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Livestock management in the Northern Levant during the First Millennium BCE

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Abstract

The economy of Levantine societies in the first millennium BCE was based on animal husbandry and the use of animal life products. New data from Iron Age sites in the Lebanon and Syria are analysed in this paper. The investigation of livestock management through the study of archaeological animal bones and their measurements reveals specialised zootechnies. Size variability is observed, especially among sheep and cattle. This heterogeneity suggests that management techniques were directed towards ensuring the necessary supply of animal types to provide the required secondary products in coastal and hinterland, small or large centres. This response to market demands was possible by using different husbandry (zootechnies) strategies and by large-scale trade activities in the region.

Keywords

Northern Levant; Iron Age; Small/large centres; Husbandry practices; Animal size; Log ratios

1. Introduction

Research on the transition from the Late Bronze Age to the Iron Age in the Northern Levant in general has not so far considered faunal and livestock data in the studied proxies. This paper is a first synthesis of the animal economy from the Northern Levant for the Iron Age. Such analyses, focusing on zooarchaeological data as a means for reconstructing subsistence patterns and dietary practices, are sorely needed in studies of the Iron Age. Archaeozoological reports from the Northern Levant are still relatively uncommon, and while several preliminary studies have been attempted in recent years, the dataset are far from sufficient to pursue general analyses of dietary preferences or animal management strategies throughout the Iron Age (Iron Age I-II-II). The Levantine Iron Age is characterized by a variety of regional patterns and cultural diversity (Porter, 2016).

This study contributes to the comparison at a larger scale between different regions of Mediterranean basin in the first millennium BC. (this special volume). Hence, this paper focuses on drawing a regional synthesis of livestock management for the northern Levant.

This paper uses original data to analyse animal husbandry (subsistence, products and size) to assess to what extent the social, cultural and climate changes have affected the livestock management. We use the term livestock management to focus especially on the identification of impacts of the zootechny on animal sizes and shape.

Our study considers faunal data from several Iron Age sites and compares them with Late Bronze Age sites, in order to address the following questions: 1) Are Late Bronze and Iron Age societal changes, particularly a return to rural life, reflected in husbandry practices? Are the climatic changes often invoked as one of the causes of the collapse at this pivotal transition evidenced by the exploitation of domestic animals? Are the phenotypes (size, robustness) of domestic animals similar for both periods? Are sheep, goat, and cattle types in the Northern Levant comparable in coastal and inland regions?

2. Chrono-cultural setting

This paper examines archaeozoological data from the Iron Age (IA: 1200-350 BCE) settlement of the Northern Levant (Lebanon and south-western part of Syria).

The transition from the Late Bronze Age (ca. 1550 BCE) to the late thirteenth-eleventh centuries is marked by instability and the collapse of major political entities, accompanied by climatic changes (Killebrew et al., 2013; Chiti, 2015; Knapp and Manning, 2016; Karakaya and Riehl, 2019). Nevertheless, the aridity and climate changes recorded at the end of the Late Bronze Age (LBA) may have not been sufficiently abrupt to cause social collapse and the end of the palatial era and kingdoms (Knapp and Manning, 2016). Furthermore, archaeobotanical data from the Northern Levant clearly show the increased cultivation of drought-susceptible plants (water-demanding field cereals and leguminous plants along with arboricultural crops) during the Iron Age, in spite of deteriorating climate conditions (Karakaya and Riehl, 2019).

The destruction of several large cities, especially in the Southern Levant, has been linked to the invasion of the coastal Levant by the so-called “Sea People”. Nevertheless, recent studies have shown that the phenomena is far more complex and the fate of several cities is variable according to their location and importance (Hitchcock, 2011; Gilboa, 2013; Maeir, 2018). Large centres of the North, such as Ugarit and Qatna, experienced destruction and abandonment at the beginning of the Iron Age (IAI) witnessing the end of the era of large cities under palatial control. However, recent discoveries revealed that several northern Levantine settlements demonstrate continuity in traditions from the Late Bronze Age onwards. They show that after a short period of abandonment (e.g., Kamid el-Loz), or after destruction (e.g., Ras Ibn Hani and Tell Afis), a direct transition took place with no gap for the

Iron Age I (Killebrew et al., 2013; Sader, 2013). Therefore, coastal sites in the Northern Levant show a combination of continuity in LBA traditions in terms of material culture and the introduction of new incoming repertoire from the Eastern Aegean and Cyprus (e.g., Tell Kazel, Ras Ibn Hani and Sidon), (Killebrew, 1998; Badre et al., 2005; Welton and Charaf, 2020). Meanwhile, hinterland settlements were transformed into agricultural rural villages (e.g., Mishrifeh/Qatna and Kamid el-Loz), (Al-Maqdissi and Souleiman, 2008; Wagner-Durand, 2020). On the other hand, monumental architecture appears by the eleventh century, marking re-urbanization, especially at Tell Afis, Aleppo, and 'Ain Dara (Abu Assaf, 1990; Mazzoni, 2000; Gonella et al., 2005).

The Iron Age II began with the expansion at the beginning of the ninth century of territorial forces: the Arameans, the Neo-Hittites and the Assyrians. Two phases of re-urbanization and reconstruction of the main cities are evidenced with the construction of residential and monumental quarters (Iron Age IIA - 9th century BCE and IIB- 8th century BC) (Mazzoni, 2000; 2013b; Steiner, 2013). The cities of the Levant are considered as small and regional states that share the same culture and develop a large-scale economy between them and with Cyprus and Greece, regardless of instability and wars. Later on, the Iron Age III is marked by the emergence of multifaceted components, such as the Arameans, Phoenicians, Philistines and others, interacting with powerful forces, such as the Assyrians, followed by the Babylonians and the Persians (Ehrlich, 1996; Lipinski, 2000; Markoe, 2000; Holger, 2013). During the seventh century BCE, a new process of Assyrian urbanization took place, culminating in the cultural unification of the region (Mazzoni, 2000; 2013b). The last phase of the IA III (seventh and sixth centuries BCE) is characterized by a new territorial organization, changes in urbanism, and a consistent transformation of the material culture, along with the diffusion of Assyrian wares. For coastal regions, local cultures in Phoenicia gradually developed through their connexion with other Mediterranean societies, the Cypriots and the Greeks (Mazzoni, 2013b). With the changes occurring in the first millennium BCE, we would expect that the economy based on animal husbandry must have been affected. The hypothesis noted on culture material is that of a shift to rural economy in IA I, and from a state economy to large scale open trade economy in IA II-IA III. Therefore, we would expect a significant change in animal exploitation between the large centres of LBA and the shift to rural economy in the beginning of Iron Age. This would be explained by for example the use of mixed economy attested in rural settlement or specialized economy attested in large centres. We would expect for independent city-states of different kingdoms of the Levant to have different pattern of animal economy and a variety of animal types (sizes, age.) especially due to the increasing trades. Meanwhile, the influence of the incoming power of the Assyrian in the Levant might have had a certain power to control the animal production and economy. Therefore, it is expected to have a centralized similar economy and animal management in the region during the IA II-III.

Furthermore, given the climatic changes throughout the transition between Bronze and Iron Ages, it is expected that livestock management to have adapted to this increased aridity in term of animal breeding practices. And in Iron Age in general, with the variability of social and political patterns, livestock management would be expected to be different between rural/urban and/or large/small centres. These challenges and adaptation to both cultural and climate changes would have eventually affected the subsistence economy and animal sizes. Certain taxa were not exploited in large centres.

3. Material and Methods

3. Material and methods A total of 38,000 animal remains were analysed in this study from fourteen Iron Age sites in the northern Levant (Table 1, Fig. 1). In addition, nine faunal assemblages dating to the Late Bronze Age are also included in the analysis to address the diachronic evolution of animal roles and types (Table 1). We based our analyses on the main livestock species exploited for consumption in the region: caprines (sheep and goats), cattle, and pigs. The relative frequencies were calculated using the number of identified specimens (NISP) of the domesticated species. In this analysis, the Iron Age is taken as a whole period without subdivisions. Indeed, published faunal studies and fauna from ongoing excavations do not always distinguish between the different stages of the Iron Age (I-II-III). Some of the assemblages discussed here are published for the first time and complete descriptions of animal exploitation from Iron Age sites, such as Tell Kazel, Gindaris, and Ras Ibn Hani, are not available elsewhere. Moreover, when phasing is published, assemblages are sometimes very small and not significant; less than 100 remains for NISP comparison. In addition, the measurable elements are not available by phases for all sites (for example, bone measurements were divided by phases for Kamid el-Loz, Tweini, and Nebi Mend only, yet they were not significant for comparison for the different species). Therefore, we grouped animal remains for each period (IA and LBA), to compare faunal assemblages of several hundreds or even several thousands of remains and to include animal sizes from all analysed sites (Table 1).

3.1. Sites and assemblages

The animal remains considered here are from five coastal and nine hinterland Iron Age sites in Syria and the Lebanon (Tab.1, Fig.1). For comparative purposes, animal remains from nine Late Bronze Age sites were included in the study: five on the coast and four in the hinterland.

Most of these sites were occupied during the Late Bronze and the Iron Age, except for Alalakh, Ugarit (LBA), Ain Dara, Gindaris, Qarqur, Al Nasriyah, and El Burak (IA). In addition, ten IA sites were occupied during the transition phase between the LBA and IA I (Table 1). The LBA sites are mainly large centres while Iron Age settlements

are diverse; eight Iron Age sites are small centres or dwellings, five are large centres and one is an Iron Age temple and residential complex (Ain Dara), (Table 1). For the Iron Age settlements, three are larger than 30 ha, six are between 10 and 22 ha and one, El Burak, is less than 10 ha. For this study, we only considered mammal remains for the comparison and included wild and domesticated ungulates for the total NISP per site (presented in Table 1). For the IA fauna, Tell Afis and Tweini yielded the highest total of animal remains with 15,770 and 7943 NISP each, respectively. Meanwhile, six sites yielded between 1000 and 3000 remains and six assemblages contained less than 1000 NISP (Table 1). On the other hand, the LBA faunal remains are mainly from Nebi Mend and Kamid el-Loz, with 11,163 and 11,526 NISP, respectively, while six sites yielded a total of between 1000 and 6000 NISP, and only one, Tell Afis yielded 357 NISP. The heterogeneity of this assemblage is related to the differential depositional context of the assemblages (e.g., temple, pits, public buildings, courtyards, etc.) but also to the differential recovery of bones (sieved from Tweini and Sidon vs not sieved from other sites), the method of excavations (old versus recent excavations) and also the identification methods of animal remains. To reduce these factors, we considered the NISP of domestic mammals by a group of caprines, cattle and pigs that are mostly collected, identified and measured by archaeozoologists. Furthermore, closed and special contexts such as burials and deposits as long as fill and levelling layers were not considered in the study. These sites are located in regions corresponding to two different bioclimates: one benefiting from Mediterranean climatic conditions and the other from variable aridity conditions, strongly influenced by the proximity of arid margins (Badiyah el Sham) in the east and the desert (Hamad) in southeast Syria (Fig. 1). The sites are presented according to their geographical position on the coast or the hinterland, from the north to the south. In the following, the analysis is conducted according to the geographical regions (coastal/hinterland) to investigate the evolution of livestock management from coastal sites that have different cultural interactions than those of the hinterland. At the beginning of the Iron Age, coastal cities are the most influenced by the changes that occurred (urban to rural settlement). Afterwards, in the IA II and IA III, hinterland sites became parts of kingdoms that progressively incorporated the Assyrian empire while coastal sites functioned as trading ports and remained as independent city-states that paid tribute to the Assyrian empire (Sader, 2013; Steiner, 2013).

3.1.1. Coastal sites

Ras Ibn Hani is a rocky promontory on the Syrian coast. It was a peninsula, protected by two bays, with a residential occupation in the Late Bronze Age associated with the Ugarit site, five kilometres away (Lagarce and Puytison-Lagarce, 1978). The capital of the Ugarit Kingdom collapsed in the LBA, whereas Ras Ibn Hani was reoccupied after the destruction of the early eleventh century BCE. The site remained occupied throughout the Iron Age (IA I-II-III) (Lagarce et al., 1987; Lagarce and Hasan, 2008). The faunal remains come from Iron Age pits and domestic dwelling levels.

Tell Tweini (ancient Gibala) is located on the Syrian coast. The site was part of the Ugaritic kingdom and was a port settlement with commercial activities during the Late Bronze Age. Evidence of occupation during the IA I is scarce. During IA II and IA III, an urban occupation with public and private buildings developed across most of the tell (12 ha), (Bretschneider and Van Lerberghe, 2010). The mammal bones were recovered from domestic and religious buildings, streets, pits and wells (Albesso, 2018; Linseele et al., 2019).

Tell Kazel is located in the Syrian Akkar coastal plain, a few kilo metres from the shoreline and the northern Lebanese border. The site is considered the ancient Sumur/Simyra, an Egyptian administrative centre that flourished in the Levant during the Late Bronze Age. The transition from the LBA to the IA is well attested in Tell Kazel. In addition, the site yielded a complete Iron Age sequence (IA I-II-III). The IA occupation corresponds to a rural settlement with scattered structures and constructions, including a small shrine in the IA IB. Settlement expansion in the IA II levels confirms new urban growth (Badre and Gubel, 1999; Chiti, 2015). A large number of animal bones were recovered from the LBA residential area and temple and the IA settle ment levels (rooms and dwellings) of Tell Kazel. The small amount of IA animal remains published in this paper is because the ongoing study was halted by the conflict in Syria (Chahoud, 2015).

Sidon is located on a rocky promontory protected by two bays on the southern Lebanese seashore. It was an important commercial centre during the LBA and recent excavations demonstrated continued occupation of the site during the transition to the IA. Temples were erected around the twelfth century BCE and were continuously occupied with at least eight phases identified (Doumet-Serhal, 2013; 2021). Animal remains were recovered from temples and residential quarters from the LBA (Chahoud, 2015). The bone remains were recovered from Iron Age I, II and III occupation levels, mainly from temples (Chahoud, 2022).

Tell El Burak is a small fortified coastal settlement in southern Lebanon, founded towards the end of the eighth century BCE, when the city-kingdom of Sidon was in full expansion (Kamlah and Sader, 2010). The site was not occupied during the LBA. An agricultural domain was subsequently established during the Iron Age. The faunal remains were recovered from dwellings and workshops (Çakırlar et al., 2014; Vermeersch, 2021).

Along with these five coastal sites, two small faunal assemblages are published from the cemetery of Tyre-Al Bass and from Iron Age pits and foundation levels from Jiyeh, on the southern coast of the Lebanon. Animal bones recovered from cremation burials from Tyre-Al Bass are not included in this paper, due to the specific inhumation context, the limited number of remains (264 NISP) and the lack of published measurements Moreover, for Jiyeh, the animal remains (104 NISP) were recovered from IA features including walls, foundations and pavements in trench tests. This material is problematic as it could be mixed with recent Persian or

Hellenistic layers. On account of the limited NISP and the two published measurements, we will not consider this assemblage in the general comparison. The main species identified from both these sites are cattle, sheep/goats and pigs (Montero, 2014; Piątkowska-Małecka, 2017).

For the LBA, for comparative purposes, we also included the faunal remains from the site of Alalakh in Turkey, the northernmost coastal site (Çakırlar et al., 2014).

3.2.2. Hinterland sites

The site of Ain Dara in the Amuq Plain of Syria extends over nearly 50 ha, and is known for its monumental temple remains (Abu Assaf, 1990; Stone and Zimansky, 1999). The Iron I-II transition and the Iron II bone remains were recovered from residential and domestic buildings, as well as workshop areas and pits (Frey and Marean, 1999).

Gindaris is the main mound along the Afrin River. It extends over an area of around 20 hectares. Two phases dating back to the Late Bronze to the Iron Age transition period (Neo-Assyrian and Late Hittite/Aramaic times) (circa 1100 to 600 BCE) have been identified (Weiss, 1997). The faunal remains were recovered from Iron Age pits and structures.

Tell Afis, identified as Aramean Hazrek, represents the most complete Late Bronze–Iron I stratigraphic sequence in the Northern Levant. It is located on the north-western Syrian plateau. During the LBA, Tell Afis was an urban commercial centre at a crossroads between the littoral and inland Syria. The Iron Age I levels of this site are characterized by domestic structures. The settlement reached its greatest dimensions (30 ha) during the IA II-III (Mazzoni, 2013a). The site was conquered by the Assyrians in 738 BCE and transformed into a provincial centre, the seat of a governor. The bones were recovered from LBA administrative and residence buildings (Wilkins, 2000), and from IA I-II-III monumental temples, official and domestic buildings (Carenti, 2012a; 2012b).

Tell Qarqur is a 12-hectare-mound located in the lower Orontes River Valley. The excavation uncovered a well-preserved transitional Iron Age I/II phase (1200–500 BCE), (Dornemann, 2012). The faunal remains were recovered from IA I courtyards, with pits and storage structures, and from IA II domestic dwellings (Grossman, 2008).

Tell Tuqan is located in the Matkh Basin. The Upper Town was densely occupied during IA II-III (Baffi and Peyronel, 2014). No public or cult buildings have been found, but the building techniques used for private houses reflect various social strata. The faunal remains were recovered from private dwellings (Minniti, 2014).

The Iron Age urban settlement of Al Nasriyah covers about 70 ha and is located in the middle valley of the Orontes. A cemetery with cremation practices was identified on the site for the IA. The site was occupied in the Middle Bronze Age and destroyed

around 1500 BCE (Al-Maqdissi et al., 2010). Iron Age II bone remains were recovered from domestic and public buildings (Renard, 2010).

Tell Mishrifeh (ancient Qatna) was a flourishing city during the Late Bronze Age, destroyed by the peoples of the sea. The site appears to be occupied again only from the end of the Iron Age I and the beginning of the Iron Age II onwards (Morandi Bonacossi, 2013). The earliest Iron Age levels recorded so far date to the late tenth–early ninth century BCE (IA IC small village). During the eighth century BCE (Iron IIB), Qatna was one of the main southern regional centres of the Aramaean kingdom of Hamath. The faunal remains were recovered from private dwellings, official buildings, and storage areas (Vila and Gourichon, 2007; Albesso, 2018).

Nebi Mend (Qadesh-on-the-Orontes) was occupied discontinuously from the seventh millennium BCE to the mid-first millennium CE (Parr, 2015). The Late Bronze Age city, Kadesh, at the crossroads of the Mittanian, Egyptian and Hittite Empires, was destroyed by the Sea People. It was reoccupied in the Iron Age. The faunal remains were recovered from LBA and IA I to III domestic buildings and deposits (Grigson, 2015).

Kamid el Loz (ancient Kumidi) is located in the Bekaa Valley. The main occupation dates to the Bronze Age when Kumidi was an urban regional centre with a palatial complex, temples and artisanal workshops. The LBA II city was then completely abandoned and a new rural settlement was established in the early IA until the IA II. Moreover, the site was transformed into a burial ground in the IA III (Heinz 2016). The faunal remains were recovered from domestic houses and activity areas (1200–539 BCE), (Bökönyi, 1990).

3.2. Method

The dataset and related references are summarised in Table 1, whereas the locations of the studied sites are presented according to their bioclimate in Fig. 1. To address the questions mentioned above and to reconstruct livestock management during the first millennium BCE, we focus on the characterization of husbandry practices and the identification of animal sizes and types.

3.2.1. Quantification

The first point to investigate is the comparison of the faunal spectra from the different sites using the relative frequency of the NISP. The NISP is the available and standard data used for most archaeozoological studies in the region. The total NISP figuring on the histograms in Figs. 2 and 3 represents the sum of all four species: sheep, goats (and unidentified sheep/goats), cattle, and pigs. Therefore, the frequency of each species is calculated from the latter total. The ratio between sheep and goats is calculated using the available NISP. Unfortunately, culling profiles could not be included in this study to identify husbandry practices due to the multiple methods used to record the age of slaughter of animals in each site and to the complete lack of data in a few cases. Therefore, it was not possible to compare the heterogenous mortality profiles.

3.2.2. Biometrical data

In order to identify animal types, we analysed bone measurements from 11 sites with biometric data (the IA sites mentioned in Table 1 and LBA Ugarit). The sites were classified by chronology and the analyses were first conducted between sites from the same period (IA and LBA) for different geographic regions (coastal, hinterland), and secondly by regrouping all the sites from each period according to their geographical region. We analysed the biometric dataset using the Logarithmic Size Index (LSI) method (Meadow, 1999), to assess changes in animal size. This method is appropriate for assemblages with very fragmented faunal remains, and scarce measurable skeletal parts. Each measurement is converted into logarithms and then compared to a standard individual ($LSI = \log X - \log \text{standard}$, with 'X' being the measurement of the archaeological specimen, with 'standard' being the corresponding measurement of the reference individual). Three dimensions can be taken on most of the bones according to anatomical orientation; length, width and depth. These dimensions reflect different aspects; length indicates stature, while width and depth are related to body mass (Pöllath and Peters, 2005). This is the reason why length and width/depth measurements have not been mixed in the analyses. Only fused post-cranial bones and well-developed bones (astragalus) that have reached their maximum size were considered. Due to the difficulties in differentiating sheep and goat phalanges, these bones were not included in the LSI for these taxa, whereas they were considered in the cattle dataset when the identification of the bones was possible (Forelimb/hindlimb according to (Dottrens, 1946). The nomenclature of measurements is detailed in S.4 and follows (Driesch, 1976).

Log ratio calculation and analysis were carried out with the package *zoolog* (Pozo et al.) in R 4.0.3 (R Core Team, 2020). In *zoolog*, we chose to extract one grouped log ratio value by length and one by width to avoid overrepresentation of bone elements with the method of priority given to the most frequent measurements. For length, the order of priority is GL, GLI, GLm, and HTC. For width, the order of priority is BT, Bd,

Bp, SD, Bfd, and Bfp (Pozo et al.). Measurements of bone depth were comparatively rare and not included. The available reference standards were used by default in the Zoolog package for sheep and goats (Clutton-Brock et al., 1990), cattle (Trentacoste et al., 2018), and pigs (Stopp and Deschler-Erb, 2018). The standard used for sheep (*Ovis aries*) is the mean measurement of a group of male Soay sheep of known age (Clutton-Brock et al., 1990). Soay sheep are one of the smallest and the last modern populations of primitive domestic sheep. The standard for goats (*Capra hircus*) consists of the mean measurements of a group of a feral flock of goats of unknown age and sex collected on the Holly Island of Scotland (Clutton-Brock et al., 1990). The cattle (*Bos taurus*) standard is a female cow dated to the Early Bronze Age from Minferri in Catalonia (Trentacoste et al., 2018). Finally, the standard used for pigs (*Sus scrofa*) is a museum reference specimen from Basel (Inv. nr. 1446); a male aged 2–3 years old with a live weight of 120 kg (Stopp and Deschler-Erb, 2018). Descriptive data of LSI values are presented in supplementary table S14.

3.2.3. Data visualisation and statistical analyses

Data visualisation and statistical analyses were performed to assess changes over time and between sites and bioclimates with histograms of relative NISP frequency and one-way ANOVA between sites. Correspondence analysis (CA) were used to explore the correlation between livestock frequencies by site, by bioclimate areas and by types of settlement (S.1). The CA were conducted in PAST (Hammer et al., 2021).

For the Log ratios, we conducted data visualisation and statistical tests of LSI values by element for each species to avoid the overrepresentation of one bone element by site, which can alter results (S2,3,6,7,10 and 11). Box plots were created by element and by site with mean values and a notch narrowing around median values (ggplot 2 in R). Differences between animal sizes were assessed using histograms of osteometric distributions by LSI values grouped firstly by site (e.g. Fig.5 and Fig.6) and secondly by chronology (IA and LBA), (e.g. Figs.7, 11 and 15) with bioclimate differentiated each time by colour. The statistical significance in the observed differences between sites and populations was assessed using Kruskal-Wallis test conducted in R. Finally, a kernel density plot was used to compare IA and LBA populations, showing the probability density of animal size distribution in each population (e.g. Figs.8, 12 and 16). All these analyses were conducted independently for LSI length and width values.

4. Results: Livestock management

385 4.1. Husbandry pattern

386 Domestic ungulates represent the main meat source for LBA and IA societies in the
387 northern Levant. The Iron Age animal economy depended mainly on four livestock
388 taxa. Wild species contribute marginally to the diet with NISP frequency less than 5%
389 for most sites, except for Qatna (11%), Tweini (7%), and Kamid el Loz (6%). Wild
390 species consist mostly of fallow deer, gazelle, wild boars and a good spectrum of wild
391 Carnivora (foxes, mustelids, wolves, leopards, bears). In addition, hippopotamus
392 bones were identified in Tweini, while elephant ivory was used for manufacturing
393 artefacts at Sidon (Chahoud, 2022). Caprines are the most exploited domestic
394 mammals on all sites in the northern Levant, followed by cattle and complemented by
395 swine (Fig. 2 and S.1). Other mammals are less frequent and include horses,
396 donkeys and dogs, whereas a few Iron Age camelid bones are attested for the first
397 time in the northern part of the studied area (e.g., Afis and Qatna). For all IA sites,
398 sheep and goats are the most frequent animals with more than 50% of the NISP (Fig.
399 2 and S.1.a, S.1.b). A significant difference between sites is observed, especially in
400 the exploitation of cattle and pigs according to geographic position, rather than the
401 type of settlement (Correspondence analyses S.1). Indeed, the frequency of cattle
402 fluctuates between 20% and 40% of the NISP on all sites, except at Tuqan (10%).
403 Furthermore, pig breeding is relatively widespread in the hinterland, especially in the
404 northern sites (e.g., Ain Dara and Gindaris), while it is less common on coastal sites
405 (Ras Ibn Hani, Kazel, Tweini, Sidon and El Burak), (Fig. 2 and S.1.a, S.1.b). Overall,
406 coastal sites show very similar husbandry practices based on sheep and cattle, while
407 hinterland sites are more diversified in terms of cattle and pig consumption. No clear
408 correlation is observed between livestock frequency and settlement types
409 (Correspondence analyses S.1.b). On the contrary, a shift from caprines and cattle
410 towards more pigs is clear for the two northernmost sites (Ain Dar and Gindaris) and
411 the hinterland sites (Fig. 2 and S.1.a, S.1.b). The sheep/goat ratio (Fig. 4) shows that
412 sheep are more frequent than goats for the IA sites. Nevertheless, goats are still
413 frequent in some assemblages as they represent about half of the identified caprines
414 at Ain Dara (northern site), Sidon, Kami del-Loz and El Burak (southern site of the
415 studied area). Unlike the IA sites, the husbandry pattern for the Late Bronze Age
416 settlements is almost exclusively based on sheep, goat and cattle exploitation, except
417 for the northernmost site of Alalakh, which probably follows the pattern observed for
418 the Anatolian sites with more pigs in the economy (Fig. 3 and S.1.c; see discussion in
419 Slim et al., 2020; Slim and Çakırlar, 2022 in this volume). Significant differences are
420 attested between coastal and hinterland sites. During the LBA, sheep and goats
421 represent more than 65% of the NISP, except for Alalakh (in Turkey) and Kazel (in a
422 temple context). The clear difference between the two geographical regions is
423 marked by the importance of cattle and the absence of pigs on the coast, while the
424 latter is attested in hinterland sites, albeit in small proportions (less than 5% of NISP),
425 (Fig. 3 and S.1. c).

Therefore, Iron Age husbandry practices can be defined as mixed exploitations based on the four domestic livestock (sheep, goats, cattle, and pigs). In contrast, the LBA pattern shows more specialised caprines and cattle exploitation, where pig husbandry plays no economic role. Progressively, from the LBA to the IA, we observe a continuous pattern for husbandry practices if we consider the trajectory in each geographical region; coast and hinterland. Nevertheless, the reintroduction of pigs marks a striking shift, especially on hinterland sites over the exploitation of sheep and goats. Pigs are entirely or nearly absent from coastal sites (Ougarit, Tweini, Kazel, and Sidon) in the LBA and IA, sheep and goats decrease slightly (on average 10%) in the IA, whereas cattle play a more constant role in the LBA and IA economy.

4.2. Livestock biometry

4.2.1. Sheep

The analysis of sheep biometry was based on 707 unique bone measurements (158 for length and 549 for width) for IA sites and 1105 for LBA sites (346 for length and 759 for width). The comparison of LSI values by anatomical element shows that archaeological sheep bones do not present any allometry in comparison with the standard used as a reference (S.2 & S.3). Most of the archaeological bone remains are fragmented, and thus more width measurements were taken for these remains. The size differences between anatomical elements reflect bone proportions, which can vary between anatomical parts and between breeds (Davis, 1996). Therefore, we compared the distribution of the LSI by element to ensure that changes in animal sizes were not due to the allometry of an abnormal element. According to the mean and data distribution, sheep LSI values of the calcaneus and astragalus lengths tend to be larger than the radius and metacarpus lengths (Kruskal-Wallis chi-squared = 5.441, df = 4, p-value = 0.245, S.2). Furthermore, LSI astragalus widths are similar to metacarpus and metatarsus values but slightly larger than the width of limbs (radius, humerus, tibia and especially femur, Kruskal-Wallis: chi-squared = 26.2, df = 6, p-value = 0.0002044, S3). Both the length and width LSI values of the metacarpus tend to be slightly smaller than those of the metatarsus. In addition, upper limbs tend to be slightly larger than lower limbs for width LSI values (related to the presence of horns, for example). These distributions show that foot bones contribute slightly to the large and robust size of IA sheep compared to limb parts (S.2 and S.3).

Based on LSI means by site assemblage, Iron Age sheep are larger and proportionally slenderer than the reference standard (Fig.5, S.4, S.5 and S.14). The dispersion of LSI values at Tweini is particularly widespread compared to the other sites. The large set of length data available from Tweini shows the presence of two main groups of sheep sizes, also attested on several sites. LSI means are quite diverse among assemblages and sheep size is significantly different between IA sites (Length: Kruskal-Wallis chi-squared = 28.931, df = 8, p-value = 0.000326 & width: Kruskal-Wallis chi-squared = 89.375, df = 9, p-value = 2.173e15; Fig. 5, S.4, S.5, and

S.14). Two sites located in the northern part of the coastal region (Tweini and Ras Ibn Hani) have the lowest LSI values and means for both width and length, while Sidon (coastal site) and the hinterland sites have higher LSI values and means. It can be noted that the single width value at Tell Kazel falls in the lower size distribution of sheep. Meanwhile, the LSI values of sheep from the Late Bronze Age sites are also higher than those of the standard (Fig. 6). The wide dispersion of values is particularly marked at Kamid el Loz, Nebi Mend, and Tweini. The Kazel site has the smallest mean for length and width LSI values.

The comparison of sheep LSI values between the two periods (LBA and IA) indicates, on most sites, a decrease in Iron Age length and width (Differences of LSI value between IA and LBA for Length: $t = 0.118$ $p = 0.90$; Width: $t = 0.64$, $p = 0.52$; Fig. 7). This is particularly clear at sites for which there are sufficient data for both periods (Nebi Mend, Sidon, Tweini, Qatna, Ras Shamra, and Ras Ibn Hani). On the contrary, the available LSI values for both periods for the two most southern sites, Sidon (coastal) and Kamid el-Loz (hinterland), tend to be higher for the Iron Age (Fig. 7). Furthermore, the density plots of length and width values by period show multimodal distributions with several density peaks distributed differently by period (Fig. 7). The dispersion of values is more pronounced in the LBA than in the IA. The multimodal distributions suggest the presence of different types of sheep. Based on size values, three types of sheep appear in the Iron Age. This difference is not only generated by the sexual dimorphism of sheep but also indicates presence of sheep types of different sizes. The presence of different sheep sizes is also suggested by the strong dispersion of values in the Late Bronze Age, which can be interpreted as the effect of greater sheep type heterogeneity, which slightly decreased in the Iron Age (Fig. 8). The synthesis of data by period and geographical regions shows that the size (length) and robustness (width) of Iron Age sheep are on average lower than those of LBA sheep (Fig. 7). The lowest values are represented in coastal assemblages. This is visible for size values in both the Late Bronze and Iron Ages. On the other hand, for robustness, the low values are more clearly marked on the coast in the Iron Age than in the Late Bronze Age. Therefore, according to the proportions of size and robustness, two ovine phenotypes are clearly shown on the coastal sites of the Iron Age. Sheep at the coastal sites appear to fall into several types given the dispersion of values that overlap with the values of assemblages from hinterland sites (e.g. Albesso, 2018). In other words, the morphometric diversity of Iron Age sheep is greater at coastal sites than at inland sites.

4.2.2. Goat

The analysis of goat biometry was based on 299 unique bone measurements for IA sites (Length: 72, Width: 227) and 511 for LBA sites (Length: 135, Width: 376); (S.14). Comparison of LSI values by anatomical element shows that the archaeological goats are smaller than the standard used as a comparative reference (S.6, S.7). The comparison of LSI values by anatomical element shows that

archaeological goats are smaller than the standard used as a comparative reference. From the perspective of proportions of anatomical parts, LSI values for calcaneus length tend to be lower than those for other bones, while average metacarpus length values tend to be higher than metatarsus length. On average, the robustness values tend to be lower for the radius and metacarpus than for the other skeletal parts. On the other hand, the astragalus provides the highest values.

Length and width values for Iron Age assemblages do not show significant differences between assemblages, except at Tweini, where average length and width values are lower than for the other assemblages (Fig.9; S.8 and S.9). The Late Bronze Age assemblages show fairly variable mean values from one site to another. The width values at Sidon and Ugarit are particularly low (Fig.10). The width values at Sidon and Ugarit are particularly low. At Nebi Mend, values are distributed in two groups: the higher values relate most probably to the presence of feral, ibex, or wild goats (Grigson et al., 2015). In addition, high values are also attested at Kamid el Loz.

The synthesis of data by period and geographical regions does not indicate major differences in goat size and robustness between coastal and hinterland sites (Differences of LSI value between IA and LBA for Length: $t = 5.410$ $p < 0.0001$; Width: $t = 4.841$, $P < 0.0001$; Fig. 11). The coastal/hinterland histograms overlap for both periods. Nevertheless, during the Iron Age, the lowest values appear on the coast. The highest values observed in the Late Bronze Age, which probably correspond to wild individuals, are only found at hinterland sites (Fig. 12). From the density plots of LSI length and width values by period, the mean Iron Age value is lower than the Late Bronze Age value. Two peaks emerge in the Iron Age for the length and width of goats. Given the low overall dispersion of values and the sharpness of the two peaks, it is likely that they represent males and females. In contrast, the Late Bronze Age density peaks are quite indistinct and values are widely dispersed. This shows greater variability in goat types and the presence of wild individuals in the assemblages. Therefore, the sizes of goats tend to be similar in LBA and IA sites.

3.2.3. Cattle

Analysis of cattle biometry was based on 1104 unique bone measurements for IA sites (Length: 320, Width: 784) and 995 for LBA sites (Length: 316, Width: 679); (S.14). However, some skeletal elements, in particular the long bones (metapodials, humerus, radius, and tibia), show higher variability in width LSI values compared to the feet (astragalus and phalanx), (Length: Kruskal-Wallis chi-squared = 93.661, $df = 179$, p -value = 1; Width: Kruskal-Wallis chi-squared = 751.87, $df = 433$, p -value $< 2.2e-16$; S.11, and S.12). This could be explained by sexual dimorphism, castration or the presence of different cattle types (zebu and taurine cattle). Prolonged growth due to castration leads to late fusing and the bones of castrated animals are thus slenderer than those of non-castrated animals (Pöllath and Peters, 2005). The Iron

Age assemblage show fairly close LSI mean values for the different assemblages, except Ras Ibn Hani, where the means are lower, and Kamid el Loz, where the means are higher (Length: Kruskal-Wallis chi-squared = 93.661, df = 179, p-value = 1 & Width: Kruskal-Wallis chi-squared = 751.87, df = 433, pvalue <2.2e-16; Fig. 13). At several sites, robustness values are widely dispersed (e.g., Gindaris, Qatna and Tweini). Some very high values fall outside the general distribution, as is clear at Tweini and Qatna. They probably correspond to aurochs (S.12 and S.13).

In the Late Bronze Age, the assemblages show quite similar dispersions and means to those of the Iron Age (Length: Kruskal-Wallis chisquared = 233.51, df = 190, p-value = 0.01722 & Width: Kruskal-Wallis chi-squared = 531.45, df = 408, p-value = 3.561e-05; Fig. 14). The lowest average LSI values are at Kazel and Sidon (coastal sites) while the highest is at Kamid el Loz (hinterland). Particularly low values outside the general dispersion values are noted at coastal sites (Kazel, Sidon, and Ugarit), but are not observed at hinterland sites.

A comparison of the LSI data for cattle between the coast and the hinterland does not show major differences between the two geographical regions (Differences of LSI value between IA and LBA for length: $t = 3.456$ $p = 0.0006$; width: $t = 4.709$, $P < 0.0001$; Fig. 15). Nevertheless, the lowest LSI values of robustness are found on the coast. On the density graph (Fig. 16), the means for the Iron Age are lower than those for the Late Bronze. Values are concentrated in several peaks for both periods. In the Late Bronze Age, size values are distributed in four major density peaks and robustness values in three weakly represented peaks. In the Iron Age, three density peaks are observed for size and robustness, with a widespread dispersion. These peaks most certainly result from the combination of males and females and the presence of castrated animals as well as the presence of several types of cattle such as taurus and zebu forms (Clason, 1978; Bökönyi, 1990; Albesso, 2018; Verdugo et al., 2019). The highest values are certainly evidenced by wild cattle. Therefore, the size of cattle tends to be smaller for Iron Age sites in comparison with LBA sites, especially for the coastal sites.

4.2.4. Pigs

The pig was the most underrepresented species in biometric data due to the scarce quantity of measurable pig elements in the assemblages (82 measurements). Hence, only robustness measurements were used for comparisons between assemblages (Fig. 17). The lack of data does not allow for a comparative analysis between the Late Bronze and Iron Ages. Pig values at Tweini and Gindaris show a similar distribution, while the higher values indicate the presence of wild boar. The lower values correspond to domestic pigs while the higher values show the occurrence of wild boars in the assemblages.

5. Discussion

589 The analyses of dataset presented above show clearly that the interpretations of
590 results are closely affected by the number of measurable bones and the number of
591 identified specimens. The economy of the Iron Age in the northern Levant is based
592 on mixed husbandry of sheep, goats, cattle, and pigs, while the more specialised
593 LBA economy is based on sheep/goats and cattle. Livestock management involves
594 more sheep than goats in Iron Age sites while the latter is more important in LBA
595 settlements. Cattle exploitation is consistent in LBA and IA sites, whereas a clear
596 reintroduction of pigs is evidenced for Iron Age settlements, especially in hinterland
597 sites. As for biometric size, we note an overall increase in the size of sheep with a
598 wide range of diversity on the coast during the Iron Age. Goat size, on the other
599 hand, shows no clear variability between the LBA and IA. As for cattle, the
600 occurrence of two categories (small/large, robust/ slender) is probably related to
601 sexual dimorphism or the presence of hybrid, castrated and/or zebu individuals in the
602 assemblages, mainly for the LBA (see discussion below). For the Iron Age, this
603 division is slightly less clear. Finally, the biometric data for pigs are too scarce to
604 reveal any clear changes.

606 5.1. Relation between climate aridity and husbandry pattern

607 Social and environmental changes between the end of the second and the beginning
608 of the first millennia BCE, i.e., between the Late Bronze and Iron Ages, have
609 important repercussions on animal husbandry and domestic fauna. The livestock
610 economy of Late Bronze Age cities is largely based on the exploitation of caprines
611 and cattle (Vila and Gourichon, 2007; Vila, 2008; Chahoud, 2013, 2015). Livestock
612 husbandry is part of larger economic systems governed at a larger scale, either at the
613 state level or at the city level, to manage the supply of meat, milk products, and raw
614 materials (wool, skin, hair, and horn), (e.g. Greenfield, 2010). On the other hand, pigs
615 are rare and their exploitation does not play any role in this period for reasons
616 discussed by different researchers, which may be ecological, economic and political
617 (e.g. (Hesse, 1990; Hesse and Wapnish, 1998; Zeder, 1998; Vila, 2006a)). However,
618 the scarcity of pigs when considering the sites of Qatna and Kamid el Loz does not
619 seem to be related to environmental conditions but rather to the economic
620 preferences of these urban centres (Vila, 2006a). Indeed at the end of the
621 Chalcolithic and during the Bronze Age, due to the development of the textile industry
622 in the Near East and the ever-increasing demand for the production of woolly fleece
623 in urban centres, sheep husbandry became the main focus of the animal economy
624 (Vila and Chahoud, 2019). The collapse of Late Bronze Age economic systems due

to conflicts and invasions, the destruction of large cities and the fall of regional centres of great economic and commercial importance necessarily implied a change of scale in the organisation of the livestock economy.

5.2. Social changes and husbandry

In the Iron Age, the animal economy and the meat diet were based on mixed breeding with the exploitation of the four domestic taxa: sheep, goats, cattle, and pigs. This type of economy, which incorporates pigs to a greater extent, could mark the rural character of early Iron Age settlements. Indeed, the latter developed without a central regional system of control and probably reflects new incoming cultural influences from the eastern Aegean and Cyprus, or an influence from northern Syria and Mesopotamia for the later IA phase. By way of comparison, it should be noted that in northern Syria and Mesopotamia, Bronze Age pig rearing is proven to be unrelated to institutional control and reflects rather an alternative animal economy (McCorriston, 1997; Price et al., 2017); cf. the textual sources (Lion and Michel, 2006). The analysis of the presence of pigs in the southern Levant shows that in the Iron Age I, urban sites (Philistines) are characterised by a strong presence of pigs and that pig consumption subsequently increases in the northern part of the southern Levant (IA IIB) and disappears in the southern part, which is related to cultural abstentions from pig consumption (Sapir-Hen et al., 2013). Thus, in the southern Levant, the pig does not appear to be linked to rural settlements. The presence of the pig at Iron Age sites in the northern Levant could also be related to the arrival of new populations by sea, as discussed for the southern Levant, with the hypothesis of the introduction of new populations, such as the Philistines with their dietary and husbandry habits from the twelfth century BCE onwards (Hesse, 1986, 1990; Lev-Tov, 2000). Recent DNA analyses show that pigs of exogenous origin became predominant in the southern Levant in the Iron Age while pigs in earlier periods were of local origin (Meiri et al., 2013). Indeed, pig breeding in the Late Bronze Age is practised, albeit on a variable scale depending on the site, in northern Syria and south-eastern Anatolia. This may be due to cultural influences from northern Syria (Cavallo, 2002; Vila, 2006b; Becker, 2008) and in south eastern Anatolia (Slim et al., 2020) introduced by the Assyrian and Hittites populations. Pig breeding in the northern Levant during the Iron Age seems to be more of an enduring tradition than the result of acculturation.

5.3. Changes in livestock management

From a morphological point of view, a major change in the domestic animal population appears during the Iron Age. There is a general reduction in the size of sheep, goats, and cattle (not analysed for the pig due to the lack of data) compared to the previous period. The fact that this reduction is observed in three different taxa is enigmatic.

Several factors could have affected animal anatomy. A first factor could be the deteriorating climatic conditions affecting the Near East with an episode of severe aridity in the early Iron Age (Riehl et al., 2014; Langgut et al., 2015) that could have impacted animal size due to a more arid general environment and less rich pastures. Nevertheless, large-sized animals are still present in most Iron Age settlements. A second factor could be related to the change in animal husbandry, management and maintenance. The practice of fattening or feeding domestic and wild animals with barley is common and has been attested in early periods. In Mesopotamia, it is attested in the third millennium, as testified in written sources (Ellison, 1978). This practice of fattening continues into the Neo-Assyrian period. It is possible that certain animal husbandry practices changed following the dismantling of the socio-political structures of the cities and states of the Late Bronze Age, and that domestic animals may have suffered from malnutrition. Finally, the contribution of new domestic 'strains', as has been demonstrated via ancient DNA for the pig, could be a satisfactory answer to this situation at this stage of research. Indeed, the smaller-sized animals observed, especially sheep, are found in coastal site assemblages. The decrease in size of the three domestic taxa between the Bronze and Iron Age periods is less clear at hinterland sites. The small-sized specimens from the coast that are not found at hinterland sites could result from the arrival of allochthonous animals by sea. This seems obvious for sheep and explains the presence of greater phenotypic variation in size and robustness on the coast than inland. Depending on their origin, certain sheep breeds may have had difficulty adapting to a new environment and different vegetation and stressful climatic constraints. Thus, this may explain the existence of different types of sheep on the coast and the hinterland of the Iron Age. On the other hand, there is no difference between the two geographical regions for goats and cattle. The goat data seem to reflect sexual dimorphism rather than the presence of different types at the sites. The wild goat (*C. ibex* or *C. aegagrus*) is attested at Nebi Mend, near Lebanon and Anti-Lebanon Mountains (Wasse, 2001; Hassan et al., 2018). The organisation of data for cattle into several groups in the Late Bronze and Iron Ages may result from several factors: sexual dimorphism, the practice of castration, the existence of several cattle breeds, and the presence of the taurus type (*Bos taurus*), the zebu type (*Bos indicus*), and their hybrids. The zebu is attested osteologically (bifid vertebrae) and archaeologically (iconography) in Mesopotamia around 1700-1600 BCE (Matthews, 2002). The earliest identification of the zebu in the Levant (Jordan) dates back to the Late Bronze/Early Iron Age (Clason, 1978). At Kamid el Loz, sexual dimorphism between males and females does not seem to be significant, according to the author of the study (B"ok"onyi, 1990). In contrast, the zebu was identified at the site based on gracile feet and the presence of bifid vertebrae for the LBA. In addition, it occurs at Nebi Mend in the Late Bronze Age (Grigson, 2015). At Kamid el Loz, the hypothesis of the presence of three distinct types or breeds at these sites has been suggested: the zebu (*Bos* cf. *indicus*), a large bovine, and a small bovine of the humpless type (B"ok"onyi, 1990). At Ras Shamra (LBA), the existence of three bovine types had also been discussed (Vila, 2008; Chahoud and Vila, 2017), and

interpreted as the occurrence of small-sized cows, average-sized oxen and castrated bulls of larger size. It is known from textual sources that one type of cattle was raised for consumption and another type for ploughing work (Yon, 1997). The regional synthesis of metric data shows continuity for the IA and points to the probable presence of more than three groups of cattle. In addition, aurochs were still present and hunted in the Iron Age.

6. Conclusion

This regional and diachronic analysis of the Iron Age and Late Bronze Age faunal assemblages reveals that variability in animal husbandry and livestock management in the northern Levant are related to climatic variations and social and political changes. As shown through architecture, cultural material and social patterns, continuity and new traditions are also demonstrated in the sphere of animal management. Despite small sets of bone assemblages and measurement data, the combined LSI analyses by period and geographic regions generate new results. The analyses corroborate previous observations, such as the decline in the size of domestic animals during the Iron Age, while revealing through comparative study that this decline in size is a widespread phenomenon and that it started earlier than the Late Bronze Age. The diversity of bovine forms in the Late Bronze Age as well as in the Iron Age is confirmed. Finally, the innovative result of the LSI analyses conducted on these Iron Age assemblages is the identification of differences between coastal and hinterland sheep types, with the presence of small-sized sheep on coastal sites suggesting the existence of allochthonous sheep populations and animal trade by boat in large centres. At the beginning of the Iron Age, coastal cities are the most influenced by the changes that occurred (urban to rural settlement). Afterwards, in the IA II and IA III, hinterland sites became parts of kingdoms that progressively were incorporated into the Assyrian empire while coastal sites functioned as trading ports and remained as independent city-states that paid tribute to the Assyrian empire (Sader, 2013; Steiner, 2013). With the changes occurring in the first millennium BCE, we would expect that the economy based on animal husbandry has been affected. The hypothesis noted in the culture material is that of a shift to a rural economy in IA I, and from a state economy to a large-scale open trade economy in IA II-III. Therefore, this observation is confirmed by the change in animal exploitation between the large centres of LBA and the shift to a rural economy at the beginning of the Iron Age. This would be explained for example by the use of mixed economy attested in rural settlements or specialised economy attested in large centres. Probably the independent city-states of different kingdoms of the Levant had a different pattern of the animal economy and a variety of animal types (sizes, age.) especially due to the increasing trade. Meanwhile, the influence of the incoming power of the Assyrians in the Levant might have had a certain power to control animal production and the economy. Therefore, it could explain a centralised similar economy and animal management in the region during the IA II-III. Furthermore, given the climatic

changes throughout the transition between the Bronze and Iron Ages, it is expected that livestock management to have adapted to this increased aridity in terms of animal breeding practices. And in Iron Age in general, with the variability of social and political patterns, livestock management would be expected to be different between rural/urban and/or large/small centres. These challenges and adaptation to both cultural and climate changes would have eventually affected the subsistence economy and animal sizes. Certain taxa were not exploited in large centres. Finally, a similar discussion on husbandry patterns is needed for the surrounding regions (e.g. S Anatolia, N Euphrates valley of Mesopotamia, southern Levant) to have a large-scale analysis of the animal economy. The climatic changes often invoked as one of the causes of the collapse at this pivotal transition only have a slight impact on the exploitation of domestic animals. The analyses carried out here identified different phenotypes (size, slender) of domestic animals for Late Bronze and Iron Age settlements. Sheep, goat, and cattle types in coastal and hinterland settlements should be assessed with a large dataset with a better-defined chronology to understand their heterogeneity. More advanced research is needed in extensive regions of the Near East to reconstruct these changes.

Author contributions

JC and EV contributed equally to the study of faunal remains, data analyses and the writing of the paper. JC performed the computations and the analyses in R and PAST.MA Contributed to the dataset of faunal remains and measurements of the Tweini site.

Data availability

The data are presented in supplementary file by mean values of Length and Width of Log Ratios for measurements and total NISP for faunal remains.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Figures

Figure 1: Map of the Northern Levant with locations of studied sites in different bioclimates (Mediterranean zone-light blue: Coastal plain-blue: Hills and piedmonts; Mountain zone-pink: Humid mountains with forests-purple: Arid mountains of eastern taurus-brown: Arid mountains of Anti-Lebanon and Syrian steppe; Steppe zone-light green: hills and mounts-dark green: Plateau and zone of arid cereal culture; arid steppe-light red: Internal margin of humid zone; sub-desert zone-light orange: Syrian desert; Desert zone-yellow: hyper arid areas; modified after ASPRO), (Hours et al., 1994)).

Figure 2: Iron Age livestock: NISP frequencies for the main domesticated ungulates in the Northern Levant by bioclimate from the north to the south (Test for equal means: One-way ANOVA: Between groups: Between groups Sum of sqrs/df/Mean square/F/p(same):1.22633E07/2/6.13166E06/2.406/0.1035; Within groups: Sum of sq/ df/Mean Square 9.94061E07/39/2.54887E06; Permutation p (n=99999); Total: Sum of squares/ df/p(same):1.11669E08/df41/0.05651; Levene's test, from medians/p (same):0.).

Figure 3: Late Bronze Age livestock: NISP frequencies for the main domesticated ungulates in the Northern Levant by bioclimate from the north to the south (Test for equal means without data from Alalakh: Between groups Sum of sqrs/df/Mean square/F/p(same):4.8298E07/df:2/2.4149E07/F:6.843/p:0.005148; Within groups: Sum of sq/ df/Mean Square: 7.41059E07/ 21/3.52885E06 /Permutation p (n=99999); Total: Sum of squares/ df/p(same): 1.22404E08/23/p:0.00289. Levene's test for homogeneity of variance, from means, p (same):0.0002586; Levene's test, from medians, p (same): 0.0007479).

Figure 4: Frequency of sheep vs goats for the Iron Age sites (NISP).

Figure 5: Histogram of distribution of LSI values Length and Width by Iron Age assemblages for Sheep (dashed lines indicates the mean; N. of variables: 158 for length and 549 for width; Length: Kruskal-Wallis chi-squared = 28.931, df = 8, p-value = 0.000326 & width: Kruskal-Wallis chi-squared = 89.375, df = 9, p-value = 2.173e-15).

Figure 6: Histogram of distribution of LSI values Length and Width by Late Bronze Age assemblages for Sheep (dashed lines indicate the mean; N. of variables: 346 for length and 759 for width; Length: Kruskal-Wallis chi-squared = 262, df = 218, p-value = 0.02213; Width: Kruskal-Wallis chi-squared = 548.49, df = 460, p-value = 0.002798).

Figure 7: Histogram of Distribution of Length and Width LSI values by periods and bioclimatic regions for Sheep. (dashed lines indicate the mean). Period/mean Length/n: Iron Age=0.05767360/158; Late Bronze=0.07372382/346 & Period/mean Width/n: Iron Age=0.04741113/549; Late Bronze=0.06183522/759. Differences of LSI value between IA and LBA for Length : t=-0.118 p=0.90; Width: t= 0.64, p=0.52).

Figure 8: Density graph of the Length and Width LSI values by periods for Sheep (dashed lines indicate the mean).

Figure 9: Histogram of distribution of LSI values Length and Width by Iron Age assemblages for Goat (dashed lines indicate the mean ; N. of variables: Length: 72, Width: 227; Length: Kruskal-Wallis chi-squared = 71, df = 62, p-value =0.2029; Width: Kruskal-Wallis chi-squared = 226, df = 185, p-value =0.02139).

Figure 10: Histogram of distribution of LSI values Length and Width by Late Bronze Age assemblages for Goat (dashed lines indicate the mean ; N. of variables: Length 135, Width 376; Length: Kruskal-Wallis chi-squared = 92.087, df = 87, p-value = 0.3341; Width: Kruskal-Wallis chi-squared = 301.1, df = 249, p-value = 0.01326).

Figure 11: Histogram of Distribution of Length and Width LSI values by periods and bioclimatic regions for Goat. (dashed lines indicate the mean; Period/mean Length/n: Iron Age=-0.04677732/72; Late Bronze=-0.02648837/135 & Period/mean Width/n: Iron Age=-0.06835092/227; Late Bronze=-0.04794987/376; Differences of LSI value between IA and LBA for Length : t=5.410 p< 0.0001; Width: t= 4.841, P < 0.0001).

1115 **Figure 12:** Density graph of the Length and Width LSI values by periods for Goat (dashed lines
1116 indicate the mean).

1117 **Figure 13:** Histogram of distribution of LSI values Length and Width by Iron Age assemblages for
1118 Cattle (dashed lines indicate the mean; N of variables : Length 320, Width 784; Length: Kruskal-Wallis
1119 chi-squared = 93.661, df = 179, p-value = 1 & Width: Kruskal-Wallis chi-squared = 751.87, df = 433, p-
1120 value <2.2e-16).

1121 **Figure 14:** Histogram of distribution of LSI values Length and Width by Late Bronze Age assemblages
1122 for Cattle (dashed lines indicate the mean ; N. of variables: Length 316, Width 679; Length: Kruskal-
1123 Wallis chi-squared = 233.51, df = 190, p-value =0.01722 & Width: Kruskal-Wallis chi-squared =
1124 531.45, df = 408, p-value = 3.561e-05).

1125 **Figure 15:** Histogram of Distribution of Length and Width LSI values by periods and bioclimatic
1126 regions for Cattle. (dashed lines indicate the mean; Period/mean Length/n: Iron
1127 Age=0.01079022/320; Late Bronze=0.02265326/316 & Period/mean Width/n: Iron
1128 Age=0.03049102/784; Late Bronze=0.04465096/679; Differences of LSI value between IA and LBA for
1129 Length : t=3.456 p=0.0006; Width: t= 4.709, P < 0.0001).

1130 **Figure 16:** Density graph of the Length and Width LSI values by periods for Cattle (dashed lines
1131 indicate the mean).

1132 **Figure 17:** Histogram of distribution of LSI values Width by Iron Age assemblages for Pig (dashed
1133 lines indicate the mean).

1134

1135 **Table**

1136 Table 1: Iron Age sites