CHAPTER 5

Conclusions

The main aim of this dissertation was to contribute to current interpretations of regional diversity in cattle husbandry practices and exploitation strategies among Neolithic farming communities in relation to their geographical and cultural complexities. I addressed the main topic by posing sub-questions on the impact of farming practices on cattle skeletal lesions, demography, seasonality of reproduction, mobility, and diet in three different regions characterised by different cultural affinities and environmental conditions. I accomplished this using a combination of pathological, zooarchaeological, and stable isotopic data. This resulted in three peer reviewed papers presented in chapters two (Kamjan et al. under review), three (Kamjan et al. 2021), and four (Kamjan et al. 2020).

Within each case study, I detected clear trends in husbandry practices and subsistence strategies linked to sociocultural and environmental varieties. This allowed me to consider how the interplay of environmental, cultural, and biological drivers shaped and evolved each aspect of cattle farming and subsequently modulated cattle’s natural behaviour (reproduction rhythm and diet), phenotypic traits (size), as well as human’s socioeconomic practices (diet). Here, I bring a summary of how this dissertation sheds light on the nature of cattle husbandry in the early Neolithic(s):

5.1. “The Horns Cannot Be Too Heavy for the Cow that Must Carry Them” – Nigerian proverb

The first topic I addressed in this dissertation was whether Neolithic cattle were used for traction (Kamjan et al. accepted). I used the pathological evidence of Bos lower limbs from the Neolithic site of Çatalhöyük, firstly because of the significance of this iconic site for understanding the westward expansion of the Neolithic from Southwest Asia (Hodder 2020), and secondly, because the Çatalhöyük faunal assemblage contains both wild and domestic cattle (Wolfhagen et al. 2021). Assessing the diachronic transitions in the nature and frequency of lesions on the Bos lower limbs at Çatalhöyük allowed me to discuss the nature of pathologies in association with Bos size, age, sex, domestication status and potentially their use for traction (see section 1.1.1).

The analysis indicated that arthropathies were common on both morphologically wild and domestic cattle, with higher frequency and intensity on anterior elements. Interpreting pathological data in
conjunction with cattle ageing and sexing data allowed a discussion on the distinction of pathologies that are likely caused by biological and environmental factors (sex, age, weight, and grazing environment) from those that are likely induced by traction (Bartosiewicz et al. 1997; Thomas et al. 2021). The interconnected nature of these aetiologies (Holmes et al. 2021), as well as the difficulties in distinguishing domestic cattle from aurochs due to a size overlap between wild and domestic populations (Grigson 1989), are the major issues in interpreting pathological data, in particular in Neolithic contexts. Consequently, pathologies cannot be associated with the use of cattle for traction in Çatalhöyük with great certainty. However, the research showed that a clear shift in the nature and severity of cattle pathologies occurred when the settlement shifted to the west mound, around 6000–5600 BCE, where the great majority of the cattle are domesticated (Orton 2018; Wolfhagen et al. 2021). Particularly, specimens with the smallest body size show a relatively higher intensity of pathologies in this assemblage. Thus the ad hoc exploitation of these small individuals for traction and/or grazing in wet environments surrounding the site can explain the increase in the severity of these pathologies. However, a larger dataset complemented by detailed age and sex data is necessary to test this proposition and discuss its implications for agricultural innovation in the early Neolithic.

The result of this study exhibited the potentials of zooarchaeological and palaeopathological data to discuss the long-awaited debate on the role of cattle draft in the dynamic socioeconomic nature of Neolithic farming communities in general, and Çatalhöyük in particular. This study stresses that the original SPR proposition for the use of draft animals starting during the 4th millennium BCE was mainly due to the state of the research at the time (Sherratt 1981, 1983), the focus of the studies on younger empirical data, and the limited use of relevant zooarchaeological evidence. Despite the significance of zooarchaeological and palaeopathological methods to explore the draft exploitation of animals in early Neolithic contexts, only a few studies applied them (e.g. Gaastra et al. 2018). In Neolithic Anatolia, as a part of the core region of cattle domestication, this topic has remained unexplored. More systematic analysis of pathological data in connection with carefully constructed ageing and sexing data would allow us to discuss when and under which cultural and socioeconomic circumstances the use of cattle for traction appeared among farming communities and how did it impact human’s health, mobility, and agricultural practices.
5.2. “All Is Not Butter That Comes from the Cow” – Italian Proverb

In my second and third case studies, I overviewed the use of mortality profiles and sex ratio in zooarchaeological assemblages for exploring herd management practices in the past (Kamjan et al. 2020, 2021). I combined the high-resolution ageing and sexing data to reflect on the cultural and environmental factors shaping culling preferences, the availability of cattle (primary and secondary) products for human’s consumption, and subsequently the socio-economic importance of cattle for farming communities (see section 1.1.2).

Meat seems to be the most important product targeted in Džuljunica I, provided through aurochs hunting and culling domestic cattle at their optimal age for meat. In Džuljunica II, there seems to be a shift towards specialisation, with a focus on both dairying and meat production. These observations are based on the presence of older (possibly female) individuals together with a peak of post-lactation slaughtering, both of which suggest milk production. This pattern continued well into Džuljunica IV, while neonate mortality increases. This may represent natural mortality at or shortly after birth, mainly during winter due to exposure.

Cattle mortality in Schipluiden is comparable to Džuljunica IV, characterising a dual-purpose management strategy for milk and meat production. In both sites, female adults are well represented in sexing data, which corroborates our observations on milk exploitation.

Along with the increasing evidence for a more specialised cattle husbandry in our studied sites, we demonstrated major changes in cattle frequency and size. In Džuljunica, the relative frequency of cattle increases over time and their meat yield surpasses that from caprines, while in Schipluiden, cattle is the only identified domestic livestock (excluding suids with unknown domestication status) (Zeiler 2006). The increased cattle abundance has been previously exhibited through the meta-analysis of Neolithic faunal remains in the Balkans, central and Northwest Europe (e.g. Arbuckle et al. 2014; Ivanova et al. 2018). This has been associated with the suitable regional environmental conditions for cattle farming as well as the introduction of a cattle-oriented farming package from the core regions of domestication into Europe along the Danube corridor. The result from our case studies corroborates these observations, and emphasizes the role of local adaptation and cultural preferences in shaping subsistence strategies.

Cattle size was significantly reduced during the Neolithisation process. We exhibited how both male and female cattle significantly reduced in size at Džuljunica, comparable with its neighbouring early Neolithic site of Koprivec. The size reduction of cattle seems to be a regional phenomenon, with
parallels in Neolithic Anatolia and Europe (Arbuckle et al. 2014; Manning et al. 2015). Whether size reduction occurred due to environmental constraints, genetic intermix with local cattle populations, or through selective breeding by farmers, remains to be explored.

Altogether, our data suggest a multi-purpose cattle husbandry in our sites with a focus on milk and meat production. Future analyses of remnant lipid residues in ceramics are necessary to prove whether dairying was practiced in Džuljunica and Schipluiden.

5.3. “Who Wants Yoghurt in Winter Must Carry a Cow in His Pocket” – Turkish Proverb

The next aspect of farming practice that I explored was the impact of farming decisions and environmental conditions on cattle reproduction cycles, and consequently the availability of fresh products from cattle (see section 1.1.3). Through sequential analysis of the stable oxygen isotope composition (δ¹⁸O) of cattle tooth bioapatite from the Neolithic sites of Džuljunica (Kamjan et al. 2021) and Schipluiden (Kamjan et al. 2020), I established that the domestic cattle calving period was limited to a restricted length of time (3 months at the former site and 5.5 months at the latter). This pattern is very similar to the seasonal breeding cycle of aurochs, as well as Neolithic domestic cattle throughout Europe (Balasse et al. 2021).

Given that domestic cattle were most probably polyestrous, the relatively more restricted calving season at Džuljunica compared to Schipluiden, can be explained in two ways. First, through the biological adaptation of the cattle breeding cycles to the season with optimum forage quality in order to minimise environmental constraints on the cows and the calf welfare. Second, because of the intentional management by the herders aiming to concentrate birth in the optimal period of the year in terms of the availability of grazing resources (Balasse et al. 2021). It is difficult to disentangle these two possibilities. The geographic situation of Džuljunica in the northern Balkans with cold winters and snow cover, likely posed a challenge for winter grazing and fodder collection. The result from stable carbon and nitrogen isotope analysis of cattle bone collagen corroborates the hypothesis that cattle consumed very limited winter fodder.

The longer calving season at Schipluiden, suggests that forage quality might have posed less stress on the cattle breeding cycle here. At the same time, farmers did not actively prevent out of season birth. The climatic circumstances in Schipluiden were less harsh but food provisioning likely remained a challenge for the Neolithic farmers because the landscape lacked sufficient forests for collecting animal fodder, and no evidence was found for the cultivation of crops specific for animal feeding. Despite this,
the contribution of winter fodder in a few individuals, evident from stable carbon and nitrogen isotope analysis of cattle bone collagen (Kamjan et al. 2020), suggests that Schipluiden farmers made major investments in maintaining their cattle herds, which possibly contributed to increased milk availability. These results are comparable with those from the LBK sites, in Central Europe, where few examples of out of season calving have been reported. Balasse et al (2021) explained this as the prevalence of weaker environmental constraints, potentially linked to the favourable climate condition and less pronounced seasonality in temperature and/or forage availability among LBK sites. This suggests that aseasonal breeding would be unfeasible without winter forage collection, hence environmental factors and forage availability are the main factors in scheduling cattle breeding cycle and farming tasks.

The direct consequence of seasonal calving in our case studies is a shorter lactation period. Therefore early farmers in the north of Bulgaria and the Dutch wetlands were both challenged with the seasonal availability of fresh milk. Milk may have been completely absent for some period of the year, which might have been compensated through transforming milk into storable products with higher digestibility and longer shelf life. This likely necessitated intensive investment of the herders in dairy production, maintaining the herd, food provision, and assisting calving. These activities can occur in different forms and scales depending on the number of animals in the herd, the type and scale of other activities (e.g. crop cultivation), the abundance of grass/tree leaves and their distance from the site, and the cultural preferences of the society. These activities play a key role in shaping the natural environment, social organization, other socioeconomic activities performed at the site, and the subsistence strategy, as well as the agropastoral calendar, which in return strengthen cattle social importance for the community. A more spread-out calving season in Schipluiden could potentially relieve the pressure on spring tasks and milk could have been available over a longer period of the year although probably in lower amount.

The results of these studies highlight the significance of further diachronic research to define, firstly, when and under which circumstances aseasonal breeding became prevalent among domestic cattle. Secondly, how cattle seasonal breeding influenced the availability of fresh milk, human dietary patterns, culinary practices, and the agropastoral calendar.

5.4. “Cattle is as good as the pasture in which it grazes” – Ethiopian Proverb

The final aspect of cattle husbandry we investigated was the control over the cattle grazing environment and fodder provision (see section 1.1.4). We used results from stable carbon isotope analysis of
sequentially sampled tooth enamel and stable carbon and nitrogen isotope analysis of animal bone collagen at both Džuljunica (Kamjan et al. 2021) and Schipluiden (Kamjan et al. 2020).

At Džuljunica, we noted clear trends in the cattle diet and grazing environment throughout time. At Džuljunica I, cattle mainly grazed in an isotopically similar environment with wild species, where C₃ plants were abundant. They occasionally consumed plants with high δ¹³C values in wintertime. From Džuljunica II onwards, it seems that farmers practiced a non-extensive cattle husbandry, in which domesticates were kept near the site, where C₃ and C₄ plants were available in summer. Additionally, cattle seem to have consumed plants with low δ¹³C values. This might be because of seasonal consumption of forest resources (either as winter fodder or through grazing in the forests) or roaming in water-rich environments. Although Džuljunica is located close to water sources, we cannot exclude a forest component in the cattle diet because the diet of one of the roe deer confirms the presence of forested areas near the site.

Domesticates represent high δ¹⁵N values in Džuljunica I and II, which may be related either to the long-term use of the same pasture, a practice that increases the nitrogen level in soil (Makarewicz, 2014) or to the use of manured crops to feed livestock (Bogaard et al. 2007). Further stable isotope analysis of botanical remains are necessary to infer the effect of manuring on the stable isotope results from livestock at the site. Overall, we suggest a non-extensive cattle husbandry at Džuljunica, in which domesticates were kept near the site. Farmers practiced control over animal diet and mobility through fodder provision since the early phases of the settlement. This control may have intensified in Džuljunica IV. This may have been a strategy to support the herd during winter droughts and to reduce the environmental and geographical constraints on animal physiology, especially when transitioning towards higher latitudes.

At Schipluiden, cattle appear to have pastured in an isotopically similar environment to red deer and suids, possibly at the beach plain where C₃ plants were abundant. Few individuals consumed carbon-depleted plants either through consumption of forest resources or grazing in wet environments, while the former is more plausible. The δ¹⁵N values measured in cattle and red deer bone collagen in our dataset are exceptionally high due to grazing on manured plants or in saline environments. It seems that the saline environment of the dune, is probably the most significant factor elevating δ¹⁵N values of cattle grazing in this environment. Overall, the results from this study suggest that farmers at Schipluiden were practicing extensive cattle husbandry, in which most cattle were roaming around the site and beach plain. In the cold seasons, farmers were compensating the forage scarcity by foddering some individuals. This suggests that farmers were making major investments in maintaining cattle herds, which would
have also strengthened cattle social importance for the community. The special attention farmers paid to cattle body disposition also corroborates our observation.

Comparing the result from the cattle grazing environment at these two Neolithic sites suggests that in both cases farmers had control over the mobility and the diet of cattle, albeit in different forms and scales, depending on the environmental opportunities. In both regions, farmers had to compensate for the winter fodder scarcity through fodder provision, which required immense collective effort. Not all cattle were treated the same way, based on the inter-individual variability in the stable isotopic values. Without further information on the age and sex of these individuals, it is difficult to conclude if the differences were intentional based on the social and economic importance of the animals or due to annual variability in food availability.

It is worthy to note that in both case studies, the limited number of teeth available for sequential sampling, lack of detailed chronological data (in case of Schipluiden), human palaeodietary analysis (in case of Džuljunica), and lipid residue analysis of ceramic vessels pose some limitations for the interpretation of these results. In addition, despite the advantages of using stable carbon isotope values for reconstructing animal grazing environment, carbon particularly for C3 plants can represent a wide range of the growing environment of the plants. Therefore, it cannot infer the precise grazing location of the animal and the type of plants they consumed. Sequential stable carbon isotope values in tooth enamel are more advantageous here because they can represent the seasonal changes in animal diet (Balasse 2002), while stable carbon isotope in mammal bone collagen reflects the average dietary protein consumed several years during or shortly before the period of bone formation (Lee-Thorp et al. 1989).

Several studies have also drawn attention to the equifinality of depleted carbon isotope values in bone collagen as it can be equally caused by the consumption of forest resources or fluvial environment (e.g. Lynch et al. 2008). This highlights the importance of creating baselines using local botanical and zooarchaeological remains. I demonstrated one of the potentials of creating baselines for a better assessment of the animal grazing environment and therefore the human dietary pattern in Schipluiden. Here, the human palaeodietary study was conducted without using isotopic data from contemporary faunal and floral remains. This resulted in proposing a marine-based diet and subsequently dismissing the role of cattle husbandry in the region (Smits et al. 2010). By creating a baseline using stable isotopic data from wild and domestic species, we demonstrated that the saline environment of the site shifted the isotopic signals towards marine values and cattle protein likely had an important role in the human diet.
5.5. Closing Remarks and Prospects

There is no single way to herd domestic cattle and exploit their products. Cattle husbandry is a complex system composed of biological, evolutionary, and ecological components, as well as the technical, social and cultural choices of the human communities. The interplay of these factors shapes the diversity of husbandry strategies. This research negates the commonly held assumption that domestic cattle herding was spread as a homogenous package. In fact, cattle are multi-purpose animals with high adaptability to different environmental and social conditions. Neolithic farmers innovated different farming practices to exploit cattle products, compatible with the animal’s biology, as well as the cultural, spiritual, economic, and environmental conditions extant within a community. These farming practices required control over cattle demography, mobility, reproduction, and diet through food provision, water supply management, and housing. These major investments might also have strengthened cattle socioeconomic value among the farming communities, represented by their special role in Neolithic symbolism as well as the special attention paid to their skeletal deposition.

In this dissertation, I demonstrated the merits of using multivariate zooarchaeological, palaeopathological, and stable isotope analysis of faunal remains to go beyond early cattle domestication and their spread, and unravel the complexities of early cattle husbandry. Zooarchaeological, palaeopathological, and stable isotopic data are still too scarce and regionally scattered to provide an overview of the diverse socioeconomic and zootechnical practices applied by early cattle farmers to exploit different products. Future multi-disciplinary analysis of inter- and intra-site analysis of cattle remains are necessary to provide a multi scalar perspective into the modalities of cattle husbandry and their reciprocal impact on animal biology and human socioeconomic practices.