Maintenance of agricultural stability in a changing environment – the archaeobotanical evidence at Emar

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1. Introduction

The site of Emar is crucial for the understanding of socio-cultural and environmental change in the Near East. Its position at the middle Euphrates, at the intersection of large cities in northern and southern Mesopotamia, the eastern inland, and the coastal area in the West enabled the economic bloom of this city state throughout the Bronze Age, while many other cities experienced decay, particularly during the Middle Bronze Age.

Emar played an important role in the Euphrates trade already during the Early Bronze Age. A sign of continuous cultural and religious stability is the fact that, during the foreign rule of the Hittites in the Late Bronze Age, the emperor originated from the city's indigenous community.[1] The Late Bronze Age archive excavated in the 1970s by a French excavation team demonstrates continuous Syrian relations, although 50% of the texts are written in a system related to the Hittites coming into power. This leads the archaeologist to the conclusion that the Hittite influence was moderate and tolerant, which is an interesting point concerning economic aspects. The Hittite attitude toward agricultural production may become clear by comparing the findings from Emar with Hittite and Syrian sites.

Situated in a landscape sensitive to changes in water availability, Near Eastern sites were all more or less intensively facing economic crises during phases of increasing aridity due to climate change. While it is no longer debated that climate change around 4200 cal. BP affected many areas in the Near East, the details and the consequences in specific areas are still mostly unknown.[2] This is mainly due to the fact that even global rapid climate change such as the 4200 BP event would have had very different effects in different areas due to differing boundary conditions.[3] Therefore we may expect a very different outcome depending on the economic strategies (preferred crops), mean annual and seasonal precipitation, river discharge or position of the settlement along the river in relation to other settlements using irrigation water. Thus site location in relation to water availability (rainfall, position to the sea coast or rivers) must have been critical for economic decisions. There are of course many more factors, particularly of political nature, that may have influenced whether the inhabitants of a settlement found a way out of a crisis or abandoned their homeland. The focus of this study is, however, on the direct relationship of climate change and agricultural production.

Estimating the boundary conditions for Emar, its crucial position in an area of very low modern mean annual precipitation (mean annual rainfall at El-Khafseh, the closest weather station roughly 30 km north of Meskene is 231 mm between 1961-1990) and high interannual rainfall variability[4] may be put into perspective by the fact that it had direct access to the Euphrates water resources.

So far the causal relationship between climate change and the abandonment of numerous settlements in the area has not been sufficiently addressed. A large number of palaeoclimate proxies, amongst them the most relevant geochemical data from Soreq Cave in Israel[5] and Lake Van[6] show positive correlation with socio-political change in the area.[7] However, correlation between climate change and cultural development does not necessarily prove their causal relationship.[8]

Regional variability in climate development and anthropogenic impact should have led to a very diverse Near Eastern landscape in the past.[9] While there is no palynological data for the closer area of modern

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1 Finkbeiner *et al*. 2001; Faist – Finkbeiner 2002.
2 Hole 1994; Staubwasser – Weiss 2006.
3 Riehl – Bryson 2007.
4 e.g. Wirth 1971.
5 Bar-Matthews 2003; Bar-Matthews – Ayalon 1998.
6 Lemcke – Sturm 1997; Wick et al. 2003.
7 e.g. Weiss 2000.
8 Riehl in press b.
9 Riehl – Bryson 2007.

Lake Assad, there is at least some information on ancient landscape use from macro-remain analysis,[10] thus indirectly on the components of the Bronze Age vegetation.

The composition of the wood assemblages at Emar in the different periods is comparatively uniform.[11] As typical for a riverine environment most of the wood charcoal throughout the Bronze Age is derived from *Populus/Salix* species, which is up to 94% of the whole charcoal assemblage in the Early Bronze Age. All the other taxa occur in only small proportions. Only *Tamarix* (tamarisk) reaches higher proportions, particularly during the Middle (36.5%) and the Late Bronze Ages (8.3%), which may be an indication of increased salinity levels during the Middle Bronze Age in contrast to the Early Bronze Age, when tamarisk was much rarer (3.6%).[12]

An acceptable causal link must be able to relate natural developments and recognizable changes in demographic patterns, thus it must reflect the environmental changes and human reactions at the same time. Promising candidates for such a link are crop plant remains, because their occurrence in archaeological sites reflect human adaptation or decision-making throughout time, while their stable carbon isotopes bear the signal of water stress the plant experienced during grain filling.[13] However, it remains difficult to disentangle human decisions based on environmental change from those made on other grounds such as economic interests or political goals.

With the incorporation of the archaeobotanical results from Emar into the investigation of the overall development of ancient production patterns, the site contributes particularly to the understanding of the massive demographic change in the Near East.

2. Materials and methods

Between 1999 and 2002 archaeobotanical sampling was conducted at Emar. In all, 58 samples were hand-floated on-site and analyzed in the archaeobotanical laboratory at the University of Tübingen with the available comparative collection and diverse identification literature specified elsewhere[14] using binoculars with magnification up to 30x. Wood charcoal was analyzed and published separately.[15] A preliminary report on a few seed samples is published in Riehl.[16]

Descriptive and multivariate statistics were used to analyse the seed assemblages. Particularly the wild plant assemblage was subject to canonical correspondence analysis (CCA) to detect chronological differences in the composition of the wild plant and weed taxa. The software used was *Analyse-it* vers. 1.73 under *Excel* for descriptive statistics, *Canoco* vers. 4.5 for CCA and *CanoDraw* vers. 4.0 for the graphic output of CCA.

Isotope analysis was conducted at the Institute of Geosciences of the University of Tübingen with a NC 2500 connected to a Thermo Quest Delta+XL mass spectrometer. Before the measurements were conducted carbonate sediment particles were dissolved by hydrochloric acid treatment. Overall analytical precision was about 0.1‰ for $\delta^{13}C$ and 0.5% for %C. The results of this study are published in Riehl *et al.* and contain the details on data evaluation.[17] The supra-regional data was collected in the *Archaeobotanical Database of Near Eastern and Eastern Mediterranean Sites*.[18]

3. Results

Of the 58 samples only 34 contained ancient seeds and fruits, 21 of these contained more than 50 seeds.

The highest seed numbers were obtained from Early Bronze Age contexts, which were most extensively sampled. With 14 Early Bronze Age samples, 3 Middle Bronze Age, 15 Late Bronze Age, and two samples

10 e.g. Küster 1989; Miller 1997a; Miller 1997b; Miller *et al.* 2000; van Zeist – Bakker-Heeres 1985; Riehl 2001; Deckers 2005.

11 Deckers 2005.

12 Deckers this volume.

13 Riehl – Bryson 2007, Riehl *et al.* 2008; Riehl 2008; 2009.

14 Riehl 1999; 2001; 2004.

15 Deckers 2005; Deckers this volume.

16 Riehl 2001.

17 Riehl *et al.* 2008.

18 Riehl – Kümmel 2005.

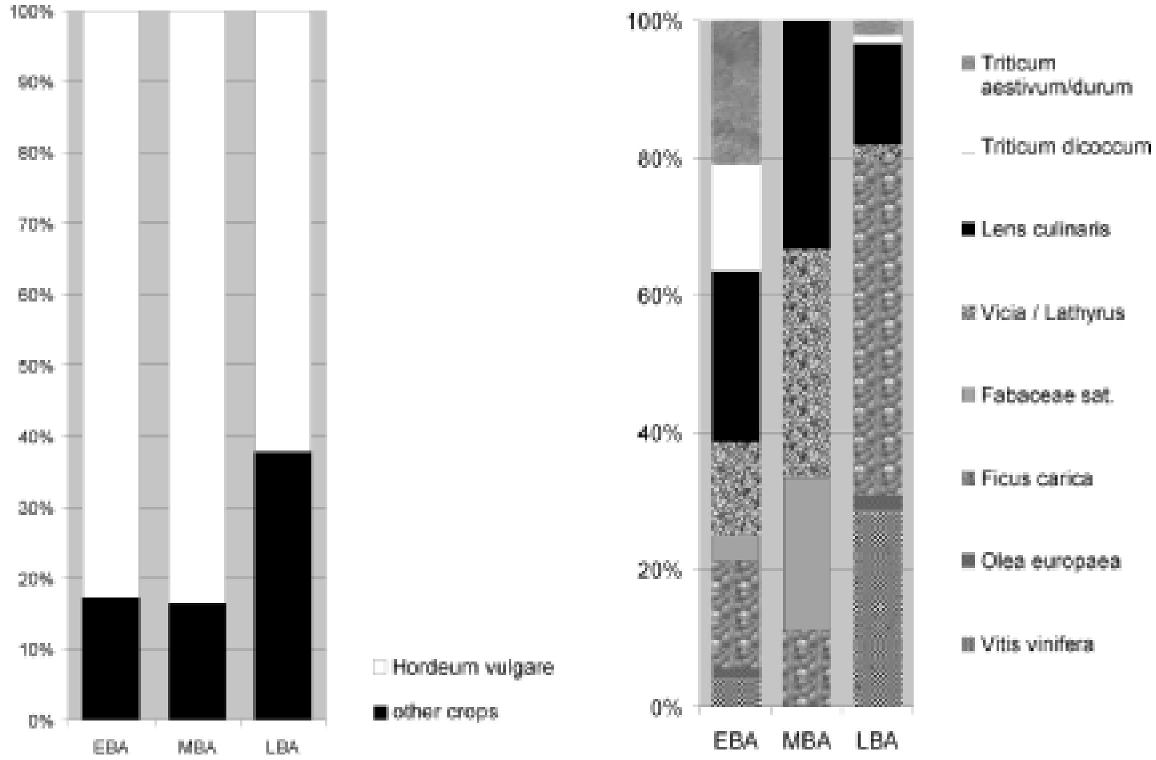

Fig. 1: Crop proportions throughout the different periods; left, the complete crop assemblage; right, "other crops" itemized

from transitional layers (MBA/LBA) the distribution of the material on the different periods is skewed with Middle Bronze Age contexts being underrepresented.

In all 5423 seeds, fruit and chaff remains were identified, of which slightly more than half of the remains are from crop species. The archaeological contexts of the sample origin are mainly described as ash layers.

3.1. The crop remains

3.1.1. Cereals

3.1.1.1. Barley (Hordeum vulgare)

Barley is the dominant crop in all the analysed periods at Emar, and makes up more than 80% of the crop remains during the Early and the Middle Bronze Age, and more than 60% during the Late Bronze Age (fig. 1, left). Due to strong corrosion, parts of the cereal grains could not be determined to the genus level. They, however, most likely belong to barley. Depending on whether the indeterminate cereals are considered to represent barley or not, the proportions of barley are even higher, i.e. between 80 and 97% during the Early and the Middle Bronze Age, and between 60 and 79% during the Late Bronze Age.

The dominance of barley in Bronze Age sites in the Near East is a very common phenomenon,[19] which has its reasons in the short life-cycle of barley, which ripens faster than wheat, reducing the hot summer season. Thus barley is considered to be more resistant to drought and salinity than other cereals.[20]

Some of the barley could be determined as the two-row variety due to good preservation of the rachis remains. However, for most of the remains this was impossible. Aside from its role as an important contributor to human diet this crop had, according to ancient texts, multi-purpose uses in economy and trade, such as for paying wages.[21]

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19 Riehl – Bryson 2007; Riehl 2009.

20 Choi – Min 1982, Hayek *et al*. 2000.

21 e.g. van Koppen 2001.

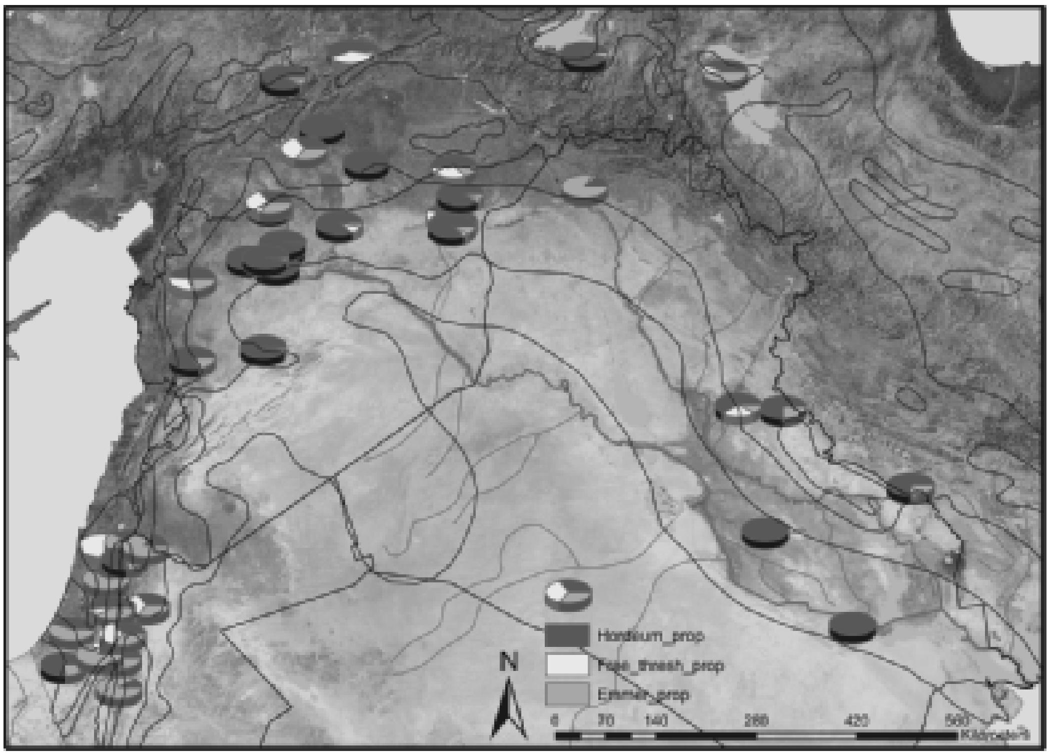

Fig. 2a: Cereal proportions in the area during the Early Bronze Age

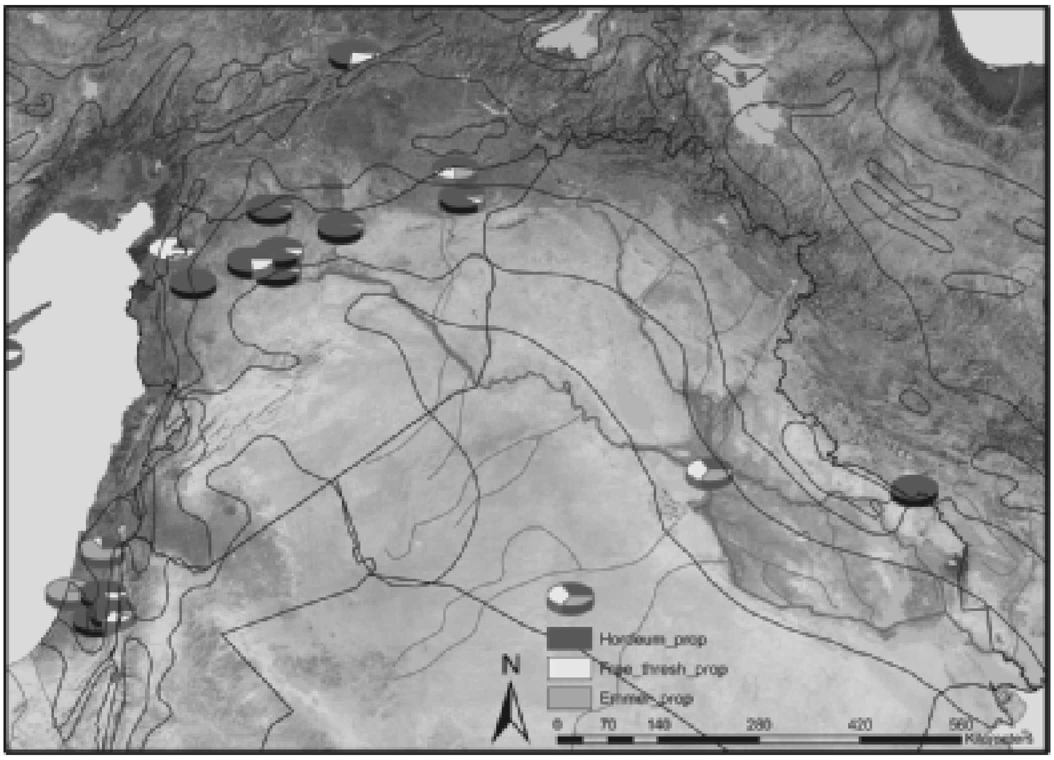

Fig. 2b: Cereal proportions in the area during the Middle Bronze Age

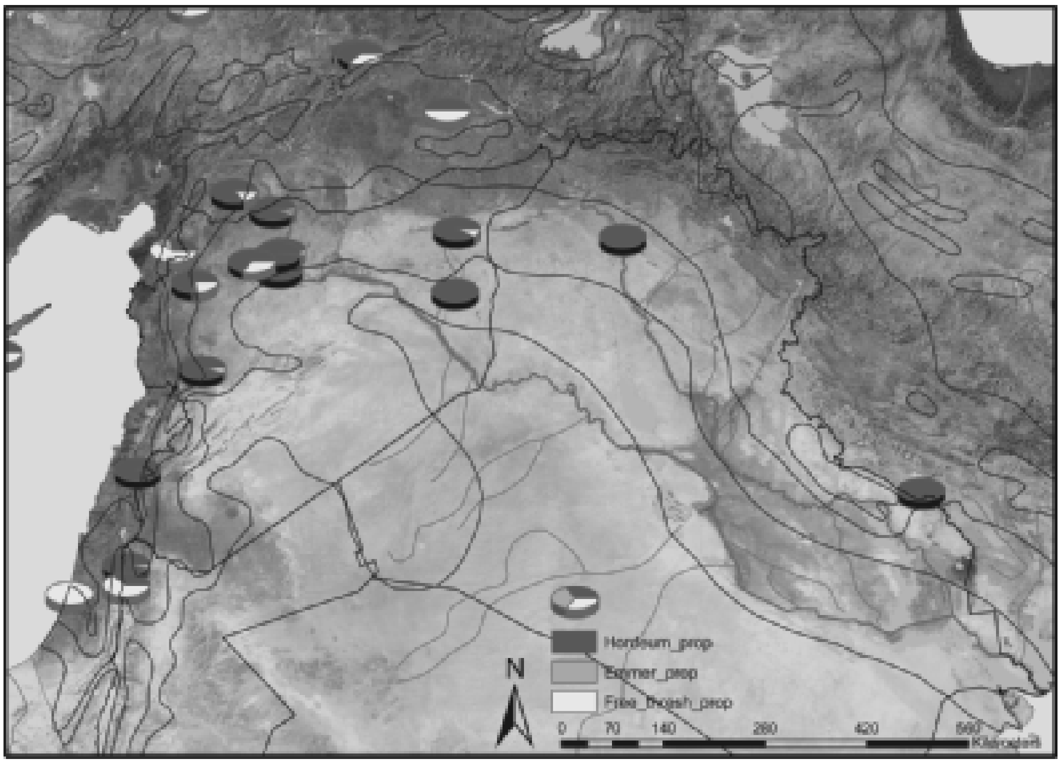

Fig. 2c: Cereal proportions in the area during the Late Bronze Age

The pattern of over-representation of barley was previously interpreted to be related to the specific economic orientation of the middle Euphrates cities, which seem to have been focused on surplus production of barley compared to more northern and coastal sites, where wheat occurred in much larger proportions.[22] The results from Emar support this interpretation. Although irrigation would have made possible the cultivation of free-threshing wheat along the middle Euphrates, the economic goals seem to have directed to agricultural production according to a "least risk - highest yield mentality". These patterns are at the same time an example of how environmental preconditions and economic interests go hand in hand in complex societies.

3.1.1.2. Wheat species (Triticum spp.)

Due to the strong dominance of barley in the Emar contexts, the quantification of the other crops is problematic, because of low find numbers, which are difficult to compare.

There are, however, some aspects of change in the crop assemblages that seem to be relevant to the overall development.

While in the Early Bronze Age samples of free-threshing wheat (*Triticum aestivum/durum*) are leastwise represented with eleven remains, there are no records for the Middle Bronze Age, and only two records from Late Bronze Age contexts. Similarly emmer wheat (*Triticum dicoccum*) is not represented in the Middle Bronze Age, and occurs only with eight remains in the Early Bronze Age and with one grain find in the Late Bronze Age. It remains unclear whether this hulled wheat was cultivated at all or whether it grew as a weed amongst other cereals during the Late Bronze Age.

The importance of emmer wheat amongst the first cereals and staple crops in the Late Neolithic decreased continuously in the Near East until the end of the Early Bronze Age, while it remained of importance further west (e.g. in the Aegean) at least until the end of the Late Bronze Age.[23] Cultivation of emmer was almost abandoned in northern Mesopotamia with the beginning of the Middle Bronze Age.[24]

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22 Riehl – Bryson 2007; Riehl 2008 and 2009; see also figure 2.

23 Riehl – Nesbitt 2003.

24 Riehl 2009; see also figure 2.

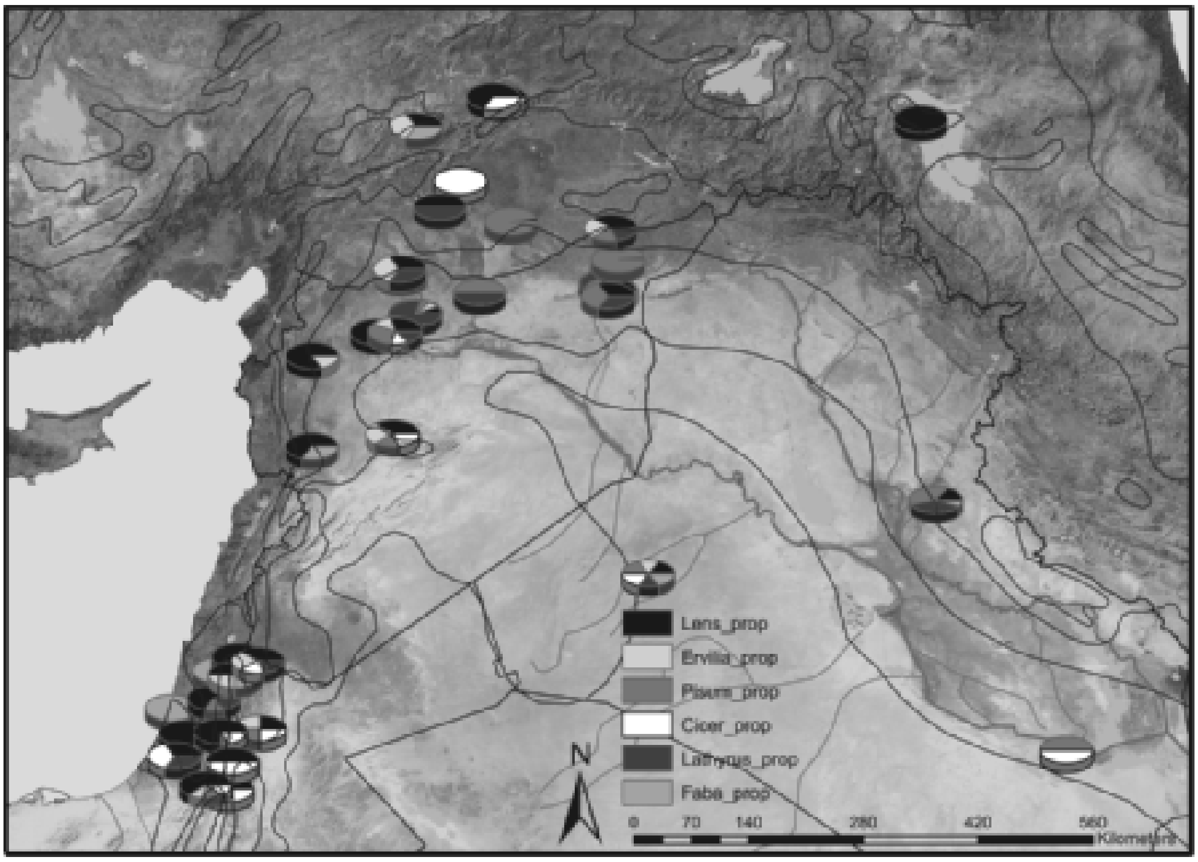

Fig. 3a: Pulse crop proportions during the Early Bronze Age

3.1.2. Pulses

The pulse crops were most prominent in the Middle Bronze Age samples at Emar, and amongst them lentils (*Lens culinaris*) reached the highest proportions, while during the Late Bronze Age they appear to be random.

Lentil belongs to the most valued pulse crops due to its taste and high protein content (ca. 25%).[25] The crop occurs in high ubiquity during the Early Bronze Age in a number of Near Eastern sites, but it seems to be somewhat reduced to the Euphrates area during the Middle Bronze Age, even when the lower number in analysed sites from this period are considered.

Experiments on the effect of seasonal rainfall and low winter temperatures on lentil yield show that rainfall accounts for most of the variance in mean seed yield, in contrast to temperature, which has only a low effect on the yield.[26]

In general with the transition from the Early to the Middle Bronze Age there seems to be a shift from large proportions of garden pea (*Pisum sativum*) in the northern Syrian territory to higher proportions in bitter vetch (*Vicia ervilia*).[27] In this relation it is important to note that bitter vetch is considered to be relatively drought tolerant in comparison to garden pea.[28] With the Late Bronze Age many settlements seem to have focused on bitter vetch and grass pea (*Lathyrus sativus*) (fig. 3c).

3.1.3. Fruit crops

Fig (*Ficus carica*) was the only fruit that was represented throughout all the periods of the Bronze Age at Emar, while olive (*Olea europaea*) and grape (*Vitis vinifera*) occur only in the Early and Late Bronze Age samples, with relatively high proportions of grape seeds in the Late Bronze Age samples. Amongst the charcoal remains three fragments of date (Phoenix) were found in a Late Bronze Age sample.[29]

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[25] Franke 1992.

[26] Erskine – El 1993.

[27] figure 3 and Riehl 2009.

[28] Enneking *et al*. 1995; Martin – Jamieson 1996.

[29] see Deckers this volume.

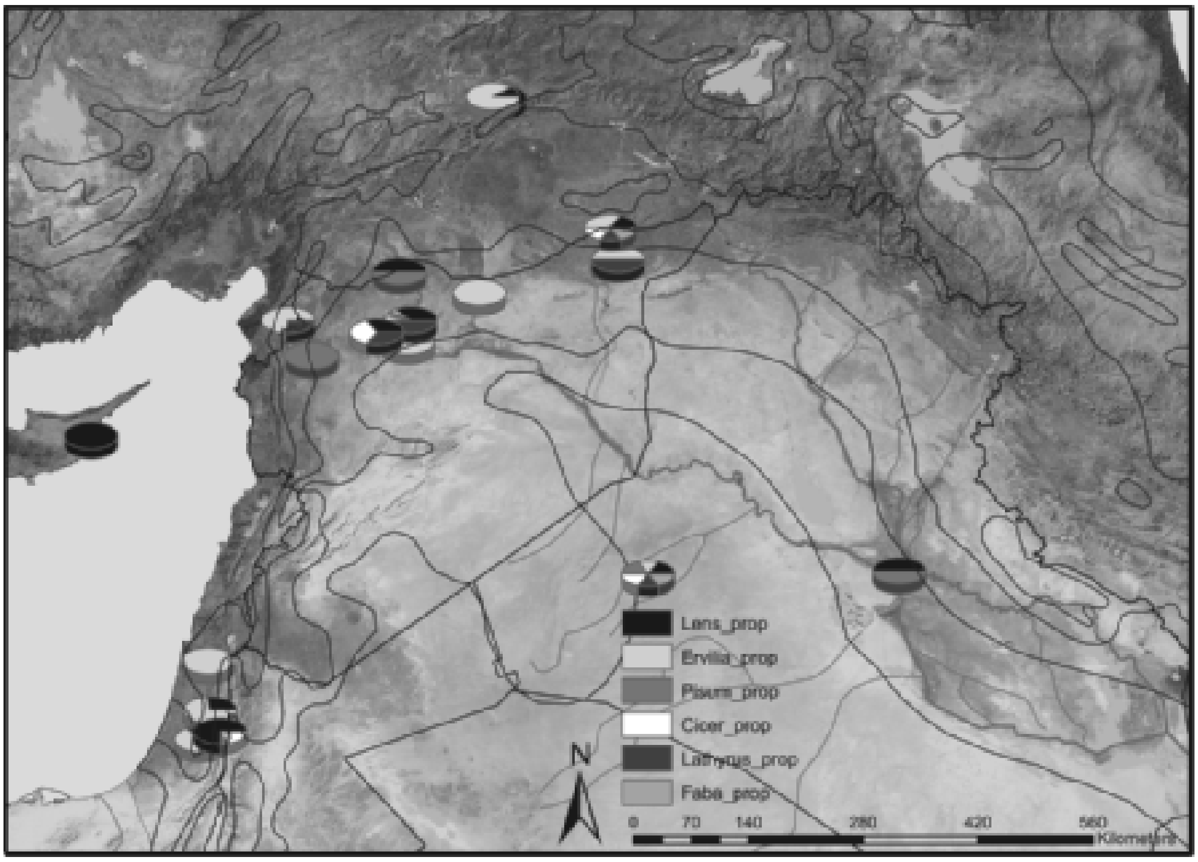

Fig. 3b: Pulse crop proportions during the Middle Bronze Age

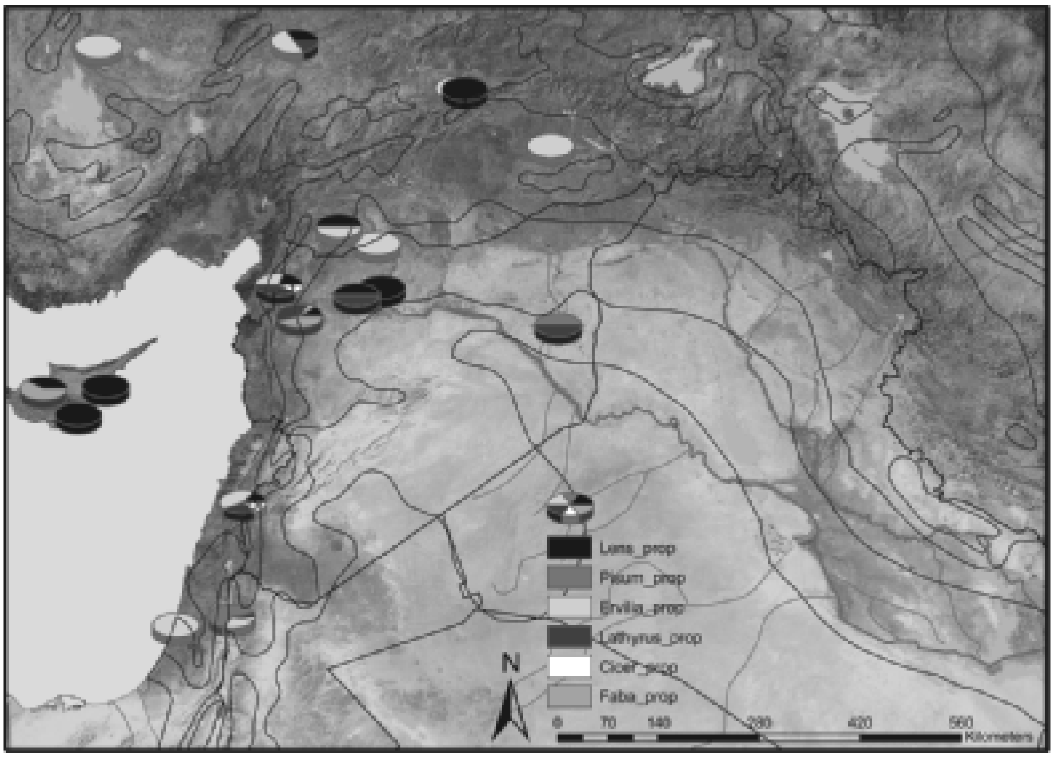

Fig. 3c: Pulse crop proportions during the Late Bronze Age

Grape is considered to have significantly contributed to food production in the Old World at least since the Early Bronze Age.[30] The fruit is rich in carbohydrates, the raisins are a valuable storable food, and the juice serves for the fermentation of wine.

Grape vine is adapted to Mediterranean-type environments, and cultivation during the Early Bronze Age seems to have been practiced considerably southward of the actual natural distribution of the wild progenitor (*Vitis vinifera* ssp. *sylvestris*) (fig. 4a). Even allowing for the fewer analyzed Middle Bronze Age sites, grape cultivation generally seems to be reduced during this period particularly in the central northern Syrian territory (fig. 4b). Particularly during the Late Bronze Age grape occurs in rather large proportions in some sites, suggesting intensive cultivation and irrigation of the species (fig. 4c).

Olive also occurs beyond its modern natural area of distribution, and suggests different distribution patterns in antiquity compared to the modern ones. Although olive pips occur only in small numbers in more inland sites the findings of olive wood charcoal[31] suggest a cultivation of the species at the location where it was found rather than the import of fruits.

3.2. Wild plant species

Roughly half of the plant remains (2385) belong to the wild plant category.

Amongst the 101 wild plant taxa, 22 occurred only with one single record (see table). They were excluded from statistical analysis.

The most numerous taxa belong to either the cereal weed category (large-seeded grasses which were growing with the cereals and arrived at the site as crop-processing by-products) or cannot definitely be considered as field weeds (e.g. *Rumex* sp. - dock).

Only the most numerous taxa, with changing presence throughout the Bronze Age will be discussed here.

The Early Bronze Age wild plant assemblage at Emar consists to 48% of large-seeded grasses like, *Bromus* spp., *Lolium* spp. *Eremopyrum* spp., *Hordeum spontaneum* and others, which were most likely growing with the cereals, particularly with barley.

Rumex species contribute 17% to the Early Bronze Age wild plant assemblage. These herbs of mainly open, sandy, sometimes moist habitats, were present by the thousands in sheep/goat coprolites from Tell el-'Abd,[32] emphasizing a specific way of arrival at the site different from crop weeds. Although it cannot be excluded that the *Rumex* in Emar was growing as a crop weed, there is a high probability that it arrived at the site via animal dung, which is mainly recorded in form of sheep and goat pellets from Early Bronze Age contexts. The genus is not represented in the Middle or in the Late Bronze Age contexts.

Besides these dominant taxa in the Early Bronze Age assemblage, other typical weeds reach relatively high proportions. These are *Galium* sp. (3%) and *Silene* sp. (2%). But also other taxa probably not of crop weed character were relatively frequent, as e.g. *Prosopis farcta* (2%), which indicates the presence of degraded areas.

The most numerous taxa in the Middle Bronze Age assemblage are *Phalaris* sp. (canary-grass), which are present with 35%. The plant is a low- to medium-growing (20-150 cm), small-seeded grass, mainly in disturbed, open habitats. Some species of the genus (*Ph. aquatica* L., *Ph. arundinacea* L.) are indicative of moist conditions and irrigated fields. It is interesting to note that they only occur with a few finds during the Early and the Late Bronze Age periods.

The large-seeded cereal weed grasses contribute 32% of the Middle Bronze Age assemblage.

Another species of comparatively high counts in the Middle Bronze Age contexts is *Scirpus maritimus* (club-rush, 4%). Club-rush occurs today as a weed of irrigated crops. It is highly adaptive to changing environmental conditions and tolerates changing water levels as well as slightly saline soils. It is often found at the edge of irrigation ditches. This assemblage, rich in taxa from predominantly moist habitats is in contrast to the crop assemblage, which is rich in drought-tolerant species and poor in drought-susceptible species. The combination of these two characteristics makes irrigation of the crops very likely due to increased arid conditions.

Besides the generally numerous large-seeded grasses (17%) an enriched species spectrum of weeds is present in the Late Bronze Age samples, although all in relatively low proportions.

Several taxa appear for the first time in the Late Bronze Age layers. These are typical weeds like *Valerianella* species, *Adonis* cf. *annua*, and *Fumaria officinalis*. There are also an increased number of taxa indicating the emergence of saline soils, like *Salsola kali* or the increased presence of *Aizoon hispanicum*.

30 Zohary – Hopf 2000.

31 see Deckers, this volume.

32 Riehl 2006.

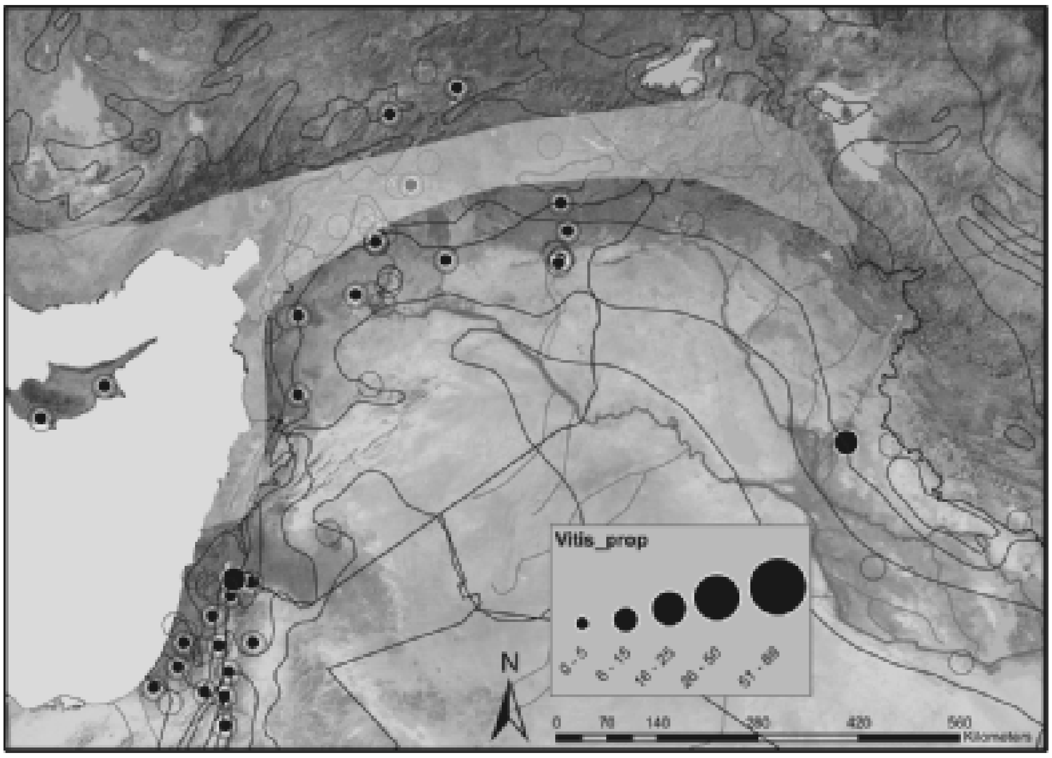

Fig. 4a: Grape proportions in Early Bronze Age Near Eastern sites; white shadow: modern natural distribution of *Vitis vinifera* subsp. *sylvestris*

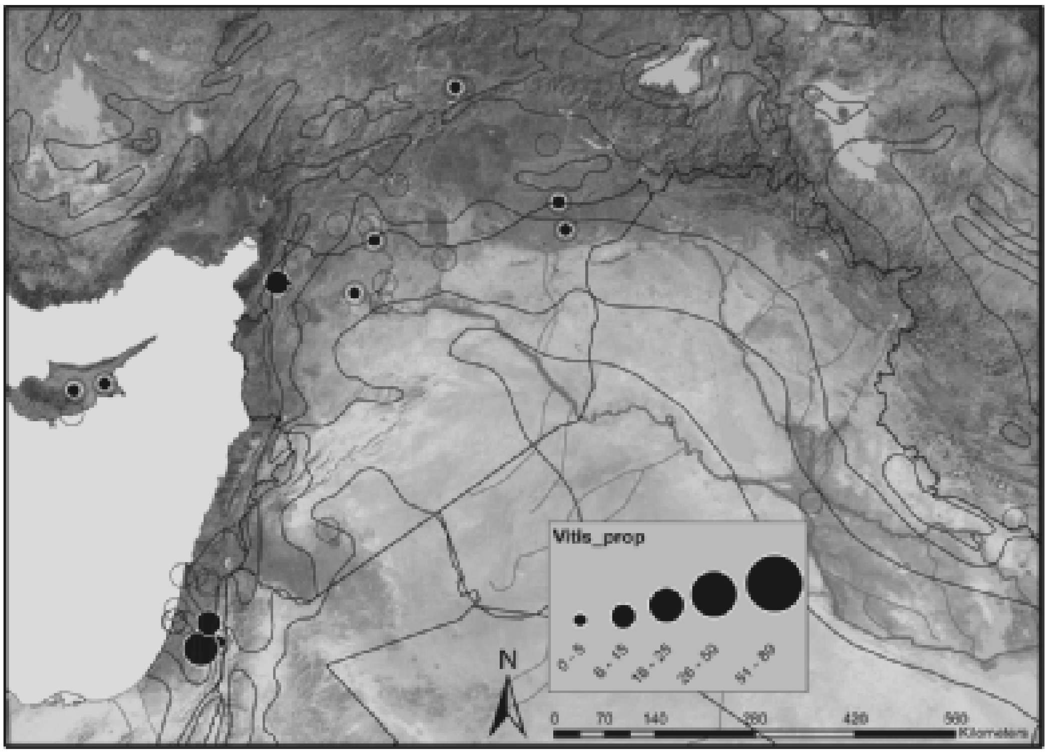

Fig. 4b: Grape proportions in Middle Bronze Age Near Eastern sites

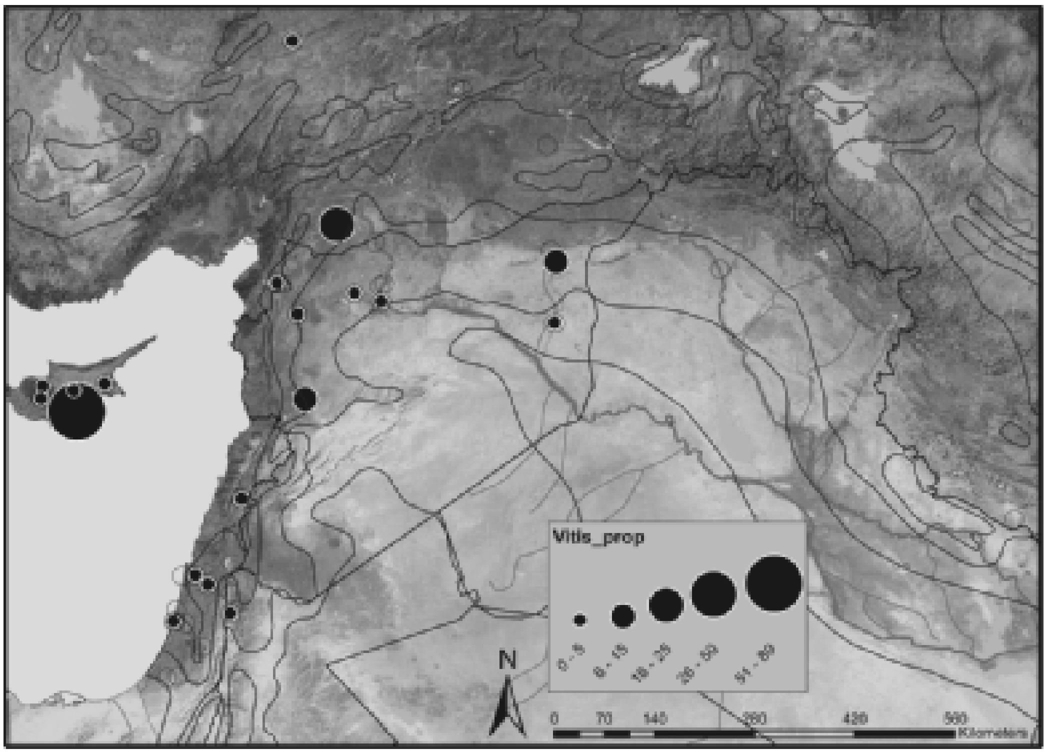

Fig. 4c: Grape proportions in Late Bronze Age Near Eastern sites

However, the taxa indicative of irrigation practice during the Middle Bronze Age are only presented with few remains in the Late Bronze Age.

The canonical correspondence analysis plot of the archaeobotanical assemblage reveals, despite a general similarity of the assemblages from different periods, the particular distinctiveness of the Middle Bronze Age data set in comparison with the Early and the Late Bronze Age data (fig. 5). Particularly a large part of the Early Bronze Age samples are relatively similar to each other (center of the diagram). The correspondence plot confirms the above described close association of *Rumex* with the Early Bronze Age samples, of moisture indicating taxa (*Phalaris* sp., *Scirpus maritimus*) with the Middle Bronze Age samples and salinity-adapted species (*Salsola kali*, *Aizoon hispanicum*) with the Late Bronze Age samples.

3.3. Stable carbon isotopes in the crop plants

Stable carbon isotopes are since recently used in archaeobotany to detect ancient moisture conditions for crop cultivation.[33] This is possible due to a positive correlation between $\delta^{13}C$ values in C3 plant tissues and available moisture. Increasing water stress leads to a reduced carbon fixation from CO_2 in the plant cells. Moisture availability during the grain-filling thus determines the range of $\delta^{13}C$, which is more negative under moist conditions and less negative under arid conditions. The fact that the CO_2 content of the atmosphere changed throughout history requires discrimination (Δ) of the values to enable time-transgressive comparisons.[34] In this case lower positive values reflect water stress.

As can be recognized in figure 6, the means of $\delta^{13}C$ in barley are slightly lower during the Middle Bronze Age, which may indicate a slightly higher water stress than during the Early and the Late Bronze Age. The ANOVA (analysis of variance) test shows however that the variation between these means is not significantly different by providing p-values (probability; p of 1-way ANOVA=0.78) not significant for discarding the null-hypothesis, which means that differences between data of the different periods may indeed not reflect differences in water availability.

Previous research on a large number of Near Eastern sites, however, demonstrated that there is indeed a significant change in moisture availability with the transition from the Early to the Middle Bronze Age in

33 e.g. Ferrio *et al*. 2005; Araus *et al*. 1997; Riehl *et al*. 2008.

34 Farquhar *et al*. 1989

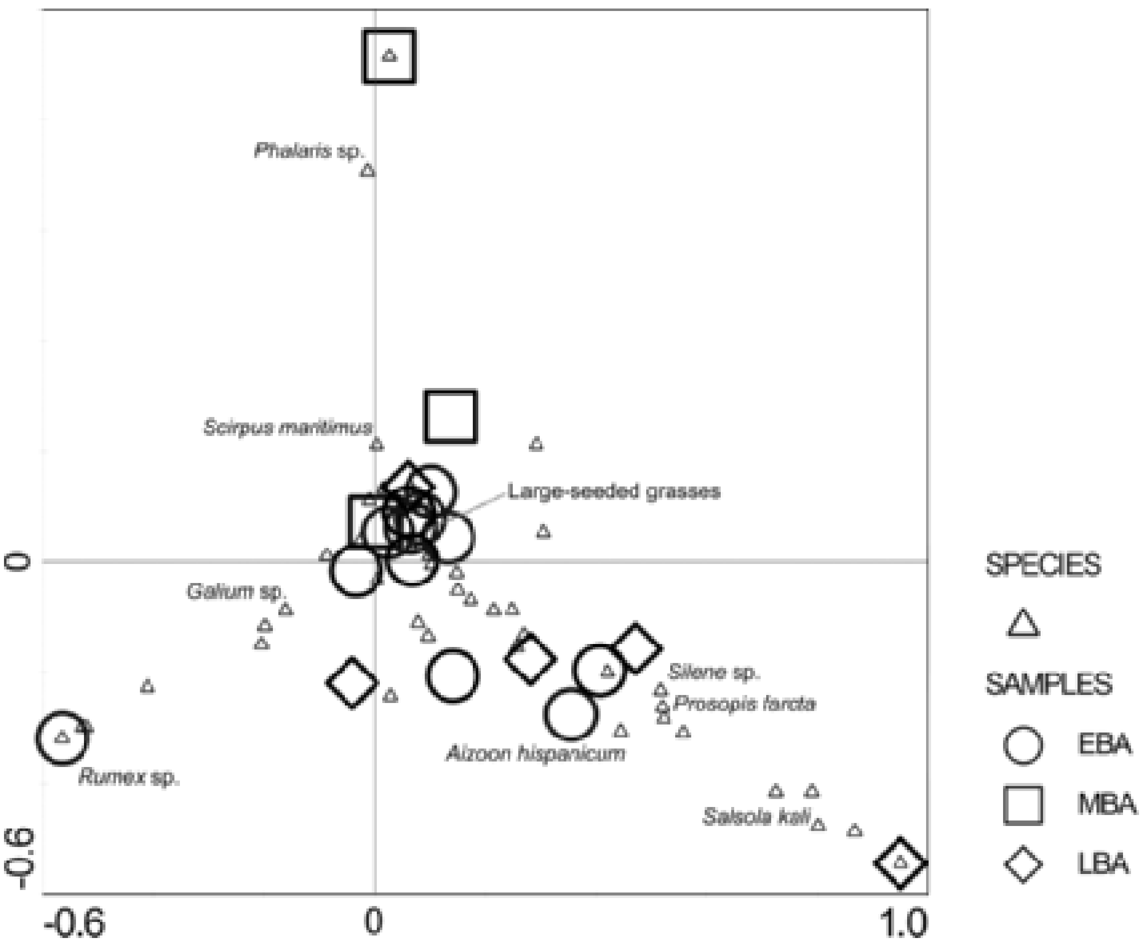

Fig. 5: Canonical correspondence analysis of the wild plant assemblages at Emar

the area.[35] The fact that this is not clearly visible in the Emar data may be related to the practice of irrigation during the Middle Bronze Age, as suggested by the wild plant assemblages.

4. Discussion

4.1. Driving forces of plant production at Emar

Barley was most likely part of the Euphrates trade, possibly not only as a trade good, but also as a currency, as it must have been the most stable plant product in the economy of the city. While city states and other settlements further to the North, the East and along the Mediterranean coast were cultivating a broader range of crops, and in particular higher proportions in wheat during the Early Bronze Age, at Emar and neighbouring settlements along the Euphrates agriculture seems to have been dominated by barley cultivation. This contrast in monopolizing on barley cultivation in comparison with the settlements in greater distance may reflect the economy distinctiveness of settlements in this area and the dependence of economy on a specific environmental potential at the same time.

The traditional orientation in culture and religion, as recognized in the Late Bronze Age archaeological evidence, may have influenced economic strategies during that period. The comparatively strong stability in agricultural production even in the Late Bronze Age may be interpreted as a sign of the liberality of the Hittites in this area or even of their understanding of the ecological diversity of their empire. Not much is known however on Hittite agro-production. The written evidence usually does not allow conclusions on proportions of actual cultivated crops in specific areas.[36] Only a few archaeobotanical investigations have been conducted

35 Riehl *et al*. 2008; Riehl 2008.

36 Hoffner 1974; Hoffner 2001.

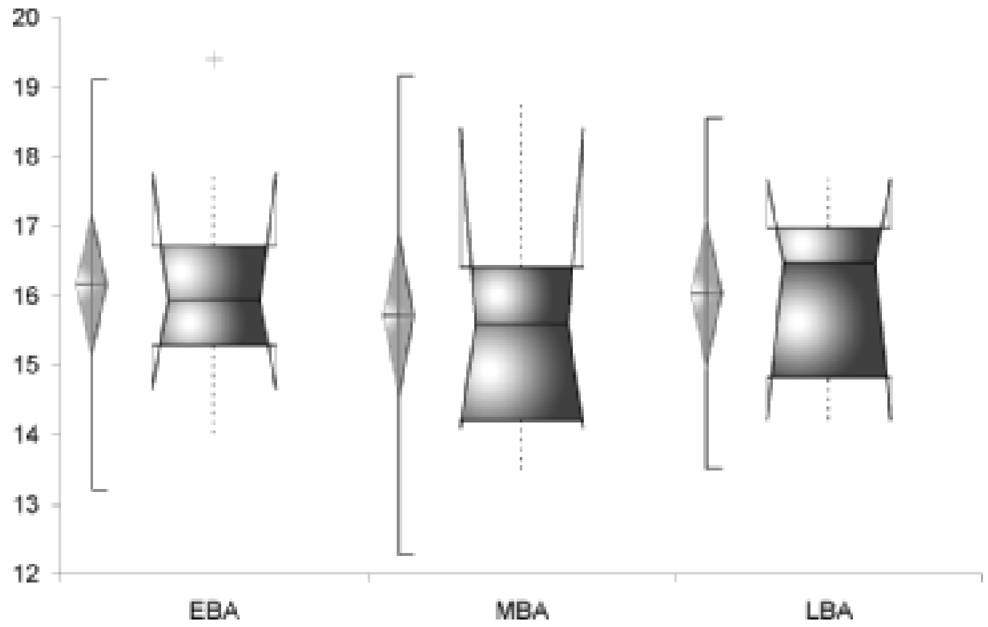

Fig. 6: $\Delta^{13}C$ values of barley from Emar throughout time. Bars show the medians with the 95% confidence level including maximum and minimum value of the data set. The diamond-shaped bars show the means and 95% confidence level. P of 1-way ANOVA = 0.78. Cross indicates potential outlier.

in the Hittite heartland, namely Bogazköy[37] and Kusakli,[38] all of which are difficult to set into a quantitative framework. Few palaeoclimate proxies[39] suffer from low chronological resolution in the recent Holocene layers. Generally any observable changes in pollen diagrams or other records in historic times are explained as signals of human impact, but how they relate to the northern Mesopotamian sites remains difficult to assess.

Despite the distinctiveness of the assemblages of the different periods at Emar, in comparison with archaeological sites further north or east[40] and within the Mediterranean ecotopes (e.g. Tell Atchana) they are relatively uniform within Emar itself as concerns change in agricultural production throughout time. This characteristic of stability in the Emar assemblage is common to a couple of other sites along the Middle Euphrates. They all are characterized by a relatively stable dominance of barley throughout the Bronze Age, signalizing a certain economic stability even in periods of critical environmental conditions like the Middle Bronze Age. This economic strategy of concentrating on barley cultivation may be described as "maximum yield under lowest risk".

During the Early and the Middle Bronze Age these production strategies may have been in relation to the general demographic patterns, which are outlined by Wilkinson.[41] While in other areas of the Syrian territory population density seems to have decreased with the transition from the Early to the Middle Bronze Age,[42] settlement density increased in the Lake Assad region with the end of the Early Bronze Age. Assuming an immigrating population from other regions during these periods the "maximum yield under lowest risk" strategy would have been most effective, and would have supported the maintenance of barley as a bulk crop.

However, for the earlier phases of the Early Bronze Age (c.2600 BC), it has been stated that agricultural conditions must have been extraordinarily favourable due to increased precipitation.[43] This was recently supported by palaeoclimate models and isotopic evidence in crop remains, which shows higher water availability during the phases II-III of the Early Bronze Age followed by a decrease in moisture towards the end of the Early Bronze Age.[44] Unfortunately it is impossible to attain such a high chronological resolution from the published archaeobotanical data, because the majority of samples are only assigned to complete periods

37 Hopf 1992; Neef 2001.

38 Pasternak 1998; 1999 and 2000.

39 e.g. Roberts et al. 2001.

40 e.g. Tell Mozan, Riehl in press a.

41 Wilkinson 2004.

42 see most recently Ristvet – Weiss 2005 for the Khabur region.

43 Akkermans – Schwartz 2003.

44 Riehl *et al*. 2008.

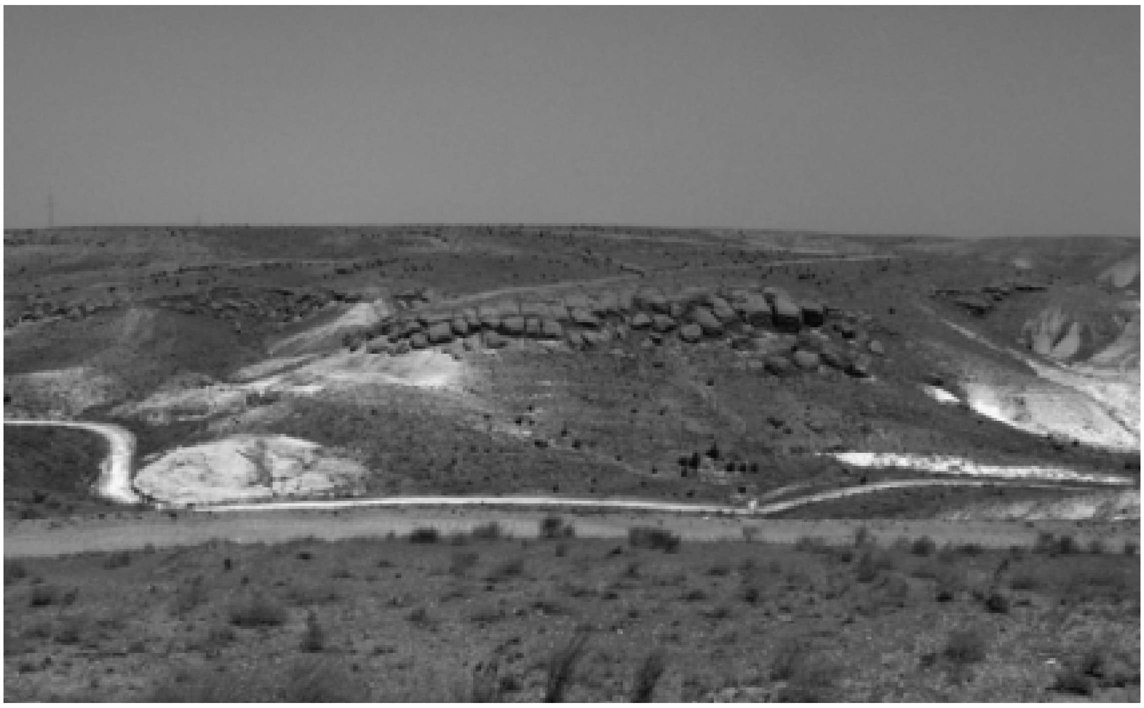

Fig. 7: Landscape at Emar

instead of being subject to direct absolute dating. Therefore, archaeobotanical assemblages deriving from different phases within a period show the mean composition for the period rather than the individual characteristics of assemblages. Particularly the long duration of the Early Bronze Age with obvious climatic fluctuations is prone to reflecting mean adaptation, thus concealing the contrast to the following or previous periods.

4.2. Agriculture and palaeoenvironmental change at Emar

The modern landscape around Emar is today amongst the most degraded in a country with already more than 80% desertification according to FAO statistics, which explains the classification of the area as so-called "badlands" (fig. 7). Potential vegetation in this area is, however, according to Hillman a terebinth-almond woodland steppe with riverine forest components, which should be present at the Euphrates,[45] and a comparatively productive landscape in terms of vegetation cover during the Early Bronze Age is also suggested by the archaeobotanical wild seed plant assemblages at Emar.

The Early Bronze Age vegetation cover was exposed to extensive environmental change throughout the Bronze Age.

While the ecological characteristics of wild plant taxa indicate the presence of moist habitats due to vegetation units that may have been more closed in the Early Bronze Age than during the following periods, the Middle Bronze Age weed taxa seem to derive from increasingly irrigated plots, which seems to continue into the Late Bronze Age with the emergence of salinity indicators. An equivalent trend is indicated in the development of woodland vegetation.[46]

There are several taxa occurring only in the Early Bronze Age samples, which suggest patches of relatively closed vegetation. *Rumex* sp., a taxon usually relatively common on sandy soils in the Mediterranean, growing under conditions which are not too arid, represents one of the most frequent finds in the Early Bronze Age samples at Emar. It is only recorded with a few specimens in the later dating samples.

Blackberry (*Rubus* spp.) usually grows at the edge of forests and its presence in the Early Bronze Age samples from Emar needs to be discussed. There are no representatives of the genus today that grow in the territory of the Syrian Euphrates. The only two species (*Rubus canescens* DC. and *Rubus ulmifolius* Schott) with a distribution in SW Asia are restricted to the coastal regions and the higher altitudes in the

[45] Hillman in Moore *et al*. 2000.

[46] see Deckers this volume.

mountainous area to the north.[47] There are at least two possible explanations for the findings. Either the landscape was very similar to the modern Mediterranean landscape or the mountainous areas in southern Turkey due to higher precipitation and denser vegetation cover, or the *Rubus* nutlets were derived from animal dung and were brought into the settlement by mobile sheep or goat flocks from very distant regions (> 150 km).

The fact that high amounts of *Populus/Salix* (poplar/willow) and *Tamarix* (tamarisk), *Alnus* (alder), *Ulmus* (elm), *Phragmites* (common reed), and *Platanus* (plane) are present in the anthracological assemblage[48] strongly supports the former argument and the existence of extensive riverine gallery forest with adequate habitats for genera like *Rubus* and *Rumex*. The fact that free-threshing wheat and grape proportions are higher during the Early Bronze Age than in the following period and the comparatively high -$\Delta^{13}C$ values of barley give additional support to good water availability.

The crop and wild plant assemblages of the Middle Bronze Age samples are in strong contrast to the Early Bronze Age assemblages. Not only are barley proportions slightly higher during the Middle Bronze Age, but also the more water demanding crops of free-threshing wheat, grape, and olive were no longer cultivated during this period. Although the $\Delta^{13}C$ values of barley are not significantly lower than in the previous period and suggest irrigation to a certain degree also by the presence of water indicators such as *Scirpus maritimus*, irrigation water seems not to have been sufficient for sustaining wheat, grape and olive cultivation. The anthracological results support this model with particularly higher proportions in *Tamarix* sp. and *Lycium* sp.[49] In general the archaeobotanical and geochemical results fit very well the palaeoclimate proxies of the area,[50] and are also in agreement with the palaeoclimate model conducted by the author[51] in using the macrophysical climate model developed by Bryson.[52]

In the Late Bronze Age at the latest continuous irrigation must have released environmental problems such as widespread salinization, which is evident by the first presence of salinity indicators such as *Salsola kali* and *Aizoon hispanicum*. However, irrigation enabled the cultivation of fruit trees and free-threshing wheat to a certain amount. Also the $\Delta^{13}C$ values of barley are slightly higher than in the Middle Bronze Age indicating slightly increased water availability during the Late Bronze Age. Relatively high proportions in grape seeds suggest a comparatively strong focus on this crop, which may be supported by the textual evidence.[53]

These results may be supported by higher *Salix/Populus* charcoal proportions during this period and the fact that the environment sustained Mesopotamian fallow deer (*Dama mesopotamica*) as identified in the zooarchaeological remains from this period.[54]

5. Conclusions

The archaeobotanical assemblage from Emar reflects a specific ecological and economic pattern in agreement with other sites of the area of the middle Euphrates.

Increasing aridity with the end of the Early Bronze Age and the beginning of the Middle Bronze Age, which led to the abandonment of settlements in various places, and in particular in the Khabur area, did not ruin the economic basis at Emar due to a persistent "maximum yield under lowest risk" strategy by focusing on barley cultivation throughout the Bronze Age.

Drought-susceptible crops such as free-threshing wheat and grape were abandoned during the Middle Bronze Age, and irrigation of at least some crops was practiced. This wise adaptation to increased aridity during the Middle Bronze Age and the genuine link to earlier traditions with increased cultivation of grape during the Late Bronze Age enabled the maintenance of a relatively stable economy at Emar throughout the Bronze Age.

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47 Browicz 1994.
48 see Deckers this volume.
49 see Deckers this volume.
50 Bar-Matthews 2003; Lemcke – Sturm 1997.
51 Riehl *et al.* 2008.
52 Bryson – DeWall 2007.
53 Beckmann 1996; Westenholz 2000.
54 Gündem – Uerpmann 2003.

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Appendix:

			Emar 1999	Emar 1999	Emar 1999	Emar 1999	Emar 1999	Emar 1999
		sample no.	BP01-1	BP01-2	BP02	BP03	BP04	BP05-1
		areal	60/52-51	60/52-51	73/52-20	74/52-42	59/52-10	63/50-91
		sedim. vol. ml						2000
		dating	EBA	EBA	LBA	LBA	LBA	EBA
crops		**plant part**						**B**
Fabaceae	cf. *Lens* sp.	seed/grain						
Fabaceae	*Cicer arietinum*	seed/grain						
Fabaceae	*Lathyrus sativus/cicera*	seed/grain						
Fabaceae	*Lens culinaris*	seed/grain						
Fabaceae	*Vicia / Lathyrus*	seed/grain		6		2		
Fabaceae	*Vicia ervilia*	seed/grain						
Moraceae	*Ficus carica*	seed/grain				5		2
Oleaceae	*Olea europaea*	pip						
Poaceae	Cerealia	seed/grain		1	1	1		
Poaceae	Cerealia, culm fragments	chaff	59	67		1	10	7
Poaceae	Cerealia, rachis	chaff	15					
Poaceae	Cerealia, root segments	chaff		1				
Poaceae	*Hordeum* cf. *vulgare*, twisted	seed/grain						
Poaceae	*Hordeum* sp., rachis	chaff		92				
Poaceae	*Hordeum vulgare* cf. *vulgare*	seed/grain						
Poaceae	*Hordeum vulgare distichum*, rachis	chaff	196	78		3	6	21
Poaceae	*Hordeum vulgare vulgare*, rachis	chaff	1	1				
Poaceae	*Hordeum vulgare*	seed/grain	33	50	2	12		13
Poaceae	*Hordeum vulgare*, rachis	chaff						
Poaceae	*Triticum aestivum/durum*	seed/grain						
Poaceae	*Triticum aestivum/durum*, rachis	chaff						
Poaceae	*Triticum dicoccum*, glume base	chaff						
Poaceae	*Triticum dicoccum/monococcum*, gb	chaff		2				
Poaceae	*Triticum* sp.	seed/grain						
Poaceae	*Triticum turgidum*, free-threshing	seed/grain						
Vitaceae	*Vitis vinifera*	pip				5		

			Emar 1999	Emar 1999	Emar 1999	Emar 1999	Emar 1999	Emar 1999
		sample no.	BP01-1	BP01-2	BP02	BP03	BP04	BP05-1
		areal	60/52-51	60/52-51	73/52-20	74/52-42	59/52-10	63/50-91
		sedim. vol. ml						2000
		dating	EBA	EBA	LBA	LBA	LBA	EBA
wild plant taxa								
Aizoaceae	*Aizoon hispanicum*	seed/grain						3
Apiaceae	*Bupleurum sp.*	seed/grain						
Apiaceae	*Torilis* sp.	seed/grain						
Asteraceae	*Anthemis cotula*	seed/grain						
Asteraceae	*Anthemis* sp.	seed/grain						1
Asteraceae	*Carthamus* sp.	seed/grain	1					
Asteraceae	Compositae	seed/grain						
Asteraceae	Compositae	flowers	1					
Boraginaceae	*Arnebia* cf. *decumbens*, uvk	seed/grain						
Boraginaceae	*Arnebia* cf. *decumbens*, vk	seed/grain						
Boraginaceae	*Echium* sp.	seed/grain	1					2
Boraginaceae	*Lithospermum arvense*, uvk	seed/grain						
Boraginaceae	*Lithospermum arvense*, vk	seed/grain						
Boraginaceae	*Lithospermum* sp., uvk	seed/grain		1	1	4		
Boraginaceae	*Lithospermum tenuiflorum*, uvk	seed/grain	1	5		1		
Boraginaceae	*Lithospermum tenuiflorum*, vk	seed/grain						
Brassicaceae	*Brassica* sp.	seed/grain						
Brassicaceae	Brassicaceae	seed/grain						
Brassicaceae	*Bunias erucago*	seed/grain						
Brassicaceae	*Cardaminopsis* type	seed/grain	1					
Brassicaceae	*Lepidium* type	seed/grain		1				
Brassicaceae	*Sisymbrium/Diplotaxis* type	seed/grain		1				
Caryophyllaceae	*Arenaria* sp.	seed/grain						
Caryophyllaceae	Caryophyllaceae	seed/grain	3	1				1

			Emar 1999	Emar 1999	Emar 1999	Emar 1999	Emar 1999	Emar 1999
		sample no.	BP01-1	BP01-2	BP02	BP03	BP04	BP05-1
		areal	60/52-51	60/52-51	73/52-20	74/52-42	59/52-10	63/50-91
		sedim. vol. ml						2000
		dating	EBA	EBA	LBA	LBA	LBA	EBA
Caryophyllaceae	Chenopodiac./Caryoph., endosperm	seed/grain						
Caryophyllaceae	*Gypsophila* spp.	seed/grain	3	3		2		8
Caryophyllaceae	*Silene* sp.	seed/grain	5	6				4
Chenopodiaceae	*Atriplex rosea*	seed/grain						
Chenopodiaceae	*Atriplex* sp.	fruit						
Chenopodiaceae	*Beta vulgaris*	seed/grain						
Chenopodiaceae	*Chenopodium* cf. *murale*	seed/grain		4				
Chenopodiaceae	*Chenopodium* sp.	seed/grain		1	1	1		
Chenopodiaceae	*Salsola kali*	seed/grain						
Chenopodiaceae	*Suaeda* sp.	seed/grain	1					
Cistaceae	*Helianthemum* sp.	seed/grain						
Cyperaceae	Cyperaceae	seed/grain				2		1
Cyperaceae	Cyperaceae, endosperm	seed/grain						
Cyperaceae	*Cyperus longus*	seed/grain						
Cyperaceae	*Scirpus maritimus*	seed/grain			2			
Fabaceae	*Astragalus* sp.	seed/grain		1				
Fabaceae	*Coronilla* sp.	seed/grain	3					
Fabaceae	*Hippocrepis* sp.	seed/grain						
Fabaceae	Fabaceae, large-seeded	seed/grain	6					
Fabaceae	Fabaceae, small-seeded	seed/grain	17	5		1		14
Fabaceae	*Medicago* type	seed/grain						4
Fabaceae	*Melilotus* cf. *officinalis*	seed/grain						
Fabaceae	*Onobrychis* sp.	seed/grain						
Fabaceae	*Prosopis farcta*	seed/grain		2				8
Fabaceae	*Trifolium* sp.	seed/grain						
Fabaceae	*Trigonella* sp.	seed/grain	2	7				
Lamiaceae	*Ajuga* sp.	seed/grain						
Lamiaceae	Lamiaceae	seed/grain						

			Emar 1999	Emar 1999	Emar 1999	Emar 1999	Emar 1999	Emar 1999
		sample no.	BP01-1	BP01-2	BP02	BP03	BP04	BP05-1
		areal	60/52-51	60/52-51	73/52-20	74/52-42	59/52-10	63/50-91
		sedim. vol. ml						2000
		dating	EBA	EBA	LBA	LBA	LBA	EBA
Liliaceae	cf. *Allium* sp.	seed/grain	3					
Liliaceae	*Ornithogalum/Muscari*	seed/grain						
Malvaceae	*Malva* cf. *parviflora*	seed/grain						
Malvaceae	*Malva* sp.	seed/grain		1		3		
Papaveraceae	*Fumaria officinalis*	seed/grain						
Papaveraceae	*Glaucium* sp.	seed/grain	1					
Papaveraceae	*Papaver* sp.	seed/grain		1				
Papaveraceae	Papaveraceae	seed/grain						
Plantaginaceae	*Plantago* sp.	seed/grain						
Poaceae	*Aegilops* sp.	seed/grain	3					3
Poaceae	*Aegilops* sp., glume base	chaff	1			1		
Poaceae	*Bromus* spp.	seed/grain	31	9				
Poaceae	c f. *Alopecurus* sp.	seed/grain						
Poaceae	*Eremopyrum* sp.	seed/grain	16	10		1	1	3
Poaceae	*Hordeum* cf. *spontaneum*	seed/grain	8					
Poaceae	*Hordeum spontaneum*, rachis	chaff	3	9				
Poaceae	*Hordeum* spp., wild	seed/grain	19	22		4		4
Poaceae	*Lolium* sp.	seed/grain		1				
Poaceae	*Phalaris* sp.	seed/grain		3				1
Poaceae	*Phragmites* type	seed/grain	8		1			
Poaceae	*Poa* type	seed/grain	10	1				20
Poaceae	Poaceae, culm node	chaff						
Poaceae	Poaceae, large	seed/grain	32	41		13		
Poaceae	Poaceae, medium	seed/grain						
Poaceae	Poaceae, small-seeded	seed/grain	11	6	1			

			Emar 1999	Emar 1999	Emar 1999	Emar 1999	Emar 1999	Emar 1999
		sample no.	BP01-1	BP01-2	BP02	BP03	BP04	BP05-1
		areal	60/52-51	60/52-51	73/52-20	74/52-42	59/52-10	63/50-91
		sedim. vol. ml						2000
		dating	EBA	EBA	LBA	LBA	LBA	EBA
Poaceae	*Setaria* sp.	seed/grain						
Polygonaceae	Polygonaceae	seed/grain		9				
Polygonaceae	*Polygonum* sp.	seed/grain	1	2				2
Polygonaceae	*Rumex* sp.	seed/grain	4	5		1		1
Portulacaceae	*Portulaca* sp.	seed/grain						
Primulaceae	*Androsace maxima*	seed/grain		3				1
Primulaceae	Primulaceae	seed/grain	1					
Ranunculaceae	*Adonis* cf. *annua*	seed/grain						
Resedaceae	*Reseda lutea*	seed/grain						
Resedaceae	*Reseda luteola*	seed/grain						
Rosaceae	*Rubus* sp.	seed/grain						
Rubiaceae	*Galium* spp.	seed/grain	4	2		3		
Rubiaceae	*Galium spurium*	seed/grain						
Rubiaceae	*Rubia* sp.	seed/grain						
Scrophulariaceae	*Verbascum* sp., capsule	capsule						
Scrophulariaceae	*Veronica persica*	seed/grain		1				
Thymelaeaceae	*Thymelaea* sp.	seed/grain						
Valerianaceae	*Valerianella* cf. *lasiocarpa*	seed/grain						
Valerianaceae	*Valerianella dentata*	seed/grain						
Valerianaceae	*Valerianella vesicaria* type	seed/grain						
Verbenaceae	cf. *Verbena* sp.	seed/grain						
	cf. Nußschale	seed/grain		2				
	Crucianella/Plantago	seed/grain						
	Cyperaceae/Polygonaceae	seed/grain						
	flower buds	flowers						
	indets.	seed/grain	10	24		7		4
	beetle indet., head			1				
	coprolites (mouse)		2					
	coprolites (sheep/goat)		7	24				1
	Sitophilus granarius		1					

			Emar 1999	Emar 1999	Emar 1999	Emar 2001	Emar 2001	Emar 2001
		sample no.	BP05-2	BP06	BP07	BP06	BP08	BP09
		areal	63/50-91	75/55-69	74/52-31	61/51-56	65/53-53	65/53-57
		sedim. vol. ml	2000	6500	300	?		
		dating	EBA	MBA/LBA	LBA	EBA IVB	LBA-MBA??	LBA?
crops		**plant part**	**A**					
Fabaceae	cf. *Lens* sp.	seed/grain						
Fabaceae	*Cicer arietinum*	seed/grain						
Fabaceae	*Lathyrus sativus/cicera*	seed/grain						
Fabaceae	*Lens culinaris*	seed/grain						
Fabaceae	*Vicia / Lathyrus*	seed/grain						
Fabaceae	*Vicia ervilia*	seed/grain						
Moraceae	*Ficus carica*	seed/grain	1	1				
Oleaceae	*Olea europaea*	pip						
Poaceae	Cerealia	seed/grain						
Poaceae	Cerealia, culm fragments	chaff	5					
Poaceae	Cerealia, rachis	chaff						
Poaceae	Cerealia, root segments	chaff						
Poaceae	*Hordeum* cf. *vulgare*, twisted	seed/grain						
Poaceae	*Hordeum* sp., rachis	chaff		4	1			
Poaceae	*Hordeum vulgare* cf. *vulgare*	seed/grain						
Poaceae	*Hordeum vulgare distichum*, rachis	chaff	32					
Poaceae	*Hordeum vulgare vulgare*, rachis	chaff	1					
Poaceae	*Hordeum vulgare*	seed/grain	15	19	4	11	2	2
Poaceae	*Hordeum vulgare,* rachis	chaff						
Poaceae	*Triticum aestivum/durum*	seed/grain						
Poaceae	*Triticum aestivum/durum*, rachis	chaff						
Poaceae	*Triticum dicoccum*, glume base	chaff						
Poaceae	*Triticum dicoccum/monococcum*, gb	chaff				1		
Poaceae	*Triticum* sp.	seed/grain						

			Emar 1999	Emar 1999	Emar 1999	Emar 2001	Emar 2001	Emar 2001
		sample no.	BP05-2	BP06	BP07	BP06	BP08	BP09
		areal	63/50-91	75/55-69	74/52-31	61/51-56	65/53-53	65/53-57
		sedim. vol. ml	2000	6500	300	?		
		dating	EBA	MBA/LBA	LBA	EBA IVB	LBA-MBA??	LBA?
Poaceae	*Triticum turgidum*, free-threshing	seed/grain						
Vitaceae	*Vitis vinifera*	pip		6				
wild plant taxa								
Aizoaceae	*Aizoon hispanicum*	seed/grain				7		
Apiaceae	*Bupleurum* sp.	seed/grain						
Apiaceae	*Torilis* sp.	seed/grain						
Asteraceae	*Anthemis cotula*	seed/grain						
Asteraceae	*Anthemis* sp.	seed/grain						
Asteraceae	*Carthamus* sp.	seed/grain						
Asteraceae	Compositae	seed/grain						
Asteraceae	Compositae	flowers						
Boraginaceae	*Arnebia* cf. *decumbens*, uvk	seed/grain						
Boraginaceae	*Arnebia* cf. *decumbens*, vk	seed/grain						
Boraginaceae	*Echium* sp.	seed/grain		2	5			
Boraginaceae	*Lithospermum arvense*, uvk	seed/grain				7		
Boraginaceae	*Lithospermum arvense*, vk	seed/grain						
Boraginaceae	*Lithospermum* sp., uvk	seed/grain		1				
Boraginaceae	*Lithospermum tenuiflorum*, uvk	seed/grain	6			3	1	
Boraginaceae	*Lithospermum tenuiflorum*, vk	seed/grain					1	
Brassicaceae	*Brassica* sp.	seed/grain						
Brassicaceae	Brassicaceae	seed/grain			1			
Brassicaceae	*Bunias erucago*	seed/grain						
Brassicaceae	*Cardaminopsis* type	seed/grain						
Brassicaceae	*Lepidium* type	seed/grain						
Brassicaceae	*Sisymbrium/Diplotaxis* type	seed/grain						

			Emar 1999	Emar 1999	Emar 1999	Emar 2001	Emar 2001	Emar 2001
		sample no.	BP05-2	BP06	BP07	BP06	BP08	BP09
		areal	63/50-91	75/55-69	74/52-31	61/51-56	65/53-53	65/53-57
		sedim. vol. ml	2000	6500	300	?		
		dating	EBA	MBA/LBA	LBA	EBA IVB	LBA-MBA??	LBA?
Caryophyllaceae	*Arenaria* sp.	seed/grain						
Caryophyllaceae	Caryophyllaceae	seed/grain		1		1		
Caryophyllaceae	Chenopodiac./Caryoph., endosperm	seed/grain						
Caryophyllaceae	*Gypsophila* spp.	seed/grain						
Caryophyllaceae	*Silene* sp.	seed/grain	1			1		
Chenopodiaceae	*Atriplex rosea*	seed/grain						
Chenopodiaceae	*Atriplex* sp.	fruit						
Chenopodiaceae	*Beta vulgaris*	seed/grain						
Chenopodiaceae	*Chenopodium* cf. *murale*	seed/grain						
Chenopodiaceae	*Chenopodium* sp.	seed/grain						
Chenopodiaceae	*Salsola kali*	seed/grain						
Chenopodiaceae	*Suaeda* sp.	seed/grain						
Cistaceae	*Helianthemum* sp.	seed/grain						
Cyperaceae	Cyperaceae	seed/grain	1					
Cyperaceae	Cyperaceae, endosperm	seed/grain						
Cyperaceae	*Cyperus longus*	seed/grain						
Cyperaceae	*Scirpus maritimus*	seed/grain						
Fabaceae	*Astragalus* sp.	seed/grain				1		
Fabaceae	*Coronilla* sp.	seed/grain						
Fabaceae	*Hippocrepis* sp.	seed/grain						
Fabaceae	Fabaceae, large-seeded	seed/grain				2		
Fabaceae	Fabaceae, small-seeded	seed/grain	4	5		2		
Fabaceae	*Medicago* type	seed/grain						
Fabaceae	*Melilotus* cf. *officinalis*	seed/grain						
Fabaceae	*Onobrychis* sp.	seed/grain				1		
Fabaceae	*Prosopis farcta*	seed/grain				1		
Fabaceae	*Trifolium* sp.	seed/grain						
Fabaceae	*Trigonella* sp.	seed/grain	1					

			Emar 1999	Emar 1999	Emar 1999	Emar 2001	Emar 2001	Emar 2001
		sample no.	BP05-2	BP06	BP07	BP06	BP08	BP09
		areal	63/50-91	75/55-69	74/52-31	61/51-56	65/53-53	65/53-57
		sedim. vol. ml	2000	6500	300	?		
		dating	EBA	MBA/LBA	LBA	EBA IVB	LBA-MBA??	LBA?
Lamiaceae	*Ajuga* sp.	seed/grain						
Lamiaceae	Lamiaceae	seed/grain						
Liliaceae	cf. *Allium* sp.	seed/grain						
Liliaceae	*Ornithogalum/Muscari*	seed/grain						
Malvaceae	*Malva* cf. *parviflora*	seed/grain						
Malvaceae	*Malva* sp.	seed/grain						1
Papaveraceae	*Fumaria officinalis*	seed/grain						
Papaveraceae	*Glaucium* sp.	seed/grain						
Papaveraceae	*Papaver* sp.	seed/grain						
Papaveraceae	Papaveraceae	seed/grain						
Plantaginaceae	*Plantago* sp.	seed/grain		1				
Poaceae	*Aegilops* sp.	seed/grain		1		1		1
Poaceae	*Aegilops* sp., glume base	chaff	1					
Poaceae	*Bromus* spp.	seed/grain	4	1				
Poaceae	cf. *Alopecurus* sp.	seed/grain						
Poaceae	*Eremopyrum* sp.	seed/grain	8					
Poaceae	*Hordeum* cf. *spontaneum*	seed/grain						
Poaceae	*Hordeum spontaneum*, rachis	chaff	1					
Poaceae	*Hordeum* spp., wild	seed/grain	6			7		
Poaceae	*Lolium* sp.	seed/grain						
Poaceae	*Phalaris* sp.	seed/grain	2	3		1		
Poaceae	*Phragmites* type	seed/grain						
Poaceae	*Poa* type	seed/grain						
Poaceae	Poaceae, culm node	chaff						
Poaceae	Poaceae, large	seed/grain	25	9				1
Poaceae	Poaceae, medium	seed/grain				1	1	
Poaceae	Poaceae, small-seeded	seed/grain	20		1			
Poaceae	*Setaria* sp.	seed/grain						

			Emar 1999	Emar 1999	Emar 1999	Emar 2001	Emar 2001	Emar 2001
		sample no.	BP05-2	BP06	BP07	BP06	BP08	BP09
		areal	63/50-91	75/55-69	74/52-31	61/51-56	65/53-53	65/53-57
		sedim. vol. ml	2000	6500	300	?		
		dating	EBA	MBA/LBA	LBA	EBA IVB	LBA-MBA??	LBA?
Polygonaceae	Polygonaceae	seed/grain						
Polygonaceae	*Polygonum* sp.	seed/grain						
Polygonaceae	*Rumex* sp.	seed/grain				4		
Portulacaceae	*Portulaca* sp.	seed/grain						
Primulaceae	*Androsace maxima*	seed/grain	3					
Primulaceae	Primulaceae	seed/grain						
Ranunculaceae	*Adonis* cf. *annua*	seed/grain	3					
Resedaceae	*Reseda lutea*	seed/grain				1		
Resedaceae	*Reseda luteola*	seed/grain	1					
Rosaceae	*Rubus* sp.	seed/grain						
Rubiaceae	*Galium* spp.	seed/grain	5	1		2		
Rubiaceae	*Galium spurium*	seed/grain						
Rubiaceae	*Rubia* sp.	seed/grain		1				
Scrophulariaceae	*Verbascum* sp., capsule	capsule						
Scrophulariaceae	*Veronica persica*	seed/grain	2					
Thymelaeaceae	*Thymelaea* sp.	seed/grain		1				
Valerianaceae	*Valerianella* cf. *lasiocarpa*	seed/grain						
Valerianaceae	*Valerianella dentata*	seed/grain						
Valerianaceae	*Valerianella vesicaria* type	seed/grain						
Verbenaceae	cf. *Verbena* sp.	seed/grain						
	cf. Nußschale	seed/grain						
	Crucianella/Plantago	seed/grain						
	Cyperaceae/Polygonaceae	seed/grain						
	flower buds	flowers						
	indets.	seed/grain	5	12	4	5		
	beetle indet., head							
	coprolites (mouse)							
	coprolites (sheep/goat)			1				
	Sitophilus granarius							

			Emar 2001	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP11	BP01	BP02	BP03	BP05	BP06
		areal	65/53-52	58/52-18	75/52-26C1	75/52-26C2	72/50-15	72/52-62
		sedim. vol. ml			1000		2000	2000
		dating	LBA?	LBA	LBA	LBA	LBA	LBA
crops		**plant part**						
Fabaceae	cf. *Lens* sp.	seed/grain						
Fabaceae	*Cicer arietinum*	seed/grain						
Fabaceae	*Lathyrus sativus/cicera*	seed/grain						
Fabaceae	*Lens culinaris*	seed/grain						
Fabaceae	*Vicia / Lathyrus*	seed/grain						
Fabaceae	*Vicia ervilia*	seed/grain						
Moraceae	*Ficus carica*	seed/grain				3		
Oleaceae	*Olea europaea*	pip						
Poaceae	Cerealia	seed/grain		4	2	7		
Poaceae	Cerealia, culm fragments	chaff			4			
Poaceae	Cerealia, rachis	chaff		3				
Poaceae	Cerealia, root segments	chaff						
Poaceae	*Hordeum* cf. *vulgare*, twisted	seed/grain						
Poaceae	*Hordeum* sp., rachis	chaff						
Poaceae	*Hordeum vulgare* cf. *vulgare*	seed/grain						
Poaceae	*Hordeum vulgare distichum*, rachis	chaff			26	14		
Poaceae	*Hordeum vulgare vulgare*, rachis	chaff						
Poaceae	*Hordeum vulgare*	seed/grain		17		8	2	
Poaceae	*Hordeum vulgare*, rachis	chaff						
Poaceae	*Triticum aestivum/durum*	seed/grain						
Poaceae	*Triticum aestivum/durum*, rachis	chaff					1	
Poaceae	*Triticum dicoccum*, glume base	chaff						
Poaceae	*Triticum dicoccum/monococcum*, gb	chaff						
Poaceae	*Triticum* sp.	seed/grain						

			Emar 2001	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP11	BP01	BP02	BP03	BP05	BP06
		areal	65/53-52	58/52-18	75/52-26C1	75/52-26C2	72/50-15	72/52-62
		sedim. vol. ml			1000		2000	2000
		dating	LBA?	LBA	LBA	LBA	LBA	LBA
Poaceae	*Triticum turgidum*, free-threshing	seed/grain						
Vitaceae	*Vitis vinifera*	pip					1	
wild plant taxa								
Aizoaceae	*Aizoon hispanicum*	seed/grain				330 (ev. modern)		
Apiaceae	*Bupleurum* sp.	seed/grain						
Apiaceae	*Torilis* sp.	seed/grain						
Asteraceae	*Anthemis cotula*	seed/grain						
Asteraceae	*Anthemis* sp.	seed/grain						
Asteraceae	*Carthamus* sp.	seed/grain						
Asteraceae	Compositae	seed/grain						
Asteraceae	Compositae	flowers						
Boraginaceae	*Arnebia* cf. *decumbens*, uvk	seed/grain		4	17	13		
Boraginaceae	*Arnebia* cf. *decumbens*, vk	seed/grain						
Boraginaceae	*Echium* sp.	seed/grain						
Boraginaceae	*Lithospermum arvense*, uvk	seed/grain				2		
Boraginaceae	*Lithospermum arvense*, vk	seed/grain						
Boraginaceae	*Lithospermum* sp., uvk	seed/grain						
Boraginaceae	*Lithospermum tenuiflorum*, uvk	seed/grain		11	2			
Boraginaceae	*Lithospermum tenuiflorum*, vk	seed/grain						
Brassicaceae	*Brassica* sp.	seed/grain						
Brassicaceae	Brassicaceae	seed/grain			1			
Brassicaceae	*Bunias erucago*	seed/grain						
Brassicaceae	*Cardaminopsis* type	seed/grain						
Brassicaceae	*Lepidium* type	seed/grain						
Brassicaceae	*Sisymbrium/Diplotaxis* type	seed/grain						
Caryophyllaceae	*Arenaria* sp.	seed/grain						

			Emar 2001	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP11	BP01	BP02	BP03	BP05	BP06
		areal	65/53-52	58/52-18	75/52-26C1	75/52-26C2	72/50-15	72/52-62
		sedim. vol. ml			1000		2000	2000
		dating	LBA?	LBA	LBA	LBA	LBA	LBA
Caryophyllaceae	Caryophyllaceae	seed/grain						
Caryophyllaceae	Chenopodiac./Caryoph., endosperm	seed/grain						
Caryophyllaceae	*Gypsophila* spp.	seed/grain						
Caryophyllaceae	*Silene* sp.	seed/grain						
Chenopodiaceae	*Atriplex rosea*	seed/grain						
Chenopodiaceae	*Atriplex* sp.	fruit						
Chenopodiaceae	*Beta vulgaris*	seed/grain						
Chenopodiaceae	*Chenopodium* cf. *murale*	seed/grain						
Chenopodiaceae	*Chenopodium* sp.	seed/grain						
Chenopodiaceae	*Salsola kali*	seed/grain	2					
Chenopodiaceae	*Suaeda* sp.	seed/grain						
Cistaceae	*Helianthemum* sp.	seed/grain				2		
Cyperaceae	Cyperaceae	seed/grain				2		
Cyperaceae	Cyperaceae, endosperm	seed/grain						
Cyperaceae	*Cyperus longus*	seed/grain						
Cyperaceae	*Scirpus maritimus*	seed/grain		1				
Fabaceae	*Astragalus* sp.	seed/grain						
Fabaceae	*Coronilla* sp.	seed/grain						
Fabaceae	*Hippocrepis* sp.	seed/grain						
Fabaceae	Fabaceae, large-seeded	seed/grain						
Fabaceae	Fabaceae, small-seeded	seed/grain	1		1	3		
Fabaceae	*Medicago* type	seed/grain						
Fabaceae	*Melilotus* cf. *officinalis*	seed/grain				1		
Fabaceae	*Onobrychis* sp.	seed/grain						
Fabaceae	*Prosopis farcta*	seed/grain						
Fabaceae	*Trifolium* sp.	seed/grain						
Fabaceae	*Trigonella* sp.	seed/grain						
Lamiaceae	*Ajuga* sp.	seed/grain						
Lamiaceae	Lamiaceae	seed/grain						

			Emar 2001	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP11	BP01	BP02	BP03	BP05	BP06
		areal	65/53-52	58/52-18	75/52-26C1	75/52-26C2	72/50-15	72/52-62
		sedim. vol. ml			1000		2000	2000
		dating	LBA?	LBA	LBA	LBA	LBA	LBA
Liliaceae	cf. *Allium* sp.	seed/grain						
Liliaceae	*Ornithogalum/Muscari*	seed/grain						
Malvaceae	*Malva* cf. *parviflora*	seed/grain			3			
Malvaceae	*Malva* sp.	seed/grain				3		
Papaveraceae	*Fumaria officinalis*	seed/grain						
Papaveraceae	*Glaucium* sp.	seed/grain						
Papaveraceae	*Papaver* sp.	seed/grain						
Papaveraceae	Papaveraceae	seed/grain						
Plantaginaceae	*Plantago* sp.	seed/grain						
Poaceae	*Aegilops* sp.	seed/grain						
Poaceae	*Aegilops* sp., glume base	chaff				1		
Poaceae	*Bromus* spp.	seed/grain						
Poaceae	cf. *Alopecurus* sp.	seed/grain						
Poaceae	*Eremopyrum* sp.	seed/grain						
Poaceae	*Hordeum* cf. *spontaneum*	seed/grain						
Poaceae	*Hordeum spontaneum*, rachis	chaff						
Poaceae	*Hordeum* spp., wild	seed/grain			1			
Poaceae	*Lolium* sp.	seed/grain						
Poaceae	*Phalaris* sp.	seed/grain						
Poaceae	*Phragmites* type	seed/grain						
Poaceae	*Poa* type	seed/grain		2				
Poaceae	Poaceae, culm node	chaff						
Poaceae	Poaceae, large	seed/grain			1		1	
Poaceae	Poaceae, medium	seed/grain						
Poaceae	Poaceae, small-seeded	seed/grain		9		4		
Poaceae	*Setaria* sp.	seed/grain						
Polygonaceae	Polygonaceae	seed/grain						
Polygonaceae	*Polygonum* sp.	seed/grain		8	2			

			Emar 2001	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP11	BP01	BP02	BP03	BP05	BP06
		areal	65/53-52	58/52-18	75/52-26C1	75/52-26C2	72/50-15	72/52-62
		sedim. vol. ml			1000		2000	2000
		dating	LBA?	LBA	LBA	LBA	LBA	LBA
Polygonaceae	*Rumex* sp.	seed/grain						
Portulacaceae	*Portulaca* sp.	seed/grain						
Primulaceae	*Androsace maxima*	seed/grain				1		1
Primulaceae	Primulaceae	seed/grain						
Ranunculaceae	*Adonis* cf. *annua*	seed/grain				1		
Resedaceae	*Reseda lutea*	seed/grain			1		1	
Resedaceae	*Reseda luteola*	seed/grain						
Rosaceae	*Rubus* sp.	seed/grain						
Rubiaceae	*Galium* spp.	seed/grain						
Rubiaceae	*Galium spurium*	seed/grain				1		
Rubiaceae	*Rubia* sp.	seed/grain						
Scrophulariaceae	*Verbascum* sp., capsule	capsule						
Scrophulariaceae	*Veronica persica*	seed/grain						
Thymelaeaceae	*Thymelaea* sp.	seed/grain						
Valerianaceae	*Valerianella* cf. *lasiocarpa*	seed/grain						
Valerianaceae	*Valerianella dentata*	seed/grain						
Valerianaceae	*Valerianella vesicaria* type	seed/grain						
Verbenaceae	cf. *Verbena* sp.	seed/grain						
	cf. Nußschale	seed/grain						
	Crucianella/Plantago	seed/grain						
	Cyperaceae/Polygonaceae	seed/grain						
	flower buds	flowers						
	indets.	seed/grain		2	2	4		
	beetle indet., head							
	coprolites (mouse)							
	coprolites (sheep/goat)							
	Sitophilus granarius							

			Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP07	BP08	BP09	BP10	BP11	BP12
		areal	74/52-39	79/50-6B	79/50-24	80/50-22	60/51-95	60/51-103
		sedim. vol. ml	3000	5000	7000	7000	20000	14000
		dating	LBA	LBA	LBA	LBA	EBA	EBA
crops		**plant part**						
Fabaceae	cf. *Lens* sp.	seed/grain	13					
Fabaceae	*Cicer arietinum*	seed/grain						1
Fabaceae	*Lathyrus sativus/cicera*	seed/grain						1
Fabaceae	*Lens culinaris*	seed/grain					6	
Fabaceae	*Vicia / Lathyrus*	seed/grain						
Fabaceae	*Vicia ervilia*	seed/grain						
Moraceae	*Ficus carica*	seed/grain	34		1			3
Oleaceae	*Olea europaea*	pip	1		1			
Poaceae	Cerealia	seed/grain	5					55
Poaceae	Cerealia, culm fragments	chaff	20		7		1	32
Poaceae	Cerealia, rachis	chaff						3
Poaceae	Cerealia, root segments	chaff	1					
Poaceae	*Hordeum* cf. *vulgare*, twisted	seed/grain						20
Poaceae	*Hordeum* sp., rachis	chaff						174
Poaceae	*Hordeum vulgare* cf. *vulgare*	seed/grain						
Poaceae	*Hordeum vulgare distichum*, rachis	chaff	100					30
Poaceae	*Hordeum vulgare vulgare*, rachis	chaff						
Poaceae	*Hordeum vulgare*	seed/grain	36	10	6		41	479
Poaceae	*Hordeum vulgare*, rachis	chaff		2	1		5	
Poaceae	*Triticum aestivum/durum*	seed/grain		1			3	4
Poaceae	*Triticum aestivum/durum*, rachis	chaff						1
Poaceae	*Triticum dicoccum*, glume base	chaff						
Poaceae	*Triticum dicoccum/monococcum*, gb	chaff	1					2
Poaceae	*Triticum* sp.	seed/grain						

			Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP07	BP08	BP09	BP10	BP11	BP12
		areal	74/52-39	79/50-6B	79/50-24	80/50-22	60/51-95	60/51-103
		sedim. vol. ml	3000	5000	7000	7000	20000	14000
		dating	LBA	LBA	LBA	LBA	EBA	EBA
Poaceae	*Triticum turgidum*, free-threshing	seed/grain						
Vitaceae	*Vitis vinifera*	pip	17		2			1
wild plant taxa								
Aizoaceae	*Aizoon hispanicum*	seed/grain	10	8	6	1		2
Apiaceae	*Bupleurum* sp.	seed/grain						
Apiaceae	*Torilis* sp.	seed/grain						
Asteraceae	*Anthemis cotula*	seed/grain						
Asteraceae	*Anthemis* sp.	seed/grain						
Asteraceae	*Carthamus* sp.	seed/grain						
Asteraceae	Compositae	seed/grain	2					
Asteraceae	Compositae	flowers						
Boraginaceae	*Arnebia* cf. *decumbens*, uvk	seed/grain	8					
Boraginaceae	*Arnebia* cf. *decumbens*, vk	seed/grain	4					
Boraginaceae	*Echium* sp.	seed/grain						
Boraginaceae	*Lithospermum arvense*, uvk	seed/grain	2		3			3
Boraginaceae	*Lithospermum arvense*, vk	seed/grain	1		7			2
Boraginaceae	*Lithospermum* sp., uvk	seed/grain						
Boraginaceae	*Lithospermum tenuiflorum*, uvk	seed/grain						4
Boraginaceae	*Lithospermum tenuiflorum*, vk	seed/grain						
Brassicaceae	*Brassica* sp.	seed/grain	1					
Brassicaceae	Brassicaceae	seed/grain	1					
Brassicaceae	*Bunias erucago*	seed/grain	2					
Brassicaceae	*Cardaminopsis* type	seed/grain						
Brassicaceae	*Lepidium* type	seed/grain						
Brassicaceae	*Sisymbrium/Diplotaxis* type	seed/grain						

			Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP07	BP08	BP09	BP10	BP11	BP12
		areal	74/52-39	79/50-6B	79/50-24	80/50-22	60/51-95	60/51-103
		sedim. vol. ml	3000	5000	7000	7000	20000	14000
		dating	LBA	LBA	LBA	LBA	EBA	EBA
Caryophyllaceae	*Arenaria* sp.	seed/grain					1	
Caryophyllaceae	Caryophyllaceae	seed/grain	8					14
Caryophyllaceae	Chenopodiac./Caryoph., endosperm	seed/grain						
Caryophyllaceae	*Gypsophila* spp.	seed/grain						
Caryophyllaceae	*Silene* sp.	seed/grain	24		2			1
Chenopodiaceae	*Atriplex rosea*	seed/grain						
Chenopodiaceae	*Atriplex* sp.	fruit	1					
Chenopodiaceae	*Beta vulgaris*	seed/grain	7					
Chenopodiaceae	*Chenopodium* cf. *murale*	seed/grain						
Chenopodiaceae	*Chenopodium* sp.	seed/grain						
Chenopodiaceae	*Salsola kali*	seed/grain	6					
Chenopodiaceae	*Suaeda* sp.	seed/grain						
Cistaceae	*Helianthemum* sp.	seed/grain						
Cyperaceae	Cyperaceae	seed/grain						
Cyperaceae	Cyperaceae, endosperm	seed/grain						
Cyperaceae	*Cyperus longus*	seed/grain						
Cyperaceae	*Scirpus maritimus*	seed/grain						
Fabaceae	*Astragalus* sp.	seed/grain			3			2
Fabaceae	*Coronilla* sp.	seed/grain						3
Fabaceae	*Hippocrepis* sp.	seed/grain						
Fabaceae	Fabaceae, large-seeded	seed/grain					4	3
Fabaceae	Fabaceae, small-seeded	seed/grain	9					8
Fabaceae	*Medicago* type	seed/grain						
Fabaceae	*Melilotus* cf. *officinalis*	seed/grain						
Fabaceae	*Onobrychis* sp.	seed/grain						
Fabaceae	*Prosopis farcta*	seed/grain					11	1
Fabaceae	*Trifolium* sp.	seed/grain	6					
Fabaceae	*Trigonella* sp.	seed/grain						6

			Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP07	BP08	BP09	BP10	BP11	BP12
		areal	74/52-39	79/50-6B	79/50-24	80/50-22	60/51-95	60/51-103
		sedim. vol. ml	3000	5000	7000	7000	20000	14000
		dating	LBA	LBA	LBA	LBA	EBA	EBA
Lamiaceae	*Ajuga* sp.	seed/grain						
Lamiaceae	Lamiaceae	seed/grain						
Liliaceae	cf. *Allium* sp.	seed/grain						
Liliaceae	*Ornithogalum/Muscari*	seed/grain						
Malvaceae	*Malva* cf. *parviflora*	seed/grain						
Malvaceae	*Malva* sp.	seed/grain	4		1			
Papaveraceae	*Fumaria officinalis*	seed/grain	2		1			
Papaveraceae	*Glaucium* sp.	seed/grain						
Papaveraceae	*Papaver* sp.	seed/grain						
Papaveraceae	Papaveraceae	seed/grain						
Plantaginaceae	*Plantago* sp.	seed/grain			1			
Poaceae	*Aegilops* sp.	seed/grain			1			1
Poaceae	*Aegilops* sp., glume base	chaff	3		1			5
Poaceae	*Bromus* spp.	seed/grain			2		2	4
Poaceae	cf. *Alopecurus* sp.	seed/grain						1
Poaceae	*Eremopyrum* sp.	seed/grain	4	6	2		3	22
Poaceae	*Hordeum* cf. *spontaneum*	seed/grain						
Poaceae	*Hordeum spontaneum*, rachis	chaff						
Poaceae	*Hordeum* spp., wild	seed/grain		2				19
Poaceae	*Lolium* sp.	seed/grain						
Poaceae	*Phalaris* sp.	seed/grain	2		1			17
Poaceae	*Phragmites* type	seed/grain						
Poaceae	*Poa* type	seed/grain						
Poaceae	Poaceae, culm node	chaff						
Poaceae	Poaceae, large	seed/grain	20		1		5	50
Poaceae	Poaceae, medium	seed/grain						
Poaceae	Poaceae, small-seeded	seed/grain						62
Poaceae	*Setaria* sp.	seed/grain						

			Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP07	BP08	BP09	BP10	BP11	BP12
		areal	74/52-39	79/50-6B	79/50-24	80/50-22	60/51-95	60/51-103
		sedim. vol. ml	3000	5000	7000	7000	20000	14000
		dating	LBA	LBA	LBA	LBA	EBA	EBA
Polygonaceae	Polygonaceae	seed/grain						
Polygonaceae	*Polygonum* sp.	seed/grain	1					
Polygonaceae	*Rumex* sp.	seed/grain						242
Portulacaceae	*Portulaca* sp.	seed/grain						
Primulaceae	*Androsace maxima*	seed/grain	1					
Primulaceae	Primulaceae	seed/grain						
Ranunculaceae	*Adonis* cf. *annua*	seed/grain	15					
Resedaceae	*Reseda lutea*	seed/grain	4					
Resedaceae	*Reseda luteola*	seed/grain						14
Rosaceae	*Rubus* sp.	seed/grain						2
Rubiaceae	*Galium* spp.	seed/grain	1		1			29
Rubiaceae	*Galium spurium*	seed/grain						
Rubiaceae	*Rubia* sp.	seed/grain						
Scrophulariaceae	*Verbascum* sp., capsule	capsule						
Scrophulariaceae	*Veronica persica*	seed/grain						8
Thymelaeaceae	*Thymelaea* sp.	seed/grain						
Valerianaceae	*Valerianella* cf. *lasiocarpa*	seed/grain						
Valerianaceae	*Valerianella dentata*	seed/grain	17					
Valerianaceae	*Valerianella vesicaria* type	seed/grain						1
Verbenaceae	cf. *Verbena* sp.	seed/grain						
	cf. Nußschale	seed/grain						
	Crucianella/Plantago	seed/grain						
	Cyperaceae/Polygonaceae	seed/grain						
	flower buds	flowers						
	indets.	seed/grain	11		2		2	24
	beetle indet., head		1					
	coprolites (mouse)		4					2
	coprolites (sheep/goat)							
	Sitophilus granarius							

			Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP13	BP14	BP15	BP16	BP17	BP18
		areal	60/51-105	62/50-14	62/50-33	62/50-17	62/50-19	62/50-25
		sedim. vol. ml	4500	5000	5000	5000	5000	5000
		dating	EBA	EBA	EBA	EBA	EBA	EBA
crops		**plant part**						
Fabaceae	cf. *Lens* sp.	seed/grain		1				
Fabaceae	*Cicer arietinum*	seed/grain						
Fabaceae	*Lathyrus sativus/cicera*	seed/grain						
Fabaceae	*Lens culinaris*	seed/grain			4		2	
Fabaceae	*Vicia / Lathyrus*	seed/grain		1				
Fabaceae	*Vicia ervilia*	seed/grain						
Moraceae	*Ficus carica*	seed/grain		1	1			
Oleaceae	*Olea europaea*	pip	1					
Poaceae	Cerealia	seed/grain			6		5	
Poaceae	Cerealia, culm fragments	chaff	4	12	4		7	1
Poaceae	Cerealia, rachis	chaff					1	
Poaceae	Cerealia, root segments	chaff	4		2			
Poaceae	*Hordeum* cf. *vulgare*, twisted	seed/grain						
Poaceae	*Hordeum* sp., rachis	chaff	15					
Poaceae	*Hordeum vulgare* cf. *vulgare*	seed/grain			3			
Poaceae	*Hordeum vulgare distichum*, rachis	chaff		26				
Poaceae	*Hordeum vulgare vulgare*, rachis	chaff						
Poaceae	*Hordeum vulgare*	seed/grain	31	37	53	1	27	15
Poaceae	*Hordeum vulgare,* rachis	chaff	59		57		35	11
Poaceae	*Triticum aestivum/durum*	seed/grain					2	
Poaceae	*Triticum aestivum/durum*, rachis	chaff						
Poaceae	*Triticum dicoccum,* glume base	chaff	1				2	
Poaceae	*Triticum dicoccum/monococcum*, gb	chaff						
Poaceae	*Triticum* sp.	seed/grain			1			

			Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP13	BP14	BP15	BP16	BP17	BP18
		areal	60/51-105	62/50-14	62/50-33	62/50-17	62/50-19	62/50-25
		sedim. vol. ml	4500	5000	5000	5000	5000	5000
		dating	EBA	EBA	EBA	EBA	EBA	EBA
Poaceae	*Triticum turgidum*, free-threshing	seed/grain						
Vitaceae	*Vitis vinifera*	pip	1					
wild plant taxa								
Aizoaceae	*Aizoon hispanicum*	seed/grain	7					
Apiaceae	*Bupleurum* sp.	seed/grain						
Apiaceae	*Torilis* sp.	seed/grain						
Asteraceae	*Anthemis cotula*	seed/grain						
Asteraceae	*Anthemis* sp.	seed/grain						
Asteraceae	*Carthamus* sp.	seed/grain						
Asteraceae	Compositae	seed/grain		1				
Asteraceae	Compositae	flowers						
Boraginaceae	*Arnebia* cf. *decumbens*, uvk	seed/grain		14				
Boraginaceae	*Arnebia* cf. *decumbens*, vk	seed/grain		2				
Boraginaceae	*Echium* sp.	seed/grain						
Boraginaceae	*Lithospermum arvense*, uvk	seed/grain	8		1		3	2
Boraginaceae	*Lithospermum arvense*, vk	seed/grain					1	
Boraginaceae	*Lithospermum* sp., uvk	seed/grain						
Boraginaceae	*Lithospermum tenuiflorum*, uvk	seed/grain	2		1		6	
Boraginaceae	*Lithospermum tenuiflorum*, vk	seed/grain						
Brassicaceae	*Brassica* sp.	seed/grain						
Brassicaceae	Brassicaceae	seed/grain	2					
Brassicaceae	*Bunias erucago*	seed/grain						
Brassicaceae	*Cardaminopsis* type	seed/grain						
Brassicaceae	*Lepidium* type	seed/grain						
Brassicaceae	*Sisymbrium/Diplotaxis* type	seed/grain						
Caryophyllaceae	*Arenaria* sp.	seed/grain					1	

			Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP13	BP14	BP15	BP16	BP17	BP18
		areal	60/51-105	62/50-14	62/50-33	62/50-17	62/50-19	62/50-25
		sedim. vol. ml	4500	5000	5000	5000	5000	5000
		dating	EBA	EBA	EBA	EBA	EBA	EBA
Caryophyllaceae	Caryophyllaceae	seed/grain						
Caryophyllaceae	Chenopodiac./Caryoph., endosperm	seed/grain						
Caryophyllaceae	*Gypsophila* spp.	seed/grain	2					
Caryophyllaceae	*Silene* sp.	seed/grain	8		1			
Chenopodiaceae	*Atriplex rosea*	seed/grain		1				
Chenopodiaceae	*Atriplex* sp.	fruit						
Chenopodiaceae	*Beta vulgaris*	seed/grain						
Chenopodiaceae	*Chenopodium* cf. *murale*	seed/grain						
Chenopodiaceae	*Chenopodium* sp.	seed/grain						
Chenopodiaceae	*Salsola kali*	seed/grain	2					
Chenopodiaceae	*Suaeda* sp.	seed/grain			1			
Cistaceae	*Helianthemum* sp.	seed/grain						
Cyperaceae	Cyperaceae	seed/grain						
Cyperaceae	Cyperaceae, endosperm	seed/grain						
Cyperaceae	*Cyperus longus*	seed/grain						
Cyperaceae	*Scirpus maritimus*	seed/grain						
Fabaceae	*Astragalus* sp.	seed/grain	1				6	
Fabaceae	*Coronilla* sp.	seed/grain					1	
Fabaceae	*Hippocrepis* sp.	seed/grain	1					
Fabaceae	Fabaceae, large-seeded	seed/grain						
Fabaceae	Fabaceae, small-seeded	seed/grain		4	2		8	4
Fabaceae	*Medicago* type	seed/grain						
Fabaceae	*Melilotus* cf. *officinalis*	seed/grain						
Fabaceae	*Onobrychis* sp.	seed/grain			1		1	
Fabaceae	*Prosopis farcta*	seed/grain		2	7			
Fabaceae	*Trifolium* sp.	seed/grain						

			Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP13	BP14	BP15	BP16	BP17	BP18
		areal	60/51-105	62/50-14	62/50-33	62/50-17	62/50-19	62/50-25
		sedim. vol. ml	4500	5000	5000	5000	5000	5000
		dating	EBA	EBA	EBA	EBA	EBA	EBA
Fabaceae	*Trigonella* sp.	seed/grain	2				1	
Lamiaceae	*Ajuga* sp.	seed/grain			1		1	
Lamiaceae	Lamiaceae	seed/grain						
Liliaceae	cf. *Allium* sp.	seed/grain						
Liliaceae	*Ornithogalum/Muscari*	seed/grain						
Malvaceae	*Malva* cf. *parviflora*	seed/grain						
Malvaceae	*Malva* sp.	seed/grain						
Papaveraceae	*Fumaria officinalis*	seed/grain						
Papaveraceae	*Glaucium* sp.	seed/grain			1			
Papaveraceae	*Papaver* sp.	seed/grain	2					
Papaveraceae	Papaveraceae	seed/grain						
Plantaginaceae	*Plantago* sp.	seed/grain						
Poaceae	*Aegilops* sp.	seed/grain	2		5		2	
Poaceae	*Aegilops* sp., glume base	chaff	1	2	2		1	
Poaceae	*Bromus* spp.	seed/grain	10	5	11		2	
Poaceae	cf. *Alopecurus* sp.	seed/grain						
Poaceae	*Eremopyrum* sp.	seed/grain	2	8	43		8	8
Poaceae	*Hordeum* cf. *spontaneum*	seed/grain						
Poaceae	*Hordeum spontaneum*, rachis	chaff	6	1	1		14	
Poaceae	*Hordeum* spp., wild	seed/grain		11	16		8	3
Poaceae	*Lolium* sp.	seed/grain			1		4	
Poaceae	*Phalaris* sp.	seed/grain					2	
Poaceae	*Phragmites* type	seed/grain						
Poaceae	*Poa* type	seed/grain	1					
Poaceae	Poaceae, culm node	chaff					2	
Poaceae	Poaceae, large	seed/grain		19	33		21	10
Poaceae	Poaceae, medium	seed/grain	9					
Poaceae	Poaceae, small-seeded	seed/grain						

			Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP13	BP14	BP15	BP16	BP17	BP18
		areal	60/51-105	62/50-14	62/50-33	62/50-17	62/50-19	62/50-25
		sedim. vol. ml	4500	5000	5000	5000	5000	5000
		dating	EBA	EBA	EBA	EBA	EBA	EBA
Poaceae	*Setaria* sp.	seed/grain					2	
Polygonaceae	Polygonaceae	seed/grain					6	
Polygonaceae	*Polygonum* sp.	seed/grain						
Polygonaceae	*Rumex* sp.	seed/grain			1			1
Portulacaceae	*Portulaca* sp.	seed/grain						
Primulaceae	*Androsace maxima*	seed/grain	1					
Primulaceae	Primulaceae	seed/grain						
Ranunculaceae	*Adonis* cf. *annua*	seed/grain		1				
Resedaceae	*Reseda lutea*	seed/grain	1		1		1	
Resedaceae	*Reseda luteola*	seed/grain						
Rosaceae	*Rubus* sp.	seed/grain						
Rubiaceae	*Galium* spp.	seed/grain	4		6			1
Rubiaceae	*Galium spurium*	seed/grain		6				
Rubiaceae	*Rubia* sp.	seed/grain						
Scrophulariaceae	*Verbascum* sp., capsule	capsule						
Scrophulariaceae	*Veronica persica*	seed/grain						
Thymelaeaceae	*Thymelaea* sp.	seed/grain						
Valerianaceae	*Valerianella* cf. *lasiocarpa*	seed/grain						
Valerianaceae	*Valerianella dentata*	seed/grain			1			
Valerianaceae	*Valerianella vesicaria* type	seed/grain						
Verbenaceae	cf. *Verbena* sp.	seed/grain					1	
	cf. Nußschale	seed/grain						
	Crucianella/*Plantago*	seed/grain						
	Cyperaceae/Polygonaceae	seed/grain						
	flower buds	flowers					6	
	indets.	seed/grain	4	3	2		5	1
	beetle indet., head							
	coprolites (mouse)							
	coprolites (sheep/goat)							
	Sitophilus granarius							

			Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP19	BP20	BP21	BP24
		areal	76/55-61	76/55-64	76/55-81	60/51-89
		sedim. vol. ml	5000	5000	6000	
		dating	MBA	MBA	MBA	EBA
crops		**plant part**				
Fabaceae	cf. *Lens* sp.	seed/grain		2	1	
Fabaceae	*Cicer arietinum*	seed/grain				
Fabaceae	*Lathyrus sativus/cicera*	seed/grain		1		
Fabaceae	*Lens culinaris*	seed/grain				
Fabaceae	*Vicia / Lathyrus*	seed/grain	1	2		
Fabaceae	*Vicia ervilia*	seed/grain	1			
Moraceae	*Ficus carica*	seed/grain	1			
Oleaceae	*Olea europaea*	pip				
Poaceae	Cerealia	seed/grain		10		
Poaceae	Cerealia, culm fragments	chaff	35	5		
Poaceae	Cerealia, rachis	chaff		3		
Poaceae	Cerealia, root segments	chaff	4			
Poaceae	*Hordeum* cf. *vulgare*, twisted	seed/grain		2		
Poaceae	*Hordeum* sp., rachis	chaff				
Poaceae	*Hordeum vulgare* cf. *vulgare*	seed/grain				
Poaceae	*Hordeum vulgare distichum*, rachis	chaff	72	12	1	
Poaceae	*Hordeum vulgare vulgare*, rachis	chaff				
Poaceae	*Hordeum vulgare*	seed/grain	102	35	6	
Poaceae	*Hordeum vulgare*, rachis	chaff	80	20		
Poaceae	*Triticum aestivum/durum*	seed/grain				
Poaceae	*Triticum aestivum/durum*, rachis	chaff				
Poaceae	*Triticum dicoccum*, glume base	chaff				
Poaceae	*Triticum dicoccum/monococcum*, gb	chaff				
Poaceae	*Triticum* sp.	seed/grain				
Poaceae	*Triticum turgidum*, free-threshing	seed/grain		4		

			Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP19	BP20	BP21	BP24
		areal	76/55-61	76/55-64	76/55-81	60/51-89
		sedim. vol. ml	5000	5000	6000	
		dating	MBA	MBA	MBA	EBA
Vitaceae	*Vitis vinifera*	pip				
wild plant taxa						
Aizoaceae	*Aizoon hispanicum*	seed/grain				
Apiaceae	*Bupleurum* sp.	seed/grain	1			
Apiaceae	*Torilis* sp.	seed/grain	3			
Asteraceae	*Anthemis cotula*	seed/grain			1	
Asteraceae	*Anthemis* sp.	seed/grain				
Asteraceae	*Carthamus* sp.	seed/grain				
Asteraceae	Compositae	seed/grain				
Asteraceae	Compositae	flowers				
Boraginaceae	*Arnebia* cf. *decumbens*, uvk	seed/grain				
Boraginaceae	*Arnebia* cf. *decumbens*, vk	seed/grain				
Boraginaceae	*Echium* sp.	seed/grain		1		
Boraginaceae	*Lithospermum arvense*, uvk	seed/grain	2			
Boraginaceae	*Lithospermum arvense*, vk	seed/grain	3	2	5	
Boraginaceae	*Lithospermum* sp., uvk	seed/grain		4		
Boraginaceae	*Lithospermum tenuiflorum*, uvk	seed/grain		1	1	1
Boraginaceae	*Lithospermum tenuiflorum*, vk	seed/grain				
Brassicaceae	*Brassica* sp.	seed/grain				
Brassicaceae	Brassicaceae	seed/grain				
Brassicaceae	*Bunias erucago*	seed/grain				
Brassicaceae	*Cardaminopsis* type	seed/grain				
Brassicaceae	*Lepidium* type	seed/grain				
Brassicaceae	*Sisymbrium*/*Diplotaxis* type	seed/grain				
Caryophyllaceae	*Arenaria* sp.	seed/grain	1			
Caryophyllaceae	Caryophyllaceae	seed/grain			4	

			Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP19	BP20	BP21	BP24
		areal	76/55-61	76/55-64	76/55-81	60/51-89
		sedim. vol. ml	5000	5000	6000	
		dating	MBA	MBA	MBA	EBA
Caryophyllaceae	Chenopodiac./Caryoph., endosperm	seed/grain	2			
Caryophyllaceae	*Gypsophila* spp.	seed/grain				
Caryophyllaceae	*Silene* sp.	seed/grain	2			
Chenopodiaceae	*Atriplex rosea*	seed/grain				
Chenopodiaceae	*Atriplex* sp.	fruit				
Chenopodiaceae	*Beta vulgaris*	seed/grain				
Chenopodiaceae	*Chenopodium* cf. *murale*	seed/grain				
Chenopodiaceae	*Chenopodium* sp.	seed/grain	1			
Chenopodiaceae	*Salsola kali*	seed/grain				
Chenopodiaceae	*Suaeda* sp.	seed/grain				
Cistaceae	*Helianthemum* sp.	seed/grain				
Cyperaceae	Cyperaceae	seed/grain				
Cyperaceae	Cyperaceae, endosperm	seed/grain		9		
Cyperaceae	*Cyperus longus*	seed/grain		1		
Cyperaceae	*Scirpus maritimus*	seed/grain	3	12		
Fabaceae	*Astragalus* sp.	seed/grain	1			
Fabaceae	*Coronilla* sp.	seed/grain				
Fabaceae	*Hippocrepis* sp.	seed/grain				
Fabaceae	Fabaceae, large-seeded	seed/grain	2			
Fabaceae	Fabaceae, small-seeded	seed/grain	3	3		
Fabaceae	*Medicago* type	seed/grain				
Fabaceae	*Melilotus* cf. *officinalis*	seed/grain				
Fabaceae	*Onobrychis* sp.	seed/grain				
Fabaceae	*Prosopis farcta*	seed/grain		2		
Fabaceae	*Trifolium* sp.	seed/grain				
Fabaceae	*Trigonella* sp.	seed/grain	2	2		

			Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP19	BP20	BP21	BP24
		areal	76/55-61	76/55-64	76/55-81	60/51-89
		sedim. vol. ml	5000	5000	6000	
		dating	MBA	MBA	MBA	EBA
Lamiaceae	*Ajuga* sp.	seed/grain				
Lamiaceae	Lamiaceae	seed/grain			2	
Liliaceae	cf. *Allium* sp.	seed/grain				
Liliaceae	*Ornithogalum/Muscari*	seed/grain		1		
Malvaceae	*Malva* cf. *parviflora*	seed/grain				
Malvaceae	*Malva* sp.	seed/grain	7			
Papaveraceae	*Fumaria officinalis*	seed/grain				
Papaveraceae	*Glaucium* sp.	seed/grain			3	
Papaveraceae	*Papaver* sp.	seed/grain				
Papaveraceae	Papaveraceae	seed/grain		1		
Plantaginaceae	*Plantago* sp.	seed/grain				
Poaceae	*Aegilops* sp.	seed/grain				
Poaceae	*Aegilops* sp., glume base	chaff	1	1		
Poaceae	*Bromus* spp.	seed/grain	17	8	2	
Poaceae	cf. *Alopecurus* sp.	seed/grain	2			
Poaceae	*Eremopyrum* sp.	seed/grain		3		
Poaceae	*Hordeum* cf. *spontaneum*	seed/grain				
Poaceae	*Hordeum spontaneum*, rachis	chaff	1			
Poaceae	*Hordeum* spp., wild	seed/grain	21	2		
Poaceae	*Lolium* sp.	seed/grain				
Poaceae	*Phalaris* sp.	seed/grain	137			
Poaceae	*Phragmites* type	seed/grain				
Poaceae	*Poa* type	seed/grain				
Poaceae	Poaceae, culm node	chaff				

			Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP19	BP20	BP21	BP24
		areal	76/55-61	76/55-64	76/55-81	60/51-89
		sedim. vol. ml	5000	5000	6000	
		dating	MBA	MBA	MBA	EBA
Poaceae	Poaceae, large	seed/grain	64	10		
Poaceae	Poaceae, medium	seed/grain				
Poaceae	Poaceae, small-seeded	seed/grain		13	6	
Poaceae	*Setaria* sp.	seed/grain				2
Polygonaceae	Polygonaceae	seed/grain				15
Polygonaceae	*Polygonum* sp.	seed/grain		3		
Polygonaceae	*Rumex* sp.	seed/grain				
Portulacaceae	*Portulaca* sp.	seed/grain	4			
Primulaceae	*Androsace maxima*	seed/grain		2		
Primulaceae	Primulaceae	seed/grain				
Ranunculaceae	*Adonis* cf. *annua*	seed/grain			1	
Resedaceae	*Reseda lutea*	seed/grain				
Resedaceae	*Reseda luteola*	seed/grain				
Rosaceae	*Rubus* sp.	seed/grain				
Rubiaceae	*Galium* spp.	seed/grain	4	1		
Rubiaceae	*Galium spurium*	seed/grain				
Rubiaceae	*Rubia* sp.	seed/grain				
Scrophulariaceae	*Verbascum* sp., capsule	capsule		1		
Scrophulariaceae	*Veronica persica*	seed/grain				
Thymelaeaceae	*Thymelaea* sp.	seed/grain				
Valerianaceae	*Valerianella* cf. *lasiocarpa*	seed/grain	1			
Valerianaceae	*Valerianella dentata*	seed/grain				

			Emar 2002	Emar 2002	Emar 2002	Emar 2002
		sample no.	BP19	BP20	BP21	BP24
		areal	76/55-61	76/55-64	76/55-81	60/51-89
		sedim. vol. ml	5000	5000	6000	
		dating	MBA	MBA	MBA	EBA
Valerianaceae	*Valerianella vesicaria* type	seed/grain				
Verbenaceae	cf. *Verbena* sp.	seed/grain				
	cf. Nußschale	seed/grain				
	Crucianella/*Plantago*	seed/grain		2	2	
	Cyperaceae/Polygonaceae	seed/grain		2		
	flower buds	flowers				
	indets.	seed/grain	3	2		
	beetle indet., head					
	coprolites (mouse)					
	coprolites (sheep/goat)			1	1	
	Sitophilus granarius					

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