the power and its influence extends over the entire Mesoamerica (Cowgill 1997, 2008) until Western Mexico (Michelet & Pereira 2009). The Classic period ends with the collapse of this large metropolis, as did other regional capitals. During the Epiclassic (650-900 AD), new trade networks are formed (Diehl & Berlo 1989). While Central Mexico is occupied by various city-states (Parsons & Sugiura Yamamoto 2012), Western Mexico reinforces its connections with Northern Mexico (Beekman 2009). In various regions of Mesoamerica, the Postclassic (900-1521 AD) corresponds to the emergence of supra-ethnic political powers (López Austin & López Luján 2012: 334). In Central Mexico, Toltecs (900-1100 AD) are followed by Aztecs (1100-1521 AD) and they extend their influence on the entire Mesoamerica (Healan 2012; Smith 2012); Western Mexico is progressively structured through the Tarascan State (1350-1525 AD; Pollard 2004, 2008). The most ancient pictographic documents preserved until today, such as Mixtec codices, are dated from the end of this period.

European settlers disembark on the Veracruz coast in 1519 and quickly impact the history of central Mexico through the conquest of the Aztec capital Tenochtitlan in 1521 (Smith 2012), while the Tarascan State collapses in 1525 (Pollard 2004). Spaniards relate their exploration and discoveries through letters, memories or even encyclopaedia (e.g., Sahagun 1938; Hernández 1959; Cortés 1996; Díaz del Castillo 1996; Alcalá 2000). They are some of the best testimonies of Mesoamerican practices at the end of the Postclassic, although they must encompass many misrepresentations due to their European eyes.

#### ARCHAEOZOOLOGICAL STUDY: PRESENTATION OF THE CORPUS

This study is based on the archaeozoological analysis of ten faunal assemblages<sup>2</sup>, all stored in the *Centre d'Études Méxicaines et Centraméricaines* (CEMCA), Mexico DF. The archaeological sites targeted for this study are located in two cultural areas: Central Mexico and Western Mexico. They represent a variety

2. Two different occupations have been identified in the Barajas Massif and the bone remains have been separated in this way.

TABLE 1. — Characteristics of the sites analysed in this paper.

|                | Site Name      | Location                | Environment                                   | Main range of site occupations        | Approximate total surface | Area excavated                   | Type of context                                            | Number of faunal remains analyzed | Sieving method                   | References                |
|----------------|----------------|-------------------------|-----------------------------------------------|---------------------------------------|---------------------------|----------------------------------|------------------------------------------------------------|-----------------------------------|----------------------------------|---------------------------|
| Central Mexico | El Salitre     | Tula metropole, Hidalgo | Marshy fields                                 | 900-1100 AD                           | Unknown                   | 2 pits – 11 m <sup>2</sup>       | Ceremonial?                                                | 127                               | None                             | Equihua 2007              |
|                | Tizayuca       | Tizayuca, Hidalgo       | Xeric shrublands                              | 200-700 AD; 900-1100 AD; 1250-1521 AD | Unknown                   | 6 sectors > 10000 m <sup>2</sup> | Urban (domestic and civico-ceremonial compounds)           | 3327                              | None                             | Equihua 2008              |
|                | Calixtlahuaca  | Toluca, Edo de México   | Lerma valley                                  | 1130-1530 AD                          | 264 ha                    | 934.6 m <sup>2</sup>             | domestic                                                   | 705                               | 6 mm mesh                        | Smith 2010                |
| Western Mexico | JR74           | Jerécuaro, Guanajuato   | Lerma valley; palaeolake?                     | 200-400 AD                            | Unknown                   | c. 250 m <sup>2</sup>            | Civico-ceremonial?                                         | 474                               | 5 mm, only for specific contexts | Faugère pers. obs.        |
|                | Mich.215       | Zacapu, Michoacan       | Lomas ; Island on a marshy field/ palaeolake  | 500-900 AD                            | > 7 000 m <sup>2</sup>    | Unknown                          | Necropolis; civico-ceremonial center                       | 1 808                             | 5 mm mesh                        | Pereira 1999, 2010        |
|                | Mich.23        | Zacapu, Michoacan       | Malpais; Xeric shrublands                     | 600-1200 AD                           | c. 50 ha                  | 14 m <sup>2</sup>                | Urban (civico-ceremonial and elite platforms)              | 498                               | 5 & 2 mm mesh                    | Forest 2014; Jadot 2013   |
|                | Mich.31        | Zacapu, Michoacan       | Malpais; Recent volcanic lava flow            | 1200-1450 AD                          | 37 ha                     | > 900 m <sup>2</sup>             | Urban (domestic and civico-ceremonial compounds)           | 2488                              | 5 & 2 mm mesh                    | Manin <i>et al.</i> 2015  |
|                | Angamuco       | Patzcuaro, Michoacan    | Malpais; Xeric shrublands and pine-oak forest | 1000-1350 AD                          | Unknown                   | Unknown                          | Urban (domestic, civico-ceremonial and funerary compounds) |                                   | None                             | Fisher <i>et al.</i> 2011 |
|                | Barajas massif | Penjamo, Guanajuato     |                                               | 400-950 AD                            | Unknown                   | Unknown                          | Urban (domestic, civico-ceremonial and funerary compounds) | 30                                | None                             | Pereira 2008              |
|                | Barajas massif | Penjamo, Guanajuato     |                                               | 1300-1500 AD                          | Unknown                   | Unknown                          | Nomadic camp                                               | 154                               | None                             |                           |

of excavation approaches, from a short diagnostic before urban layout to multiple years of intensive excavations. Moreover, unlike most of the studies published until now, we focused essentially on secondary settlements or peripheral residential areas. In that way, we wish to have an exhaustive approach of human activities and complement previous works on animal exploitation. Principal characteristics of each site have been reported in Table 1.

## METHOD

Due to the diversity of excavation methods and objectives, faunal analysis results of each site would not have been comparable without the use of a critical and systematic approach and an extreme care regarding induced bias. In

order to understand the accumulation process leading to each assemblage (Lyman 2010), surface of animal bones was examined for taphonomic evidences. We targeted traces of human activities (butchery, cooking, industry), modifications induced by animals (carnivores, rodents) as well as climatic, edaphic and environmental alterations (e.g., Behrensmeyer 1978; Binford 1981; Lyman 1994; Denys & Patou-Mathis 2014).

Animal remains have been identified using the Vertebrates reference collection of the Muséum national d'Histoire naturelle (Paris, France) and the specimens from the Laboratorio de Arqueozoología M. en C. Ticul Álvarez (INAH, Mexico). Because it was possible to transport only a part of the material to these collections, the best preserved bones were determined first and then used as a reference. We took a large number of photos for an



TABLE 2. — List of published references used in taxonomic identification.

| Taxa                               | Reference                                                          |
|------------------------------------|--------------------------------------------------------------------|
| Actinopterygii, Amphibia, Reptilia | Olsen 1968                                                         |
| Aves                               | Bochenski & Tomek 2009; Gilbert <i>et al.</i> 1981; Olsen 1979a, b |
| Mammalia (general)                 | Elbroch 2006; Hilson 2005; Olsen 1964                              |
| Artiodactyla                       | Chavez 2008; Lawrence 1951                                         |
| <i>Odocoileus</i>                  | Jacobson 2004                                                      |

*a posteriori* identification of some elements. The discrimination of morphologically close taxa was conducted using strict criteria based on published data (Table 2). Indeed, in order to strengthen the validity of the interpretations, a special care has been taken in the identification, especially when dealing with rare species (Wolverton 2012). This is why we often stayed at the family or genus level when it was not possible to find a specific criterion.

Bone remains were quantified using common units. The fundamental unit we used is the number of specimens (NSP), corresponding to the total number of bone remains (or articulated skeletons) found in each site or sector. When the taxa is identified (to the species, genus or family level) we speak about the number of identified specimens (NISP).

To determine the differential abundance of each taxa, we used the number of identified specimens (NISP; Lyman 2008: 27) and we confronted it to an estimation of the minimum number of individuals (MNI, Lyman 2008: 38). The MNI was obtained from the most abundant skeletal part in each site, or each sector when the assemblage was large enough; this number was adjusted if different age categories were determined. An estimation of the meat weight represented by each animal was calculated from the mean weight of the species and the MNI, according to White (1953) and Stewart & Stahl (1977)'s method. When it was clear that the animal was previously butchered, especially in the case of white-tailed deer (*Odocoileus virginianus* Zimmermann, 1780), we estimated the meat weight per anatomical unit (Madrigal & Zimmermann Holt 2002).

Diversity and taxonomic richness has been approached with indices such as the number of taxa (Ntaxa, Lyman 2008: 172), Margalef's taxonomic richness index (d, Margalef 1958) and Shannon-Wiener's diversity index (H, Lyman 2008: 192). However, the sample size might be an important factor in an assemblage richness or diversity. Indeed, it has been shown that the number of species identified in an assemblage increases along with the number of identified specimens following a logarithmic relationship (Bartosiewicz & Gal 2007). If a strong correlation exists between these indices and the number of identified specimens, it would mean that sample size may be the principal cause of variation in richness and diversity (Grayson 1984: 116-130). This method has been criticized by Cannon (2001) though, showing that dealing with small samples would highly enhance interpretation errors.

As this study of Mesoamerican archaeofaunal assemblages is essentially based on small samples, we developed as well a qualitative analysis designed to evaluate the variability of

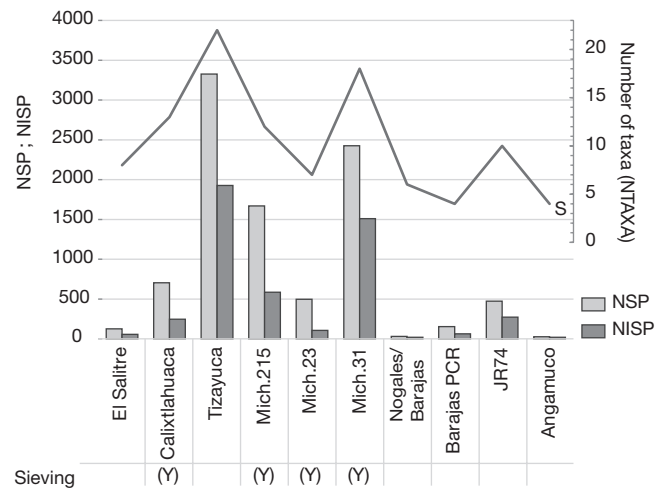


FIG. 2. — Graphical representation of NSP, NISP and NTAxa in the different assemblages. Sites where sieving has been done are indicated by (Y).

animals exploited in the different sites using the nestedness theory, which application to zooarchaeology has been proposed by Jones (2004; 2013; 2015) and Lyman (2008: 167-171). According to the nestedness theory, taxonomic composition of various biotas might be based on a non-random nested pattern when the species of the most depleted one are actually a subset of the richest ones (Patterson & Atmar 1986; Patterson 1987). From a binary matrix reporting the presence/absence of each species, the data are arranged to be getting close to a maximally packed matrix: biotas are ordered from the richest to the poorest and taxa from the most stable to the most tenuous. It is then possible to calculate the temperature (T) of order (0°) or disorder (100°) of the matrix and the probability that this layout is random (Atmar & Patterson 1993). As suggested by Lyman (2008: 170), biotas could be assimilated to archaeofaunal assemblages. Assuming that human population of the different sites had access to the same animal resources, it is possible to detect fundamental taxa and rare ones. But if the matrix shows a high disorder, it would demonstrate a significant heterogeneity in animal exploitation. Finally, Lyman (2008: 170) proposes to evaluate the weight of sample size using the correlation between the rank of each assemblage in the matrix and NISP, and we used this approach to enhance our interpretations. We performed nestedness analyses using the free software BINMATNEST (Rodríguez-Gironés & Santamaría 2006) and control for sample size incidence calculating the Spearman correlation  $\rho$  between the rank of each assemblage in the matrix and NISP<sup>3</sup>.

Proportions of taxa in each site have been estimated with a 5% range confidence to take into account the sample size in the calculation of percentages. Hence, the precision of percentages is more accurate for larger assemblages than for smaller ones. Using a proportion with a 5% range confidence

3. As suggested by Grayson (1984) and Cannon (2001), correlation coefficients involving NSP, NISP or MNI should be calculated using the Spearman's rank sum test, as these variables might be closer to discrete data than continuous ones.

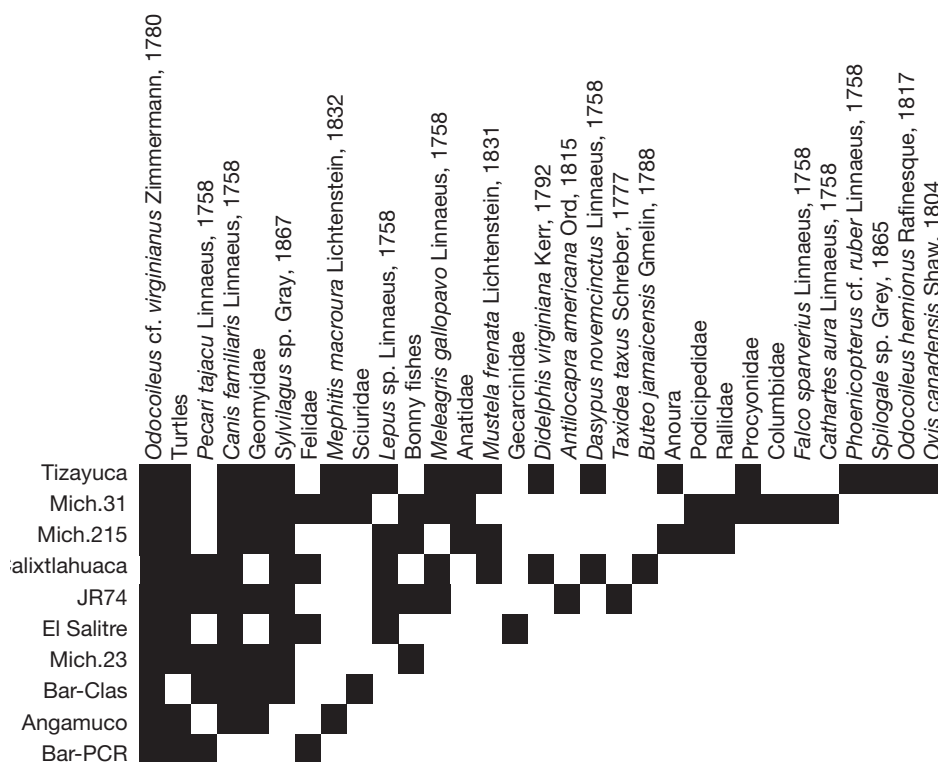


FIG. 3. — Matrix of the nestedness analysis on taxonomic list per site (black=present; white=absent) showing a high degree of order ( $T=16.55$ ;  $p<0.001$ ). Abbreviations: **Bar-Clas**, Classic/Early Postclassic occupation; **Bar-PCR**, Late Postclassic occupation.

allows to highlight significant differences between taxa. Variations of the proportions of one taxon in different sites has been controlled with a Z-test using a threshold  $\alpha = 5\%$  and Chi squared tests have been performed to compare sites or regions one by one. Finally, we visualized the overall variation of all the faunal assemblages with a canonical analysis (CA), looking for tendencies in animal exploitation. This a posteriori representation of variability has been successfully used by various authors to find out patterns and trends in human activities (e.g., Tresset & Vigne 2001; Bréhard 2011). We used the method proposed by Alberti (2013) to compute groups of proximity from Euclidian distances of the  $\text{Chi}^2$ , hierarchical ascendancy classification (HAC) and K-means algorithm. However, these groups will be considered with care as establishing a model of human activities might be extremely difficult to perform with traditional algorithm.

## COMPARISON OF ARCHAEOZOOLOGICAL RESULTS PER SITE

Archaeozoological study of the different sites led to the analysis of 9438 animal remains unequally distributed between them (Fig. 2). Actually, the objectives of each excavation project were disparate, especially the total area explored by the archaeologists, and we can expect that aspect to have an incidence on the number of collected remains. For example in the site of Calixtlahuaca, 27 sectors have

been excavated and the size of each strictly reported. We noticed that the number of animal remains per sector was correlated to its surface area (Spearman's correlation rank sum test,  $\rho = 0.52$ ;  $p = 0.005$ ) suggesting the influence of this factor on sample size should not be neglected. Although this information on surface area explored was not available for each site we studied, it is important to notice that the largest assemblage, Tizayuca, come from an intense exploration of several thousands of squared meters, while in El Salitre, one of the smallest, only 11  $\text{m}^2$  have been explored. However, human activities could affect the distribution of the remains as well and variations in the amount of animal bones may be related to different intensities of faunal exploitation. As it was not possible to precisely assess if the contrasting number of animal remains was caused by differential activities or archaeological bias, the sites have not been compared from this perspective.

We identified a total of 35 taxa exploited by the studied human groups. Compared to the high species diversity available in the region, it is a fairly restricted range of animals that has been used. Ntaxa is highly correlated to both NSP ( $\rho = 0.89$ ;  $p<0.001$ ) and NISP ( $\rho = 0.88$ ;  $p<0.001$ ), confirming the importance of sample size in faunal diversity. Indeed, Tizayuca is the site showing the highest Ntaxa as well as the highest NSP and NISP, despite the fact that the animal remains have been collected without any sieving procedure.

Nestedness analysis has been performed on taxonomic list per site in order to detect a potential heterogeneity in

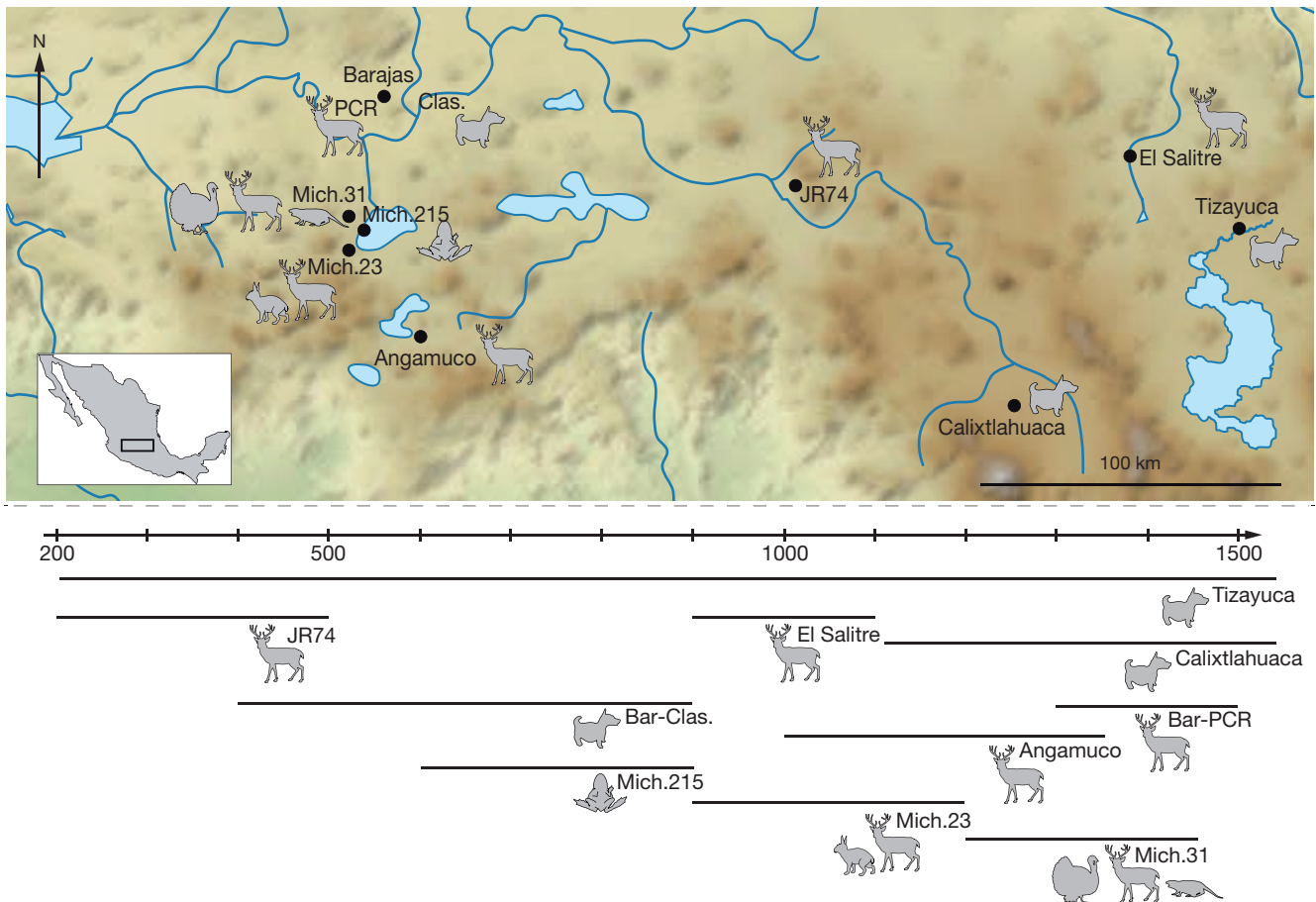


FIG. 4. — Predominant taxa in each site. Abbreviations: **Bar-Clas.**, Classic/Early Postclassic occupation; **Bar-PCR**, Late Postclassic occupation.

exploited species. Some taxa have been grouped under more general categories (turtles, felids) to limit bias due to unequal identification when diagnostic anatomical characters were not observable. The analysis results in a non-random low temperature matrix ( $T = 16.55^\circ$ ;  $p < 0.001$ ; Fig. 3) showing a homogeneous exploitation of animals in the different sites. The poorest sites contain only fundamental species whereas the richest ones include also rare animals. High correlation between site rank in the matrix and NISP per site ( $\rho = 0.89$ ;  $p < 0.001$ ) indicates once again the importance of sample size on animal diversity.

Proportions of each taxon per site are reported in Appendix 1. With a 5% confidence interval, we were able to identify one to three predominant animals in each site (Fig. 4). Deer, probably white-tailed deer (cf. *Odocoileus virginianus*) is predominant in most of the assemblages (El Salitre, JR74, Angamuco, Barajas Late Postclassic occupation) but it shares the first place with cottontails (*Sylvilagus* sp. Gray, 1867) in Mich.23 and with turkey and pocket gophers (Geomyidae) in Mich.31. Dog is the most abundant species in Calixtlahuaca, Tizayuca and Barajas Classic/Early Postclassic occupation. Finally, frogs (*Anoura*) overpass all other species in Mich.215. These observations do not lead to any clear chronologic or regional trend, though.

Besides the homogeneity of taxonomic range suggested by nestedness analysis, the sites studied here are showing high contrasts and small sample size implicates that any comparison is ambiguous. That is why we use a multivariate approach to better understand data structuration and trends in faunal exploitation. Taxa were first grouped in different categories according to their phylogenetic and ecologic characteristics in order to preserve evidences of differential human activities and reduce the number of null observations (Table 3). Canonical analysis (CA) has been performed on the NISP of each animal category per site. Smallest sites as well as large subsets of Mich.31 (see the details of Mich.31 contexts and zooarchaeological study in Manin *et al.* 2015) have been considered as supplementary individuals: their location in CA graphical representation is only illustrative but they did not take part in the calculation of the  $\chi^2$  distances. Data are significantly heterogeneous (Pearson's  $\chi^2$  test,  $\chi^2 = 3892.434$ ;  $d.f. = 77$ ;  $p < 0.001$ ) and the first three components of CA represent more than 96% of the variance they exhibit. Among taxonomic groups, aquatic animals have the major inertia (38%) followed by canids (28%) and white-tailed deer (21%). The first component (C1) accounts for 51% of the variance and receives a positive contribution of aquatic animals (53%) and a negative contribution of canids (37%). The second component

TABLE 3. — Animal categories used in canonical analysis.

| Abbreviations | Category           | Taxa                                                                                                                                                                                                           |
|---------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Exo.          | Exotic animals     | Gecarcinidae; <i>Trachemys</i> sp./ <i>Rhinoclemmys</i> sp; <i>Dermatemys mawii</i> Gray, 1847; <i>Ovis canadensis</i> Shaw, 1804                                                                              |
| Aq.           | Aquatic animals    | Actinopterygii; Anoura; <i>Kinosternon</i> sp. Spix, 1824; Anatidae; Podicipedidae; <i>Phoenicopterus</i> cf. <i>ruber</i> Linnaeus, 1758                                                                      |
| Rap.          | Prey birds         | <i>Cathartes aura</i> Linnaeus, 1758; <i>Buteo jamaicensis</i> Gmelin, 1788; <i>Falco sparverius</i> Linnaeus, 1758                                                                                            |
| Com.          | Commensal animals  | Columbidae; Geomyidae; Sciuridae                                                                                                                                                                               |
| Tur.          | Turkey             | <i>Meleagris gallopavo</i> Linnaeus, 1758                                                                                                                                                                      |
| Lag.          | Lagomorpha         | <i>Sylvilagus</i> sp. Gray, 1867; <i>Lepus</i> sp. Linnaeus, 1758                                                                                                                                              |
| Fel.          | Felids             | <i>Puma concolor</i> Linnaeus, 1771; <i>Lynx rufus</i> Schreber, 1777; unidentified felid                                                                                                                      |
| Can.          | Canids             | <i>Canis familiaris</i> Linnaeus, 1758; <i>Canis</i> sp.                                                                                                                                                       |
| Sc.           | Small carnivore    | <i>Mephitis macroura</i> Lichtenstein, 1832; <i>Mustela frenata</i> Lichtenstein, 1831; <i>Taxidea taxus</i> Schreber, 1777; <i>Spilogale</i> sp. Grey, 1865; Procyonidae; <i>Procyon lotor</i> Linnaeus, 1758 |
| Ov.           | White-tailed deer  | <i>Odocoileus virginianus</i> Zimmermann, 1780; <i>Odocoileus</i> cf. <i>virginianus</i>                                                                                                                       |
| Art.          | Other artiodactyls | <i>Pecari tajacu</i> Linnaeus, 1758; <i>Odocoileus hemionus</i> Rafinesque, 1817; <i>Antilocapra americana</i> Ord, 1815                                                                                       |
| Oth.          | Miscellaneous taxa | <i>Didelphis virginiana</i> Kerr, 1792; <i>Dasypus novemcinctus</i> Linnaeus, 1758                                                                                                                             |

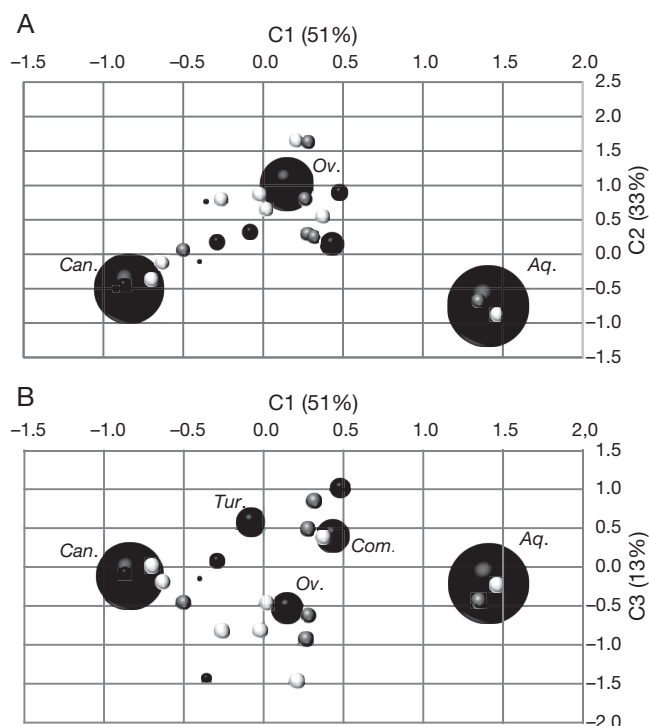


FIG. 5. — Distribution of CA scores on: **A**, C1x2 axes; and **B**, C1x3 axes. Taxa bubbles represent their actual inertia in each plan. Sites and supplementary individuals are normalized to 1. Abbreviations: **Aq.**, Aquatic animals; **Can.**, Canids; **Com.**, commensal animals; **Ov.**, white-tailed deer; **Tur.**, turkey. ●, taxa; ○, sites; ○, supplementary individuals.

(C2) gathers 33% of the total variance and is mostly defined by white-tailed deer (46%) on the positive side and aquatic animals (23%) as well as canids (20%) on the negative side. Finally, the third component (C3) represents 13% of the total variance and receives a positive contribution of turkeys (28%) and commensal animals (17%) and the negative contribution of white-tailed deer (31%). In the 3D space considered in this analysis (accounting for 96% of the total variance), the other taxonomic groups do not participate consistently

in the data repartition (Fig. 5). HAC and K-means consolidation allow to separate four groups of sites and four groups of animals that may represent as many trends in anthropic activities. However, no chronologic nor regional pattern can be distinguished (Fig. 6).

## ANIMAL EXPLOITATION IN PREHISPANIC NORTHERN MESOAMERICA

### A LIMITED TAXONOMIC RANGE

Faunal range exploited by human populations might be evaluated along different perspectives, helping to reconstruct both unicity and diversity in cultural behaviour. Taxonomic diversity is restricted to 35 taxa of homogenous use but 10 appear fundamental to all the populations of Northern Mesoamerica studied here. The independent analysis of each site shows that animal exploitation was directed to one to three major species, especially deer and dog. Six different animals have been targeted, most of them being also fundamental taxa. Frogs represent a peculiar case as their use is uncommon in all sites but one. In Mich.215, they are exploited in high quantity and overpass other species in both NISP and MNI. Finally, the studied sites show distinctive trends in animal exploitation exemplified by CA. Five taxonomic groups mostly structure the data, meaning that it is their relative proportions in each site that lead to the observed distribution. These significant points are synthesized in Table 4.

Whereas a large diversity of animals was locally available to the Prehispanic populations of northern Mesoamerica, it seems that only a few were exploited. Some groups are absent, such as lizards and snakes: if some bone remains have been identified, they were in disturbed contexts and it was not possible to link them to any anthropic activity. Moreover, small animal bones must have been missed because of the absence of sieving in most of the sites. Local birds identified pertain only to seven families while 58 different families are present in the area (Navarro & Gordilla 2008): it would represent only 14% of the actual diversity. On the other



TABLE 4. — Major taxa identified in the archaeozoological assemblages studied in this paper.

| Fundamental taxa                                                             | Predominant taxa                        | Structuring taxa                             |
|------------------------------------------------------------------------------|-----------------------------------------|----------------------------------------------|
| <i>Odocoileus virginianus</i><br>Zimmermann, 1780                            | <i>Odocoileus virginianus</i>           | Aquatic animals                              |
| <i>Canis familiaris</i><br>Linnaeus, 1758                                    | <i>Canis familiaris</i>                 | <i>Canis familiaris</i>                      |
| Turtles                                                                      | Lissamphibia                            | <i>Odocoileus virginianus</i>                |
| <i>Sylvilagus</i> spp.                                                       | <i>Sylvilagus</i> spp.                  | <i>Meleagris gallopavo</i><br>Linnaeus, 1758 |
| Geomyidae<br><i>Pecari tajacu</i><br>Linnaeus, 1758                          | <i>Meleagris gallopavo</i><br>Geomyidae | Commensal animals                            |
| <i>Lepus</i> spp.<br><i>Meleagris gallopavo</i><br>Actinopterygii<br>Felidae |                                         |                                              |

side, eight local mammal families have been identified out of the 20 families present in the area (Ceballos & Arroyo Cabrales 2012), representing 40% of the actual diversity. Moreover, several species of carnivores and artiodactyls are exploited, constituting respectively 50% to 100% of the local specific diversity. This repartition may reveal the importance of these two families in the Mesoamerican economy and may reflect their easy availability. However ethnohistoric data and indigenous taxonomy show that a large number of animals were known by Aztec populations and their neighbours, especially in birds and reptiles groups (Majewski & Feldman 1976; Máinez 1991).

The importation of non-local animals such as bighorn sheep and Central American river turtle also shows the interest of human populations for these exotic goods and enhance the range of exploited fauna.

#### HUSBANDRY PRACTICES IN NORTHERN MESOAMERICA AND THE ROLE OF DOMESTIC ANIMALS

Only two animal species are usually recognised as domesticated and breed by Mesoamerican populations: dog and turkey. This brings to some drastic opinions against the importance of husbandry in Mesoamerica (Weigand 2000, 2010). Nonetheless, other authors have considered in details the issue of animal management by Prehispanic people, using mostly ethnohistorical descriptions (e.g., Sahagun 1938; Torquemada 1943; Hernández 1959; Cortés 1996; Díaz del Castillo 1996) to demonstrate their zootechnic skills (e.g., Valadez Azúa 1994, 2003a, 2003b; Blanco *et al.* 2009; López Luján *et al.* 2012; Corona 2013; Sugiyama *et al.* 2013, 2015). It led to the description of various potential captive animals (mostly birds and carnivores) and the exhaustive analysis of some captive specimens sacrificed in Teotihuacan (Sugiyama *et al.* 2013, 2015) and Tenochtitlan (López Luján *et al.* 2012) showing that since about 2000 years, Mesoamerican people were able to provide, at least temporarily, cougars (*Puma concolor* Linnaeus, 1771), wolves (*Canis lupus* Linnaeus, 1758) and golden eagle (*Aquila chrysaetos* Linnaeus, 1758) needs for ritual purposes. Evidences of captivity are given by

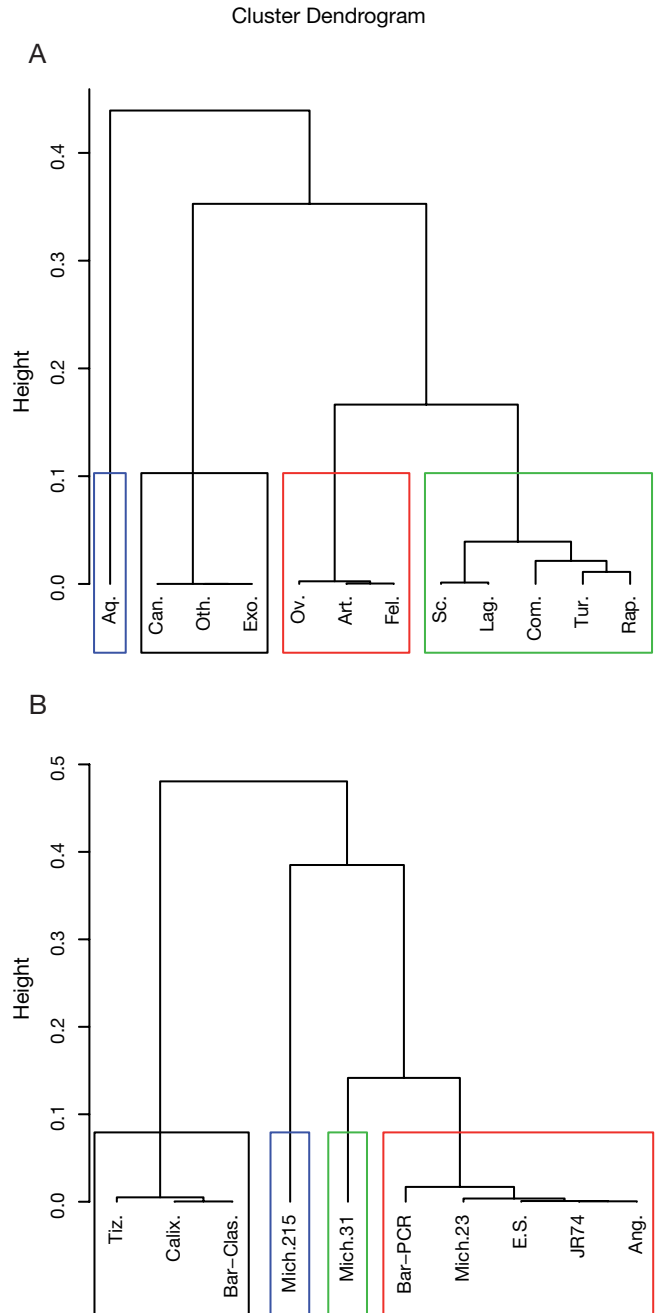


FIG. 6. — Hierarchical clustering of the: **A**, taxa; and **B**, sites analysed in the Canonical Analysis. Abbreviations: **Aq.**, Aquatic animals; **Can.**, Canids; **Oth.**, Miscellaneous taxa; **Exo.**, exotic animals; **Ov.**, white-tailed deer; **Art.**, other artiodactyls; **Fel.**, felids; **Sc.**, small carnivores; **Lag.**, lagomorpha; **Com.**, commensal animals; **Tur.**, turkey; **Rap.**, prey birds; **Tiz.**, Tizayuca; **Calix.**, Calixtlahuaca; **Bar-Clas.**, Barajas Classic/Early Postclassic occupation; **Bar-PCR**, Barajas Late Postclassic occupation; **E.S.**, El Salitre; **Ang.**, Angamuco.

pathologies and healed fractures that would have prevented the individual to survive in the wild (López Luján *et al.* 2012; Sugiyama *et al.* 2013). When performed, analysis of stable isotopes also indicate human implication in feeding these animals (Sugiyama *et al.* 2015). Eventually, some authors have suggested the breeding of cottontails in certain Teotihuacan compounds (Valadez Azúa 1993; Manzanilla 1996; ) but it could also be a case of specialized hunting.

TABLE 5. — List of animals targeted by garden-hunting or actual hunting in the corpus studied. Taxa in grey are present in both categories.

| Garden-hunting                         | Hunting                                     |
|----------------------------------------|---------------------------------------------|
| Aves                                   | Aves                                        |
| <i>Buteo jamaicensis</i> Gmelin, 1788  | <i>Cathartes aura</i> Linnaeus, 1758        |
| Columbidae                             | Mammalia                                    |
| <i>Falco sparverius</i> Linnaeus, 1758 | <i>Didelphis virginiana</i> Kerr, 1792      |
| Mammalia                               | <i>Dasypus novemcinctus</i> Linnaeus, 1758  |
| <i>Didelphis virginiana</i>            | <i>Sylvilagus</i> sp. Gray, 1867            |
| Sciuridae                              | <i>Lepus</i> sp. Linnaeus, 1758             |
| Geomyidae                              | <i>Puma concolor</i> Linnaeus, 1771         |
| <i>Sylvilagus</i> sp.                  | <i>Lynx rufus</i> Schreber, 1777            |
| <i>Lepus</i> sp. Linnaeus, 1758        | <i>Canis latrans</i>                        |
| <i>Odocoileus virginianus</i>          | <i>Taxidea taxus</i> Schreber, 1777         |
| Zimmermann, 1780                       |                                             |
|                                        | <i>Mustela frenata</i> Lichtenstein, 1831   |
|                                        | <i>Mephitis macroura</i> Lichtenstein, 1832 |
|                                        | <i>Spilogale</i> sp. Grey, 1865             |
|                                        | <i>Procyon lotor</i> Linnaeus, 1758         |
|                                        | <i>Pecari tajacu</i> Linnaeus, 1758         |
|                                        | <i>Odocoileus hemionus</i>                  |
|                                        | Rafinesque, 1817                            |
|                                        | <i>Odocoileus virginianus</i>               |
|                                        | <i>Antilocapra americana</i> Ord, 1815      |

In the analysed sites of this study, no pathologies related to animal captivity were observed. Stable isotope analyses could still be carried out to detect a potential anthropic feeding, but since it has not been done currently, it is not possible to identify any captive specimen. That is why we focus on turkeys and dogs to deal with Mesoamerican husbandry practices, considering that they must have been raised by Prehispanic societies. Both animals are part of the fundamental taxa and can be predominant in some sites. However CA shows that if they take part in the data structuration, they are not associated to the same trends, meaning that there would be no specialized economy centred on the exploitation of these two domesticates. While turkey bones were only present in four sites, dog remains have been identified in nine assemblages on the ten studied.

It seems that dog remains are more numerous in Central Mexico (especially in the sites of Tizayuca and Calixtlahuaca) than in Western Mexico. Moreover, no carnivore teeth marks have been observed on bone surfaces of some Western sites (in particular Mich.31 and Barajas Late Postclassic occupation), suggesting that dogs might not have been numerous in these sites. Burning patterns on some dog bones from Tizayuca and butchery marks on a dog femur in Mich.31 show that they were sometimes consumed. This practice is confirmed by the first Spanish chroniclers such as Sahagun (1938) though it would have been restricted to specific occasions. Beside their role as aliments, dogs were highly symbolic companions, related with the death, the underworld and the planet Venus (de la Garza 1997, 2013; Merino Carrión & García Cook 1997). This aspect is illustrated in Mich.215 (Rodríguez Galicia *et al.* 2001) and Tizayuca by the inhumation of complete dogs in ceremonial and funerary areas.

Turkey bone remains are less common than dog ones in the archaeological sites of Northern Mesoamerica. Whereas few bones are present from the Classic occupation of JR74 (NISP = 4; MNI = 2), they do not appear until the Late Postclassic in the Zacapu Basin and are not present in other archaeological sites of Western Mexico Highlands, either in the studied sites or in published literature (Migeon 1990; Blanco, Carot *et al.* 1993; Blanco, Fauvet-Berthelot *et al.* 1993; Valadez Azúa & Rodríguez Galicia 2004; Polaco 2006). It could indicate an evolution in subsistence strategies at the end of the Postclassic, when husbandry came to complement hunting and fishing. In the same time, demographic pressure increases in the Zacapu Basin (Michelet *et al.* 2005) and the Pátzcuaro Basin (Pollard 2008). This trend still needs to be confirmed by the analysis of more archaeozoological assemblages but turkey husbandry may have been related somehow with the emergence of the Tarascan State in Western Mexico. However in Central Mexico, turkey bones are found since the Middle Preclassic (Thornton & Emery 2015) and are quite abundant in the Classic Teotihuacan (Valadez Azúa 1992, 1993). We found them in number in Tizayuca and Calixtlahuaca but not in El Salitre. Nonetheless, other excavations in the Tula metropolis, in the areas of El Canal and El Corral (Diehl 1981) and Cerro la Malinche (Paredes Gudiño & Valadez Azúa 1988), delivered some turkey bone remains. Hence this domestic bird would have been more present in Central Mexico than in Western Mexico. In both areas, the bone remains were found associated with domestic contexts and probably came from food waste. It means that turkeys must have been raised to be eaten. However, a morphometrical analysis has shown that most of the birds uncovered were actually adult females (Manin *et al.* 2016) and very few immature bones were identified, that could represent the limited slaughter of young males. This demographic profile is different from the expected one in a husbandry system directed to avian meat or eggs production (Albarella 1997; Speller & Yang 2016), meaning that males might have been kept alive for other purposes than food.

#### HUNTING OR GARDEN-HUNTING? TWO WAYS TO CATCH WILD TERRESTRIAL ANIMALS

Most of the taxa identified in this corpus are wild terrestrial animals. A large panel of activities may have allowed their acquisition, but two kinds of practices deserve to be distinguished: hunting and garden-hunting. Indeed, ethnographical surveys have shown that, nowadays, indigenous Mexican societies clearly separate both practices which are not carried out in the same contexts, the same places and by the same parts of the population (Hémond 1996; Katz 2006b).

Garden-hunting has been defined by Linares (1976) as a practice taking place in cultivated fields and other culturally modified environments and focusing on anthropophilous animals privileged by human activities. She adds that “in this dual system, animal protein and carbohydrates [meaning cultivated crops] are spatially concentrated and their abundance *vis à vis* each other is regulated. By reducing seasonality and scheduling problems, garden-hunting [is] analogous to [...] actual animal domestication”. In some places of the Maya

TABLE 6. — Proportion of NISP in the different categories of animals. The numbers in brackets indicate the precision of the percentage with an error threshold of 5%.

|                | El Salitre      | Calix.           | Tizayuca        | Mich.215        | Mich.23         | Mich.31         | Bar-Clas.        | Bar-PCR         | JR74            | Angamuco         |
|----------------|-----------------|------------------|-----------------|-----------------|-----------------|-----------------|------------------|-----------------|-----------------|------------------|
| Garden-hunting | 0% ( $\pm 0$ )  | 2% ( $\pm 5$ )   | 29% ( $\pm 4$ ) | 85% ( $\pm 7$ ) | 13% ( $\pm 7$ ) | 39% ( $\pm 3$ ) | 29% ( $\pm 33$ ) | 0% ( $\pm 0$ )  | 7% ( $\pm 4$ )  | 8% ( $\pm 16$ )  |
| Hunting        | 3% ( $\pm 5$ )  | 18% ( $\pm 12$ ) | 2% ( $\pm 1$ )  | 1% ( $\pm 2$ )  | 1% ( $\pm 2$ )  | 7% ( $\pm 2$ )  | 14% ( $\pm 26$ ) | 4% ( $\pm 5$ )  | 3% ( $\pm 3$ )  | 17% ( $\pm 21$ ) |
| Both methods   | 97% ( $\pm 5$ ) | 80% ( $\pm 12$ ) | 69% ( $\pm 4$ ) | 14% ( $\pm 6$ ) | 86% ( $\pm 8$ ) | 54% ( $\pm 3$ ) | 57% ( $\pm 37$ ) | 97% ( $\pm 5$ ) | 90% ( $\pm 5$ ) | 75% ( $\pm 24$ ) |

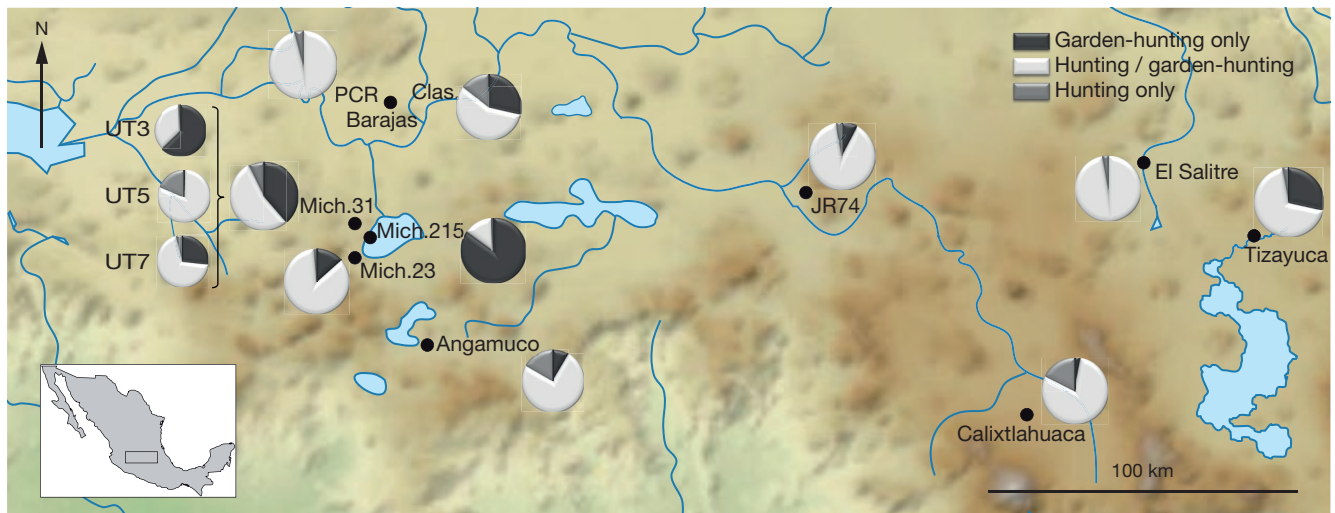


FIG. 7. — Proportion of animals targeted by hunting (grey), garden-hunting (black) or both methods (white) in each sites.

region, people are even cultivating specific crops that are not eaten but allow to attract animals to be hunted in the fields (Santos-Fita *et al.* 2013). In archaeological contexts, opportunistic garden-hunting can be detected by the abundance of garden taxa, species or genera that are likely to frequent gardens and culturally modified environments (Neusius 2008). Thanks to the list of garden animals proposed by Neusius (2008) and observations of Katz (2006b), nine taxa potentially acquired by garden-hunting can be highlighted in the Northern Mesoamerican corpus we studied (Table 5). Ethnographical records show this activity may have been carried out by any part of the population, including women and youths; in addition to birds and mammals, they would have also collected insects and snails (Hémond 1996; Katz 2006b).

On the other hand, hunting is a codified and ritualized activity (Szuter 1991) taking place in the *monte* (Hémond 1996), outside the domestic space (Brown & Emery 2008). Ethnographical and ethnohistorical investigations on hunting in Mesoamerica usually address the case of white-tailed deer, the outstanding game, but other species ought to be targeted. According to Mesoamerican cosmogony, wildlife in the *monte* is ruled by a non-human entity, the animal guardian, who protects wild fauna by making sure hunters do not hurt them or kill more than they need (Brown & Emery 2008; Olivier 2011). Besides, only men can participate in the hunting which is enclosed in specific ceremonies and rituals (Lemaistre 1991; Dehouve 2006). Once the prey has been killed, its bones have to be returned to the animal guardian to ensure the constant replacement of wildlife (Lemaistre 1991;

Dehouve 2006; Olivier 2010; Brown & Emery 2008). We listed 17 taxa that would have served as preys for hunting and are actually considered as “wild” animals (Table 5).

Unlike emphasized by Neusius (2008) in Southwestern USA, hunting in northern Mesoamerica would have concerned a broader spectrum of animals than garden-hunting. Moreover, many of the garden-hunting preys (four out of nine) may have been hunted in the *monte* as well and it is difficult to precisely distinguish both activities in the archaeological record. Finally, it is worth notice that regarding rituals related to hunting, bone repartition could be highly biased in archaeological sites: either they would be under-represented in domestic contexts or over-represented in specific caches. Comparison of NISP from hunting *versus* garden-hunting is given in Table 6 and Fig. 7.

Most of the NISP is represented by garden taxa which could also be hunted in the *monte*. White-tailed deer in particular is an emblematic prey for hunters (e.g., Montolú 1967; Lemaistre 1991; Faugère 1998, 2008; Dehouve 2008, 2010; Olivier 2010, 2011), but is also known to often visit cultivated fields (Emery & Thornton 2008). When comparing the proportion of taxa belonging to a single category, we see they only seldom differ. Although they are less diverse, the NISP of garden taxa is higher than “wild” taxa in Tizayuca, Mich. 215, Mich. 23 and Mich. 31, pocket gophers being the most abundant animals. It is important to note that even if pocket gophers are burrowers and well-known intrusive species in North-American archaeological sites (Pierce 1992), we found evidences of cooking in Mich. 31 (Fig. 8) and other



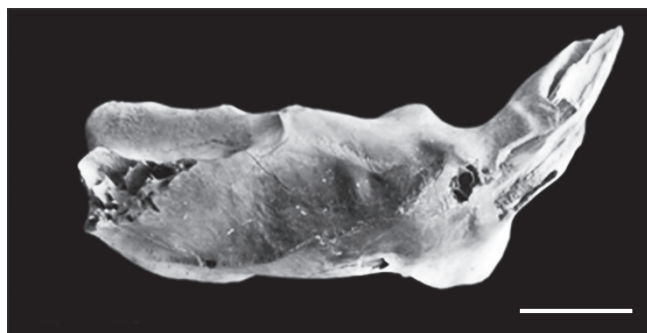


FIG. 8. — Right mandible of Geomyiidae (cf. *Cratogeomys* sp.) from Mich.31 showing evidences of cooking: burnt marks are located on the most prominent part of the bone, lateral side. Scale bar = 1 cm

burnt traces on teeth in Mich.215: that is why they have been considered of anthropic origin when found unarticulated in archaeological contexts. Comparing the largest subsets of Mich.31, the domestic one (UT3) clearly shows a garden-hunting profile while the funerary one (UT5) contains mostly remains of hunted species: both thus illustrate the evidence of different activities (Manin *et al.* 2015).

In other sites, the archaeological context will help to distinguish between hunting and garden-hunting, that is to say the degree of symbolism given to animal capture. Still in Western Mexico, even if NISP is too small to get a significant conclusion, the Late Postclassic occupation of Barajas might represent a hunting episode. Indeed, the archaeologists detected this occupation in superficial layers, where Tarascan ceramic sherds were associated with fireplaces (Michelet *et al.* 2000). Bone remains recovered pertain mostly to white-tailed deer as well as a few hunted species like collared peccary (*Pecari tajacu* Linnaeus, 1758; NISP = 1) and felid (NISP = 1). Butchery marks and burnt bones show an intense anthropic activity on these remains and a fragment of *omichicahuaztli*, a grooved bone (Pereira 2005), suggests that ritual and ceremonial activities may have taken place in this camp. These elements allow to interpret the Late Postclassic occupation of Barajas as the relics of a hunter camp. In Angamuco, mandibles of deer (MNI = 4) were buried in the vicinity of the main pyramid, inside the major civico-ceremonial centre. The location of these remains and the scarcity of animal remains in other parts of the site let us assume that these deers – and maybe their capture – were highly symbolic for the inhabitants of Angamuco. On the other hand, few animals from garden-hunting have been found in Calixtlahuaca. This site is a typical example of Aztec low density urbanism and agricultural terraces were included inside the city (Isendahl & Smith 2013), which is different from other sites as Mich.31, where cultivated fields were located in areas surrounding the main city. Therefore the presence of commensal animals may have been limited in Calixtlahuaca gardens due to anthropic pressure. In such place, it would hence be difficult to assess the symbolic value of hunting regarding animal remains found in domestic areas we studied.

According to archaeological and ethnographic data, garden-hunting would then be the principal activity in acquiring animals, even if urbanism and local environment may have affected this trend. The importance of small game in Mesoamerican subsistence has already been proposed by Valadez Azúa and Rodríguez Galicia (2014) in Central Mexico and garden-hunting practice should be extended to Western Mexico. On the other hand, some examples show hunting was often restricted to particular occasions and subject to ceremonies that are ought to reduce its evidences in the archaeological record by storing the bones in specific places. The interest of this study lies in the fact that taking into account a broad range of contexts, it is thus possible to observe different patterns in bone removal, allowing to distinguish both influences of hunting and garden-hunting.

#### EXPLOITATION OF AQUATIC ENVIRONMENTS

Aquatic environments are known to favour a large diversity of animals and ethnographic observations actually highlight their importance in human subsistence in the Trans-Mexican Volcanic Belt (e.g., Rojas Rabiela 1985; Argueta Villamar 2008; Williams 2009). Their leading role in ancient Mesoamerican cultural development has also been addressed by various archaeologists (e.g., Flannery 1968; Serra & Valadez Azúa 1986; Manzanilla & Serra 1987; Niederberger Betton 1987; Parsons 2005, 2008). However no study stresses on a regional comparison of their relative importance, which is what we attempted to do by comparing the different assemblages we studied. All the sites analysed in this paper are located near a waterway or a lacustrine basin, giving the populations an equal access to aquatic animals; except for Mich.215, which, being situated on a small island in the Zacapu Basin, offers to its occupants an easier access to these resources.

Two aquatic taxa are part of the fundamental animal resources, considering the results of nestedness analysis: turtles and bonny fishes. Mud turtle (*Kinosternon* sp. Spix, 1824) have been found in all assemblages except in the former occupation of Barajas and El Salitre. Local bonny fishes have really small bones and it is unusual to find them without a systematic sieving procedure. Even so, their remains are present in four assemblages, mostly located in the Zacapu Basin (Mich.215, Mich.23 and Mich.31) and also in JR74. A specific care had been taken to the recovery of organic remains in the sites of the Zacapu Basin, with fine mesh sieving process, and it could explain the presence of small fish bones. Frogs are the most abundant animals in Mich.215, in both in NISP (192) and MNI (26), whereas they are absent in all other sites but Tizayuca (NISP = 5). Aquatic animals in general are also a major structuring group in CA, and the composition of Mich.215 assemblage seems defined by their abundance. As the population of this site also had the easiest access to aquatic environments, being located on an island, it could be an example of opportunistic exploitation of locally available fauna.

Some ethnohistoric sources express the importance of Western Mexico in the exploitation of aquatic environments. According to Sahagun (1938), Aztecs consider Michoacán



inhabitants as famous fishermen and describe a country abounding in aquatic resources. Although our corpus is limited and disparate, we tested the assertion that there was a difference in the exploitation of aquatic animals between Central and Western Mexico. Excluding Mich.215, because its location can greatly influence the use of aquatic resources, the proportion of aquatic animals in Western Mexico sites is statistically superior to their proportion in Central Mexico (Z-test,  $Z = 10.52$ ;  $p < 0.001$ ). It is a first element to confirm the dichotomy between the two regions, though it needs to be confirmed with the analysis of more assemblages.

#### USING ANIMALS IN NORTHERN MESOAMERICA

One observation arising from this study is that there are rather few animal bone remains in the archaeological sites and it might be an evidence of the limited use of animals in ancient Mesoamerica. Animal bones recovered in domestic contexts are usually supposed to give a first insight of everyday meat-food. Most of the taxa identified may have been consumed, while some might have had a therapeutic purpose, according to various authors (Sahagún 1938; Leopold 1959; Katz 2006a, b; Corona 2008; Barragan *et al.* 2007). Only a few animals are not explicitly mentioned in these sources, all pertaining to the family of the carnivores (Table 7). However, the fat of the jaguar (*Panthera onca* Linnaeus, 1758), was of therapeutic use (Katz 2006b) and this practice may have been extended to other felids as well. The animals potentially consumed are diverse but they represent little amount of meat. As an example, in the site of Mich.31, the richest trash deposit associated to one domestic unit (UT3) contained 1832 bone remains representing only 57 kg of meat. In the same site two other domestic units did not deliver any animal bone in their rubbish. It points to a differential access to meat resources that may be related with people status. Inequalities have actually been already mentioned in the Maya area thanks to zooarchaeology (Emery 2003) and stable isotopes (White 2005; Somerville *et al.* 2013). Moreover, other animals could have been consumed that do not leave evidences in archaeological record, as it would be the case of insects and larvae (Katz 2006a).

The use of animal bones and antlers as raw material for the production of tools and decorative objects has been observed in all sites except in Angamuco and El Salitre. Large mammals are the most commonly used with 43 worked elements examined in this study. However, some of them were so transformed that it was not possible to distinguish between artiodactyls and human bones. We also identified 3 worked canid bones and one perforated canid tooth, as well as one object from a raccoon (*Procyon lotor* Linnaeus, 1758) femur and another from a cottontail femur. Turtles shells may have been used as drums as suggested by different authors (Flannery 1976; Álvarez & Ocaña 1999; Flannery & Marcus 2000; Manin & Lefèvre in press), according to iconographic (e.g., Pohl & Pohl 1983; Manin & Lefèvre in press) and ethnohistoric (e.g., Alcalá 2000: 301) evidences. It could be the reason for the importation of the large Central American river turtle (*Dermatemys mawii* Gray, 1847) as assumed by Flannery (1976: 336) but smallest ones ought to be used as well.

TABLE 7. — List of taxa found in the archaeological sites concerned by this study, either usually consumed in Mesoamerica or used as medicinal resources, from Barragan *et al.* (2007), Corona (2008), Katz (2006a,b), Leopold (1959) and Sahagún (1938). Animals included in brackets are usually consumed but might also be used as medicinal resources. The last column indicates animals found in the sites but with no mention of consumption.

| Usually consumed animals                       | Medicinal resources                          | No mention of consumption                 |
|------------------------------------------------|----------------------------------------------|-------------------------------------------|
| Actinopterygii                                 | (Anatidae)                                   | <i>Puma concolor</i> Linnaeus, 1771       |
| Lissamphibia                                   | ( <i>Meleagris gallopavo</i> Linnaeus, 1758) | <i>Lynx rufus</i> Schreber, 1777          |
| <i>Kinosternon</i> sp. Spix, 1824              | <i>Buteo jamaicensis</i> Gmelin, 1788        | <i>Taxidea taxus</i> Schreber, 1777       |
| Anatidae                                       | <i>Cathartes aura</i> Linnaeus, 1758         | <i>Mustela frenata</i> Lichtenstein, 1831 |
| <i>Meleagris gallopavo</i> Linnaeus, 1758      | (Columbidae)                                 |                                           |
| Podocopedidae                                  | <i>Falco sparverius</i> Linnaeus, 1758       |                                           |
| Columbidae                                     | ( <i>Didelphis virginiana</i> Kerr, 1792)    |                                           |
| <i>Didelphis virginiana</i> Kerr, 1792         | <i>Canis latrans</i> Say, 1823               |                                           |
| <i>Dasypus novemcinctus</i> Linnaeus, 1758     | <i>Mephitis macroura</i> Lichtenstein, 1832  |                                           |
| Sciuridae                                      | <i>Spilogale</i> sp. Grey, 1865              |                                           |
| Geomyidae                                      |                                              |                                           |
| <i>Lepus</i> sp. Linnaeus, 1758                |                                              |                                           |
| <i>Sylvilagus</i> sp. Gray, 1867               |                                              |                                           |
| <i>Canis familiaris</i> Linnaeus, 1758         |                                              |                                           |
| <i>Procyon lotor</i> Linnaeus, 1758            |                                              |                                           |
| <i>Pecari tajacu</i> Linnaeus, 1758            |                                              |                                           |
| <i>Odocoileus hemionus</i> Rafinesque, 1817    |                                              |                                           |
| <i>Odocoileus virginianus</i> Zimmermann, 1780 |                                              |                                           |
| <i>Antilocapra americana</i> Ord, 1815         |                                              |                                           |

Felid and small carnivore remains could represent other kind of attributes even if their bones do not show evidences of work. Indeed, they are often represented by cranial elements: a maxillary of bobcat in Calixtlahuaca, mandibles and skulls of long-tailed weasel (*Mustela frenata* Lichtenstein, 1831) in Calixtlahuaca, Tizayuca and Mich.215, mandibles and skulls of skunk (Mephitidae) in Tizayuca, Angamuco and Mich.31. In El Salitre, a metacarpus of cougar has been identified. Yet cranium and legs extremity are presented by López Austin (2013) as repositories of the animal power. Moreover, if the skins of these animals were prepared, they could have been left inside: their presence in archaeological sites would hence be the only remaining evidence of the skin. The use of carnivore skins as attributes is often illustrated in Mesoamerica; the frescoes of Cacaxtla (Morelos, Mexico) are one of the most figurative examples in Central Mexico.

## CONCLUSION

The comparative analysis of ten assemblages from Central and Western Mexico allows to draw a more accurate pattern of animal exploitation in Northern Mesoamerica between the Classic period and the Spanish Conquest. We have shown the homogeneity in the taxa used in all these sites, though differences exist in their proportions in each site. Compared to the available animal diversity, only few species have been targeted, with 35 taxa identified. Among them, mammals are the most diverse. If no clear regional or chronological trend can be found, essentially due to the small size of our corpus, the most influent animals would be white-tailed deer, dog, turkey and commensal animals such as pocket gophers: they are fundamental in the faunal range exploited, appear in turns as dominant species in the assemblages and their proportions structure the differentiation between sites. The use of two domesticated animals (dog and turkey) was common but further investigations have to be carried out to better understand their role in cultural differentiation. Other managed species might also be uncovered as the use of stable isotope analyses is increasing. Terrestrial wild mammals must have been acquired mostly through garden-hunting while hunting would have been limited to specific occasions. Nonetheless a differential discarding of the bones of hunted animals related to their use in ceremonies could reduce their presence in the archaeological assemblages and induce a bias in our interpretations. Aquatic environment was intensively exploited in Mich.215, located on an island. In the other sites, aquatic animals only represent a slight part of the fauna used but they are more abundant in Western Mexico than in Central Mexico. Finally we can consider that animals were not intensively used, not even as aliments, which would explain the reduced number of animal bones in archaeological sites. However, they had a symbolic value when alive that ended up in their bones, whether as power attributes or hunting relics given back to the animal guardian.

The diversity of results arising from this study proves the interest of a systematic analysis of all kind of sites, even the smallest ones, and their integration in a broader pattern to complement the data obtained from large metropolis. This first attempt at a synthesis on animal use in Northern Mexico needs of course to be improved with the study of more archaeological sites in order to refine the regional evolution and look for chronological trends.

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## REFERENCES

- ALBARELLA U. 1997. — Size, power, wool and veal: zooarchaeological evidence for late medieval innovations, in DE BOW G. & F. VERHAEGHE (eds), *Environment and Subsistence in Medieval Europe*. Instituut voor het Archeologisch Patrimonium, Bruxelles: 19-30.
- ALBERTI G. 2013. — An R script to facilitate correspondence analysis. A guide to the use and the interpretation of results from an archaeological perspective. *Archaeologia e Calcolatori* 24: 25-53.
- ALCALÁ J. DE 2000. — *Relación de Michoacán*. FRANCO MENDOZA M. (ed.), El Colegio de Michoacán, Gobierno del Estado de Michoacán, 333 p.
- ÁLVAREZ T. & OCAÑA A. 1999. — *Sinopsis de los restos arqueozoológicos de vertebrados terrestres*. Instituto Nacional de Antropología e Historia, México D. F., 108 p.
- ARGUETA VILLAMAR A. 2008. — *Los saberes P'urhépecha. Los animales y el diálogo con la naturaleza*. Universidad Michoacana de San Nicolás de Hidalgo, Morelia; Universidad Nacional Autónoma de México, México, 240 p.
- ATMAR W. & PATTERSON B. D. 1993. — The measure of order and disorder in the distribution of species in fragmented habitat. *Oecologia* 96 (3): 373-382.
- BARRAGÁN F., RETANA O. G. & NARANJO E. J. 2007. — The rodent trade of Tzeltal Indians of Oxchuc, Chiapas, Mexico. *Human Ecology* 35 (6): 769-773. <http://doi.org/10.1007/s10745-007-9116-7>
- BARTOSIEWICZ L. & GAL E. 2007. — Sample size and taxonomic richness in mammalian and avian bone assemblages from archaeological sites. *Archeometria i Mühely* 1: 37-44.
- BEEKMAN C. S. 2009. — Recent research in western Mexican archaeology. *Journal of Archaeological Research* 18 (1): 41-109. <http://doi.org/10.1007/s10814-009-9034-x>
- BEHRENSMEYER A. K. 1978. — Taphonomic and ecologic information from bone weathering. *Paleobiology* 4 (2): 150-162.
- BINFORD L. R., 1981. — *Bones. Ancient Men and Modern Myths*. Academic Press, New York, 320 p.
- BLANCO A., PÉREZ G., RODRÍGUEZ B., SUGIYAMA N., TORRES F. & VALADEZ R. 2009. — El zoológico de Moctezuma ¿Mito o realidad? *AMMVEPE* 20 (2): 28-39.
- BLANCO A., CAROT P. & POLACO O. J. 1993. — La fauna encontrada en contexto Loma Alta, in ARNAULD C., CAROT P. & FAUVET-BERTHELOT M.-F. (eds), *Arqueología de las Lomas en la cuenca lacustre de Zacapu, Michoacán, México*. Centro de Estudios Mexicanos y Centroamericanos, México D. F.
- BLANCO A., FAUVET-BERTHELOT M.-F. & POLACO O. J. 1993. — La fauna encontrada en contexto Lupe, in ARNAULD C., CAROT P. & FAUVET-BERTHELOT M.-F. (eds), *Arqueología de las Lomas en la cuenca lacustre de Zacapu, Michoacán, México*. Centro de Estudios Mexicanos y Centroamericanos, México D. F.
- BOCHENSKI Z. M. & TOMEK T. — 2009. *A Key for the Identification of Domestic Birds Bones in Europe: Preliminary Determination*. Institute of Systematic and evolution of animals, Polish academy of sciences, Kraków, 101 p.
- BRANIFF B. 1989. — Oscilación de la frontera norte mesoamericana: un nuevo ensayo. *Arqueología* 1: 99-114.
- BRÉHARD S. 2011. — Le complexe chasséen vu par l'archéozoologie: révision de la dichotomie Nord-Sud et confirmation de la partition fonctionnelle au sein des sites méridionaux. *Bulletin de la Société Préhistorique Française* 108 (1): 73-92.
- BROWN L. A. & EMERY K. F. 2008. — Negotiations with the animate forest: hunting shrines in the Guatemalan Highlands. *Journal of Archaeological Method and Theory* 15 (4): 300-337.
- CANNON M. D. 2001. — Archaeofaunal relative abundance, sample size, and statistical methods. *Journal of Archaeological Science* 28 (2): 185-195. <http://doi.org/10.1006/jasc.2000.0558>
- CEBALLOS G. & ARROYO CABRALES J. 2012. — Lista actualizada de los mamíferos de México. *Revista Mexicana de Mastozoología Nueva época* 2 (1): 27-80.

- CHAVEZ A. 2008. — Comparative vertebral morphology in medium-sized North American Artiodactyla. *The Artifact* 46: 1-17.
- CORONA M. E. 2008. — Las aves como recurso curativo en el México antiguo y sus posibles evidencias en la arqueozoología. *Arqueobios* 2: 11-18.
- CORONA M. E. 2013. — Birds of the pre-hispanic domestic spheres of central Mexico, in GÖTZ C. M. & EMERY K. F. (eds), *The Archaeology of Mesoamerican Animals*. Lockwood Press, Atlanta: 81-94.
- CORTÉS H. 1996. — *La conquête du Mexique*. La Découverte, Paris, 462 p.
- COWGILL G. L. 1997. — State and society at Teotihuacan. *Annual Review of Anthropology* 26: 129-161.
- COWGILL G. L. 2008. — An update on Teotihuacan. *Antiquity* 82 (318): 962-975.
- CRABTREE P. J. 1990. — Zooarchaeology and complex societies: some uses of faunal analysis for the study of trade, social status, and ethnicity. *Archaeological Method and Theory* 2: 155-205.
- DEHOUE D. 2006. — Les rituels cynégétiques des Indiens mexicains, in SIDERA I., VILA E. & ERIKSON P. (eds), *La chasse. Pratiques sociales et symboliques*. De Brocard, Paris: 195-204.
- DEHOUE D. 2008. — El venado, el maíz y el sacrificio. *Diario de campo*. Cuaderno 4: 1-39.
- DEHOUE D. 2010. — Un ritual de cacería. El conjuro para cazar venados de Ruiz de Alarcón. *Estudios de cultura nahuatl* (40): 299-331.
- DENYS C. & PATOU-MATHIS M. 2014. — Les agents taphonomiques impliqués dans la formation des sites paléontologiques et archéologiques, in DENYS C. & PATOU-MATHIS M. (eds), *Manuel de taphonomie*. Errance, Arles: 31-64.
- DÍAZ DEL CASTILLO B. 1996. — *La conquête du Mexique*. Actes Sud, Paris, 809 p.
- DIEHL R. A. 1981. — Tula, in SABLOFF J. A. (ed.), *Supplement to the Handbook of Middle American Indians, Volume 1*. University of Texas Press, Austin: 277-295.
- DIEHL R. A. & BERLO J. C. 1989. — Introduction, in DIEHL R. A. & BERLO J. C. (eds), *Mesoamerica after the Decline of Teotihuacan*. Dumbarton Oaks Research Library and Collections, Washington DC: 1-8.
- ELBROCH, M., 2006. — *Animal Skulls, a Guide to North American Species*. Stackpole Books, Mechanicsburg, 727 p.
- EMERY K. F. 2003. — The noble beast: status and differential access to animal in the Maya world. *World Archaeology* 34 (3): 498-515. <http://doi.org/10.1080/0043824021000026477>
- EMERY K. F. 2013. — Conclusion: from zooarchaeological remains to a human context, in GÖTZ C. M. & EMERY K. F. (eds), *The Archaeology of Mesoamerican Animals*. Lockwood Press, Atlanta: 607-630.
- EMERY K. F. & THORNTON E. K. 2008. — A regional perspective on biotic change during the Classic Maya occupation using zooarchaeological isotopic chemistry. *Quaternary International* 191: 131-143.
- EQUIHUA J.-C. 2007. — *Informe final Rescate Arqueológico el Salitre – Tula*. Instituto Nacional de Antropología e Historia, México D.F. (Unpublished technical report).
- EQUIHUA J.-C. 2008. — *Proyecto Salvamento Arqueológico Tizayuca 2006. Informe. Secuencias estratigráficas y conjuntos arquitectónicos, Tomo I*. Instituto Nacional de Antropología e Historia, México D.F. (Unpublished technical report).
- FAUGÈRE B. 1998. — Venados y hogares sagrados en la Relación de Michoacán: reivindicación nórdica y construcción del Estado en los pueblos tarascos, in DARRAS V. (ed.), *Génesis, culturas y espacios en Michoacán*. Centro de Estudios Mexicanos y Centroamericanos, México D. F.: 89-100.
- FAUGÈRE B. 2008. — Le cerf chez les anciens P'urhépecha du Michoacan (Mexique): guerre, chasse et sacrifice. *Journal de la Société des Américanistes* 94 (2): 109-142.
- FISHER C. T., LEISZ S. & OUTLAW G. 2011. — LIDAR – a valuable tool uncovers an ancient city in Mexico. *Photogrammetric Engineering & Remote Sensing* 77 (10): 962-967.
- FLANNERY K. V. 1967. — Vertebrate fauna and hunting patterns, in MACNEISH R. S. & BYERS D. S. (eds), *Environment and Subsistence*. University of Texas Press, Austin.
- FLANNERY K. V. 1968. — Archaeological systems theory and early Mesoamerica, in MEGGERS B. J. (ed.), *Anthropological Archaeology in the Americas*. Anthropological Society of Washington, Washington: 67-87.
- FLANNERY K. V. 1976. — *The Early Mesoamerican Village*. Academic Press, New York, 388 p.
- FLANNERY K. V. & MARCUS J. 2000. — Formative mexican chiefdoms and the myth of the “Mother Culture.” *Journal of Anthropological Archaeology* 19: 1-37.
- FOREST M. 2014. — *L'organisation sociospatiale des agglomérations urbaines du Malpaís de Zacapu, Michoacán, Mexique*. PhD thesis, Université de Paris 1 - Panthéon Sorbonne, 596 p.
- GILBERT B. M., MARTIN L. D. & SAVAGE H. G. 1981. — *Avian Osteology*. Bone Books, 252 p.
- GRAYSON D. K. 1984. — *Quantitative Zooarchaeology*. Academic Press, Cambridge MA, 202 p. (Coll. Studies in Archaeology).
- HEALAN D. M. 2012. — The archaeology of Tula, Hidalgo, Mexico. *Journal of Archaeological Research* 20 (1): 53-115. <http://doi.org/10.1007/s10814-011-9052-3>
- HÉMOND A. 1996. — Pratiques cynégétiques et nouveaux discours écologiques chez les Nahuas du Balsas (Mexique). *Journal d'agriculture traditionnelle et de botanique appliquée* 38 (2): 269-288.
- HERNÁNDEZ F. 1959. — *Historia natural de Nueva España*. Universidad Nacional Autónoma de México, México D.F.
- HILSON S. 2005. — *Teeth*. Cambridge University Press, Cambridge, 388 p.
- ISENDAHL C. & SMITH M. E. 2013. — Sustainable agrarian urbanism: the low-density cities of Mayas and Aztecs. *Cities* 31: 132-143. <http://doi.org/10.1016/j.cities.2012.07.012>
- JACOBSON J. A. 2004. — *Determining Human Ecology on the Plains through the Identification of Mule Deer (Odocoileus hemionus) and White-tailed Deer (Odocoileus virginianus) postcranial material*. PhD thesis. University of Tennessee, Knoxville.
- JADOT E. 2013. — Sondeos estratigráficos en el sitio de El Palacio (Mich.23), in PEREIRA G., MICHELET D., JADOT E., MANIN A., ELLIOTT M. & FOREST M. (eds), *Proyecto Uacúisecha. Informe técnico sobre los trabajos de campo llevados a cabo en Malpaís Prieto y otros asentamientos de la región de Zacapu, Michoacán. Temporada 5 (noviembre-diciembre 2012)*. INAH, México D. F.: 107-124 (Unpublished technical report).
- JONES E. L. 2004. — Dietary evenness, prey choice, and human-environment interactions. *Journal of Archaeological Science* 31 (3): 307-317. <http://doi.org/10.1016/j.jas.2003.08.011>
- JONES E. L. 2013. — Subsistence change among the 17<sup>th</sup> century Diné? A reanalysis of the faunas from the Fruitland Data Recovery project. *Journal of Ethnobiology* 33 (1): 148-166. <http://doi.org/10.2993/0278-0771-33.1.148>
- JONES E. L. 2015. — Archaeofaunal evidence of human adaptation to climate change in Upper Paleolithic Iberia. *Journal of Archaeological Science: Reports* 2: 257-263. <http://doi.org/10.1016/j.jasrep.2015.02.008>
- KATZ E. 2006a. — Les normes alimentaires des paysans mixtèques (État d'Oaxaca, Mexique). *Journal des anthropologues* (106-107): 205-223. <http://jda.revues.org/1330> last consultation: 17/10/2016.
- KATZ E. 2006b. — Statut de la chasse et consommation du petit gibier chez les paysans mixtèques du Mexique. Approche diachronique, in SIDERA I., VILA E. & ERIKSON P. (eds), *La chasse. Pratiques sociales et symboliques*. De Brocard, Paris: 181-192.
- DE LA GARZA M. 1997. — El perro como símbolo religioso entre los mayas y los nahuas. *Estudios de Cultura Náhuatl* 27: 519 p.
- DE LA GARZA M. 2013. — El carácter sagrado del xoloitzcuintli entre los nahuas y los mayas. *Arqueología Mexicana* 31 (125): 58-63.
- LAWRENCE B. 1951. — Post-cranial skeletal characters of deer, pronghorn and sheep-goat with notes on Bos and Bison. *Papers of the Peabody Museum of Archaeology and Ethnology* 35 (3): 9-43.



- LEMAISTRE D. 1991. — Le cerf-peyotl et le cerf-maïs: la chasse, rituel formateur de la "trinité" huichole. *Journal de la Société des Américanistes* 77 (1): 27-43.
- LEONARD J. A., WAYNE R. K., WHEELER J., VALADEZ R., GUILLÉN S. & VILA C. 2002. — Ancient DNA evidence for Old World origin of New World dogs. *Science* 298: 1613-1616. <http://doi.org/10.1126/science.1076980>
- LEOPOLD A. S. 1959. — *Wildlife of Mexico: the Game Birds and Mammals*. University of California Press, Berkeley, 568 p.
- LINARES O. F. 1976. — "Garden hunting" in the American tropics. *Human Ecology* 4 (4): 331-349.
- LÓPEZ AUSTIN A. 2013. — La fauna maravillosa de Mesoamérica (una clasificación), in MILLONES L. & LÓPEZ AUSTIN A. (eds), *Fauna fantástica de Mesoamérica y los Andes*. Universidad Nacional Autónoma de México, Instituto de Investigaciones Antropológicas, México D.F.: 31-91.
- LÓPEZ AUSTIN A. & LÓPEZ LUJÁN L. 2012. — *Le passé indigène. Histoire pré-coloniale du Mexique*. Les Belles Lettres, Paris, 384 p.
- LÓPEZ LUJÁN L., CHÁVEZ BALDERAS X., ZÚÑIGA-ARELLANO B., AGUIRE MOLINA A. & VALENTÍN MALDONADO N. 2012. — Un portal al inframundo. Ofrendas de animales sepultadas al pie del Templo Mayor de Tenochtitlan. *Estudios de Cultura Náhuatl* 44: 9-40.
- LYMAN R. L. 1994. — *Vertebrate Taphonomy*. Cambridge University Press, Cambridge, 552 p. (Coll. Cambridge Manuals in Archaeology).
- LYMAN R. L. 2008. — *Quantitative Paleozoology*. Cambridge University Press, Cambridge, 307 p. (Coll. Cambridge Manuals in Archaeology).
- LYMAN R. L. 2010. What is Taphonomy, what it isn't, and why taphonomists should care about the difference. *Journal of Taphonomy* 8: 1-16.
- MADRIGAL T. C. & ZIMMERMANN HOLT J. 2002. — White-tailed deer meat and marrow return rates and their application to Eastern Woodlands archaeology. *American Antiquity* 67 (4): 745-759. <http://doi.org/10.2307/1593802>
- MAJEWSKI T. & FELDMAN L. 1976. — A catalogue of animals: the zoo in Molina's Vocabulario. *Estudios de Cultura Náhuatl* 12: 335-343.
- MANIN A. 2015. — *Utilisation matérielle et symbolique des animaux dans le nord de la Mésoamérique entre le Classique et la Conquête (200-1521 apr. J.-C.)*. PhD thesis. Muséum national d'Histoire naturelle, Paris.
- MANIN A., CORNETTE R. & LEFÈVRE C. 2016. — Sexual dimorphism among Mesoamerican turkeys: a key for understanding past husbandry. *Journal of Archaeological Science: Reports*. Corrected proofs: <http://doi.org/10.1016/j.jasrep.2016.05.066>
- MANIN A. & LEFÈVRE C. (in press). — Uso material y simbólico de los animales en Vista Hermosa, in STRESSER-PÉAN G., STRESSER-PÉAN C. & PEREIRA G. (eds), *Vista Hermosa. Nobles, artesanos y mercaderes en los confines del mundo huasteco. Estudio arqueológico de un sitio posclásico tardío del municipio de Nuevo Morelos, Tamaulipas, México*. Ediciones del Museo de Antropología e Historia, CEMCA, México D.F.
- MANIN A., PEREIRA G. & LEFÈVRE C. 2015. — El uso de los animales en una ciudad tarasca posclásica: estudio arqueozoológico del sitio de Malpaís Prieto (Michoacán, México). *Arqueobios* 1 (9): 28-42.
- MANZANILLA L. 1996. — Corporate groups and domestic activities at Teotihuacan. *Latin American Antiquity* 7 (3): 228-246.
- MANZANILLA L. & SERRA M. C. 1987. — Aprovechamiento en recursos de origen biológico en la cuenca de México (2500 antes de Cristo - 1500 después de Cristo). *Geofísica Internacional* 26 (1): 15-28.
- MARGALEF D.R. 1958. — Information theory in ecology. *General Systems* 3: 36-71.
- MÁYNEZ P. 1991. — La fauna mexicana en la obra de fray Bernardino de Sahagún. *Estudios de Cultura Náhuatl*, 21: 145-161.
- MERINO CARRIÓN L. & GARCÍA COOK A. 1997. — Enterramiento de perros durante el Formativo temprano en el noreste de México, in MANRIQUE C. L. & CASTILLO T. N. (eds), *Homenaje al doctor Ignacio Bernal*. Instituto Nacional de Antropología e Historia, México D.F.: 411-432.
- MICHELET D. & PEREIRA G. 2009. — Teotihuacan y el Occidente de México, in SOLIS F. (ed.), *Teotihuacan: ciudad de los dioses*. Instituto Nacional de Antropología e Historia, México D.F.: 79-83.
- MICHELET D., PEREIRA G. & MIGEON G. 2000. — *Informe de los trabajos de campo realizados en el Cerro de Barajas, Guanajuato. Proyecto Dinámicas Culturales en el Bajío*. INAH, México D. F. (Unpublished technical report).
- MICHELET, D., PEREIRA G. & MIGEON G. 2005. — La llegada de los Uacúsechas en la región de Zacapu, Michoacán: datos arqueológicos y discusión, in MANZANILLA L. (ed.), *Reacomodos demográficos del Clásico al Posclásico en el centro de México*. Universidad Nacional Autónoma de México, Instituto de Investigaciones Antropológicas, México D.F.: 137-153.
- MIGEON G. 1990. — *Archéologie en pays Tarasque. Structure de l'habitat et ethnopréhistoire des habitations tarasques de la région de Zacapu (Michoacán, Mexique), au Postclassique récent*. PhD thesis. Université de Paris 1 – Panthéon Sorbonne.
- MONTOLÍU M. 1967. — Algunos aspectos del venado en la religión de los mayas de Yucatán. *Estudios de Cultura Maya* 10 (7): 149-172.
- NAVARRO A. & GORDILLA A. 2008. — Catálogo taxonómico de especies de México, Aves, in OCEGUEDA S. & LLORENTE-BOUSQUETS J. (eds), *Capital natural de México, Vol. 1: Conocimiento actual de la biodiversidad*. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México D.F.
- NEUSIUS S.W. 2008. — Game procurement among temperate horticulturalists: the case for garden hunting by the Dolores Anasazi, in REITZ E. J., SCARRY C. M. & SCUDDER S. J. (eds), *Case Studies in Environmental Archaeology*. Springer: 297-314. [http://doi.org/10.1007/978-0-387-71303-8\\_15](http://doi.org/10.1007/978-0-387-71303-8_15)
- NICHOLS D.L. & POOL C.A. 2012. — Mesoamerican archaeology: recent trends, in NICHOLS D. L. & POOL C. A. (eds), *The Oxford Handbook of Mesoamerican Archaeology*. Oxford University Press, New York: 1-30.
- NIEDERBERGER BETTON C. 1987. — *Paléopaysages et archéologie pré-urbaine du bassin de Mexico*. Centre Français d'Etudes Mexicaines et Centraméricaines, México D.F., 357 p.
- OLIVIER G. 2010. — El simbolismo sacrificial de los Mimixcoa: cacería, guerra, sacrificio e identidad entre los Mexicas, in OLIVIER G. & LÓPEZ LUJÁN L. (eds), *El sacrificio humano en la tradición mesoamericana*. INAH, México D.F.: 453-482.
- OLIVIER G. 2011. — Cerfs mélomanes et chasseurs lubriques: chasse, musique et érotisme dans l'ancien Mexique, in RAGOT N., PEPPERSTRAETE S., & OLIVIER G. (eds), *La quête du serpent à plumes. Arts et religions de l'Amérique précolombienne, hommage à Michel Graulich*. Bibliothèque de l'École Pratique des Hautes Etudes, Paris: 57-79.
- OLSEN S. J. 1964. — Mammals remains from archaeological sites. Part 1: Southeastern and Southwestern United States. *Papers of the Peabody Museum of Archaeology and Ethnology* 56 (1): 1-162.
- OLSEN S. J. 1968. — Fish, amphibians and reptile remains from archaeological sites. *Papers of the Peabody Museum of Archaeology and Ethnology* 56 (2), 156 p.
- OLSEN S. J. 1979a. — North American birds: postcranial skeletons. *Papers of the Peabody Museum of Archaeology and Ethnology* 56 (5).
- OLSEN S. J. 1979b. — North American birds: skulls and mandibles. *Papers of the Peabody Museum of Archaeology and Ethnology* 56 (3).
- PEREDES GUDIÑO B. & VALADEZ AZÚA R. 1988. — Uso y aprovechamiento de la fauna en las zonas habitacionales exploradas en la antigua ciudad de Tula, Hgo. *Revista Mexicana de Estudios Antropológicos* 14 (1): 169-194.



- PARSONS J. R. 2008. — Beyond Santley and Rose (1979): the role of aquatic resources in the Prehispanic economy of the Basin of Mexico. *Journal of Anthropological Research*, 64 (3): 351-366. <http://www.jstor.org/stable/20371260>
- PARSONS J. R. 2005. — The aquatic component of Aztec subsistence: hunters, fishers, and collectors in an urbanized society. *Michigan Discussions in Anthropology* 15 (1): 49-89. <http://hdl.handle.net/2027/spo.0522508.0015.104>
- PARSONS J. R. & SUGIURA YAMAMOTO Y. 2012. — Teotihuacan and the Epiclassic in Central Mexico, in NICHOLS D. L. & POOL C. A. (eds), *The Oxford Handbook of Mesoamerican Archaeology*. Oxford University Press, Oxford: 309-323.
- PATTERSON B. D. 1987. — The principle of nested subsets and its implications for biological conservation. *Conservation Biology* 1 (4): 323-334.
- PATTERSON B. D. & ATMAR W. 1986. — Nested subsets and the structure of insular mammalian faunas and archipelagos. *Biological Journal of the Linnean Society* 28 (1-2): 65-82. <http://doi.org/10.1111/j.1095-8312.1986.tb01749.x>
- PEREIRA G. 1999. — Potrero de Guadalupe. Anthropologie d'une communauté pré-tarasque du nord du Michoacán, Mexique. *British Archaeological Reports International Series* 816.
- PEREIRA G. 2005. — The utilization of grooved human bones: a reanalysis of artificially modified human bones excavated by Carl Lumholtz at Zacapu, Michoacán, Mexico. *Latin American Antiquity* 16 (3): 293-312. <http://www.jstor.org/stable/30042495>
- PEREIRA G. 2008. — L'archéologie de la Mésoamérique septentrionale vue depuis le massif de Barajas (Guanajuato). *Les nouvelles de l'archéologie* (111-112): 101-106. <https://nda.revues.org/408> last consultation: 17/10/2016.
- PEREIRA G. 2010. — Arqueología de un lugar de pasaje hacia el inframundo. *TRACE* (58): 19-28.
- PIERCE C. 1992. — Effects of pocket gopher burrowing on archaeological deposits: a simulation approach. *Geoarchaeology* 7 (3): 185-208.
- POHL M. & POHL J. 1983. — Ancient Maya cave ritual. *Archaeology* 36 (3): 28-51.
- POLACO Ó. J. 2006. — La arqueofauna, in FAUGÈRE B. (ed.), *Cueva de los Portales. Un sitio arcaico del norte de Michoacán, México*. Centro de Estudios Mexicanos y Centroamericanos, México D.F.: 115-137. <http://doi.org/10.4000/books.cemca.1079>
- POLLARD H. P. 2004. — El imperio Tarasco en el mundo mesoamericano. *Relaciones. Estudios de historia y sociedad* 25 (99): 115-145.
- POLLARD H. P. 2008. — A model of the emergence of the Tarascan State. *Ancient Mesoamerica* 19 (2): 217-230. <http://doi.org/10.1017/S0956536108000369>
- RODRÍGUEZ GALICIA B., VALADEZ AZÚA R., PEREIRA G., VINIEGRA RODRÍGUEZ F., OLMOS RODRÍGUEZ K. & BLANCO PADILLA A. 2001. — Restos arqueozoológicos de perros (*Canis familiaris*) encontrados en el sitio de Guadalupe, Estado de Michoacán. *AMMVEPE* 12 (6): 199-209.
- RODRÍGUEZ-GIRONÉS M. A. & SANTAMARÍA L. 2006. — A new algorithm to calculate the nestedness temperature of presence-absence matrices. *Journal of Biogeography* 33 (5): 924-935. <http://doi.org/10.1111/j.1365-2699.2006.01444.x>
- ROJAS RABIELA T. 1985. — La cosecha del agua: pesca, caza y recolección de otros productos biológicos acuáticos de la cuenca de México. *Cuadernos de la Casa Chata* 116: 1-111.
- SAHAGUN B. DE 1938. — Historia general de las cosas de Nueva España. Editorial Pedro Robredo: México D.F.
- SANTOS-FITA D., NARANJO PIÑERA E. J., BELLO BALTAZAR E., ESTRADA LUGO E. I. J., MARIACA MÉNDEZ R. & MACARIO MENDOZA P. A. 2013. — La milpa comedero-trampa como una estrategia de cacería tradicional Maya. *Estudios de Cultura Maya* 42: 87-118. [http://doi.org/10.1016/S0185-2574\(13\)71387-X](http://doi.org/10.1016/S0185-2574(13)71387-X)
- SERRA M. C. & VALADEZ AZÚA R. 1986. — Aprovechamiento de los recursos lacustres en la cuenca de México: los patos. *Anales de antropología* 23 (1): 51-86.
- SMITH M. E. 2010. — *Proyecto: Calixtlahuaca: Organización de un Centro Urbano Posclásico. Informe Técnico Parcial*. INAH, México D. F. (Unpublished technical report).
- SMITH M. E. 2012. — *The Aztecs. Third edition*. Willey-Blackwell, Oxford, 256 p.
- SOMERVILLE A. D., FAUVELLE M. & FROEHLE A. W. 2013. — Applying new approaches to modeling diet and status: isotopic evidence for commoner resiliency and elite variability in the Classic Maya lowlands. *Journal of Archaeological Science* 40 (3): 1539-1553. <http://doi.org/10.1016/j.jas.2012.10.029>
- SPELLER C. F. & YANG D. Y. (in press). — Identifying the sex of archaeological turkey remains using ancient DNA techniques. *Journal of Archaeological Science: Reports*. Corrected proofs: <http://doi.org/10.1016/j.jasrep.2016.05.049>
- STEWART F. L. & STAHL P. W. 1977. — Cautionary note on edible meat poundage figures. *American Antiquity* 42 (2): 267-270.
- SUGIYAMA N., VALADEZ R., PÉREZ G., RODRÍGUEZ B. & TORRES F. 2013. — Animal management, preparation and sacrifice: reconstructing burial 6 at the Moon Pyramid, Teotihuacan, México. *Anthropozoologica* 48 (2): 467-485.
- SUGIYAMA N., SOMERVILLE A. D. & SCHOENINGER M. J. 2015. Stable isotopes and zooarchaeology at Teotihuacan, Mexico reveal earliest evidence of wild Carnivore management in Mesoamerica. PINHASI R. (ed.). *PLoS ONE* 10 (9): e0135635. <http://doi.org/10.1371/journal.pone.0135635>
- SZUTER C. R. 1991. — Hunting by Hohokam desert farmers. *Kiva* 56 (3): 277-291.
- THORNTON E. K. & EMERY K. F. 2015. — The uncertain origins of Mesoamerican turkey domestication. *Journal of Archaeological Method and Theory* December: 1-24. <http://doi.org/10.1007/s10816-015-9269-4>
- TORQUEMADA J. DE 1943. — *Monarquía indiana*. S. Chávez Hayhoe, México D. F.
- TRESSET A. & VIGNE J.-D. 2001. — La Chasse, principal élément structurant la diversité des faunes archéologiques du Néolithique ancien, en Europe tempérée et en Méditerranée: tentative d'interprétation fonctionnelle, in ARBOGAST R.-M., JEUNESSE C. & SCHIBLER J. (eds), *Rôle et statut de la chasse dans le Néolithique danubien*. Marie Leidorf, Leidorf: 129-151.
- VALADEZ AZÚA R. 1992. — *Impacto del recurso faunístico en la sociedad teotihuacana*. PhD thesis, Universidad Nacional Autónoma de México, México D.F.
- VALADEZ AZÚA R. 1993. — Macrofósiles faunísticos, in MANZANILLA L. (ed), *Anatomía de un conjunto residencial teotihuacano en Oztotlahualco*. Instituto Nacional de Antropología e Historia, México D.F.: 729-813.
- VALADEZ AZÚA R. 1994. — Religión y domesticación en Mesoamérica. *Veterinaria México* 25 (4): 303-308.
- VALADEZ AZÚA R. 2003a. — Domesticación y zootecnia en el México antiguo. *Imagen veterinaria* 4 (3): 32-45.
- VALADEZ AZÚA R. 2003b. — *La domesticación animal*. Second edition. Universidad Nacional Autónoma de México, México D.F., 148 p.
- VALADEZ AZÚA R. & RODRÍGUEZ GALICIA B. 2004. — *Fauna descubierta en el proyecto "Chupicuaro" (CEMCA). Informe técnico*. (Unpublished technical report).
- VALADEZ AZÚA R. & RODRÍGUEZ GALICIA B. 2014. — Uso de la fauna, estudios arqueozoológicos y tendencias alimentarias en culturas prehispánicas del centro de México. *Anales de antropología* 48 (1): 139-166. [http://doi.org/10.1016/S0185-1225\(14\)70493-X](http://doi.org/10.1016/S0185-1225(14)70493-X)
- WEIGAND P. C. 2000. — La antigua ecumene Mesoamericana: ¿un ejemplo de sobre-especialización? Relaciones. *Estudios de historia y sociedad* 31 (82): 41-58.
- WEIGAND P. C. 2010. — Las fronteras antiguas: una comparación social entre Mesoamérica y el Cercano Oriente. *Istor: revista de historia internacional* 43 (3): 44-62.
- WEST R. C. 1998. — Mesoamerican subsistence techniques. *Latin American Geography: Historical-Geographical Essays* 35: 77-101.

- WHITE C. D. 2005. — Gendered food behaviour among the Maya: time, place, status and ritual. *Journal of Social Archaeology* 5 (3): 356-382. <http://doi.org/10.1177/1469605305057572>
- WHITE T. E. 1953. — A method of calculating the dietary percentage of various food animals utilized by aboriginal peoples. *American Antiquity* 18 (4): 396-398. <http://www.jstor.org/stable/277116>
- WILLIAMS E. 2009. — The exploitation of aquatic resources at Lake Cuitzeo, Michoacán, Mexico: an ethnoarchaeological study. *Latin American Antiquity* 20 (4): 607-627. <http://www.jstor.org/stable/40650049>
- WITT K. E., JUDD K., KITCHEN A., GRIER C., KOHLER T. A., ORTMAN S. G., KEMP B. M. & MALHI R. S. 2015. — DNA analysis of ancient dogs of the Americas: identifying possible founding haplotypes and reconstructing population histories. *Journal of Human Evolution* 79: 105-118. <http://doi.org/10.1016/j.jhevol.2014.10.012>
- WOLVERTON S. 2012. — Data quality in zooarchaeological faunal identification. *Journal of Archaeological Method and Theory* 20 (3): 381-396. <http://doi.org/10.1007/s10816-012-9161-4>

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APPENDIX 1. — List of identified taxa per assemblage; count of number of identified specimens (NISP). Abbreviations: %NISP, percentage of the total NISP per site, in italics; (**precision**), precision of %NISP at a 5% threshold, between brackets and in italics; **Bar-Clas.**, Classic/Early Postclassic occupation of Barajas Massif; **Bar-PCR**, Late Postclassic occupation of Barajas Massif.

| Identified taxa                                                       | El Salitre | %NISP | (precision) | Calixtlahuaca | %NISP | (precision) | Tizayuca    | %NISP | (precision) | Mich.215   | %NISP | (precision) |
|-----------------------------------------------------------------------|------------|-------|-------------|---------------|-------|-------------|-------------|-------|-------------|------------|-------|-------------|
| Land crab (Gecarcinidae)                                              | 1          | 1.8   | (3.5)       |               |       |             |             |       |             |            |       |             |
| Bonny fish (Actinopterygii)                                           |            |       |             |               |       |             |             |       |             | 6          | 1.2   | (1.0)       |
| Anoura (Anoura)                                                       |            |       |             |               |       |             | 5           | 0.3   | (0.3)       | 192        | 38.7  | (4.3)       |
| <b>Testudines:</b>                                                    |            |       |             |               |       |             |             |       |             |            |       |             |
| Mud turtle ( <i>Kinosternon</i> sp. Spix, 1824)                       |            |       |             | 4             | 2.2   | (2.1)       | 4           | 0.3   | (0.2)       | 90         | 18.2  | (3.4)       |
| Other turtles (cf. <i>Trachemys</i> sp. /cf. <i>Rhinoclemmys</i> sp.) |            |       |             | 2             | 1.1   | (1.5)       | 22          | 1.4   | (0.6)       |            |       |             |
| Central American river turtle ( <i>Dermatemys mawii</i> Gray, 1847)   | 1          | 1.8   | (3.5)       |               |       |             | 6           | 0.4   | (0.3)       |            |       |             |
| Unidentified turtle                                                   | 1          | 1.8   | (3.5)       | 6             | 3.2   | (2.6)       | 19          | 1.2   | (0.5)       |            |       |             |
| <b>Aves:</b>                                                          |            |       |             |               |       |             |             |       |             |            |       |             |
| Duck/goose (Anatidae)                                                 |            |       |             |               |       |             | 13          | 0.8   | (0.4)       | 56         | 11.3  | (2.8)       |
| Turkey ( <i>Meleagris gallopavo</i> Linnaeus, 1758)                   |            |       |             | 26            | 14.1  | (5.0)       | 144         | 8.9   | (1.4)       |            |       |             |
| Grebe (Podicipedidae)                                                 |            |       |             |               |       |             |             |       |             | 7          | 1.4   | (1.0)       |
| Flamingo ( <i>Phoenicopterus</i> cf. <i>ruber</i> Linnaeus, 1758)     |            |       |             |               |       |             | 1           | 0.1   | (0.1)       |            |       |             |
| Coot/rail (Rallidae)                                                  |            |       |             |               |       |             |             |       |             | 3          | 0.6   | (0.7)       |
| Pigeon/dove (Columbidae)                                              |            |       |             |               |       |             |             |       |             |            |       |             |
| Turkey vulture ( <i>Cathartes aura</i> Linnaeus, 1758)                |            |       |             |               |       |             |             |       |             |            |       |             |
| Red-tailed hawk ( <i>Buteo jamaicensis</i> Gmelin, 1788)              |            |       |             | 1             | 0.4   | (1.1)       |             |       |             |            |       |             |
| American kestrel ( <i>Falco sparverius</i> Linnaeus, 1758)            |            |       |             |               |       |             |             |       |             |            |       |             |
| <b>Mammalia:</b>                                                      |            |       |             |               |       |             |             |       |             |            |       |             |
| Virginia opossum ( <i>Didelphis virginiana</i> Kerr, 1792)            |            |       |             | 1             | 0.4   | (1.1)       | 4           | 0.3   | (0.2)       |            |       |             |
| Long-nosed armadillo ( <i>Dasypus novemcinctus</i> Linnaeus, 1758)    |            |       |             | 1             | 0.4   | (1.1)       | 1           | 0.1   | (0.1)       |            |       |             |
| Squirrel (Sciuridae)                                                  |            |       |             |               |       |             | 37          | 2.3   | (0.7)       |            |       |             |
| Pocket gopher (Geomyidae)                                             |            |       |             |               |       |             | 80          | 4.9   | (1.1)       | 97         | 19.6  | (3.5)       |
| Hare ( <i>Lepus</i> sp. Linnaeus, 1758)                               | 7          | 12.7  | (8.8)       | 2             | 1.1   | (1.5)       | 110         | 6.8   | (1.2)       | 2          | 0.4   | (0.6)       |
| Cottontail ( <i>Sylvilagus</i> sp. Gray, 1867)                        | 3          | 5.5   | (6.0)       | 3             | 1.6   | (1.8)       | 94          | 5.8   | (1.1)       | 4          | 0.8   | (0.8)       |
| Unidentified lagomorph                                                | 2          | 3.6   | (5.0)       | 3             | 1.6   | (1.8)       | 67          | 4.1   | (0.1)       | 2          | 0.4   | (0.6)       |
| Cougar ( <i>Puma concolor</i> Linnaeus, 1771)                         | 1          | 1.8   | (3.5)       |               |       |             |             |       |             |            |       |             |
| Bobcat ( <i>Lynx rufus</i> Schreber, 1777)                            |            |       |             | 2             | 1.1   | (1.5)       |             |       |             |            |       |             |
| Medium-sized felid                                                    |            |       |             |               |       |             |             |       |             |            |       |             |
| Large-sized felid                                                     |            |       |             | 1             | 0.5   | (1.1)       |             |       |             |            |       |             |
| Dog ( <i>Canis familiaris</i> Linnaeus, 1758)                         | 10         | 18.2  | (10.2)      | 88            | 47.6  | (7.2)       | 877         | 53.9  | (2.4)       | 19         | 3.8   | (1.7)       |
| Coyote ( <i>Canis latrans</i> Say, 1823)                              |            |       |             |               |       |             |             |       |             |            |       |             |
| American badger ( <i>Taxidea taxus</i> Schreber, 1777)                |            |       |             |               |       |             |             |       |             |            |       |             |
| Long-tailed weasel ( <i>Mustela frenata</i> Lichtenstein, 1831)       |            |       |             | 2             | 1.1   | (1.5)       | 4           | 0.2   | (0.2)       | 1          | 0.2   | (0.4)       |
| Hooded skunk ( <i>Mephitis macroura</i> Lichtenstein, 1832)           |            |       |             |               |       |             | 1           | 0.1   | (0.1)       |            |       |             |
| Spotted skunk ( <i>Spilogale</i> sp. Grey, 1865)                      |            |       |             |               |       |             | 2           | 0.1   | (0.2)       |            |       |             |
| Procyonids (Procyonidae)                                              |            |       |             |               |       |             | 2           | 0.1   | (0.2)       |            |       |             |
| Raccoon ( <i>Procyon lotor</i> Linnaeus, 1758)                        |            |       |             |               |       |             |             |       |             |            |       |             |
| Collared peccary ( <i>Pecari tajacu</i> Linnaeus, 1758)               |            |       |             | 1             | 0.5   | (1.1)       |             |       |             |            |       |             |
| Mule deer ( <i>Odocoileus hemionus</i> Rafinesque, 1817)              |            |       |             |               |       |             | 2           | 0.1   | (0.2)       |            |       |             |
| White-tailed deer ( <i>Odocoileus virginianus</i> Zimmermann, 1780)   | 26         | 47.3  | (13.2)      | 23            | 12.4  | (4.8)       | 7           | 0.4   | (0.3)       |            |       |             |
| White-tailed/mule deer ( <i>Odocoileus</i> sp. Rafinesque, 1832)      |            |       |             |               |       |             | 42          | 2.6   | (0.8)       | 8          | 1.6   | (1.1)       |
| Bighorn sheep ( <i>Ovis canadensis</i> Shaw, 1804)                    |            |       |             |               |       |             | 4           | 0.3   | (0.2)       |            |       |             |
| Pronghorn ( <i>Antilocapra americana</i> Ord, 1815)                   |            |       |             |               |       |             |             |       |             |            |       |             |
| Unidentified artiodactyl                                              | 3          | 5.5   | (6.0)       | 19            | 10.3  | (4.4)       | 79          | 4.9   | (1.0)       | 9          | 1.8   | (1.2)       |
| <b>Total</b>                                                          | <b>55</b>  |       |             | <b>185</b>    |       |             | <b>1627</b> |       |             | <b>496</b> |       |             |



Appendix 1. — Continuation.

| Identified taxa                                                       | Mich.23   | %NISP | (precision) | UT1       | UT3        | UT5        | UT7       | Mich.31     | %NISP | (precision) | Bar-Clas  | %NISP | (precision) |
|-----------------------------------------------------------------------|-----------|-------|-------------|-----------|------------|------------|-----------|-------------|-------|-------------|-----------|-------|-------------|
| Land crab (Gecarcinidae)                                              |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Bonny fish (Actinopterygii)                                           | 1         | 1.0   | (2.0)       |           | 21         |            | 52        | 73          | 6.3   | (1.4)       |           |       |             |
| Anoura (Anoura)                                                       |           |       |             |           |            |            |           |             |       |             |           |       |             |
| <b>Testudines:</b>                                                    |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Mud turtle ( <i>Kinosternon</i> sp. Spix, 1824)                       | 5         | 5.1   | (4.4)       | 1         | 19         | 1          |           | 21          | 1.8   | (0.8)       |           |       |             |
| Other turtles (cf. <i>Trachemys</i> sp. /cf. <i>Rhinoclemmys</i> sp.) |           |       |             |           | 1          |            |           | 1           | 0.1   | (0.2)       |           |       |             |
| Central American river turtle ( <i>Dermatemys mawii</i> Gray, 1847)   |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Unidentified turtle                                                   |           |       |             |           |            |            |           |             |       |             |           |       |             |
| <b>Aves:</b>                                                          |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Duck/goose (Anatidae)                                                 |           |       |             |           | 12         | 1          |           | 13          | 1.1   | (0.6)       |           |       |             |
| Turkey ( <i>Meleagris gallopavo</i> Linnaeus, 1758)                   |           |       |             | 1         | 240        | 4          | 2         | 247         | 21.3  | (2.4)       |           |       |             |
| Grebe (Podicipedidae)                                                 |           |       |             |           | 7          |            |           | 7           | 0.6   | (0.5)       |           |       |             |
| Flamingo ( <i>Phoenicopterus</i> cf. <i>ruber</i> Linnaeus, 1758)     |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Coot/rail (Rallidae)                                                  |           |       |             |           | 16         |            |           | 16          | 1.4   | (0.7)       |           |       |             |
| Pigeon/dove (Columbidae)                                              |           |       |             |           | 2          |            |           | 2           | 0.2   | (0.2)       |           |       |             |
| Turkey vulture ( <i>Cathartes aura</i> Linnaeus, 1758)                |           |       |             |           |            | 51         | 1         | 52          | 4.5   | (1.2)       |           |       |             |
| Red-tailed hawk ( <i>Buteo jamaicensis</i> Gmelin, 1788)              |           |       |             |           |            |            |           |             |       |             |           |       |             |
| American kestrel ( <i>Falco sparverius</i> Linnaeus, 1758)            |           |       |             |           | 2          |            |           | 2           | 0.2   | (0.2)       |           |       |             |
| <b>Mammalia:</b>                                                      |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Virginia opossum ( <i>Didelphis virginiana</i> Kerr, 1792)            |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Long-nosed armadillo ( <i>Dasypus novemcinctus</i> Linnaeus, 1758)    |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Squirrel (Sciuridae)                                                  |           |       |             |           | 28         | 1          |           | 29          | 2.5   | (0.9)       | 1         | 5.9   | (11.2)      |
| Pocket gopher (Geomyidae)                                             | 11        | 11.2  | (6.3)       | 5         | 256        |            | 7         | 268         | 23.1  | (2.4)       | 1         | 5.9   | (11.2)      |
| Hare ( <i>Lepus</i> sp. Linnaeus, 1758)                               |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Cottontail ( <i>Sylvilagus</i> sp. Gray, 1867)                        | 33        | 33.7  | (9.4)       | 4         | 122        |            | 10        | 136         | 11.7  | (1.9)       | 2         | 11.8  | (15.3)      |
| Unidentified lagomorph                                                |           |       |             |           | 27         |            | 1         | 28          | 2.4   | (0.9)       |           |       |             |
| Cougar ( <i>Puma concolor</i> Linnaeus, 1771)                         |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Bobcat ( <i>Lynx rufus</i> Schreber, 1777)                            |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Medium-sized felid                                                    |           |       |             |           | 2          |            |           | 2           | 0.2   | (0.2)       |           |       |             |
| Large-sezed felid                                                     |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Dog ( <i>Canis familiaris</i> Linnaeus, 1758)                         | 9         | 9.2   | (5.7)       |           | 1          |            |           | 1           | 0.1   | (0.2)       | 6         | 35.3  | (22.7)      |
| Coyote ( <i>Canis latrans</i> Say, 1823)                              |           |       |             |           | 1          |            |           | 1           | 0.1   | (0.2)       |           |       |             |
| American badger ( <i>Taxidea taxus</i> Schreber, 1777)                |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Long-tailed weasel ( <i>Mustela frenata</i> Lichtenstein, 1831)       |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Hooded skunk ( <i>Mephitis macroura</i> Lichtenstein, 1832)           |           |       |             |           | 1          |            |           | 1           | 0.1   | (0.2)       |           |       |             |
| Spotted skunk ( <i>Spilogale</i> sp. Grey, 1865)                      |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Procyonids (Procyonidae)                                              |           |       |             |           |            | 1          |           | 1           | 0.1   | (0.2)       |           |       |             |
| Raccoon ( <i>Procyon lotor</i> Linnaeus, 1758)                        |           |       |             |           |            | 1          |           | 1           | 0.1   | (0.2)       |           |       |             |
| Collared peccary ( <i>Pecari tajacu</i> Linnaeus, 1758)               | 1         | 1.0   | (2.0)       |           |            |            |           |             |       |             | 1         | 5.9   | (11.2)      |
| Mule deer ( <i>Odocoileus hemionus</i> Rafinesque, 1817)              |           |       |             |           |            |            |           |             |       |             |           |       |             |
| White-tailed deer ( <i>Odocoileus virginianus</i> Zimmermann, 1780)   |           |       |             | 1         | 20         | 229        | 7         | 257         | 22.2  | (2.4)       | 2         | 11.8  | (15.3)      |
| White-tailed/mule deer ( <i>Odocoileus</i> sp. Rafinesque, 1832)      | 38        | 38.8  | (9.7)       |           |            |            |           |             |       |             |           |       |             |
| Bighorn sheep ( <i>Ovis canadensis</i> Shaw, 1804)                    |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Pronghorn ( <i>Antilocapra americana</i> Ord, 1815)                   |           |       |             |           |            |            |           |             |       |             |           |       |             |
| Unidentified artiodactyl                                              |           |       |             |           |            |            |           |             |       |             | 4         | 23.5  | (20.2)      |
| <b>Total</b>                                                          | <b>98</b> |       |             | <b>12</b> | <b>778</b> | <b>289</b> | <b>80</b> | <b>1159</b> |       |             | <b>17</b> |       |             |

## Appendix 1. — Continuation.

| Identified taxa                                                       | Bar-PCR   | %NISP | (precision) | JR74       | %NISP | (precision) | Angamuco  | %NISP | (precision) |
|-----------------------------------------------------------------------|-----------|-------|-------------|------------|-------|-------------|-----------|-------|-------------|
| Land crab (Gecarcinidae)                                              |           |       |             |            |       |             |           |       |             |
| Bonny fish (Actinopterygii)                                           |           |       |             | 5          | 2.0   | (1.7)       |           |       |             |
| Anoura (Anoura)                                                       |           |       |             |            |       |             |           |       |             |
| <b>Testudines:</b>                                                    |           |       |             |            |       |             |           |       |             |
| Mud turtle ( <i>Kinosternon</i> sp. Spix, 1824)                       | 1         | 1.7   | (3.3)       | 3          | 1.2   | (1.4)       | 2         | 13.3  | (17.2)      |
| Other turtles (cf. <i>Trachemys</i> sp. /cf. <i>Rhinoclemmys</i> sp.) |           |       |             |            |       |             |           |       |             |
| Central American river turtle ( <i>Dermatemys mawii</i> Gray, 1847)   |           |       |             |            |       |             |           |       |             |
| Unidentified turtle                                                   | 1         | 1.7   | (3.3)       | 2          | 0.8   | (1.1)       |           |       |             |
| <b>Aves:</b>                                                          |           |       |             |            |       |             |           |       |             |
| Duck/goose (Anatidae)                                                 |           |       |             |            |       |             |           |       |             |
| Turkey ( <i>Meleagris gallopavo</i> Linnaeus, 1758)                   |           |       |             | 4          | 1.6   | (1.6)       |           |       |             |
| Grebe (Podicipedidae)                                                 |           |       |             |            |       |             |           |       |             |
| Flamingo ( <i>Phoenicopterus</i> cf. <i>ruber</i> Linnaeus, 1758)     |           |       |             |            |       |             |           |       |             |
| Coot/rail (Rallidae)                                                  |           |       |             |            |       |             |           |       |             |
| Pigeon/dove (Columbidae)                                              |           |       |             |            |       |             |           |       |             |
| Turkey vulture ( <i>Cathartes aura</i> Linnaeus, 1758)                |           |       |             |            |       |             |           |       |             |
| Red-tailed hawk ( <i>Buteo jamaicensis</i> Gmelin, 1788)              |           |       |             |            |       |             |           |       |             |
| American kestrel ( <i>Falco sparverius</i> Linnaeus, 1758)            |           |       |             |            |       |             |           |       |             |
| <b>Mammalia:</b>                                                      |           |       |             |            |       |             |           |       |             |
| Virginia opossum ( <i>Didelphis virginiana</i> Kerr, 1792)            |           |       |             |            |       |             |           |       |             |
| Long-nosed armadillo ( <i>Dasypus novemcinctus</i> Linnaeus, 1758)    |           |       |             |            |       |             |           |       |             |
| Squirrel (Sciuridae)                                                  |           |       |             |            |       |             |           |       |             |
| Pocket gopher (Geomysidae)                                            |           |       |             | 11         | 4.4   | (2.6)       | 1         | 6.7   | (12.6)      |
| Hare ( <i>Lepus</i> sp. Linnaeus, 1758)                               |           |       |             | 6          | 2.4   | (1.9)       |           |       |             |
| Cottontail ( <i>Sylvilagus</i> sp. Gray, 1867)                        |           |       |             | 16         | 6.4   | (3.1)       |           |       |             |
| Unidentified lagomorph                                                |           |       |             | 5          | 2.0   | (1.7)       |           |       |             |
| Cougar ( <i>Puma concolor</i> Linnaeus, 1771)                         |           |       |             |            |       |             |           |       |             |
| Bobcat ( <i>Lynx rufus</i> Schreber, 1777)                            |           |       |             |            |       |             |           |       |             |
| Medium-sized felid                                                    | 1         | 1.7   | (3.3)       |            |       |             |           |       |             |
| Large-sized felid                                                     |           |       |             |            |       |             |           |       |             |
| Dog ( <i>Canis familiaris</i> Linnaeus, 1758)                         |           |       |             | 32         | 12.9  | (4.2)       |           |       |             |
| Coyote ( <i>Canis latrans</i> Say, 1823)                              |           |       |             |            |       |             | 1         | 6.7   | (12.6)      |
| American badger ( <i>Taxidea taxus</i> Schreber, 1777)                |           |       |             | 2          | 0.8   | (1.1)       |           |       |             |
| Long-tailed weasel ( <i>Mustela frenata</i> Lichtenstein, 1831)       |           |       |             |            |       |             |           |       |             |
| Hooded skunk ( <i>Mephitis macroura</i> Lichtenstein, 1832)           |           |       |             |            |       |             | 2         | 13.3  | (17.2)      |
| Spotted skunk ( <i>Spilogale</i> sp. Grey, 1865)                      |           |       |             |            |       |             |           |       |             |
| Procyonids (Procyonidae)                                              |           |       |             |            |       |             |           |       |             |
| Raccoon ( <i>Procyon lotor</i> Linnaeus, 1758)                        |           |       |             |            |       |             |           |       |             |
| Collared peccary ( <i>Pecari tajacu</i> Linnaeus, 1758)               | 1         | 1.7   | (3.3)       | 1          | 0.4   | (0.8)       |           |       |             |
| Mule deer ( <i>Odocoileus hemionus</i> Rafinesque, 1817)              |           |       |             |            |       |             |           |       |             |
| White-tailed deer ( <i>Odocoileus virginianus</i> Zimmermann, 1780)   | 52        | 88.1  | (8.3)       | 110        | 44.2  | (6.2)       | 9         | 60.0  | (24.8)      |
| White-tailed/mule deer ( <i>Odocoileus</i> sp. Rafinesque, 1832)      |           |       |             |            |       |             |           |       |             |
| Bighorn sheep ( <i>Ovis canadensis</i> Shaw, 1804)                    |           |       |             |            |       |             |           |       |             |
| Pronghorn ( <i>Antilocapra americana</i> Ord, 1815)                   |           |       |             | 1          | 0.4   | (0.8)       |           |       |             |
| Unidentified artiodactyl                                              | 3         | 5.1   | (5.6)       | 51         | 20.5  | (5.0)       |           |       |             |
| <b>Total</b>                                                          | <b>59</b> |       |             | <b>249</b> |       |             | <b>15</b> |       |             |