

Hunting, Husbandry, and Human-Environment Interactions in the Neolithic Lakeshore Sites of Western Switzerland

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The lakeshores of western Switzerland are one of Europe's best-known Neolithic settlement areas, thanks to dendrochronological dating and the exceptional preservation of organic materials. Against this outstanding background, this study uses zooarchaeological data to answer a series of questions regarding the Neolithic economy, environment and human-environment interactions at these lakeshore sites. It also discusses, within an interdisciplinary framework, the possible impact climatic fluctuations, cultural influence, topographical conditions, and demographic growth had on economic change. The results show that the faunal economy was mainly based on animal husbandry, with fluctuations in the cattle-pig ratio. Hunting also played an important role in the food system and focused mainly on large game, especially red deer, which contributed significantly to the meat supply. The results from comparing these animal bone remains also show that multiple factors, such as topography, climatic conditions, and cultural influence, played a part in the socio-economic organisation of the Neolithic communities. Exploratory procedures such as correspondence analysis support these interpretations.

Keywords: Neolithic, western Switzerland, lakeshore settlements, faunal remains, hunting, husbandry

INTRODUCTION

In recent years, numerous studies of animal bones from sites at the lakes of Bienne, Morat, Burgäschi, and Neuchâtel in Switzerland have greatly enriched our knowledge of the Neolithic period (Stampfli, 1980; Becker & Johansson, 1981; Glass & Schibler, 2000; Hafner & Suter, 2000; Stampfli et al., 2003; Chiquet, 2005; Reynaud Savioz, 2005; Schibler, 2006; Chiquet, 2012; Schibler, 2017). By summarizing and synthesizing these data, this article aims to investigate the subsistence practices of hunters and herders between 4000 and 2500 cal. BC.

The majority of the assemblages studied were from the lakes of Bienne and Neuchâtel but data from Lake Morat and Lake Burgäschi were also used. The sites, their dating, and dating methods are listed in Figure 1 and Table 1. The zooarchaeological results are based on hand-collected animal bones only, excluding fish, amphibians, reptiles, and the smallest mammals, given the lack of sieved soil samples at most sites. The exceptional quality of the preservation below the water table meant that the large mammal bones were recovered in a perfect state of conservation.

As Schibler (2006) remarks, marked fluctuations in the importance of game

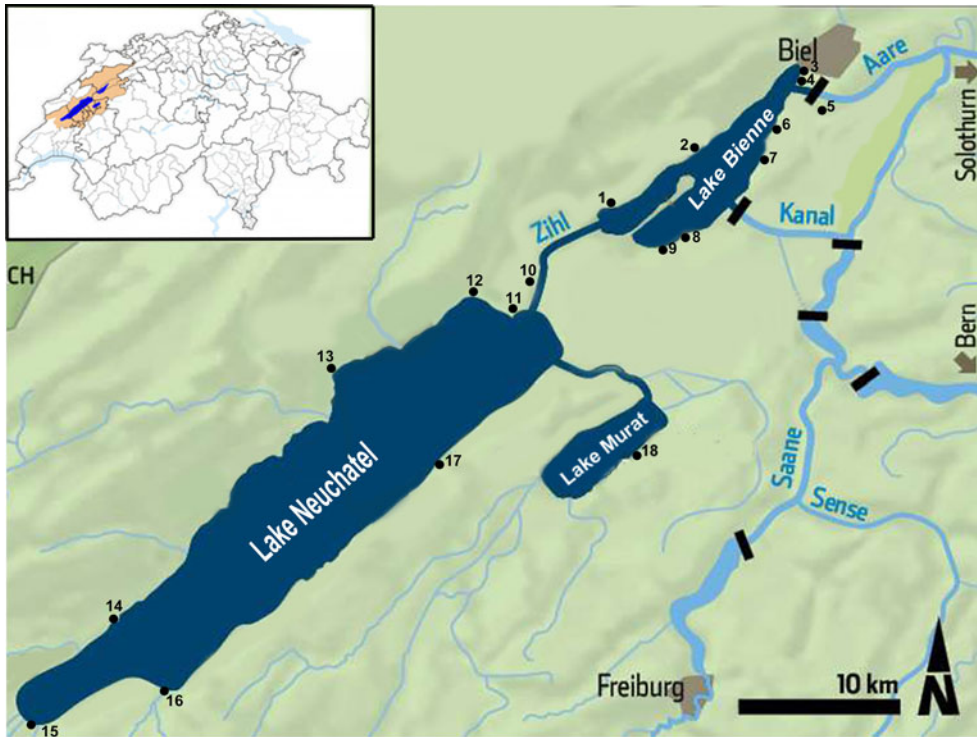


Figure 1. Distribution of Neolithic lakeshore sites in western Switzerland. 1: La Neuville; 2: Twann; 3: Port; 4: Nidau; 5: Port-Südeli; 6: Sutz-Rütte; 7: Sutz-Lattrigen; 8: Lüscherz; 9: Vinelz; 10: Thielle; 11: Marin les Piécettes; 12: Saint-Blaise; 13: Auvernier; 14: Concise; 15: Yverdon; 16: Yvonand; 17: Portalban; 18: Muntelier. Most of these sites comprise several settlement phases. For settlement phases and dating see [Table 1](#).

animals can be recognized throughout the Neolithic lake dwelling period. These fluctuations coincide with climatically induced economic crises, which, because of the threat of starvation, forced people to intensify hunting and gathering. On the other hand, Arbogast and Jeunesse (2013) point out that the different exploitation strategies of livestock and the integration of hunting into the meat supply coincided with the distributions of cultural groups as categorized by pottery styles and burial practices. It is assumed that cultural identities include both behaviour and food production.

In this study, the zooarchaeological data were compared chronologically, culturally, and geographically in order to find potential reasons for the differences in animal

husbandry and hunting practices, or in individual domestic or wild mammal species. The zooarchaeological evidence was also used to explore possible environmental, cultural, or social relations.

MATERIAL AND METHODS

The data discussed here come from 38 settlement layers located on both sides of Lake Biennet and 17 settlements on both sides of Lake Neuchâtel; they are complemented by two settlement layers each from Lake Morat and Lake Burgäschli (Figure 1). Among these 59 settlement layers, 49 have been dated precisely by dendrochronology. The others have been dated by

Table 1. List of waterlogged site and settlement phases at the lakes of Biemme, Neuchâtel, Morat, and Bürgäschli (sites references in Schibler et al. 1997).

Site	Dating method	Date BC
Lake Biemme		
Sutz-Lattrigen Hafen US	Dendrochronology	3834–3820
Twann E1 + 2	Dendrochronology	3838–3768
Twann E3	Dendrochronology	3702–3687
Port-Südéli US	Dendrochronology	3686–3638
Twann E4	Dendrochronology	3663–3658
Twann E5	Dendrochronology	3643–3631
Sutz-Lattrigen Hafen OS	Dendrochronology	3641–3631
Twann E5a	Dendrochronology	3622–3607
Sutz-Lattrigen VII Hauptstation Innen	Dendrochronology	3613–3566
Twann E6	Dendrochronology	3596–3573
Twann E7	Dendrochronology	3596–3573
Port-Südéli OS	Dendrochronology	3560
Twann E8	Dendrochronology	3563–3532
Twann E9	Dendrochronology	3563–3532
Nidau 5	Dendrochronology	3406–3398
Twann UH	Dendrochronology	3405–3391
Sutz-Lattrigen VI	Dendrochronology	3393–3388
Sutz-Lattrigen Aussen	Dendrochronology	3201–3147
Twann MH	Dendrochronology	3176–3166
La Neuville- Chavannes	Dendrochronology (?)	3171–3058 (?)
Lüscherz-Binggeli	Dendrochronology	3156–3122 (?)
St. Blaise Bains des Dames 9	Dendrochronology	3176–3112
Portalban Les Grèves	Dendrochronology	3171–3095
Twann OH	Dendrochronology	3093–3072
Nidau 3	Dendrochronology	2977–2958
Vinelz Grabung Strahm 1960	Dendrochronology	2853/2848/2833/2808
St. Blaise Bains des Dames 7	Dendrochronology	2797–2679
Lüscherz Fluhstation	Dendrochronology	c. 2736
Lüscherz Dorf, Äussere Station	Dendrochronology	2792–2709
Vinelz-Hafen	Dendrochronology	2774–2703
Sutz Rütte	Dendrochronology	2759–2746/2757–2754/2726–2689/2714–2696/2646–2627
Vinelz Alte Station NW	Dendrochronology	2735–2626 (?)
Lake Neuchâtel		
Yvonand III 1 + 2	Typology	Classic Cortaillod, c. 3800
Auvernier Port Vb–c	Dendrochronology	3791–3785
Thielle-Mottaz		3719–3699
Auvernier Port Va	Dendrochronology	3728–3679
Concise E2B	Dendrochronology	3692–3676
Concise E3B	Dendrochronology	3666–3656

Table 1. (Cont.)

Site	Dating method	Date BC
Concise E4A	Dendrochronology	3645–3636
Yverdon Garage Martin 18–20	Typo-stratigraphy	c. 3600
Yverdon Garage Martin 14–16b	Dendrochronology	3588–3581
Auvernier Port III	Dendrochronology	3627–3621/3560–3550
Concise E6	Dendrochronology	3533–3516
Marin les Piécettes	Dendrochronology/C14	3504–3483/3435
Yverdon Garage Martin 11–12	Typology	2800–2750
Yvonand IV	Dendrochronology	2784–2740
Auvernier Brise-Lames	Dendrochronology	2792–2778/2767/2756–2750/2740–2701
Thielle Wavre, Pont-de-Thielle	Dendrochronology	2701 (3750–3700)
Auvernier La Saunerie	Dendrochronology	2606–2440
St. Blaise Bains des Dames Auv.	Dendrochronology/ stratigraphy	2550–2500
St. Blaise Bains des Dames E	Dendrochronology/ stratigraphy	2550–2500
St. Blaise Bains des Dames F	Dendrochronology/ stratigraphy	2550–2500
St. Blaise Bains des Dames G	Dendrochronology/ stratigraphy	2550–2500
St. Blaise Bains des Dames H	Dendrochronology/ stratigraphy	2550–2500
Lake Morat		
Muntelier-Strandweg		3851–3837
Muntelier-Fischergässli	Dendrochronology	3842–3819
Lake Burgäschli		
Burgäschisee SW	Dendrochronology	3760–3748
Burgäschisee Süd	Dendrochronology	3760–3748

radiocarbon or typological methods (Table 1). The settlements are all fairly evenly distributed between the Middle Neolithic (4000–3400 cal BC, (30 instances) and the Late Neolithic (3400–2500 cal BC (29 instances), but data from the twenty-seventh century, the twenty-ninth to the thirty-first, or the thirty-third to the thirty-fifth centuries cal BC are rare or even missing (Table 1). In total, 59 settlement layers from 34 sites are included in the database, which contains a total of about 189,000 identifiable animal bones (Figure 1 and Table 1).

The comparison between the assemblages was based on the number of identified specimens (NISP, bone fragments). Although

NISP has some disadvantages when comparing quantities of bones between large assemblages, because it can lead to overestimating the number of individuals, especially when the bones are highly fragmented (Marshall & Pilgram, 1993), it was not a concern for this study.

To investigate the economic aspect of food in more detail, factorial correspondence analysis was used to include and compare the importance of the different animal species in one diagram (Vaillé, 2011). This multivariate statistical approach made it possible to investigate the underlying structure of the dataset and to describe the most significant trends in the animal economy.

In order to describe the diversity of mammals exploited at the different sites, nine variables were retained: cattle (*Bos taurus*), pigs (*Sus domesticus*), dogs (*Canis familiaris*), aurochs (*Bos primigenius*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), and the species groups sheep (*Ovis aries*)/goat (*Capra hircus*) and ‘various wild species’, the latter primarily containing various carnivores, as well as beaver, hare, or even moose.

RESULTS

Husbandry and domestic animal meat

One of the most obvious aspects of the faunal spectra was the high frequency of domestic animal remains (Figure 2). In the Neolithic sites around Lake Bièvre, husbandry mostly contributed to the supply of meat: more than two thirds of the settlements contained over 70 per cent of domestic animal remains (Figure 3). This feature especially concerns the husbandry of cattle and pigs, as the meat of these two domestic species was the most frequently consumed (Figure 4). The frequency of bones from domestic animals fluctuates remarkably during the time of the Cortaillod culture (3900–3400 cal. BC), between 28 and 76 per cent. During the period of the Horgen and Lüscherz cultures (3400–2800 cal. BC), the proportion of domestic animals is high, comprising over 75 per cent of the identified bone material. And during the timespan of the Auvèrnier culture, the importance of domestic animals reached its highest level (e.g. 80 per cent at Vinèlz-Alte Station). Compared to the Lake Bièvre region, the proportion of domestic animals was slightly lower in the Lake Neuchâtel basin (Figure 5): in most assemblages the percentage varied between 50 and 70 per cent.

From 4000 cal. BC to 3400 cal. BC, cattle were the dominant domestic species

exploited in Neolithic lake dwellings in western Switzerland (Figure 4). The proportion of cattle bones is greater than that of any other domestic species at the beginning of the fourth millennium, with more than half of all the remains being those of cattle at most sites on both lakes. At the beginning of the thirty-fourth century, the proportion of cattle bones decreases in favour of pig bones. Smaller proportions of cattle bones and higher proportions of pig bones are therefore typical in the second half of the fourth millennium and the first half of the third millennium BC. This trend is common to sites on both lakes. The ratio of cattle bones in both lake settlements is also quite similar, confirming that this was a chronological trend and not a reflection of geographical and topographical differences between the two regions (Figure 4). On the other hand, when finds’ densities (number of bones per m²) from sites near Lake Zurich are considered, no decrease in cattle bones during this period can be seen (Schibler, 2017).

Between the thirty-ninth and the thirty-fourth centuries BC, pig bones make up less than one third of all domestic animal bones (Figure 4), except at the settlement of Concise E4A dated to the thirty-seventh century BC. From the beginning of the Horgen culture at Lake Bièvre (c. 3400 cal. BC), a significantly higher proportion of pig bones can be recognized (Schibler, 2006; 2017): pig bones account for 80 per cent of the domestic animal remains. In contrast, during the same period at Lake Neuchâtel, the importance of pig bones is much lower, averaging around 40–50 per cent (Figure 6). With the beginning of the third millennium, pigs decrease again in favour of cattle.

During the Cortaillod culture (until the thirty-fourth century BC), sheep and goats are represented in stable proportions of up to 20 per cent at most sites. From the beginning of the third millennium, the

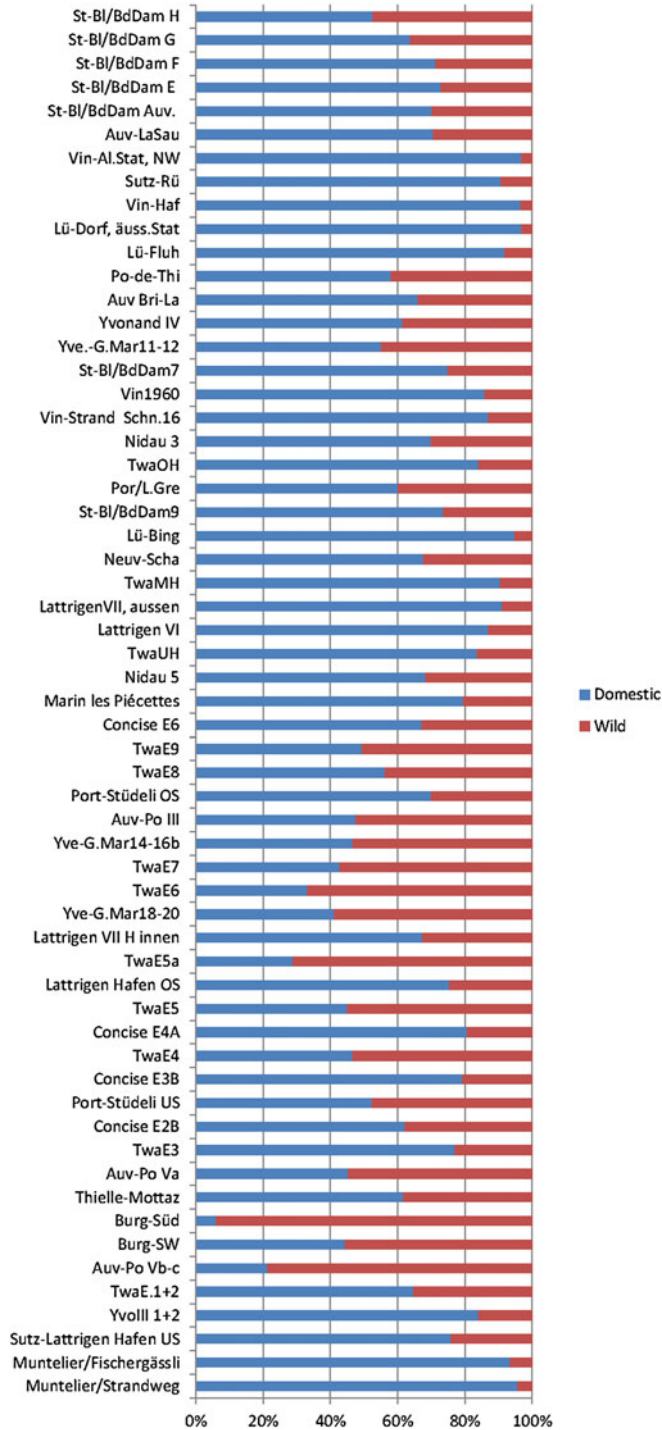


Figure 2. Importance of domestic and wild animals according to the number of bone fragments in Neolithic western Switzerland (100% = domestic and wild animals).

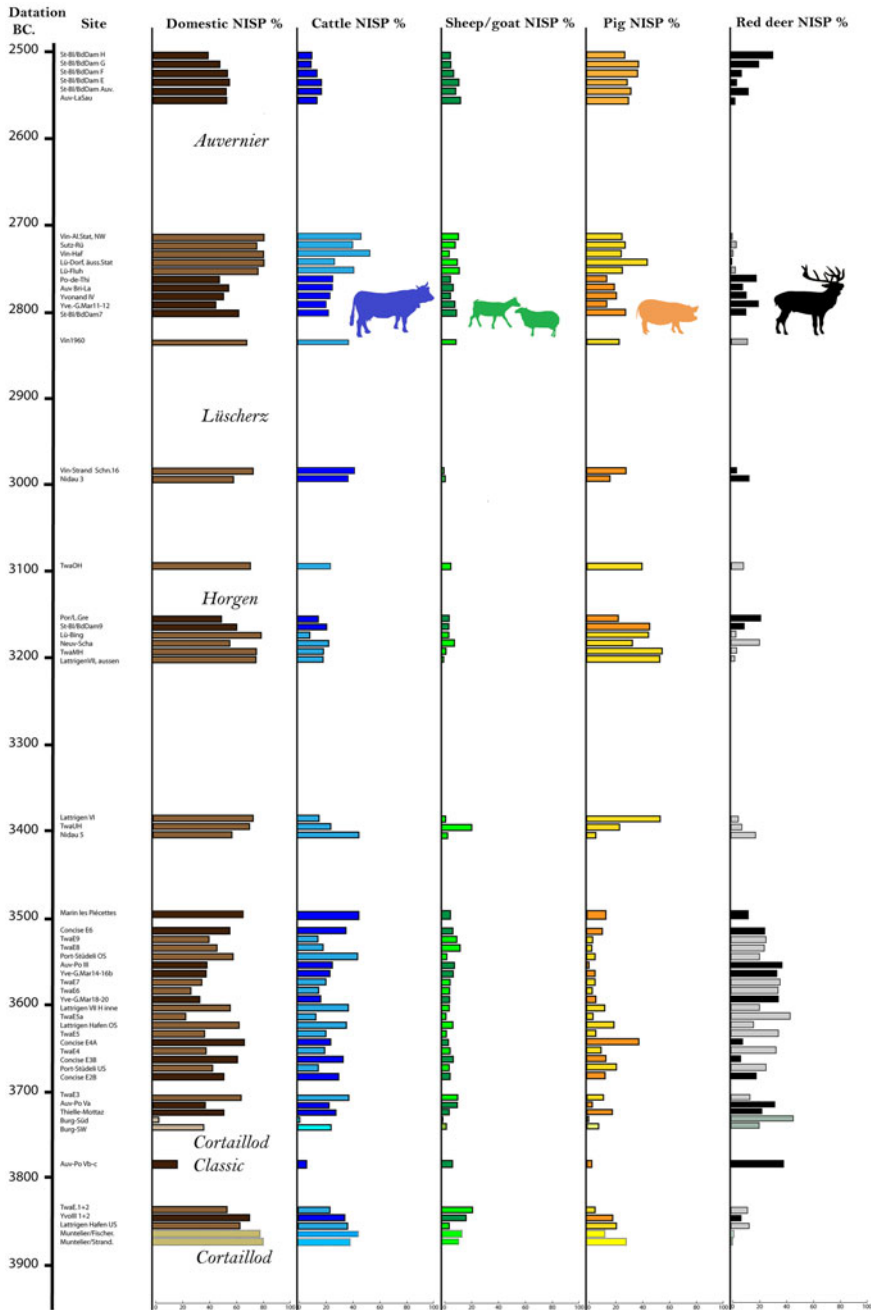


Figure 3. Importance of cattle, pigs, sheep/goats, and red deer at Neolithic lakeshore sites in western Switzerland (shown in their cultural sequence), according to percentages based on fragment numbers (100% = domestic and wild animals). Dark shading represents sites on Lake Neuchâtel, light shading represents sites on Lake Bièvre; the two sites on Lake Morat and the two sites on Lake Burgäschli are marked by even lighter shading.

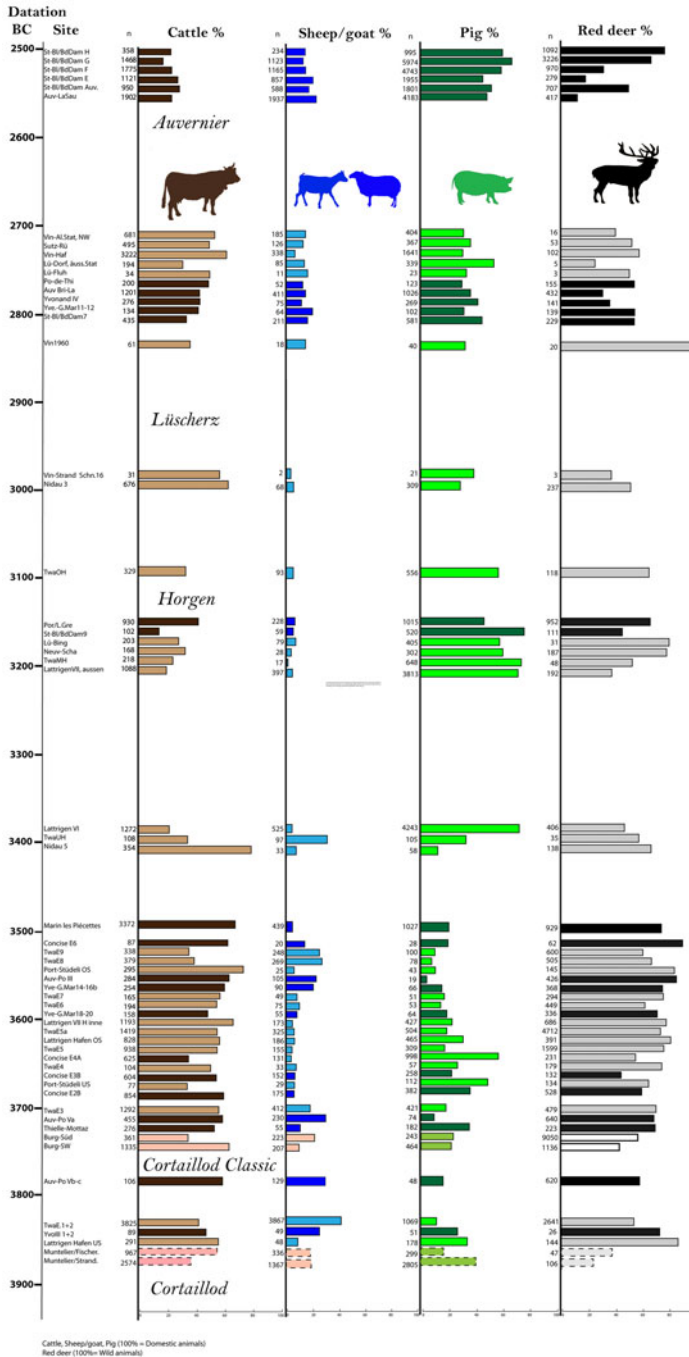


Figure 4. Importance of domestic animals based on the number of bone fragments at Neolithic lakeshore sites in western Switzerland, shown in their cultural sequence: cattle, sheep/goats, and pigs (100% = domestic animals); red deer (100% = wild animals). Dark shading represents sites on Lake Neuchâtel, light shading represents sites on Lake Bienn; the two sites on Lake Morat and the two sites on Lake Burgäschli are marked by even lighter shading.

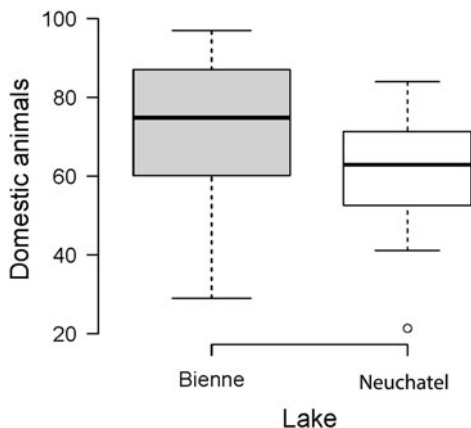


Figure 5. Mean value of the importance (% of fragment numbers) of domestic animal remains at Lake Bienne and Lake Neuchâtel.

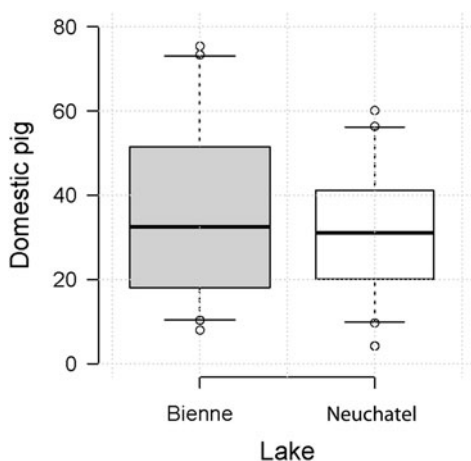


Figure 6. Mean value of the importance (% of fragment numbers) of domestic pig remains at Lake Bienne and Lake Neuchâtel.

importance of sheep and goat increased again (Figures 2 and 3).

Hunting and wild animal meat

Wild mammal remains were recovered on all the sites studied, but their importance fluctuates strongly between 2 and 95 per cent (Figure 3). The percentage of wild

mammals makes up to one third of the identified bones at the beginning of the thirty-ninth century BC on sites around Lake Bienne (Stampfli, 1980; Becker & Johansson, 1981; Glass & Schibler, 2000). Red deer was the dominant species (Figure 4), with aurochs, roe deer, and wild boar being of minor importance. During the thirty-seventh and thirty-sixth centuries BC, the percentage of wild mammal bones increased abruptly by up to two thirds of the assemblage. In the Late and Final Neolithic, the proportion of wild animals decreased again to 5–20 per cent of the identified bones (Kerdy, *in prep.*; Brombacher & Marti-Grädel, 1999; Schibler, 2006, 2017).

The sites around Lake Neuchâtel gave different results. Higher percentages of wild animals are present on most sites from the beginning of the thirty-eighth century until the twenty-fifth century cal. BC, with an especially high proportion of red deer bones on these sites in those centuries. Other wild animals, mainly carnivores, i.e. foxes and wolves, but also beavers and hares have been identified, but only in small numbers. Some cut marks found on these carnivore bone remains indicate that their meat was also eaten, even if they were primarily killed for their skins and fur (Chiquet, 2012).

Food economy: a multiplicity of factors

To concentrate more fully on the meat economy as a whole (rather than just on a single species) and to further explore the economic aspects of food, this study examined the results of correspondence analysis. The information shown by the first two axes on Figure 7 reaches almost 63 per cent, which is a high score indeed.

The sites on axis 1 are distributed in chronological order. The Middle Neolithic sites (red to pink symbols) are positioned on the right half of the diagram, while more

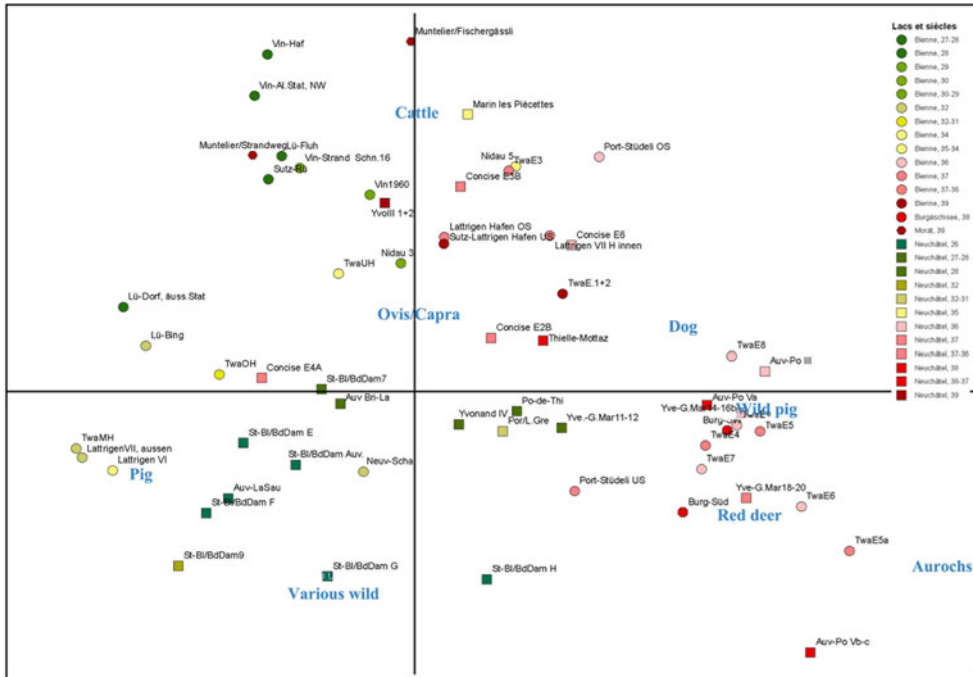


Figure 7. Correspondence analysis of the faunal composition at lakeshore sites located in western Switzerland (Biene, Neuchâtel, Morat, and Burgäschli). See text for an explanation of the symbols.

recent sites (yellow to green symbols) are on the left.

Looking at the animal species, axis 1 is dominated by two variables, i.e. pigs (left side) and red deer (right side); the two animal species account for more than 82 per cent of the contributions. In addition, red deer is associated with two other wild species that also provide high amounts of meat: wild boar and aurochs.

Axis 2 seems to have some geographical significance. A dichotomy between sites located around Lake Biene (circles: mostly upper part) and sites located on Lake Neuchâtel (squares: mostly bottom part) can be recognized.

Regarding the species, wild animals can be found in the lower part of axis 2, where only one domestic species can be recognized: the domestic pig.

The Lake Biene sites (circles) show a much stronger correlation with husbandry

(axis 2), especially with cattle remains, which alone make up 59 per cent of the contribution.

For wild animals, the correspondence analysis shows two aspects: first, wild animals are more frequently associated with earlier sites that are dated to the first half of the fourth millennium BC; second, more wild animals, especially red deer, are observed on sites on the northern shores of the lakes of Biene and Neuchâtel. Red deer and wild boar are the most hunted animals across all sites.

DISCUSSION

The ratio between the number of domestic and wild animal bones fluctuates considerably during the fourth and the first half of the third millennium, with a remarkable increase in wild animal proportions during

specific phases of intensified hunting (Figure 3). It appears that in some periods farmers had to rely on wild resources to cover their routine demand for meat, specifically during the thirty-seventh and thirty-sixth centuries BC. In these periods, a concentration of large animal species, such as red deer, can be seen, as is the case in the Zurich region (Schibler & Jacomet, 2010). This phenomenon could be a sign of economically driven hunting, whose only goal was to ‘produce’ as much meat as possible during periods when other foodstuffs (e.g. cereals) were rare (Schibler, 2017).

Hunting wild animals was part of the exploitation strategy integrated into the economy of the lake settlements, and it offered people a valuable source of meat during periods of food shortages. This remarkable relationship—between the intensity of hunting and short-term climatic fluctuations—has been demonstrated for the Neolithic lakeshore settlements in the Zurich region (Schibler *et al.*, 1997; Hüster-Plogmann *et al.*, 1999). Short-term climatic deterioration may have been responsible for agricultural catastrophes which could have caused crop failures. Strong evidence for the highly specialized, economically stimulated hunting of large-sized mammals has been noticed at several lake sites already. The higher the quantity of wild animal remains found, the lower the diversity of wild animal species is observed in favour of larger species (Schibler & Jacomet, 2010). Furthermore, at the lakes in western Switzerland, hunters focused on species that offered the highest possible meat yield, that is, mainly red deer but also wild boar and aurochs (Figure 3).

Later, during the second half of the fourth millennium, the proportion of wild animal remains decreases significantly. This decline could have two reasons: first, an increase in some plant food species that are more tolerant of bad weather conditions

(Brombacher & Jacomet, 2003), and second, an increase in pig keeping, from the thirty-fourth century BC onwards, which greatly increased meat production. This chronological replacement of hunting large wild animal species by intensive husbandry of domestic pigs is also convincingly supported by the result of the correspondence analysis. It shows a strong dichotomy between wild animals and domestic pigs on the first axis with a solid chronological correlation between a greater frequency of hunting at older settlements of the first half of the fourth millennium BC and a higher importance of pigs at more recent sites of the second half of the fourth and third millennium BC (Figure 7). A comparison between the importance of wild animal bones and cultural boundaries shows clearly that there was no relationship, which signifies that the importance of hunting is not culturally determined (Schibler, 2006: fig. 2).

From the middle of the fourth millennium BC onwards, an increase in the proportions of domestic animals can be seen. After the fluctuation in the share of wild/domestic animals in the Cortaillod period, the proportion of domestic animals in the Late Neolithic is visibly higher. However, not only does the ratio of wild to domestic animals fluctuate, but so do the proportions of different domestic species. The share of cattle bones is greater than that of other species in the Middle Neolithic (Figure 4: 4000–3400 cal. BC). Cattle proportions are constantly high at the beginning of the fourth millennium at all the lakeshore sites studied. It seems that not only were Neolithic cattle used as producers of meat but also as draught animals and for providing milk. The fatty acids from cow’s milk discovered on pottery sherds suggest that cow’s milk was being systematically used from at least 3400 cal. BC onwards (Spangenberg, 2004; Spangenberg *et al.*, 2006; Schibler, 2006).

A significant increase in pig bones from 3400 cal. BC onwards was also detected. Pigs, being highly reproductive and having large litters, are perfect animals for the production of meat; therefore, larger quantities of meat can be produced in a relatively shorter time than is needed for cattle (Serjeantson, 2011). Moreover, the decision to exploit more pigs among the available domestic resources may also have resulted from the discovery that rearing pigs is the only form of farming that requires little space or additional fodder; pigs can be kept on fallow land and fed with household refuse, or they can be let loose in the forest to browse and then attracted back to the village, using fodder, when their meat is needed (Schibler & Schäfer, 2017). Additionally, keeping pigs was not only a source of protein, but also a way of tilling the arable farmland, as pigs have an instinct for rooting in the ground (Schibler et al., 1997). While pigs were of particular importance for bulk manure, other livestock, mainly cattle, goats, and sheep only made a complementary contribution to intensive cultivation (Bogaard, 2012). Cattle, goats, and especially pigs also contributed to the clearance of forest vegetation and weeds on arable land, and they deposited manure through penning on arable land (Bogaard, 2012). Therefore, pigs proved tremendously adaptable and enabled households to have a 'refuse compactor' which converted domestic waste, forest products, and field remains into meat (Bogucki, 1993). The importance of pig keeping, therefore, may have been because it was the only practicable solution for producing more meat without greater effort. The existing arable farmland and the marshy/sparsely-wooded floodplain around the settlements could all have been used as pastures for pigs (Schibler et al., 1997; Pétrequin et al., 1998; Hüster Plogmann et al., 1999; Serjeantson, 2011).

Furthermore, intensive pig keeping made it possible to replace the hunting of large wild ungulates (red deer, wild boar, and aurochs). This shift from hunting wild ungulates to pig husbandry was developed in eastern Switzerland during the time of the Pfyn culture between 3800 and 3400 cal. BC and was adapted in western Switzerland during the Horgen culture in a very short time (in the thirty-fourth century), as the settlements at Lake Biemme and in Concise (Lake Neuchâtel) demonstrate (Chiquet, 2012; Schibler, 2017). This change obviously allowed better control of available protein resources. This growing interest in pig husbandry has been recorded in other regions, such as the French Jura region, and it reflects a more supra-regional or even cultural tendency (Arbogast et al., 2006; Arbogast, 2008; Schibler, 2006; Kerdy *in prep.*).

Sheep and goat proportions fluctuated less strongly than those of cattle and pig. A high proportion of sheep and goats was typical in the early settlements of the fourth millennium, as at Twann and Auvèrner Port and some sites of the Jura lakes (Arbogast, 2008). Later, smaller proportions of sheep and goats (less than 25 per cent) remain stable until the Late Neolithic. During the final period of the Neolithic, the slightly higher importance of sheep (and goats) was possibly due to the exploitation of wool. This impression is supported by the fact that larger animals and older slaughter ages can be recognized, at least in the Zurich region (Hüster-Plogmann & Schibler, 1997), and by the first evidence of bone and antler needles and buttons at Corded Ware and Auvèrner sites (Schibler et al., 1997b; Schibler, 2017).

Dog bones were found on all lakeshore sites in Switzerland. Usually the percentage lies between 1 and 10 per cent of the domestic animal remains. Yet, by looking at the proportion of dog remains, significant

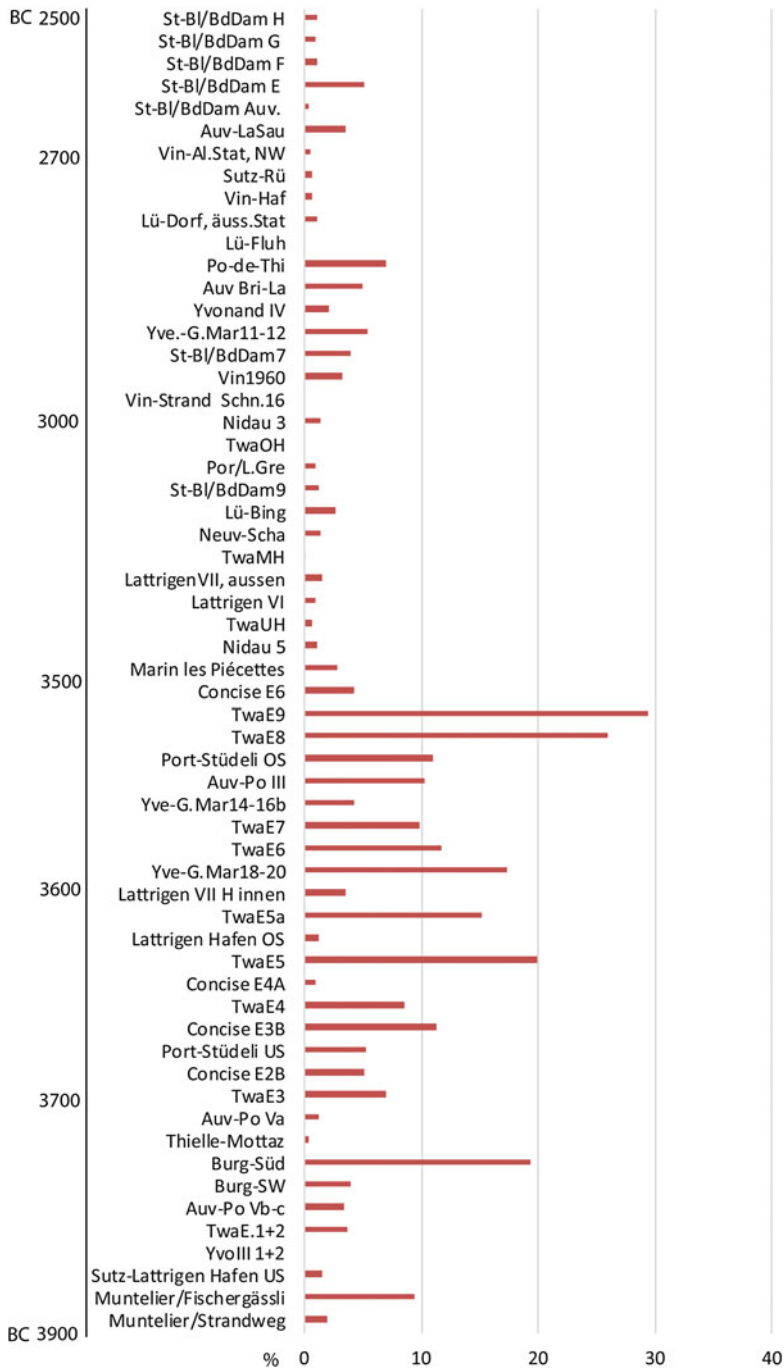


Figure 8. The importance of dogs (*Canis familiaris L.*) at Neolithic lakeshore sites in western Switzerland according to percentages based on fragment numbers (100% = domestic animals).

increases in dog bones were noticed in the western Swiss sites dated to between 3700 and 3500 cal. BC (Figure 8). However, if all Neolithic lakeshore sites in Switzerland are considered, no correlation between the proportion of dog remains and wild animal bones can be observed (Schibler, 2006).

Higher frequencies of dog bones with cut marks in the period between 3700 and 3400 cal. BC and the young age of the dogs could indicate that dogs were used as additional meat sources during periods of food crises (e.g. starvation). Based on the tooth-wear classification of Habermehl (1975), 43 per cent of the dogs in the upper layer at Sutz-Lattrigen Hafen were killed just after their first year. At the site of Concise, E2B, half of the dogs were killed before they had even reached 6 months (Chiquet, 2012). These results indicate that dog meat was an additional source of food during periods of economic problems. This scenario is observed at sites around Lake Zurich, e.g. at Opera Parkhouse, layer 13 (Schibler & Schäfer, 2017). In both regions, i.e. western Switzerland (end of the second half of the fourth millennium BC) and eastern Switzerland (first half of the third millennium BC), the increase in dog bone proportions, as well as pendants made from dog metapodials and canine teeth (Schibler, 1981; Deschler-Erb et al., 2002), indicate that special relations existed between dogs and humans.

As stated above, farmers in western Switzerland faced many challenges to meet their daily food demands. These challenges could be caused by natural factors (e.g. weather conditions); however, topographical situations or cultural tradition could also have been factors that influenced the Neolithic economy. At sites like Twann or Auvernier, located on the steeper northern slopes of the lakes of Bienne and Neuchâtel, hunting was

important. On the southern side of the lakes, i.e. the flatter southern shore, different results were obtained, with lower proportions of wild species and higher proportions of domestic animal remains. The steep northern shores of the lakes obviously influenced the strategies of the farmers, restricting the intensity of husbandry and agriculture. Farming, especially cattle and pig husbandry, on steep slopes is much more challenging and would have made this region less favourable for domestic animals. On the other hand, the inhabitants were surrounded by wider areas of forests which offered an increased range of hunting opportunities. Farmers on the steeper northern lakeside were also more influenced by climatic conditions, which could have reduced their already restricted productivity of cultivated plants. Conversely, the undulating southern shore was an ideal place for farming and offered better possibilities for cultivation (Marti-Grädel & Stopp, 1997; Kerdy, in prep.).

CONCLUSION

This review has brought together zooarchaeological data from Neolithic settlements established on the shores of two large (Neuchâtel, Bienne) and two small (Morat, Burgäschisee) lakes in western Switzerland. The results illustrate profound changes in the subsistence strategies used by the communities that lived in this region between the thirty-ninth and the twenty-sixth centuries cal. BC.

The archaeological data point to a period of economic crisis in the thirty-seventh and thirty-sixth centuries cal. BC, which could have been caused by climatic deterioration. The resulting decrease in available crops forced the farmers to intensify their exploitation of wild resources. However, when hunting did take place, it generally targeted the most abundant and meat-rich animals

such as the red deer. Wild plant gathering also intensified markedly.

During periods of favourable conditions, the animal economy of the Neolithic farmers was mostly based on keeping domestic animals. Cattle were the most common animals in the first half of the fourth millennium. The economic importance of domestic pig starts to increase from the beginning of the thirty-fourth century cal. BC, replacing the meat supply previously provided by hunted wild ungulates. Neolithic farmers probably intensified pig husbandry because pigs were more easily fed with household refuse, or by browsing the harvested fields or the adjacent forest. In addition, keeping cattle, sheep, goats, and pigs on harvested fields provides manure to fertilize the land. Sheep and goats were kept more frequently during two periods: the beginning of the fourth millennium cal. BC and the beginning of the third millennium cal. BC. In the earlier period, meat and milk are the most plausible reason for this increased frequency; during the later period, the earliest evidence of the use of wool is the most likely explanation. Increased frequencies of dog bones, correlated with cut marks and the preferred slaughter age at one year old, make it probable that dogs were also a source of meat during periods of economic crisis in the first half of the fourth millennium cal. BC.

In conclusion, the economy of the lake-shore sites in western Switzerland was influenced by many sub-regional trends and local factors. Short climatic fluctuations correlate well with the varying importance of hunting. The significant factor influencing the relative importance of domestic animal species is the topographical location of the sites (steep or lower hills). Obviously, environmental, topographic, and material cultural factors were responsible for the complex system that created the faunal composition at

each individual settlement. To fully understand this system, further investigations in neighbouring regions are necessary. The evidence of contact and even displacement across the Jura Mountains during the Neolithic period offers the possibility of new research perspectives on these fundamental issues (see Burri, 2007; Chiquet, 2012, Burri-Wyser et al., 2015; Pétrequin et al., 2015; Schibler, 2017).

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Chasse, élevage et interactions entre hommes et environnement dans les sites littoraux des lacs de Suisse occidentale

Les sites littoraux suisses sont parmi les sites néolithiques les mieux connus d'Europe grâce à la dendrochronologie et du fait de l'excellent état de conservation des matériaux organiques. Dans le cadre de cet article, nous aurons recours à ces données hors du commun afin de répondre à une série de questions concernant l'économie néolithique, l'environnement et les interactions homme-milieu. Il s'agit de discuter, dans une perspective interdisciplinaire, de la possible incidence des fluctuations climatiques, des affinités culturelles, des conditions topographiques et de la croissance démographique sur les changements économiques qui s'observent dans la région des lacs de Suisse occidentale. L'économie animale de ces communautés repose principalement sur l'élevage, avec toutefois des variations dans le rapport bœuf/porc. La chasse joue également un rôle important dans le système alimentaire. Elle se concentre en particulier sur le grand gibier, notamment le cerf qui contribue de façon non négligeable à l'approvisionnement carné. Une comparaison des résultats obtenus à partir des restes de faune montre que de multiples facteurs, que ce soit la topographie, les conditions climatiques ou l'ancrage culturel, ont joué un rôle dans l'organisation socio-économique de ces communautés néolithiques. Des procédures exploratoires comme l'analyse des correspondances corroborent ces interprétations.

Mots-clés: Néolithique, Suisse occidentale, sites littoraux, restes de faune, la chasse, l'élevage

Jagd, Tierhaltung und Mensch-Umwelt Interaktionen in neolithischen Seeufersiedlungen der Westschweiz

Die Seeufersiedlungen in der Westschweiz sind dank der möglichen dendrochronologischen Datierungen sowie aussergewöhnlichen Erhaltung von organischen Resten eines der bekanntesten neolithischen Siedlungsgebiete Europas. Anhand von archäozoologischen Daten kann eine Reihe von Fragen zur neolithischen Wirtschaft, Umwelt und zu Mensch-Umwelt-Interaktionen an diesen Seeufern beantwortet werden. Darüber hinaus werden in einem interdisziplinären Rahmen mögliche Auswirkungen von Klimaschwankungen, kulturellem Einfluss, topografischen Bedingungen und demografischem Wachstum auf den wirtschaftlichen Wandel diskutiert. Die Ergebnisse zeigen, dass Faunenwirtschaft, mit Schwankungen im Rinder-Schweine-Verhältnis, hauptsächlich auf der Tierhaltung basierte. Die Jagd spielte im Nahrungssystem ebenfalls eine wichtige Rolle und konzentrierte sich hauptsächlich auf grosse Tiere, insbesondere den Hirsch, der wesentlich zur Fleischversorgung beitrug. Darüber hinaus lässt sich zeigen, dass mehrere Faktoren, wie Topografie, klimatische Bedingungen und kultureller Einfluss, eine Rolle in der sozioökonomischen Organisation der neolithischen Dörfer spielten. Explorative Verfahren wie die Korrespondenzanalyse unterstützen diese Interpretationen.

Stichworte: Neolithikum, Westschweiz, Seeufersiedlungen, Faunenreste, Jagd, Tierhaltung