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Human Impact on the Habitat of Large Herbivores in Eastern Switzerland and Southwest Germany in the Neolithic

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ABSTRACT: The Neolithic lake shore settlements in Switzerland and Southern Germany offer excellent conditions for the preservation of various organic matter. Based on dendrochronological dating the economic and ecological changes in the Alpine foreland may be traced within a precise chronological framework. Using typological and radiocarbon data this chronological framework could be extended to the adjacent settlement areas with terrestrial sites providing additional archaeobiological evidence.

The archaeobiological analysis shows that during the Neolithic occupation of the lake shores (4300-2500 BC), the originally dense forest was gradually opened up by the exploitation by people, at least in the wider area around the settlements, and a more open mixed deciduous woodland increasingly developed. Consequently, the anthropogenic influence in the immediate and more distant areas around the settlements ought to have had a positive effect on the living conditions of large herbivores.

Despite this, the bones of wild cattle (*Bos primigenius*, *Bison bonasus*) and elk (*Alces alces*) are clearly found less regularly and in lower frequencies after 3300 BC than between 4300 and 3500 BC. Besides the settlers' great need for wood, the fodder demands for their stock also had a great impact on the environment. The on site-botanical investigations point to an intensive use of all the natural areas of grassland, as well as the herb-rich undergrowth of deciduous and wet woodlands, as pastoral land for cattle. But these were exactly the sort of locations that would have been the preferred pastures of wild cattle. This food competition certainly intensified by the increasing importance of cattle keeping together with hunting resulted in decreasing population densities of large wild herbivores within the Neolithic and the following periods.

Red deer obviously adapted to the changing ecological situation and remained the most important hunted species throughout the Neolithic period. The intensification in red deer hunting during the second half of the 37th century BC eventually led to the killing of increasing proportions of not yet fully grown deer. During a longer-lasting period of more intensive hunting (>80 years) this could have become a danger for the red deer population. In extreme cases we could be looking at the total extinction of local red deer populations. Technologically and culturally this had far-reaching consequences, since a heavily used raw material (antler) would then no longer be available. Evidence for such a decline in raw material has been found in a few settlements known today from the 35th to 33rd centuries BC (early Horgen culture) in the eastern part of Switzerland.

Between 4000 BC and 3500 BC substantial amounts of horse remains occur in the Neolithic bone assemblages from the Alpine foreland and the adjacent areas in the north. These bone finds are considered to represent small wild populations living in natural areas of grassland (e.g. flood-plains and bogs). According to the available biometric evidence the two contemporary populations have similar body proportions, but the northern one is caracterized by a slightly higher body mass. This difference may reflect the Early and Middle Neolithic human impact probably improving the living conditions of the wild horses in this area.

KEYWORDS: NEOLITHIC, SWITZERLAND, GERMANY, HUMAN IMPACT, LARGE HERBIVORES

RESUMEN: Los yacimientos lacustres neolíticos de Suiza y Alemania meridional exhiben excelentes condiciones de conservación de las diferentes materias orgánicas. Basándonos en dataciones dendrocronológicas, los cambios económicos y ecológicos en las tierras prealpinas

pueden rastrearse dentro de un marco cronológico preciso. Con el uso de dataciones tipológicas y radiocarbónicas, tal marco cronológico podría ampliarse a las áreas de asentamiento adyacentes con yacimientos terrestres que proporcionan evidencia arqueobiológica adicional.

El análisis arqueobiológico evidencia que, durante la ocupación neolítica (4300-2500 a.C.) de las márgenes lacustres, el originalmente denso bosque se clareó gradualmente como consecuencia de su explotación por parte del hombre, cuando menos en zonas amplias alrededor de los asentamientos, de tal suerte que se fue desarrollando un bosque deciduo mixto más abierto. En consecuencia la influencia antrópica sobre las áreas más inmediatas y distantes alrededor de los asentamientos hubo de haber influido de manera positiva en las condiciones vitales de los grandes herbívoros.

A pesar de esto, los huesos de grandes bóvidos (*Bos primigenius, Bison bonasus*) y el alce (*Alces alces*) se encuentran de modo menos regular y en frecuencias más bajas después del 3300 a.C. que entre el 4300 y el 3500 a.C. Además de las grandes necesidades de madera por parte del hombre, los requisitos de pasto de sus ganados tuvieron también gran impacto sobre el ambiente. Las investigaciones botánicas locales evidencian un uso intenso de todas las zonas de praderas naturales así como del sotobosque rico en herbáceas de los bosques deciduos y húmedos como tierras de pasto para el vacuno. Eran éstas precisamente las zonas de pasto preferente de los grandes rumiantes silvestres. Esta competencia por el pasto ciertamente se intensificó como consecuencia de la creciente importancia del vacuno doméstico simultaneado con la caza lo cual resultó en decrecientes densidades de población de los grandes herbívoros silvestres a lo largo del Neolítico y periodos posteriores.

El ciervo se adaptó a las cambiantes condiciones ecológicas y permaneció como la especie cinegética más relevante a lo largo de todo el Neolítico. La intensificación de la caza del venado a lo largo de la segunda mitad del siglo XXXVII a.C. eventualmente condujo a la caza de cada vez mayores proporciones de ciervos subadultos. De haberse mantenido un periodo más dilatado (> de 80 años) de esta caza tan intensiva se podría haber llegado a un colapso de las poblaciones de ciervos. En casos extremos estaríamos incluso atestiguando la extinción completa de poblaciones locales de ciervo. Tecnológica y culturalmente, este hecho tendría enormes consecuencias en la medida en que una de las materias primas de mayor utilización (el asta) no estaría ya disponible. La evidencia del declinar del asta se ha detectado en unos pocos yacimientos de la cultura Horgen inicial (siglos XXXV-XXXIII a.C.) en la zona oriental de Suiza.

Entre el 4000-3500 a.C. aparecen cantidades sustanciales de restos de caballo en las asociaciones óseas neolíticas de las tierras prealpinas y de áreas adyacentes hacia el norte. Se considera que estos hallazgos representan pequeñas poblaciones silvestres que subsisten en zonas de pradera natural (por ejemplo, llanuras aluviales y pantanosas). De acuerdo con los datos biométricos disponibles las dos poblaciones contemporáneas presentan similares proporciones corporales, si bien la septentrional viene caracterizada por una masa corporal ligeramente superior. Esta diferencia podría reflejar el impacto humano durante el Neolítico inicial y medio que habría mejorado las condiciones de subsistencia de los caballos silvestres en toda esta área.

PALABRAS CLAVE: NEOLÍTICO, SUIZA, ALEMANIA, IMPACTO HUMANO, MEGA-HERBÍVOROS

INTRODUCTION

The Neolithic settlements of the Northern Alpine Foreland provide outstanding archaeological preconditions for the study of the economic and ecological significance of individual domestic and wild animal species. For one thing, the density of Neolithic lakeside settlements is extraordinarily high. During the last 25 years, in conjunction with the construction of the motorway and urban building activities, partly continuous areas of the shores of the Alpine Foreland lakes could be intensively investigated archaeologically. In addition, the excellent preservational conditions have provided a very comprehensive insight into the living conditions of the various settlers. Because the cultural layers were located below the ground water level, the remains of the lakeside settlements have produced extremely well preserved organic find assemblages. As a general rule, both the animal bones and the plant remains, mostly in uncarbonized state, have remained well preserved over the millennia. Besides food remains such as seeds and fruits, the numerous wooden construction ele-

ments of the houses that have been recovered are of particular value. With the help of dendrochronology the settlements can be dated with relative accuracy.

In combination with typological comparisons and ^{14}C data this chronological framework could be extended to the settlement areas bordering the region to the north. This provides an indispensable prerequisite for the supra-regional comparison of archaeobiological results (Table 1 and Figure 1).

THE ECOLOGICAL BACKGROUND

Pollen-analytical investigations in off-site situations indicate that throughout the entire research period the Northern Alpine Foreland was heavily wooded, based on the very low amount of non-arboreal pollen recorded (Richoz & Haas, 1995; Rösch, 1990; Liese-Kleiber, 1995). If however, we look at the results of botanical analyses of macrofossils from all settlement levels (on-site), a more complex picture emerges (Jacomet *et al.*, 1989; Brombacher & Jacomet, 1997; Rösch, 1990; Maier, 1990; Maier, 1995). During the "*Jungneolithikum*" time period (4300–3400 BC) there is only evidence for small, naturally open areas and small arable fields. Towards the end of the Lake Shore Neolithic in particular, the indicators of open locations increase significantly.

In the "Jungneolithikum" (4300–3400 BC) the seeds and fruits of plants which grow in woods and in woodland edge communities, or in clearings (coppiced areas) (such as *Moehringia trinervia*, *Ajuga reptans*, *Clinopodium vulgare*, *Agrimonia eupatoria*) regularly appear in cereal stores. They make it clear that the arable fields were small and surrounded by woodland; but as annual species were also present, we can assume that these areas were permanently open. In the later period of the Lake Shore Neolithic, between 3400 and 2500 BC, the plants named above appear more infrequently, and instead many more (mainly winter) annual weeds (such as *Lathyrus* and *Vicia* species) can be

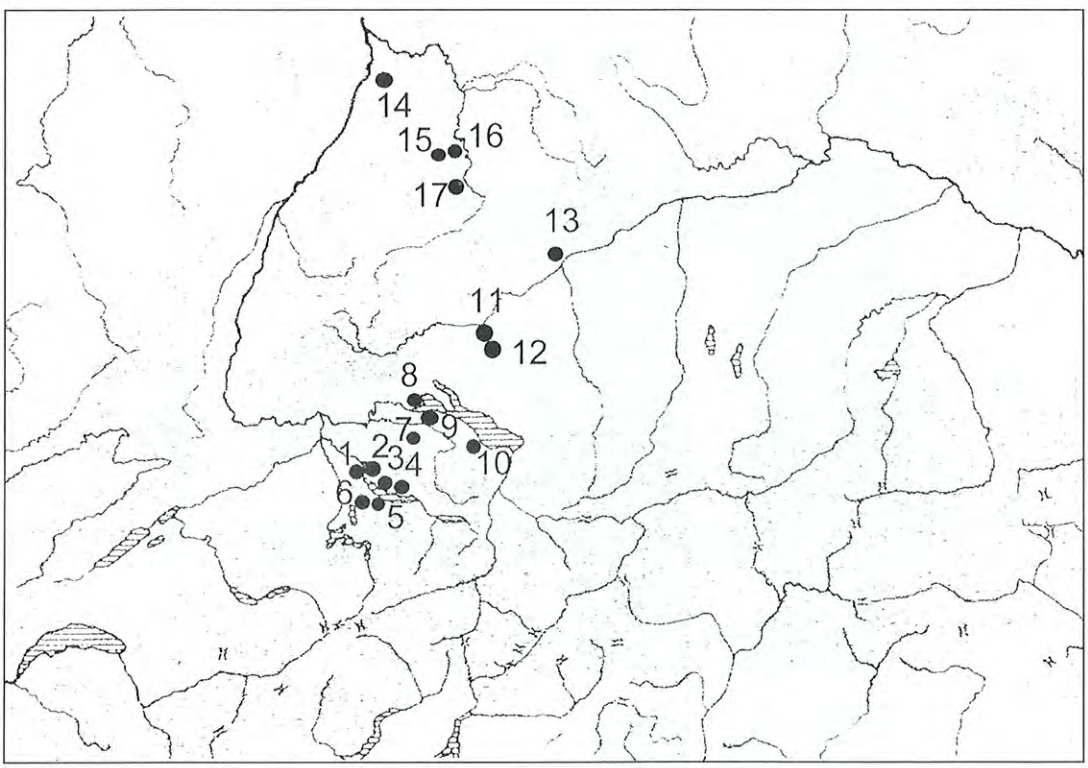

FIGURE 1
Location of the Neolithic sites in Eastern Switzerland and Southwest Germany.

Time BCcal	Nr.	Eastern Switzerland		Nr.	Southwestern Germany	
		Sites	References		Sites	References
2500						
	1	Zürich Mythenschloss 2.1	Hüster-Plogmann/Schibler 1997			
	2	Zürich Mozartstrasse 2 oben	Hüster-Plogmann/Schibler 1997			
2600	2	Zürich Mozartstrasse 2 unten	Hüster-Plogmann/Schibler 1997			
	1	Zürich Mythenschloss 2.2-3	Hüster-Plogmann/Schibler 1997			
	2	Zürich Seefeld Kan.San. A	Hüster-Plogmann/Schibler 1997			
	1	Zürich Mythenschloss 2.4	Hüster-Plogmann/Schibler 1997			
	2	Zürich Seefeld Kan.San. C/B	Hüster-Plogmann/Schibler 1997			
	2	Zürich Seefeld Kan.San. D	Hüster-Plogmann/Schibler 1997			
2700	2	Zürich Pressehaus C2	Hüster-Plogmann/Schibler 1997			
	2	Zürich Seefeld Kan.San. E	Hüster-Plogmann/Schibler 1997			
	2	Zürich Seefeld Kan.San. F	Hüster-Plogmann/Schibler 1997			
2800	2	Zürich Kleiner Hafner 2A-D	Schibler 1987			
2900						
3000	4	Meilen Rohrenhaab 2	Sakellaridis 1979			
	3	Feldmeilen Vorderfeld 1x	Schibler/Veszeli 1998			
	3	Feldmeilen Vorderfeld 1y	Schibler/Veszeli 1998			
	2	Zürich Pressehaus E	Hüster-Plogmann/Schibler 1997			
	2	Zürich Seefeld Kan.San. 2	Hüster-Plogmann/Schibler 1997			
	2	Zürich Mozartstrasse 3 oben	Hüster-Plogmann/Schibler 1997			
3100	2	Zürich Mozartstrasse 3 allg.	Hüster-Plogmann/Schibler 1997			
	2	Zürich Mozartstrasse 3 unten	Hüster-Plogmann/Schibler 1997			
	1	Zürich Mythenschloss 3	Hüster-Plogmann/Schibler 1997			
	3	Feldmeilen Vorderfeld 1	Schibler/Veszeli 1998			
	2	Zürich Pressehaus G	Hüster-Plogmann/Schibler 1997			
	2	Zürich Seefeld Kan.San. 3	Hüster-Plogmann/Schibler 1997			
3200	2	Zürich Kleiner Hafner 3A+B	Schibler 1987			
	2	Zürich Seefeld Kan.San. 4	Hüster-Plogmann/Schibler 1997			
	3	Feldmeilen Vorderfeld 3	Schibler/Veszeli 1998			
3300						
	3	Feldmeilen Vorderfeld 4	Schibler/Veszeli 1998			
3400	10	Arbon Bleiche	Markert 1985a			
3500						
	6	Zug Vorstadt total	Rehazek/Schibler unp.			
	9	Steckborn Schanz	Markert 1985b			
	2	Zürich Seefeld Kan.San. 5	Hüster-Plogmann/Schibler 1997			
3600	2	Zürich Mozartstrasse 4 oben	Hüster-Plogmann/Schibler 1997			
	2	Zürich Mozartstrasse 4 mitte	Hüster-Plogmann/Schibler 1997			
	2	Zürich Mozartstrasse 4 unten	Hüster-Plogmann/Schibler 1997			
	4	Meilen Rohrenhaab 3	Sakellaridis 1979			
	5	Horgen Dampfschiffsteg	Sakellaridis 1979			
	4	Meilen Rohrenhaab 4/4a	Sakellaridis 1979			
	7	Gachnang Niederwil	Clason 1991			
	2	Zürich Seefeld Kan.San. 6	Hüster-Plogmann/Schibler 1997			
	2	Zürich AKAD/Pressehaus J	Hüster-Plogmann/Schibler 1997			
	2	Zürich Seefeld Kan.San. 7	Hüster-Plogmann/Schibler 1997			
3700	2	Zürich Seefeld Kan.San. 8	Hüster-Plogmann/Schibler 1997	11	Oedenahlen	Kokabi 1995
	3	Feldmeilen Vorderfeld 5	Schibler/Veszeli 1998			
	3	Feldmeilen Vorderfeld 6	Schibler/Veszeli 1998	12	Reute-Schorrenried	Kokabi 1990
	3	Feldmeilen Vorderfeld 7	Schibler/Veszeli 1998	14	Bruchsal-Scheelkopf	Steppan 1998
	3	Feldmeilen Vorderfeld 8	Schibler/Veszeli 1998	14	Bruchsal-Aue II	Steppan 1998
	3	Feldmeilen Vorderfeld 9	Schibler/Veszeli 1998			
	2	Zürich Pressehaus L	Hüster-Plogmann/Schibler 1997			
	2	Zürich Seefeld Kan.San. 9	Hüster-Plogmann/Schibler 1997			
3800	2	Zürich Kleiner Hafner 4G	Schibler 1987			
	2	Zürich Mozartstrasse 5 oben	Hüster-Plogmann/Schibler 1997	8	Wangen-Hinterhorn	Kokabi 1990
	2	Zürich Mozartstrasse 5 unten	Hüster-Plogmann/Schibler 1997			
	2	Zürich Kleiner Hafner 4F	Schibler 1987			
	4	Meilen Rohrenhaab 5	Sakellaridis 1979			
	9	Steckborn Turgi	Markert 1985c			
3900	2	Zürich Kleiner Hafner 4E	Schibler 1987	8	Hornstaad Hörnle IA	Kokabi 1990
	2	Zürich Mozartstrasse 6 oben	Hüster-Plogmann/Schibler 1997			
	2	Zürich Kleiner Hafner 4D	Schibler 1987	13	Ehrenstein	Scheck 1977
	2	Zürich Mozartstrasse 6 unten	Hüster-Plogmann/Schibler 1997			
4000				14	Bruchsal-Aue I	Steppan 1998
4100	2	Zürich Kleiner Hafner 4C	Schibler 1987	16	Ludwigsburg-Schlösslesfeld	Nobis 1977
	2	Zürich Kleiner Hafner 4B	Schibler 1987			
4200	2	Zürich Kleiner Hafner 4A	Schibler 1987	15	Hochdorf	Makovicz-Poliszot 1988
4300	2	Zürich Kleiner Hafner 5A+B	Schibler 1987	17	Aldingen	Kokabi 1988

no assemblages

TABLE 1
List of settlements in Eastern Switzerland and Southwest Germany yielding archaeozoological assemblages.

found in the cereal stores. These facts are an indication of the greater extent of cleared, cultivated areas; moreover, it is is now evident that these areas were kept open permanently. In this later period, after 3400 BC, it also appears from layer samples that there were woodland edges and hedgerows great in extent. Evidence for this is provided, for example, by sloe (*Prunus spinosa*), which is encountered more frequently in macrorest samples. Treading-resistant indicators of pasture, which suggest grazing of fallow fields, also occur more frequently, and were to some extent also found in storage samples - a sign that they grew on the arable fields (e.g. *Prunella vulgaris*, *Plantago major*, *Potentilla reptans*). Indications of pastoral woodland, too, become clearer - species such as *Calluna vulgaris*, *Juniperus* and *Ilex aquifolium* in particular are now encountered more frequently in the pollen spectra of the sites. These changes in the species spectrum can readily be interpreted as a sign that the landscape was becoming more open, and that the settlements were surrounded by larger arable fields, light woodland pastures, and managed woodland.

The wild animal fauna also confirms a general opening-up of the landscape: among the birds (Figure 2) there is in the later period of the Neolithic (3400-2400 BC) an increase in species which prefer open landscape as their habitat (e.g. beangoose, partridge, crow species), while the mean ubiquities of species which are mostly at home in dense woodland is higher by far in the older period of the "Jungneolithikum" (e.g. black kite, woodcock, jay).

The shy badger is one of the mammals that can be classified as a classic woodland animal. It is clear that badger occurs more frequently and in greater quantities in the settlement layers from before 3600 BC than in the younger levels (Figure 3). Conversely, we find significantly higher proportions of fox and brown hare in the youngest settlements of the "*Schnurkeramik*" (Corded Ware) period, from about 2800 BC (Figure 3). Both species need structured woodland landscapes and open fields as an ecological requirement for stable population density.

On the basis of the botanical and zoological parameters available to us, we can, in summary, ascertain that the landscape in the Alpine foreland changed fundamentally during the course of the Neolithic. At least in the area around the Neolithic farming villages, the dense woodland of the "Jungneolithikum" (4300-3400 BC) gave way to a structured, open landscape in the "Spät- und Endneolithikum" (3400-2500 BC).

In the northern part of the study area the archaeobiological evidence from a total of ten sites is sparse and limited to the period of the "Jungneolithikum". Due to the specific preservational conditions of the settlements situated in loess covered regions the animal bones are often well preserved. Unfortunately, the botanical remains consist primarily of carbonized cereal stores providing very little information about the surrounding landscape (Stika, 1996).

Here, high proportions of brown hare already occur in the late fifth millennium pointing to structured woodland and open fields. The dense and continous Neolithic settlement of this region since the middle of the 6th millenium BC probably resulted in a likely opening up of the landscape.

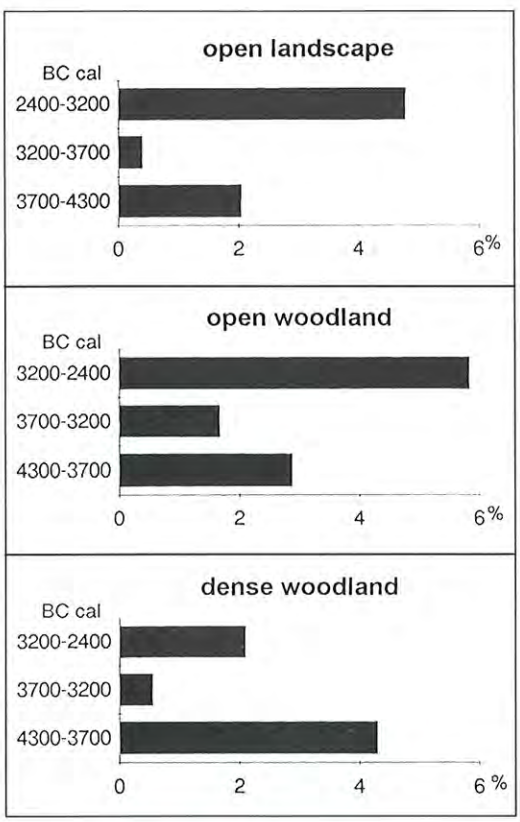

FIGURE 2
Ubiquities of bird taxa from different habitats in the Neolithic settlements of Eastern Switzerland (ecological classification see Schibler/Hüster-Plogmann 1995, Abb. 33). 4300 - 3700 BC, 100%: 28 settlements; 3700 - 3200 BC, 100%: 36 settlements; 3200 - 2400 BC, 100%: 48 settlements.

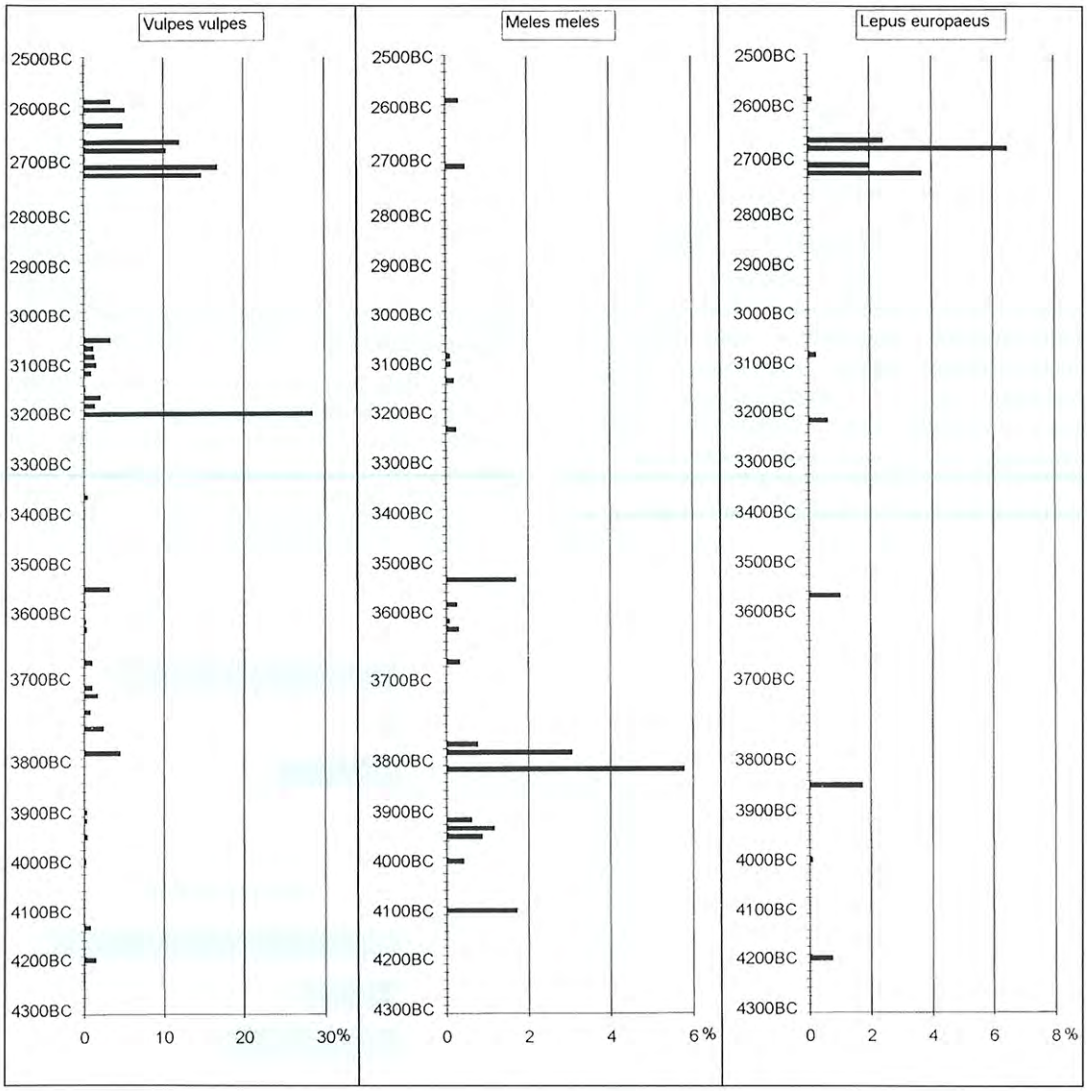

FIGURE 3
Bone frequencies (100%: wild animal bones) of red fox (*Vulpes vulpes*), badger (*Meles meles*) and brown hare (*Lepus europaeus*) in the Neolithic settlements of Eastern Switzerland.

THE ECONOMIC BACKGROUND

Archaeobotanical and archaeozoological investigations in Neolithic lakeside settlements – in particular on the lake Zurich - have provided deep insights into the economic systems of early farming villages on the Swiss Plateau. On the basis of model-calculations (Gross *et al.*, 1990) as well as calculations of find concentrations we can assume that the greatest part of the calories required had to be provided by plants. In addition, the concentration of bone finds points to relatively small herds of domestic animals in the period between 4300 and 3300 BC (Hüster-Plogmann & Schibler, 1997; Schibler, 1997). It was not until 3300 BC that there was an intensification in pig rearing, which was followed from about 2800 BC by significantly larger herds of ruminants, which included cattle, sheep and goats. That cattle herding in particular was not practised more intensively until the end of

the Lake Shore Neolithic, probably has to do with the provision of fodder for the animals: before the 3rd millennium there were no large areas of pasture, aside from river meadows and the areas along the lake shores. The provision of fodder for domestic ruminants was based in the summer months on woodland pasture in the wider area around the settlements, while in late summer and autumn the fallow fields were presumably grazed. In winter the animals most likely had to be fed on leaf-fodder, which was time-consuming to procure (Schibler *et al.*, 1997a). All in all, it becomes clear that the provision of fodder was the most important limiting factor in the prehistoric cattle economy, influencing the size of the herds.

Under these conditions, the scarce natural grassland habitats must surely have been valuable sources of fodder, as they provided very nutritious cattle feed. Natural grass and herb meadows consisted above all of flood and pioneer grasslands in the meadow area of the delta of the river Sihl and along the river Limmat, but also included woodlands along the lake shores which had been opened up by human activities, and where the first beginnings of dispersed meadows can be seen (Brombacher & Jacomet, 1997). Under these conditions, difficulties in the food economy could not be overcome by a short-term increase in meat production by intensifying the rearing of domestic animals. A quick and effective increase in quantity was only possible through the deliberate use of wild re-sources. Consequently, during crises in the food economy, hunting - in particular of red deer - and gathering - in particular of the fatty and starch-rich fruits and seeds of the hazel (*Corylus avellana*), turnip (*Brassica rapa*) and 'fat hen' (*Chenopodium album*) - was strongly intensified. Economic crises, which required immediate measures in order for the population to survive, occurred in the first instance when the most important source of food, cereal, was not available in adequate quantities because of poor harvests. These failed harvests are, in turn, closely connected to short-term climatic fluctuations, as comparisons with climate-historical data have shown (Schibler *et al.*, 1997a, b, 329ff.; Gross-Klee & Maise, 1997; Magny, 1995). There are strong indications of a connection between economic crisis situations and short-term climatic fluctuations around the transition from the 40th to the 39th centuries BC and during the second half of the 37th century BC (Figure 4).

The effects of climatic changes and their economic consequences are undoubtedly dependent on the respective natural factors prevailing in the different regions at that time. There are also high proportions of wild mammals in the early thirty-eighth century BC in the climatically favourable old settlement areas, such as the Kraichgau. In south-west Germany, too, analogous strategies for coping with climatically-based subsistence crises were pursued (Steppan, 1998a, b).

HUMAN IMPACT AND FAUNAL DIVERSITY

As a measure of diversity we have calculated an index of "number of species/number of identifiable wild animal bones", which takes into account the size of the assemblages. Since the sediment in none of the assemblages discussed here was systematically wet-sieved, we consider a comparison of indices to be legitimate.

Despite all the methodological problems, statistical comparisons of species diversities between the assemblages of the Pfyn and Corded Ware settlements from Zürich show a significant increase in species diversity in the later period (Hüster-Plogmann & Schibler, 1997).

On the one hand, it is obvious that through the increasing impact of people on the environment not only were new biotopes created which provided better living conditions for newly immigrated or rare species, but resident species were also being forced out of their traditional habitats. On the other hand, it is noticeable that when hunting is intensified it also becomes more selective, and therefore the species diversity mostly turns out to be very small.

Aurochs (*Bos primigenius*) and Elk (*Alces alces*)

In the Alpine Foreland maximum values for wild cattle are calculated at 18% of all wild animal bones. The maximum number of elk bones is about 5%. Like the remains of wild cattle, elk bones from the "Spät- und Endneolithikum" (3400-2500 BC) of the Swiss Plateau appear in lower numbers (Figure 5).

In the old settlement areas bordering the Alpine Foreland to the north the situation is different (Steppan, 1998a, b). Between 4100 and 3600 BC aurochs are the most important game species in the Northern Upper Rhine area (Kraichgau) with a maximum value of 72% (Figure 5).

At Lake Zurich wild cattle - mostly aurochs - and elk bones are, on the basis of the concentration

values of domestic to wild animal bones, found in time periods where lower levels of hunting activity can be expected (Figure 6).

The ecological conditions during this time period would probably not have been capable of accommodating larger populations of wild cattle or elk, as the results of the botanical analyses, which we have already addressed, still point to dense forestation for this time period. Although the ancestor of our domestic cattle disappeared in the 17th century A.D., so that we have no exact information on its ecological requirements, it can hardly be assumed that dense primeval forest would be one of its preferred habitats. The habitats of bovines in general, as well as the elk, are more likely to be found in undergrowth-rich river meadow woodlands, light deciduous forests with a rich understorey, natural grasslands, as well as marshy areas. Such conditions were not created by people until after 3300 BC. Thus the influence of people, both close to and in the wider areas around the settlements, in fact should have had a positive effect on the living conditions and population density of the aurochs. Nevertheless, the bones of wild cattle and elk are found significantly less frequently and in lower quantities after 3300 BC than between 4000 and 3500 BC.

One explanation for this contradiction may lie in the lifestyle and economic customs of the settlers: based on the botanical results it may be suspected that the lakeside settlers regularly exploited as pastures for cattle all the natural areas of grassland, as well as the herb-rich understorey of deciduous forests and wet woodlands in the immediate and more distant areas around the settlement. Since these are the same locations which would

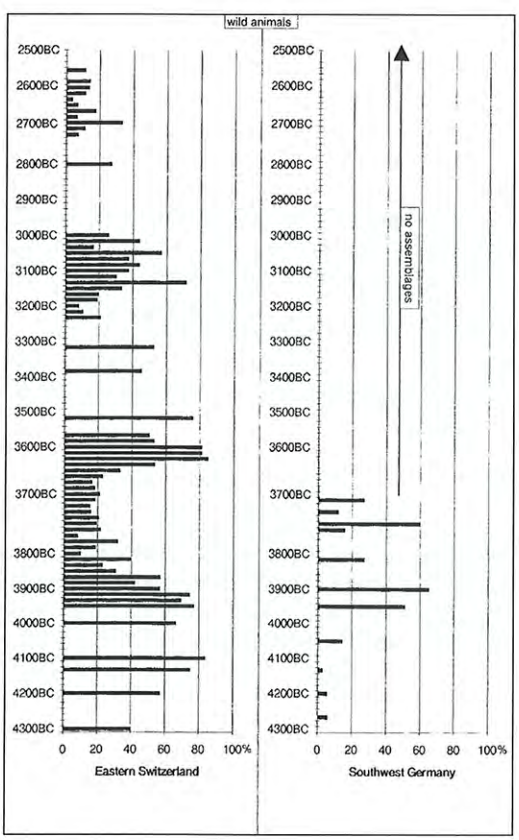

FIGURE 4
Frequencies of wild animal bones in the Neolithic settlements of Eastern Switzerland and Southwest Germany.

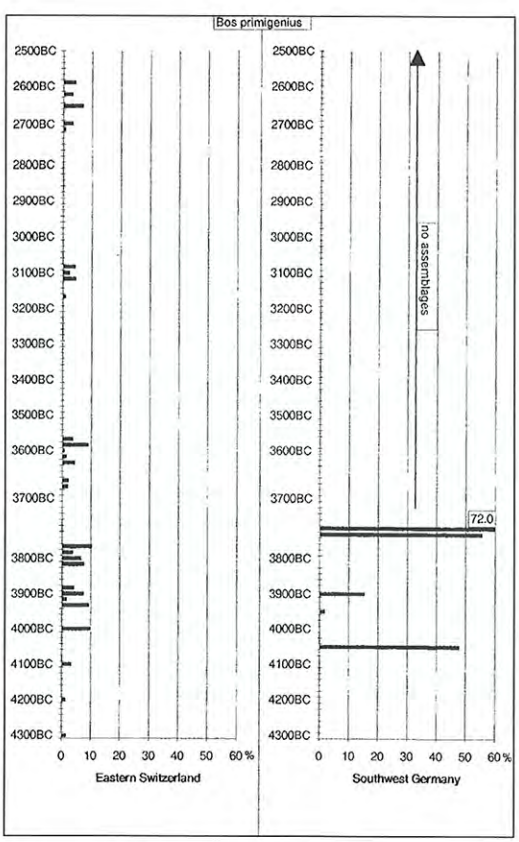

FIGURE 5
Frequencies of aurochs bones (100%: wild animal bones) in the Neolithic settlements of Eastern Switzerland and Southwest Germany.

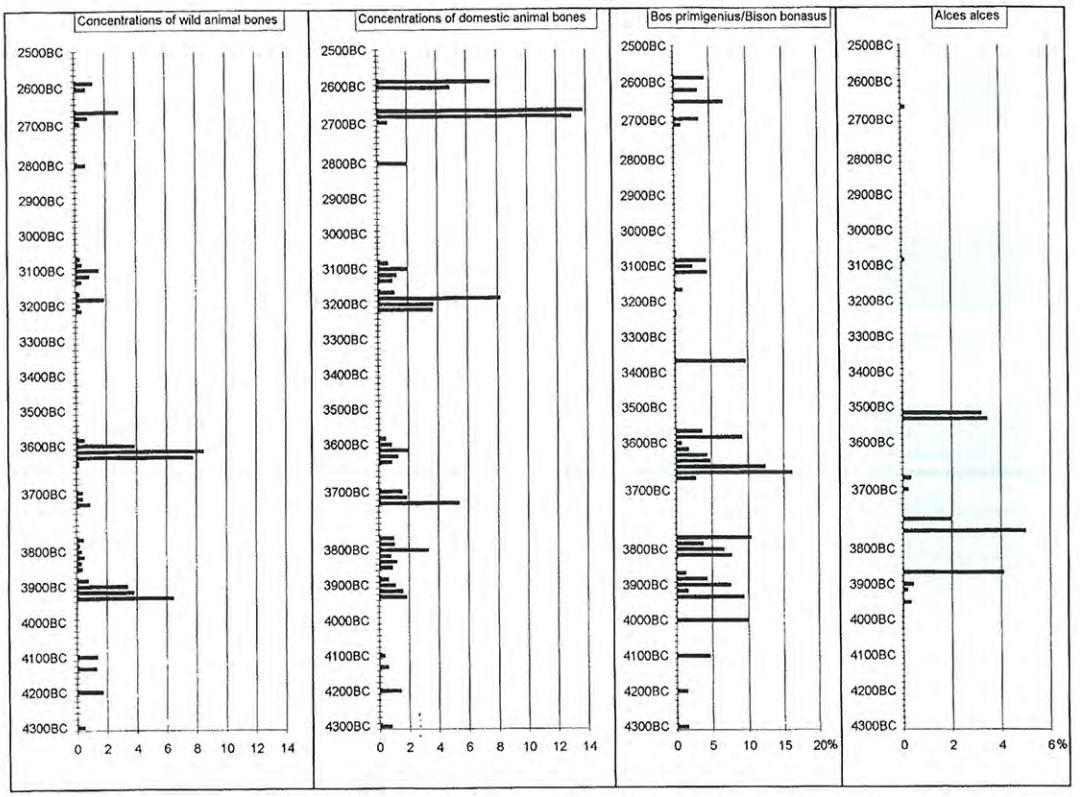

FIGURE 6
Concentrations (number of bones per squaremeter and occupation phase) of wild respectively domestic animal bones and frequencies of aurochs and elk bones in the Neolithic settlements of Lake Zurich.

presumably have been part of the preferred habitats of the aurochs and the elk, it is likely that these species and domestic cattle became competitors for food.

This circumstance, but above all the increasingly intensive presence of people, and the exploitation of these biotopes by people and their domestic animals (as pasture, for the acquisition of wood for timber and firewood, for the gathering of seeds and fruit, and for hunting) could in the end have led to a reduction in the population density of the aurochs and elk. Hunting alone, which, according to our figures cannot have been very intensive, would surely not have resulted in great decreases in the population of these large herbivores.

Red deer (*Cervus elaphus*)

Among the wild animals, red deer dominates over aurochs everywhere in the settlements of the Alpine Foreland, irrespective of whether the basis of calculation is the number or the weight of bones recovered. The red deer bones reach frequencies of up to 90% of all wild animal remains (Figure 7).

The intensification in red deer hunting, especially in the 40th and 37th centuries BC in the Alpine Foreland affected the size variability of the local red deer populations. According to the osteometric data from Lake Zurich the increasing hunting pressure led to a decrease in red deer size and vice versa (Figure 8 and Table 2). Whether this phenomenon is caused by the killing of not yet fully grown deer and/or an unbalanced sex ratio will be the subject of further research. According to the results of model calculations only during a longer-lasting period of more intensive hunting (>80 years) could this have become a danger for the local red deer population (Müller, in prep.).

Despite this intensive hunting, red deer obviously adapted to the changing ecological situation

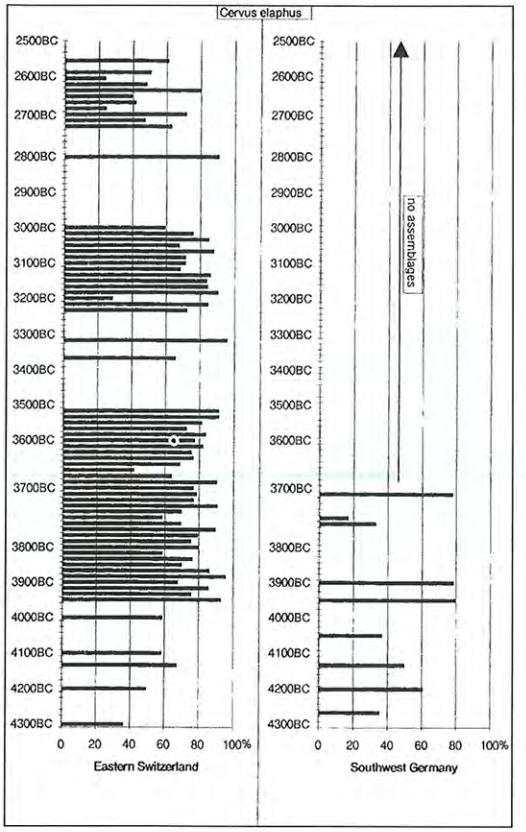

FIGURE 7
Frequencies of red deer bones (100%: wild animal bones) in the Neolithic settlements of Eastern Switzerland and Southwest Germany.

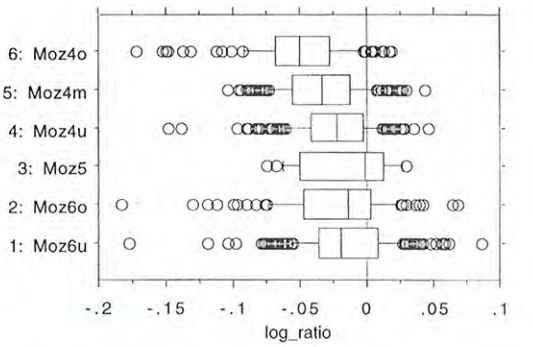

FIGURE 8
Box-plot with the logarithmic size indices of red deer bones from the occupation phases 4 - 6 in Zurich-Mozartstrasse (see Table 2).

Level	n	Median	IQR	Minimum	Maximum
Moz4o	115	-0.049	0.040	-0.172	0.018
Moz4m	249	-0.034	0.042	-0.104	0.043
Moz4u	245	-0.022	0.039	-0.148	0.045
Moz5	22	-0.001	0.063	-0.075	0.029
Moz6o	104	-0.014	0.049	-0.183	0.069
Moz6u	294	-0.019	0.045	-0.178	0.086

TABLE 2
Descriptive statistics (IQR: Interquartile Range) of the logarithmic size indices of red deer bones from the occupation phases 4 - 6 in Zurich-Mozartstrasse (see Table 1).

and remained the most important hunted species throughout the Neolithic period of the Swiss Plateau.

Horse (*Equus* sp.)

Generally, substantial amounts of horse bones only occur in time periods with intensified hunting (Figure 9). These bone finds are considered to represent small wild populations. Natural grasslands (e.g. flood-plains and bogs) are supposed to be the preferred habitats of the horse based on its food requirements. The horse populations from the 38th/37th centuries had similar body proportions. According to the logarithmic size indices (Uerpmann, 1990) the populations in southwestern Germany were characterized by a slightly greater body mass (Figure 10 and Table 3). Certainly, this difference is due to local or regional living conditions and reflects the ecological adaptability of this species.

The absence of horse remains from the archaeological record after 3600 BC in eastern Switzerland probably points to the local extinction of the species. The horse remains from the Corded Ware settlements (2600 BC) may already be attributed to domestic horses (Hüster-Plogmann & Schibler, 1997) and do not prove the persistence of wild horses in this region.

CONCLUSIONS

As our results have shown, even the early human impact 6000 to 4000 years ago, can be recognized within the archaeozoological assemblages on the Swiss plateau. This human impact has had positive and negative effects on the wild animal popula-

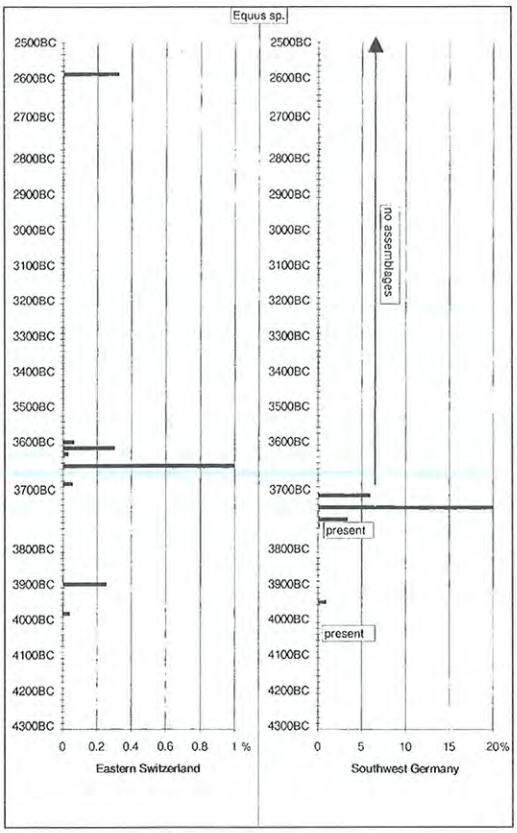

FIGURE 9
Frequencies of horse bones (100%: identified animal bones) in the Neolithic settlements of Eastern Switzerland and Southwest Germany.

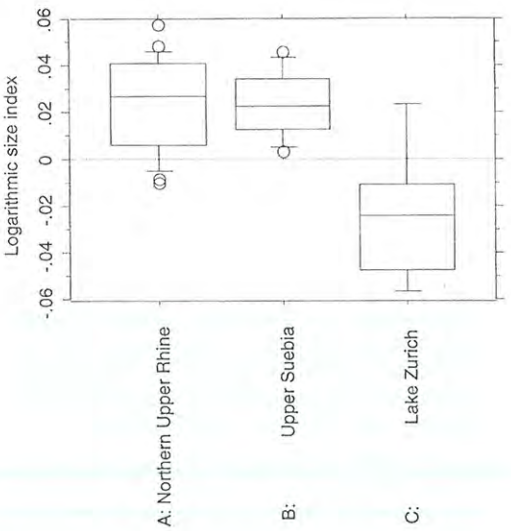

FIGURE 10
Box plot with the logarithmic size indices of horse bones from Eastern Switzerland and different regions in Southwest Germany (see Table 3).

Region	n	Median	IQR	Minimum	Maximum
Northern Upper Rhine	23	0.027	0.035	-0.010	0.057
Upper Suebia	7	0.023	0.022	0.004	0.046
Lake Zurich	5	-0.024	0.036	-0.057	0.023

TABLE 3
Descriptive statistics (IQR: Interquartile Range) of the logarithmic size indices of horse bones from Eastern Switzerland and different regions in Southwest Germany.

tion. On one hand by the use of the nearer settlement surroundings by man, new biotopes were created and gave place for new species or certain seldom species became more frequent. On the other hand man and his domestic animals exploited environments where wild species were frequent, specially large herbivores as aurochs and elk. Therefore early farmers and their domestic animals became competitors for food for certain wild species. This could have led to a reduction in the population density of wild species. Also the intensive hunting of certain wild species as red deer could have led to a reduction of the population and also to a negative selection within the population which can be recognized by a reduction of the body size. Over all this human impact was limited only to small areas and therefore positive effects as the rising biodiversity are more important as negative effects.

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