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Measuring Local Diversity in Early Iron Age Animal Economies: A View from Khirbat al-Mudayna al-ʿAliya (Jordan)

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We use faunal evidence from Khirbat al-Mudayna al-ʿAliya, an agropastoral settlement located in west-central Jordan, to examine early Iron Age subsistence regimes. Analysis of faunal evidence reveals a low-intensity, nonspecialized animal economy dependent on both domesticated and wild species, including freshwater crabs. The subsistence economy of the settlement, we argue, was structured so as to take maximum advantage of its location overlooking the Wadi al-Nukhayla, a perennial water source supporting a relatively verdant floral and faunal array. This diverse and flexible organization made subsistence in this resource-scarce environment more sustainable. When this profile is compared with other early Iron Age southern Levantine communities, the diversity of ways that animal economies were organized during this period is apparent, signaling the need to investigate the local strategies that communities used to adapt to their immediate environmental circumstances, not only ecologically but also socially.

As in many parts of the world (see deFrance 2009), the zooarchaeology of post-Neolithic communities in the southern Levant has tended to focus on issues of social complexity, particularly political economy, status, and ideology/identity. Indeed, the growth of interest in the zooarchaeology of early Iron Age communities in the southern Levant since the 1980s can be credited directly to one of these themes—namely, ideology/identity. Analysis of the ideological use of animals (e.g., in ritual sacrifice), and the relationship between diet and collective identity (e.g., pork consumption), fit well with the questions traditionally asked by biblical archaeologists. At the same time, ideology and identity demarcated a topic where evidence from the southern Levant generated immediate global interest, due to the region's historical link to three major world religions. By and large, this marriage of global and traditional interests has been positive, if only for its role in promoting the serious collection and analysis of faunal assemblages from historic-period settlements. However, this success has come at a price—namely, the prioritizing of group identity in explaining diversity within and between early Iron Age faunal assemblages. In contrast, a comparison of recent zooarchaeological studies (e.g., Lev-Tov 2006; Raban-Gerstel et al. 2008; Marom et al. 2009) suggests that early Iron Age faunal assemblages can show a high degree of inter-settlement variability best explained in terms of localized subsistence strategies and environmental adaptations. In this paper, we illustrate the importance of such local adaptations in early Iron Age subsistence practices using the faunal assemblage from Khirbat al-Mudayna al-ʿAliya (hereafter KMA), an early Iron Age settlement located on the semiarid eastern margins of west-central Jordan.

KMA (Routledge 2000; 2004: 96–108; Routledge and Porter 2007) was one of several small agropastoralist communities founded in the 11th century B.C.E. in west-central Jordan and abandoned after no more than a century of occupation. These settlements were located in a semiarid zone with limited precipitation levels and poor soil quality. The analysis of excavated faunal evidence reveals that the community organized a low-intensity, nonspecialized animal economy that depended on both domesticated and wild species. When this profile is compared with published data from other early Iron Age southern Levantine settlements, the diversity of ways that animal economies were organized during this period is apparent. These findings reaffirm the need for archaeologists to investigate the local strategies that communities use to adapt to their immediate environmental circumstances and avoid regional panoramic generalizations that do not account for synchronic diversity.

EARLY IRON AGE ANIMAL ECONOMIES: TRENDS AND LIMITATIONS

Comparatively speaking, the animal economies of the early Iron Age southern Levant have seen extensive investigation by zooarchaeologists. This attention is due, in part, to the search for data beyond the limited and problematic written sources (e.g., the Hebrew Bible) used to reconstruct the time period's history and societies. The early Iron Age (the 12th through early 10th centuries B.C.E.) throughout the southern Levant is characterized as a period of gradual recovery following a period of political and economic upheavals unevenly experienced throughout the eastern Mediterranean and Near East at the end of the Late Bronze Age.[1] Although scholars have long debated the reasons for these upheavals (e.g., Bachhuber and Roberts 2009; Gitin, Mazar, and Stern 1998; Ward and Joukowsky 1992), their effects are visible in the archaeological record: the collapse of palace economies, the migration of groups between regions, and the intensification of settlement in areas previously limited or lacking in population. Due to the collapse of international commercial networks and the decline in demand for finished goods and luxury items, early Iron Age economies experienced a reorganization that emphasized meeting local subsistence needs rather than market demand. This shift to a limited and local subsistence economy is reflected in the many small and medium-sized settlements that have been surveyed and excavated across the region (e.g., Miller 2003). Excavated evidence indicates that these settlements often depended on naturally available local resources to organize low-intensity agropastoral economies around grain production, viticulture, and animal husbandry at household and community levels (Hopkins 1985; Stager 1985).

Faunal assemblages recovered from early Iron Age settlements, like other archaeological and textual evidence, have been used to distinguish among early Iron Age ethnic groups (Finkelstein 1996; Hesse 1990; Faust 2006: 35–40; Killebrew 2005: 176, 219; but cf. Hesse and Wapnish 1997). Early Iron Age Israelite society, for example, is characterized as recently settled agropastoralists living in villages in the Central Highlands north and south of modern Jerusalem, while the Philistines are characterized as urban agricultural producers and craftspeople living in the coastal plain between Gaza and Tel Aviv (e.g., Dever 1995; Killebrew 2005; Miller 2004; Stager 1998). The suggestion that ethnic differences should be apparent in the faunal evidence is strengthened by the Hebrew Bible's tendency to link subsistence practices with early Iron Age ethnic groups—Canaanites, Israelites, Philistines, Moabites—that scholars believe were bounded by discrete identities and practices, and expressed in the material record. Scholars combine these textual and artifactual representations of early Iron Age subsistence practices with ethnographic categories constructed from recently past and contemporary Middle Eastern societies (e.g., "nomads" and "pastoralists") in order to help them interpret patterns in the archaeological evidence. These patterns, then, are sought in the archaeological record and then linked to specific ethnic identities (e.g., Levy and Holl 2002; Levy 2008).

While we are not interested here in passing judgment on attempts to identify early Iron Age ethnic groups, we do argue that this rush to "read" ethnicity into sub-

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[1] See Bloch-Smith and Nakhai 1999 for an overview of the time period.

sistence strategies, and particularly, animal economies, has analytical consequences. The first consequence is that subsistence practices are often characterized only by the relative abundance of a particular animal type (e.g., pigs). A second consequence is that static categories are created that do not represent how complex such strategies likely were in antiquity. Societies are described as being, or becoming, either nomadic or sedentary, pastoralist or farmer, hunter or herder, when in fact, the evidence suggests that a combination of these labels and a variety of herding regimens best describes household or community practices. Even the hybrid category of "agropastoralist" begs the question of how these two practices, diverse in their own ways, combined to create sustainable production routines. A more pressing consequence is that this link between subsistence and ethnicity gives primacy to identity while subordinating, or even ignoring, the ways local environmental conditions structured subsistence strategies. The southern Levant is characterized by a diversity of microclimates differing in soil quality, precipitation patterns, and naturally available fauna and flora (cf. Cordova 2007: 47–54). Based on these differences, one would predict that early Iron Age societies (and perhaps all past Levantine societies) responded differently to these local conditions, adjusting their subsistence routines to match the social and environmental conditions in which they resided, or selecting locations based on the naturally available resources or other factors such as accessibility to trade routes. What becomes necessary, then, is to search for explanations as to why certain subsistence strategies were employed in local contexts. These issues will be discussed comparatively, following the detailed presentation of an example from KMA in the semiarid zone of west-central Jordan.

THE ANIMAL ECONOMY OF KHIRBAT AL-MUDAYNA AL-ʿALIYA

Archaeological Context

KMA is located on the eastern edge of the Karak Plateau in west-central Jordan, approximately 19 km northeast of the modern town of al-Karak (UTMG: 773.4/464.5; Palestine Grid: 233.0/76.8) (fig. 1). The settlement is approximately 2.2 ha in size and is positioned on a promontory overlooking the juncture of the Wadi al-Mukhayris and Wadi al-Nakhayla (fig. 2). Archaeological investigations at the settlement were conducted between 1994 and 2004, comprising five seasons of mapping and excavation on various scales (Routledge 2000; 2004: 96–108; 2008; Routledge and Porter 2007). The settlement is positioned in a semiarid zone, falling between the 100 and 300 mm isohyets (el-Sherbini 1979: 174, table 2), and therefore receives only the minimum amount of precipitation needed to practice rain-fed agriculture.[2] The yellow Mediterranean and yellow steppic soils surrounding the settlement make agricultural production difficult, as compared with the red Mediterranean soils to the west.[3] Far below the settlement, lush riparian zones are found at the bottom of the canyons, where runoff precipitation and perennial aquifers refuel stream systems that eventually drain into the Jordan Valley (fig. 3). This persistent water source fosters a microclimate of wild fauna and flora that is ideal for hunting-and-gathering subsistence routines. Additionally, approximately 5 km north of KMA, the Wadi al-Nukhayla is joined by several tributaries and temporarily broadens before narrowing dramatically on its way to join the Wadi al-Mujib. This topography has created a large sediment trap, where the alluvium creates rich soil beds on a small floodplain ideal for low-intensity agriculture.

KMA is one of a number of early Iron Age settlements subsisting in semiarid zones of west-central Jordan that have been identified in survey projects, most notably that of Worschech (1985) and Miller (1991) on the Karak Plateau, Parker (2006) on the eastern desert fringe, Ji (Ji and ʿAttiyat 1997; Ji and Lee 1998; 2000) on the Dhiban Plateau, Jacobs (1983) in the Wadi Isal, and Clark on the northern edge of the Wadi al-Hasa (Clark et al. 1992; Clark et al. 1994) (summarized in Routledge 2004: table 4.2). The best evidence comes from six settlements: ʿAroʿer (Olávarri 1965; 1969; Olávarri-Goicoechea 1993), Baluʿa (Worschech 1989; Worschech and Ninow 1994; 1999; Worschech, Rosenthal, and Zayadine 1986), Lahun (Homès-Fredericq 1992; 1994; 1995; 1997; 2000; Swinnen 2009), KMA (Routledge 2000; 2004; 2008; Routledge and Porter 2007), Khirbat al-Mudayna al-Muʿarradja (hereafter KMM) (Olávarri 1977–1978; 1983), and Khirbat al-Muʿammariyya (Ninow 2004;

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[2] Holocene climate studies (Bar-Matthews et al. 1998; 1999) indicate that these regional precipitation patterns were relatively similar in the early Iron Age, although droughts likely introduced some variability in annual precipitation amounts.

[3] Cordova has determined that portions of these soil beds were already eroded into the wadi canyons during earlier periods of agricultural intensification (e.g., the Early Bronze Age) prior to the Iron Age (Cordova 2007: 192–95).

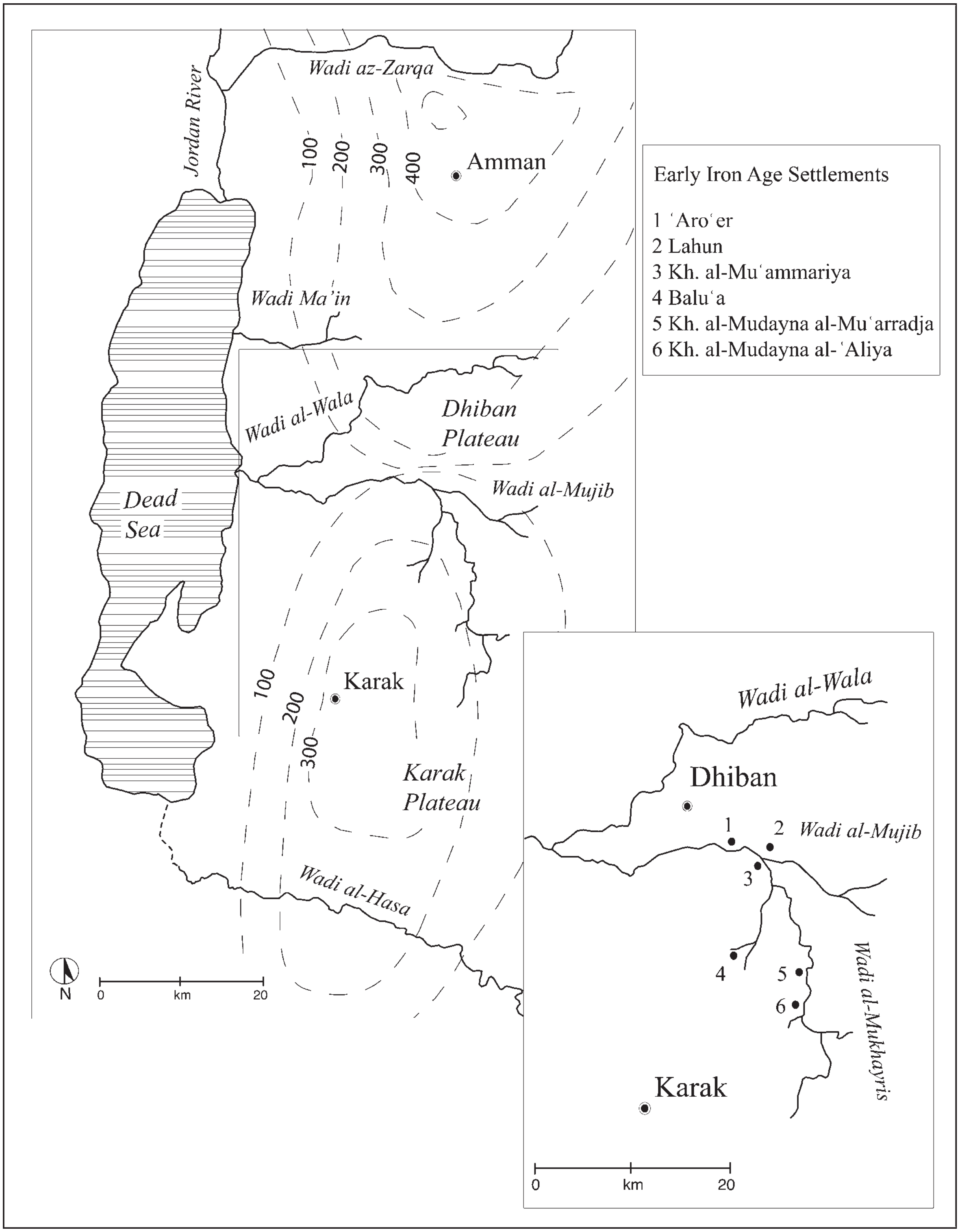

Fig. 1. Map of west-central Jordan displaying precipitation isohyets and key early Iron Age settlements.

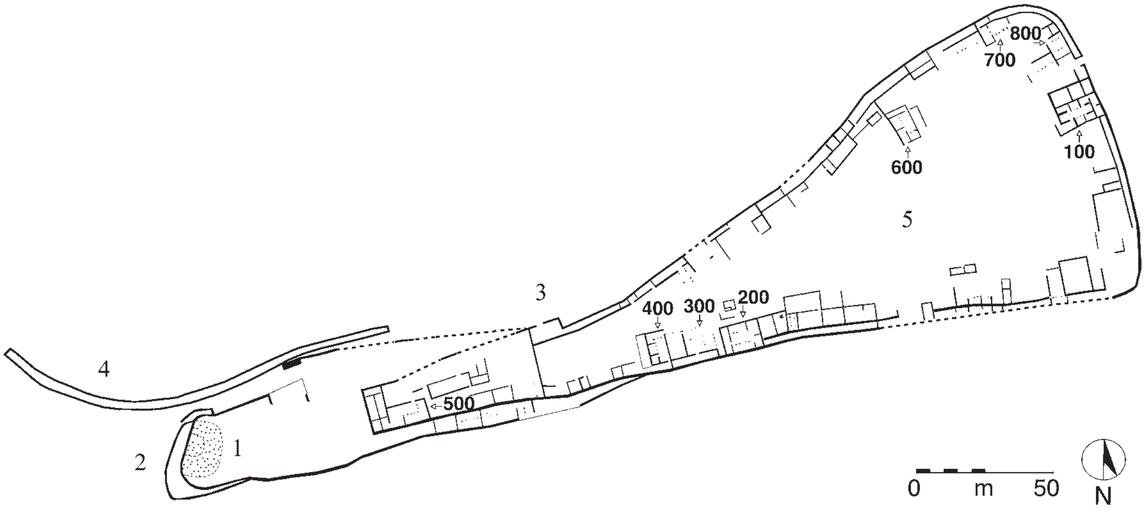

Fig. 2. Map of KMA denoting Buildings 100 through 800, tower (1), moat (2), a possible gated entrance (3), paved pathway (4), and courtyard (5).

Fig. 3. Spring located at the bottom of the Wadi al-Nakhayla, a tributary of the Wadi al-Mujib. Such water sources guaranteed a constant, albeit difficult to access, water supply (Photo: B. Porter).

2006).[4] Several settlements share a similar architectural pattern: a series of Levantine pillared buildings with adjacent walls form an oval or elliptical ring around a central courtyard that was either left empty (e.g., KMA, Khirbat al-Muʿammariyya) or contained additional buildings (e.g., Lahun and KMM). Many of these early Iron Age settlements were located along the edges of the steep wadi canyons that bisect the plateaus, the Wadi al-Wallah, the Wadi al-Mujib, and the Wadi al-Hasa (Routledge 2004: 95–96). Their position guaranteed access to the canyon riparian zones as well as flat tablelands where herds could graze on naturally available grasses.

KMA, KMM, and Lahun, whose early Iron Age remains are exposed at or near the surface, measure 2.2, 1.6, and 1.7 ha in area, respectively. While the full extent of ʿAroʿer and Baluʿa are difficult to measure because early Iron Age remains have only been explored in limited horizontal exposures, a reasonable estimate for each settlement would not exceed 3.0 ha overall. These similarities in size, as well as in settlement design (discussed above), indicate a single-tiered settlement hierarchy that lacks a central administrative metropole from which one settlement could dominate others, or demand surplus production for regional elites.[5] The absence of a highly integrated regional political organization, however, does not eliminate the likelihood that these settlements interacted with one another. Aside from Lahun, which may have been founded as early as the end of the 13th century B.C.E. and continued to be occupied into the 11th century (Routledge 2008: 163–64),[6] the remaining five settlements were likely founded at some point during the 11th century. This dating is only supported chronometrically at KMA,[7] but published ceramic evidence suggests roughly contemporary occupation at all of the settlements in question (Routledge 2000: 47; 2008).[8]

Archaeological evidence for agropastoralist subsistence practices in these early Iron Age settlements is best documented at KMA. Storage bins were located in the rear of many pillared buildings, where produce could be kept dry and safe from rodents and thieves (Routledge 2004: fig. 5.9). Preliminary analysis of palaeobotanical evidence from one storage bin in Building 100 (Unit 4J41) provides evidence for cropping strategies and consumption practices (Simmons 2000). A number of cereals in grain and chaff form, as well as pulses and fruits, were present in the sampled data, with an emphasis on two-row barley and figs (Simmons 2000: fig. 15). Additionally, Sim-

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[4] In addition, four excavated settlements present limited evidence for early Iron Age occupation. In most cases, evidence datable to the early Iron Age—usually ceramic artifacts—are recovered in secondary debris contexts not associated with the surfaces of architectural units. In other instances, early Iron Age materials are identified in contexts mixed with earlier or later materials. A final persisting issue is the quality or lack of published information that would permit a better assessment of excavated materials. Such settlements include Abu Kharakha (Parker 1987), Boz al-Mushelle (Strobel 1990: 83–85; Strobel and Wimmer 2003: 84–88), Dhiban (Winnett and Reed 1964; Tushingham 1972; Routledge 2004: fig. 8.5), and Khirbat al-Mudayna al-Mujib (Worschech, Rosenthal, and Zayadine 1986; Worschech 1990: 54–59). Nevertheless, these poorly stratified contexts are worth mentioning, as their existence speaks to the widespread distribution of early Iron Age settlements across the region.

[5] The characterization of these settlements' political and economic organization as relatively independent differs from that of other scholars, who have sought evidence for an early Iron Age Moabite polity like that portrayed in the Hebrew Bible, especially Num 21:21–30; 21:26, and 22–24, and Judg 3:12–30, which describe early Iron Age Moabite kings (Timm 1989; Worschech 1990; van Zyl 1960). Nelson Glueck, for example, described the function of these early Iron Age settlements as fortresses protecting the polity's northern and eastern borders (Glueck 1939: 121–22; 1940: 167–72). Other scholars have suggested that social evolutionary categories such as "tribe" and "chiefdom" be used to characterize the region's political organization (LaBianca and Younker 1995; Mattingly 1992). Porter most recently has argued that these settlements are best conceived of as communities whose organizations were determined by internal principles and local environmental conditions (Porter 2007).

[6] At Lahun, ceramic evidence dating to the Late Bronze/Iron Age transition was sealed beneath an early Iron Age fortification wall (Homès-Fredericq 1992; 1997). Pottery from the surfaces in the excavated Iron I houses is comparable to late Iron Age IB assemblages from KMA, KMM, and Khirbat al-Muʿammariyya (Swinnen 2009: fig. 21). Also, the discovery of a scarab bearing iconography of the 19th and 20th Egyptian Dynasties gives a terminus post quem for settlement between ca. 1186 and 1070 B.C.E. (Homès-Fredericq 1992: 189–90).

[7] Four radiocarbon dates from burned silo rooms in two houses cluster very consistently. Short-lived barley and reed samples have calibrated two sigma (95.4%) confidence intervals of 1115–926 cal B.C. (OXa-18966), 1115–925 cal B.C. (OXa-19016), and 1108–913 cal B.C. (with the 93.5% confidence interval being 1056–913 B.C.; OXa-19017). The one roof beam assayed has a two sigma interval of 1209–997 cal B.C. (OXa-18967). If one accepts the stratigraphic evidence that KMA was occupied for only a short period of time, then these dates support an 11th-century construction date for the houses and an abandonment linked to burning the stored barley in the 11th or 10th century B.C.E. These Oxford AMS dates using the InCal 04 atmospheric curve supersede the problematic beta-counted dates from Université Laval published in Routledge 2000: 47–48, fig. 8.

[8] The settlements appear to share a relatively similar ceramic vessel assemblage with secure 11th- and early 10th-century strata at Deir ʿAlla (Phases E–H) in the Jordan Valley and at various settlements in Palestine, including Beersheba Strata VII–VI, Gezer Strata XI–X, Hazor Strata Xb–IXb, ʿIzbet Sartah Strata II–I, Megiddo Strata VI–V, Qasile Strata XII–X, and Taʿanach Strata IIA and IIB.

TABLE 1. Identifications for All Bones Recovered at Khirbat al-Mudayna al-ʿAliya

Common Name	*Scientific Name*	*NISP*	*Percent*	*MNI*
Freshwater crab	*Potamon potamios*	100	23	27
Bony fish	Actinopterygii	1	+	1
Heron or stork	Ardeidae/Ciconiidae	1	+	1
Perching bird	Passeriformes	1	+	1
Unidentifiable birds	Aves	10	2	—
Rodent	Rodentia	12	3	2
Possible hedgehog	cf. Erinaceidae	1	+	1
Domestic dog	*Canis familiaris*	3	1	2
Red deer	*Cervus elaphus*	1	+	1
Domestic cattle	*Bos taurus*	11	3	1
Pig	*Sus scrofa*	6	1	1
Domestic goat	*Capra hircus*	10	2	3
Domestic sheep	*Ovis aries*	8	2	2
Sheep or goat	*Ovis/Capra*	229	53	7
Camel	*Camelus* sp.	1	+	1
Ass or onager	*Equus asinus* or *hemionus*	8	2	1
Horse	*Equus caballus*	12	3	2
Horse, ass, or onager	*Equus* sp.	16	4	3
Unidentifiable bones		1,798	—	—
Total Identifiable		431		29
Grand Total		2,229		

mons identified several wetland weed species mixed with barley (2000: 44–46, fig. 23), suggesting that the cereals in this storage bin were harvested near water sources, likely using floodwater farming techniques in the canyon below the settlement. The presence of culm nodes and twining weed species suggests that the barley was harvested by plucking the stalk, rather than cutting the head, and was only coarsely sieved. This suggests that the barley was being stored for animal, rather than human, consumption, since it contained a high percentage of straw and other roughage. Stored fodder may have been necessary to get herds through the lean portions of the year after field stubble had been completely grazed.

KMA'S FAUNAL ASSEMBLAGE: PRESENTATION AND ANALYSIS

Three excavation seasons yielded a total of 2,229 fragments of animal skeletons (table 1), in addition to 25 human bone fragments. All excavated soils were sieved through 5-mm mesh. While the chosen mesh size may have resulted in a size bias against small species, especially fish (see Zohar and Bellmaker 2003), this 100% sieving policy remains unusually comprehensive among published faunal assemblages from the Iron Age southern Levant. Furthermore, flotation samples ranging from 7 to 50 liters of soil were collected from all excavated contexts. Flot was captured with a 250μ mesh, while heavy fraction was retained using a 1-mm mesh. These fine-sieved sediments produced some additional pieces of bone, but notably did not result in the recovery of species and elements not represented in the dry-sieved portion of the assemblage.

All bones were identified to the lowest possible taxonomic category, and for each, morphological and taphonomic features, where visible and relevant, were recorded, including butchery marks and age-related information. This resulted in the identification of 431 nonhuman specimens to the taxonomic level of family or below. Unfortunately, the small size, and fragmentary character, of the KMA assemblage prevented the determination of age profiles and hence kill-off patterns. However, quantifiable variables on the bones, fragment counts, weight, and metric measurements were recorded. In addition to taking, where possible, standardized metric measurements as given in von den Driesch's (1976) manual, all fragments were measured along their greatest axis, in order to generate a variable by which to compare carcass reduction/sample preservation across and/or within the site (cf. Bar-Oz and Adler 2005: 187–89). Measurements were taken using a digital caliper (accurate to 0.01 mm) with a computer interface cable for direct input of measurements to a database. The number of identified specimens (NISP) was used as the primary means of abundance calculations, as it is both the most common method employed in Near Eastern zooarchaeological investigations and that which employs the least number of mathematical assumptions concerning the relationship of excavated bones and the amount of meat once present at an archaeological site. The minimum number of individuals (MNI) was also calculated and is presented in table 1 alongside NISP, but this statistic was not the primary means used for comparisons in this article. Instead, the latter quantification is offered principally for those who prefer the method and wish to use these data instead of NISP.

Measurements were used in two ways. First, we followed the guidelines established by von den Driesch (1976), which standardized animal bone measurements meant as primary data for reconstructing individual animal or average species size. Although this information was collected, we recovered too few measurable bones from any one species to make meaningful reconstructions of animal sizes. We also used measurements to understand the bone collection's taphonomic history. For bones identifiable to lower taxonomic categories, family or more specific, we measured the bones and bone fragments along their longest axis, in order to assess the postdepositional effects on the animal bones as part of a taphonomic study of settlement abandonment at KMA (to be published in a future article).

This small faunal assemblage consists primarily of remains from domesticated mammals—that is, sheep (*Ovis aries*), goats (*Capra hircus*), cattle (*Bos taurus*), pigs (*Sus scrofa*), dogs (*Canis familiaris*), and a camel (*Camelus* cf. *dromedarius*) (although the last bone may be a recent deposition). Unsurprisingly, the most common species present are sheep and goats. In most cases, it proved impossible to differentiate between these species, a common problem that derives from the fact that sheep and goats are differentiable only on the basis of a few skeletal elements (cf., e.g., Boessneck, Müller, and Teichert 1964; Halstead, Collins, and Isaakidou 2002; Payne 1985; Prummel and Frisch 1986; Zeder and Pilaar 2010) without recourse to new genetic separation techniques (cf. Buckley et al. 2010). The 7% of all the sheep/goat bones that could be speciated were made up of eight sheep and ten goat elements. This limited evidence may suggest that sheep and goats were kept in relatively equal numbers, as one might expect in an unspecialized, subsistence-level economy focused on herd security. Nonetheless, the faunal data concerning sheep vs. goats is too limited to make such a statement on the basis of that evidence alone, given the complexities of sheep and goat herd management (cf. Redding 1981) and the fact that the sample size is small and lacks quality age and sex data. Other forms of evidence from the site, discussed below, do point toward a generalized economy, however, and therefore the sheep and goat numbers may provide some limited ancillary support for that postulate.

In addition to the above species, bones of at least two equid species were also found, mainly teeth and mandible fragments. It is difficult to differentiate, however, among the teeth of onagers, the Asian ass, and the African donkey. Metric tooth measurements show overlap among the species, and morphological criteria are not consistent (Eisenmann 1986; Payne 1991; Uerpmann 1991; Vila 2006). Some teeth are clearly larger than others, but size overlaps in teeth are a known problem even between horses and the smaller equid species (Eisenmann 1986: 75–76). Nonetheless, they morphologically resemble horse rather than ass or onager, based on Davis's (1980) published criteria. Some of the other specimens are referred to as *Equus asinus* (donkey) or *hemionus* (onager), indicating that they are likely from either one or both of the two species. Von den Driesch and Boessneck (1995: 86) provisionally identified a few onager bones from Tall Hesban, so onagers are a possibility for this area of Jordan. Admittedly circumstantial evidence—namely, the rarity of wild equids after the Early Bronze Age in the region—in addition to the horse teeth in this assemblage, suggests that the bones are more likely from domestic donkeys than onagers.

Other domestic food-producing species (i.e., cattle and pigs) provide further economic clues. Both species are present but rare, with neither accounting for even 1% of all recovered bones. This profile is typical of semiarid animal economies, as sheep and especially goats require much less water than cattle (Tchernov and Horwitz 1990: 208). Although it has often been observed that pigs require even more water, and generally wetter conditions, than cattle, sheep, and goats (cf. Diener and Robkin 1978), this point should not be overemphasized. Today, Christian villagers in Smakiah, a town located near KMA, keep pigs. In ancient times, pigs could have been kept in the canyon's riparian zone, which the palaeobotanical evidence discussed above indicates was exploited by ancient residents in their subsistence regimes. Alternatively, it is possible that these pig bones are from wild boars, which are endemic to the Levant and generally can be found wherever there are sources of freshwater (Qumsiyeh 1996: 200). Some archaeological studies suggest that when low numbers of pig bones are found at semiarid settlements, they should probably be considered wild, albeit that assumption should not be made in lieu of measurements and comparison to modern wild specimens (Marom et al. 2009: 63). The cattle bones, on the other hand, came from animals too small to be wild and thus represent evidence that villagers kept a small number, perhaps primarily for labor and/or dairying rather than meat.

In addition to the proportions of domesticated food species, the presence of horse and ass bones in the assemblage proved intriguing. The total number of equid bones, 36 (MNI = 6), in addition to the single camel element (a first phalange), is greater (9% of identifiable bones) than at several broadly contemporary sites in the region.[9] The proportion of identifiable bones from the Iron Age levels of nearby Hesban is 1.7% (cf. von den Driesch and Boessneck 1995: 72), which is in turn more than the percentage at Tel ʿIra (Horwitz 1999). The percentage of beasts of burden from KMA is also higher than that from Shiloh in the southern Levantine Central Highlands (0.02%; Hellwing, Sade, and Kishon 1993: 311). The importance of these finds is that the domesticated forms of these animals were used in antiquity as beasts of burden, whether for regional or long-distance transport of people and goods, or for local agricultural tasks. Given the evidence for agricultural exploitation of the wadi bottom the role of equids would have been particularly important at KMA.

Perhaps most interesting of all was the presence of wild animal species, suggesting that hunting and trapping played an important role in KMA's animal economy. The faunal assemblage includes at least four wild animal species likely to have been taken for food. Four of the five species, red deer, one or more small bird taxa, a heron or stork, and unidentified fish are present as either single bone finds or as just a few bones. The sole species with greater numbers of fragments is the freshwater crab (*Potamon potamios*). A total of 100 crab claws were recovered during excavation. Crab remains are rarely discussed in the archaeological literature of the southern Levant (but see Ashkenazi et al. 2005), although specimens are reported from settlements ranging from the Palaeolithic (Ashkenazi et al. 2005; Edwards 1988; Goring-Morris 1980), through the Neolithic (Bar-Yosef et al. 1991; Edwards et al. 2002; Horwitz 2003; Noy, Schuldenrein, and Tchernov 1980), Bronze (Fischer and Holden 2008; Mienis 2002) and Iron Ages (Horwitz et al. 2005: 402–3; Horwitz 2006: 698, table 26.7; Lev-Tov 2000: 119, 171), as well as later periods (Horwitz 2006: 695, table 26.4). It should be noted that KMA is located more than 250 m in elevation above the wadi bottom, and hence there was limited opportunity for the accidental transport of crabs from the wadi to the site. While mud-bricks were not used at KMA, one possible medium for the accidental introduction of crabs was the use of clay-rich mud for roof construction (Routledge 2000: 53–54). However, only one fragment of crab exoskeleton was recovered from the two burned rooms (4J41 and 2E22) where significant quantities of collapsed roofing material were recovered. Indeed, the distribution frequency of crab remains follows that of most other artifact categories, being concentrated in units (e.g., 5I05, 2G87) where no roofing material was recovered and deposits appear to have been post-occupational middens. Furthermore, unlike the vertebrate bones, a relatively large proportion—20%—of the crab shell fragments was burned. Because burned crab claws were found in the same locus and basket as unburned bones, we may presume that the crabs' shells were burned as a result of cooking methods rather than via the burning of organic refuse after disposal. We are, therefore, relatively confident that crabs were brought to KMA as a food source. We would suggest that the crabs were probably roasted over, or even in, a fire, thus using the shell as cooking container and, in so doing, blackening or calcining the surviving claws.

The exclusive presence of claw parts, especially pincers (fig. 4), in the KMA assemblage is probably a product of taphonomy, as claws are more heavily calcified than the body carapace (Ashkenazi et al. 2005: 676). Admittedly, there are harvesting strategies in which only the crab's claw is taken, allowing the crab to remain alive and regrow its claw as a kind of renewable food source (Oliveira et al. 2000). However, this seems to occur primarily with species (such as the fiddler crab) whose males possess one overdeveloped claw with significant meat content.

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[9] Of 27 equid bones from KMA, 25 were teeth (many from the same architectural unit, 5I05, which produced most of the bones). Many of the teeth emanated from the same skulls, such that the relative abundance of equids is inflated according to NISP. In any case, the MNI for all equids together, 6, is impressive and presents a better estimate of relative abundance for these particular animals.

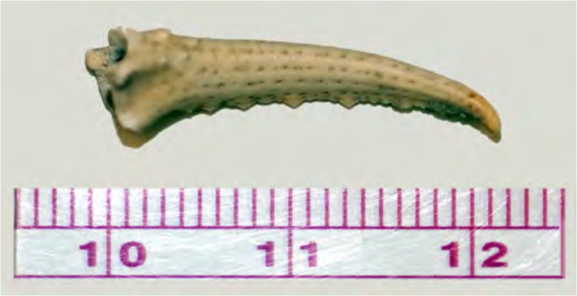

Fig. 4. Pincer of freshwater crab excavated at KMA (Photo: C. Morgan, S. Jagani, and A. Farahani).

Potamon potamios do exhibit handedness, with functionally distinct claws (crushing and cutting) of slightly different sizes (Scalici and Gheradi 2008). However, the overall size of the dominant claw, and hence its meat content, remains small (cf. Losey, Yamada, and Largaespada 2004: 1606–7 for a similar conclusion regarding harvesting of the larger Dungeness crab).

While we have yet to complete the metrical studies necessary for reconstructing crab size from the exoskeletal parts recovered from KMA (see Ashkenazi et al. 2005 for methodology), nothing in our sample suggests that these crabs were larger than modern populations of *Potamon potamios*. The carapace lengths of two such modern populations in Israel ranged from 12.50 to 57.50 mm (Gherardi and Micheli 1989: 139) and from 3.50 to 63.4 mm (Ashkenazi et al. 2005: 684), with sexually mature specimens measuring over 35.0 mm (Gherardi and Micheli 1989). Total length of the main propodite claw in mature males is generally similar to that of carapace length (Gherardi and Micheli 1989: fig. 2). No data is available on meat yields from *Potamon potamios*. Limited data (n = 2) on meat yields from the similarly proportioned but larger (ca. 300% at maximum size) Dungeness crab show a range of 330–360 g of meat per crab, with roughly 60% coming from the legs (including the claws) and 40% from the main body cavity (Losey, Yamada, and Largaespada 2004: 1607, table 1). As meat yields from *Potamon potamios* would be considerably less than that of the Dungeness crab, we should not exaggerate the contribution of crab meat to the diet of KMA's inhabitants. At the same time, crab remains do constitute a sizable proportion of all animal remains recovered from KMA. While one could argue that their high contribution to the NISP figures for KMA (ca. 23%) reflects the fact that crab shells have a 100% identification rate, crab remains still constitute a significant proportion (ca. 4.5%) of all animal remains recovered (identified and unidentified). As we shall see below, this gives the faunal assemblage from KMA a distinct profile that is suggestive of broader patterns in early Iron Age subsistence practices.

Interpretation and Synthesis

The general profile of the faunal assemblage indicates that KMA's animal economy can be characterized as low in intensity and nonspecialized in orientation. The dominance of sheep and goats, and near absence of both cattle and pigs, is hardly surprising in this semiarid zone. Still, as the crab remains and wetland weed remains indicate, the environment around the settlement contained a steady supply of flowing water. Identifiable bones of sheep and goats indicate that the two species were probably kept in equal proportions. In other words, so far as the dominant caprine livestock herding regimen is concerned, the inhabitants of the settlement did not intensify the output of secondary products obtainable from sheep and goat, such as dairy products or wool.

But how were livestock flocks supported in this semiarid landscape? We think that clues are tendered by certain faunal and floral remains outside the bones of the domesticated mammals. As already observed, studies of floral remains from the settlement demonstrate a mixture of barley with wetland weed specimens, suggesting that the grain was grown in the moist soils at the bottom of the wadi. Similarly, the large number of crab shell fragments—in fact, all claws—indicates the riparian zone was used for collecting wild animals. Movement between the plateau and wadi bottom would, therefore, be a regular occurrence, one that the location of KMA facilitated and one that also suited the grazing of livestock on wadi slopes and in the wadi bottom.

In such a scenario, then, harvested crabs or waterfowl may have been a seasonally scheduled supplemental food source (cf. Flannery 1968) exploited during periods when residents were active on the canyon slopes and in the wadi bottom. If, as the evidence suggests, agriculture and pastoralism were integrated at KMA, then use of the wadi would have been scheduled around the availability of water and grazing, general temperature and comfort levels, and the balancing of agricultural and pastoral land use in order to avoid conflict. While water and forage plants are available all year round in the wadi bottom, current residents of the region state that the wadi bottom is too hot, stifling, and mosquito infested for extended residence during the height of summer. This is true even of those directly engaged in commercial fruit and vegetable farming in the wadi bottom, many of whom hire migrant workers to reside on their irrigated plots during the summer. Ethnohistoric evidence also suggests that in the 18th and 19th centuries, prior to the foundation of most of the modern villages on the eastern Karak Plateau, local residents camped in the wadis during the winter and moved to the plateau during the summer months (Lancaster and Lancaster 1995: 116).

This said, we should remember that post-harvest stubble would have provided an excellent source of summer forage just as the dry season began to restrict the availability of natural pasture. It is likely that grain was grown both on the plateau adjacent to KMA and in the wadi bottom, but summer water supplies on the plateau would have been limited primarily to cisterns, making the wadi's perennial springs an attractive summer resource. Late summer fruits, such as figs and grapes, are attested in KMA's palaeobotanical sample and, if local, would probably have been concentrated in the wadi bottom adjacent to springs due to their water requirements. We have no indication that fruit production was occurring on a large scale in the vicinity of KMA; however, the extensive natural terracing of the wadi edges would have easily facilitated discrete, adjacent land uses, much as it does today (e.g., irrigated fruit crops, small-scale grain fields, seasonal grazing). Hence, summer activity in the wadi is likely to have been greater in antiquity than in the recent past.

Freshwater crabs are highly adaptable, a fact witnessed by the distribution of the primary eastern Mediterranean species *Potamon potamios* in bodies of freshwater from the eastern Aegean islands south to the Sinai Desert (Brandis, Storch, and Türkay 2000; Flower 1931). As such, these crabs are not narrowly seasonal, provided water is available (Gherardi and Micheli 1989; Wolcott 1988: 60–64), although their activity levels do vary with body size and temperature (Warburg, Goldenberg, and Rankevich 1982). Crabs are primarily nocturnal, and their activity levels decline at temperatures below 10°C and above 35° (Warburg, Goldenberg, and Rankevich 1982; Gherardi et al. 1988). This suggests that crabs may have been less active and visible in the depths of winter and the height of summer. However, crabs were probably difficult to catch at all times of the year, as they occupy deep burrows along stream banks, with males wandering farther from the streambed than females but generally only at night (Gherardi and Micheli 1989: 143). Harvesting may well have required the use of traps, which would need to be laid and checked at regular intervals. Whatever the strategy, it seems likely that the seasonality of crab harvesting would have related not so much to the behavior of crabs as to the behavior of humans.

Two points in the year stand out in particular as times when human presence in the wadi bottom may have intensified and hence increased the likelihood of crab harvesting on any scale. From late August until the first rains (late October/November), the harvesting of summer fruits, the exhaustion of pasture and sources of surface water on the plateau, and the need to fertilize and plow fields in preparation for planting would have increased human activity in the wadi. As field stubble and natural pasture on the plateau were exhausted, herds would be drawn to the wadi's riparian zones, where they could forage on native grasses and shrubs growing along the perennial stream. By herding the animals in the wadi bottomlands, the settlement's herders may have aided agriculture via the manuring of fields, especially in the period immediately before initial plowing (Fuller 1991; Halstead 1987). Crabs collected from the end of summer to early winter would have provided an additional source of animal protein prior to the spring cull of domestic herds.

Between early and late spring, sheep, goats, and cattle give birth, at once increasing the flocks as well as increasing the risk that young animals would not make it through the dry season. The principal annual slaughter of sheep and goats, when it occurred, would be scheduled in this time of year, prior to the onset of the dry season, when flocks are the costliest to keep. During the spring, when winter crops were maturing in the bottomlands and on the western plateau, sheep and goats could have been moved between the wadi slopes and the highlands east of the wadi, so that crops could be protected from the animals. On the slopes and eastern highlands, the animals could feed on noncultivated plants prior to the dry season's onset.

The grain and legume harvests (late April–June) are the second period when human activity in the wadi would peak. Here labor "bottlenecks" may have limited the time available for non-harvesting activities. However, the nocturnal habits of freshwater crabs would favor checking and laying traps at the beginning or end of the working day; so perhaps crabbing could have been scheduled to complement the labor demands of the harvest. At the height of summer, herds could graze on post-harvest field stubble on the western plateau, before moving into the wadi bottom late in the summer as water and forage on the plateau became scarce.

The open nature and relatively small scale of the house-based storage facilities at KMA suggest that stored fodder, such as the barley stored in Building 100 at KMA, served as seasonal supplemental and emergency feed, rather than as a primary food source for village herds. Hence, we would not disagree with Tchernov and Horwitz (1990: 208) who state that "on the whole, herds were free ranging, possibly with access to harvested or fallow fields at certain times of the year. . . . [I]t was only in exceptional instances that the animals were totally dependent upon man-supplied forage." We would only add that, based on the KMA evidence, short-term seasonal dependence on fodder in the late summer–autumn may have been an important feature of the animal economy in arid and semiarid zones (cf. Tully et al. 1985).

This reconstruction of KMA's animal economy and its scheduling cannot emphasize enough the importance of the canyon's riparian zone beneath the settlement. It is this econiche that serves as the best explanation for why so many early Iron Age settlements were founded adjacent to the edges of major wadis. Thus, it was geography rather than political boundaries or defensive needs that determined these settlement patterns. This link between settlement pattern and riparian zones may explain why we see a degree of difference when comparing KMA's faunal assemblage with other early Iron Age assemblages in the southern Levant, especially with regard to its relatively high proportion of crab exoskeletal parts.

The role of wild fauna in post-Neolithic subsistence economies is rather interesting and difficult to interpret. Grigson (1998), in her survey of Levantine subsistence from the late Neolithic to the Iron Age, fails to even mention the role of such animals, presumably because they are rare in most faunal assemblages. In contrast, Horwitz and Milevski (2001) note that between the Middle and Late Bronze Ages, within settlements lying to the west of the Jordan River, there was a general increase in dietary diversity due to an increase in the wild fauna (including fish) found in such bone assemblages. This trend is also visible at Iron Age settlements such as Tall al-ʿUmayri (Peters, Pöllath, and von den Driesch 2002), and Hesban (von den Driesch and Boessneck 1995). At Hesban, approximately 1% of the Iron Age fauna collected came from wild ungulates (von den Driesch and Boessneck 1995: 86), along with an unknown proportion of wild birds as well as freshwater and saltwater fish (von den Driesch and Boessneck 1995; Lepiksaar 1995). Recent analysis of transitional Late Bronze/early Iron Age faunal remains from al-ʿUmayri includes a proportion of approximately 10% wild game, including not only ungulates, but also a variety of birds as well as a few bones of Nile perch. Interestingly, while the relative abundance of the core domesticated animal species (sheep/goat, cattle, and pigs) seems linked to differences in the emphasis of animal economies, it is the rare (especially wild) species that seem to most distinguish the subsistence practices of individual settlements.

COMPARING ANIMAL ECONOMIES ACROSS THE EARLY IRON AGE SOUTHERN LEVANT

Comparing KMA's animal economy to published assemblages from other early Iron Age southern Levantine communities helps determine the degree to which KMA's profile is normative. Here we face a problem, in that inter-settlement variability in faunal assemblages can be caused by at least five factors: (1) the nature of the deposit(s); (2) collection methods; (3) sample size; (4) species richness and animal abundance within a given settlement catchment; and (5) ancient food production and procurement practices. Factors 1–4 have the biggest impact on the presence and frequency of wild and rare species in any given assemblage, while factor 5 is most relevant to the core domesticated species that appear in quantity in most assemblages. For this reason, we first address factors 1–4 primarily in terms of wild and rare species, before turning to consider factor 5 primarily in terms of the core domesticates. For the purposes of our comparative analysis, we have only taken account of specimens identified to the taxonomic level of family or lower. Hence, unidentified rodents, birds, and fish, for example, have been excluded from the figures we consider.

Two faunal assemblages from early Iron Age settlements in the northern part of the Negev Desert—Tel Beersheba (Hellwing 1984) and Tel Masos (Tchernov and Drori 1983)—were selected for comparison with KMA due to their position in a comparable semiarid environment. A transitional Late Bronze/early Iron Age faunal assemblage from al-ʿUmaryri, located south of modern Amman (Peters, Pöllath, and von den Driesch 2002), was selected because of its relatively close proximity to KMA. Additionally, the faunal assemblages of four other settlements, ʿIzbet Sartah, Shiloh, Tel Miqne-Ekron, and Tel Dor, all located in nonarid environmental zones, were selected to provide a broad regional comparison with the KMA faunal evidence. Two further settlements, Tall Hesban and Tel Rehov, are included only in the discussion of the production strategies of core domesticates. Hesban is the early Iron Age settlement most proximate to KMA with a published faunal assemblage. Unfortunately, the final publication of the Hesban assemblage does not distinguish between different phases of the Iron Age for wild and rare species. However, summary statistics are given by stratum for the core domesticated species in the faunal assemblage from the 1976 season. Hence, the faunal assemblage from Stratum 19 (early Iron I) excavated during the 1976 season is used in our comparative analysis of core domesticated species. The published Rehov faunal assemblage (Marom et al. 2009) overlaps with the very end of the early Iron Age but is primarily Iron IIA in date, providing a chronological contrast with KMA. As the nonmammalian bone assemblage from Rehov has not yet been published, this settlement will only be used when comparing the core domesticated animals.

Context

Each of the nine faunal assemblages under comparison represents slightly different depositional conditions. The KMA assemblage represents a cross section of deposits from the site's single early Iron Age occupational phase. The Beersheba and ʿIzbet Sartah assemblages represent an amalgam of several early Iron Age phases. As none of these settlements attest to any pre–Iron Age occupation, there is no reason to suspect that residual bones will distort patterns defined in terms of the broad chronological category "Early Iron Age." ʿIzbet Sartah does have a later Byzantine occupation at the settlement, and this is likely the source of at least some of the bones from so-called mixed loci. For this reason, we have included only the faunal assemblage from Strata I–III in this study. Residuality is also likely to be minimal at Masos, as pre–Iron Age occupation on the tell is limited to a small Chalcolithic pit-dwelling in Area B (Thuesen 1983). In contrast, Shiloh, Dor, Miqne-Ekron, and al-ʿUmayri are all tell sites with fairly extensive pre–Iron Age occupational layers, and hence residual bones present a potential problem. Raban-Gerstel et al. (2008: 51–52) have made some effort to address this issue at Dor, noting that bone assemblages from single, well-sealed contexts exhibit patterns of relative species abundance similar to those attested for the amalgamated assemblage as a whole. Hesse (1986), Hesse and Rosen (1988), and Lev-Tov (2000) also addressed the issue with respect to Miqne-Ekron, albeit using different approaches: Hesse argued for a post-hoc approach, where samples that produced "interpretable patterning" (Hesse 1986: 20) must be from loci with little to no chronological mixing, while Lev-Tov advocated an a priori method, analyzing faunal samples according to the loci types from which they were derived, as well as based on the amount of mixing evident from the date of the deposit's ceramic artifacts (Lev-Tov 2000: 58–60). In the case of al-ʿUmayri, the published bone assemblage derives from a single large pit, rather than from an amalgam of deposits. In this case, residuality may be less of a problem than special function, as the fauna from this pit were identified by taxa at a high rate (72%) and included a large number of wild animal species, but a lower than expected number of small animal species (see below).

Collection Methods

Collection methods also varied between sites. As noted above, all excavated sediments at KMA were sieved through 5-mm mesh screens. The Area B pit at al-ʿUmayri was sieved through a 3-mm mesh (Peters, Pöllath, and von den Driesch 2002: 314), while none of the other projects made systematic use of sieves in recovering their faunal assemblages. The extent of sieving and the differences in mesh size are most likely to have impacted both the number of different small taxa recovered and the relative abundance of specimens within each small taxon (Zohar and Bellmaker 2003). Table 2 (column 6–7) compares the proportion of small taxa (average adult length < 30 cm) for seven of our eight faunal assemblages.

When examining table 2 (columns 6–7), one can see that the absence of any small taxa from faunal assemblages at Masos and ʿIzbet Sartah suggests that collection methods could be a factor in species representation within these assemblages; hence, one should be very cautious in drawing any conclusions regarding the exploitation of small or rare taxa at either of these settlements. A Fisher's Exact Test (used in preference to the chi-squared test due to the low expected values) indicates that the remaining six settlements show no statistically significant difference in the proportion of small taxa recovered ($p = 0.884$). In particular, despite using a smaller mesh size, there is no evidence that small species are better represented at al-ʿUmayri than at KMA (indeed, quite the opposite appears to be true).

TABLE 2. Comparative Data on Early Iron Age Faunal Assemblages

Site Name/ Excavation Area	*Sample Size*	*NISP*	*Percent Identifiable**	*n = All Taxa*	*n = Small Taxa (< 30 cm)*	*Small Taxa (%)*	*Species Not Present at Tall al-ʿUmayri Area B*
KMA	2,229	408	18.31	13	4	30.77	*Potamon potamios* Freshwater crab *Erinaceidae* Hedgehog *Ardeidae/Ciconiidae* Heron/stork *Talpa* sp. Mole *Passeriformes* Perching birds *Equus caballus* Horse *Cervus elaphus* Red deer
Beersheba	N.A.	1,238	N.A.	12	2	16.67	*Lepus* sp. Hare *Gallus domesticus* Domestic fowl *Passeriformes* Perching birds
Dor	N.A.	2,308	ca. 30.00	34	8	23.53	*Hippopotamus amphibius* Hippopotamus *Cervus elaphus* Red deer *Vulpes vulpes* Red fox *Erinaceidae* Hedgehogs *Trionyx triungulis* Soft shell turtle *Chondrichtyes* Cartilaginous fishes *Balistes carolinesis* Grey triggerfish *Clarias bagrus* Nile catfish *Clarias gariepinus* North African catfish *Liza ramada* Red mullet *Mugil cephalus* Grey mullet *Argyrosomus* sp. Meagre *Sparus* sp. Sea bream *Epinephelus* sp. Grouper *Tilapia* sp. St. Peter's fish *Anas platyrynchos* Mallard duck *Phalacrocorax carbo* Great cormorant *Pelecanus onocrotalus* Great white pelican *Grus grus* Common crane *Himantopus himantopus* Black-winged stilt *Anser* sp. Goose *Gyps fulvus* Eurasian griffon
ʿIzbet Sartah	N.A.	872	N.A.	8	0	0.00	None
Tel Masos	N.A.	419	N.A.	8	0	0.00	None
Tel Miqne Field I.NE	8,676	2,010	23.17	16	2	12.5	*Hippopotamus amphibius* Hippopotamus *Equus caballus* Horse *Potamon potamios* Freshwater crab *Spalax* sp. Mole rat *Meles meles* Marten
Shiloh	N.A.	1,347	N.A.	12	2	16.67	*Cervus elaphus* Red deer *Gallus domestica* Domestic fowl *Anser* sp. Goose
ʿUmayri Area B	5,989	4,326	72.23	22	4	18.18	N.A.

*"Identifiable" in this context is used to mean bones that could be assigned to a taxonomic grouping lower than class.

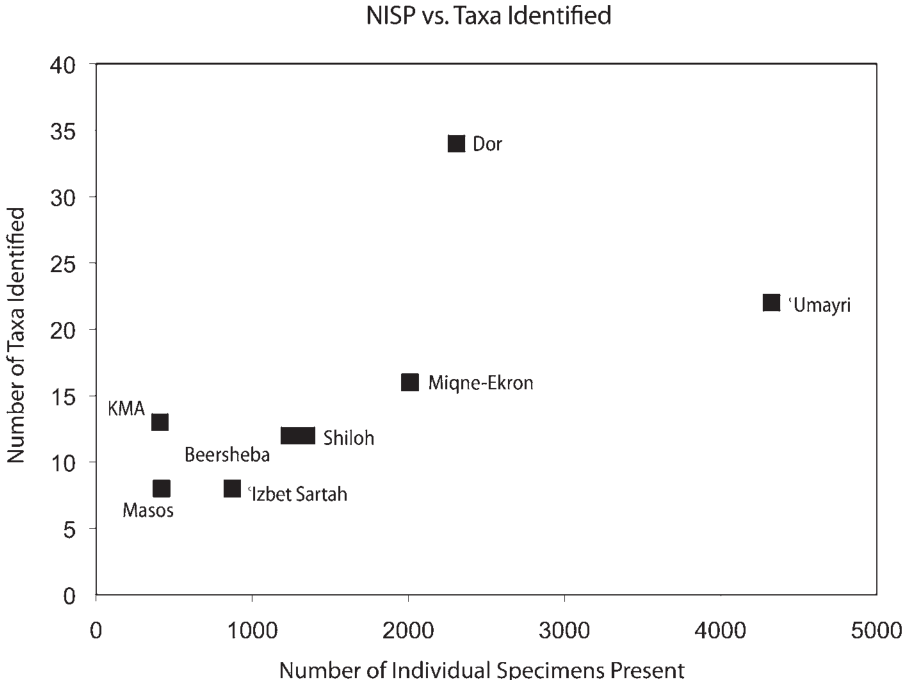

Fig. 5. Number of individual specimens identified (NISPs) versus number of taxa identified for key early Iron Age faunal assemblages.

This suggests that comparisons of small fauna taxa, such as the freshwater crab, on a presence/absence basis ("species richness") are not strongly biased by differences in collection methods, with the possible exception of Masos and ʿIzbet Sartah. The relative abundance of specimens within each taxon ("species evenness") is another matter altogether; hence, we do not use NISP to compare rare and wild taxa across different assemblages.

Sample Size

Sample size has an even larger impact than collection methods, due to the rather simple fact that the greater the size of the assemblage, the more likely it is that rare taxa will be identified within it (Grayson 1984). This rule holds true in a general way for our early Iron Age faunal assemblages where, as figure 5 shows, the number of individual specimens present (NISP) is moderately correlated with the number of identified taxa ($r = 0.644$), with Dor as a significant outlier ($r = 0.905$ without Dor).

The relationship between sample size and the number of different taxa identified can be seen even more clearly if we carry out single sample rarefaction analysis (Sanders1968; Hammer 2010: 125). Rarefaction analysis uses the number of taxa and the abundance of specimens in the largest assemblage (in this case, al-ʿUmayri Area B) in order to model how many distinct taxa that assemblage would be likely to have if the sample size was made progressively smaller. These model figures are expressed in terms of a mean number of taxa to be expected at a given sample size, along with a standard deviation. As such, these figures can be graphed as a curve and compared with the number of taxa found in actual samples of a smaller size. This comparison tests the assumption that differences in the number of taxa identified between assemblages is the result of differences in sample size, rather than differences in the diversity of species actually utilized at different sites in the past.

Figure 6 shows a rarefaction curve based on the al-ʿUmayri Area B assemblage, with the 95% confidence interval marked above and below the plotted mean line, and the remaining early Iron Age assemblages plotted according to their sample size and the number of taxa identified in each assemblage. Four of the seven assemblages smaller than al-ʿUmayri's fit comfortably within the 95% confidence interval of the rarefaction model, and hence one cannot rule out

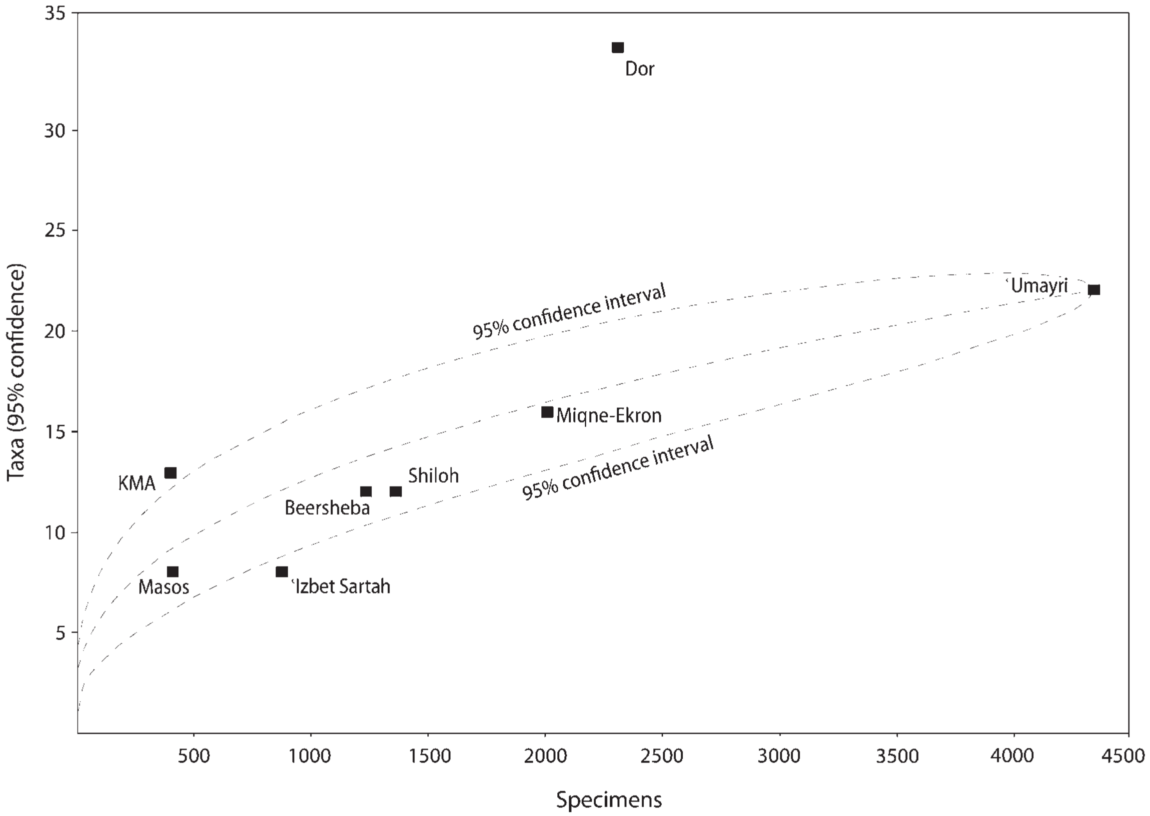

Fig. 6. Key early Iron Age faunal assemblages plotted on a rarefaction curve modeling number of taxa versus different sample sizes for the Tall al-ʿUmayri Area B assemblage (curve generated using PAST V.2.0 [Hammer 2010]).

that sample size is the primary cause of differences in the number of taxa identified at each site. KMA has a slightly higher, and ʿIzbet Sartah a slightly lower, number of taxa identified than one would expect given their sample size relative to that of al-ʿUmayri Area B. Hence, either collection methods or the underlying animal economy at these two sites may have been slightly different from that represented by the al-ʿUmayri Area B assemblage. These differences pale, however, in comparison with Dor, which is literally "off the chart" in terms of the number of taxa identified relative to its sample size. Dor's coastal position, adjacent to a species-rich marine environment, seems to explain its anomalous position, a fact we return to below.

Rarefaction analysis would lead us to conclude that, with the exception of Dor, residents of the early Iron Age sites under consideration did not utilize a radically different number of animal species. However, one limitation of rarefaction analysis is that it takes no account of which species are being exploited at individual sites. In other words, one can ask only whether smaller faunal samples contain fewer or more taxa than the largest sample would contain if it were reduced to the size of the smaller sample. One cannot ask whether or not the samples contain different taxa.

To account for differences in which taxa were being utilized at individual sites, we began from the al-ʿUmayri Area B assemblage, as this has the largest number of identified specimens, recovered with the smallest mesh size. From a methodological point of view, the al-ʿUmayri assemblage should be the most complete. For each of the other settlements under examination, we then listed those species attested in early Iron Age contexts at that settlement that are not attested at al-ʿUmayri. This process highlights the rare species that appear in a given faunal assemblage despite its smaller sample size, and hence may give insights into the distinct features of subsistence strategies at that settlement.

Table 2 (column 8) presents the results of this exercise, revealing several interesting patterns. It is noteworthy that the same two settlements (Masos and ʿIzbet Sartah) lacking any small taxa are also the only sites where no new taxa were identified beyond those found at al-ʿUmayri. This suggests that rare taxa are underrepresented in these assemblages, perhaps due to systematic biases in the collection methods employed. All settlements share a common core of domestic species (sheep, goats, cattle, equids, and sometimes pigs), although the absence of domestic fowl (chicken and geese) from al-ʿUmayri distinguishes this assemblage from a number of settlements west of the Jordan River. In contrast, despite their generally low levels of abundance, wild species show much more marked variation between settlements. Hunting is evident at most settlements, with those in the foothills and highlands sharing a primary focus on large ungulates (esp. gazelle and fallow deer), and a secondary focus on wild boar in a number of cases. Red deer are not present at al-ʿUmayri, but are found at many of the other settlements, including KMA. Deer populations in general, and red deer in particular, were probably subject to extreme pressures during the Iron Age as the result of hunting and habitat reduction (Tsahar et al. 2009: 8–9). However, the presence of red deer in Ayyubid-Mamluk contexts at neighboring Hesban, although interpreted as non-indigenous (von den Driesch and Boessneck 1995: 86–87; Boessneck and von den Driesch 1995: 111–19), may indicate that their absence from the al-ʿUmayri early Iron Age assemblage was a product of sampling error, rather than a habitat that did not support the animals, since Hesban and al-ʿUmayri are close together. Small burrowing animals, such as moles and mole rats (and perhaps also hedgehogs?), were probably unintentionally incorporated into faunal assemblages, and hence their absence from al-ʿUmayri may reflect the contained, single-deposit origin of this assemblage.

Local Environment

The most striking aspects of table 2 (column 8) are those differences that point strongly to local ecological adaptations. The freshwater crabs and the heron, or stork, from KMA are a good example of this, as is the exploitation of an astounding variety of fish, waterfowl, and other water-related species at Dor. Additionally, the presence of both cranial and post-cranial elements among the abundant specimens of Nile perch recovered from Dor suggests that these fish were imported to the settlement whole (perhaps salted), and that Dor may have served as an entrepôt for the shipment of such fish farther inland (cf. Raban-Gerstel et al. 2008: 31, 48–49). Dor was, of course, a seaport with access to a species-rich marine environment; but it is also located on the coastal plain, which contains numerous small watercourses and, in the Iron Age (prior to large-scale drainage projects during the 20th century), is likely to have contained large tracts of swamp or otherwise waterlogged land (Karmon 1961). In this regard, it is interesting to note that like Dor, Miqne-Ekron yielded hippopotamus bones and, like KMA, freshwater crabs. These species are indicative of Miqne-Ekron's access to the wetlands of the coastal plain. The population of Miqne-Ekron during the early Iron Age also raised large numbers of cattle and pigs, probably also indicative of the gentle and relatively well-watered region in which the city was situated. We return to some of the implications of these local adaptations after a closer consideration of the core domesticated species.

Production Strategies and Core Domesticates

We can expand the range of settlements under comparison by focusing specifically on the core domesticated species used for food and draft power, as these are all medium to large animals, found in higher quantities at all settlements. Comparing only large, well-represented animals reduces the impact of collection methods and sample size discussed above. Tables 3 and 4 show the proportions of these domesticates, exclusive of all other species at settlements in semi-arid and Mediterranean climate zones, respectively. Admittedly, the inclusion of pigs and camels in these tables is potentially problematic. Pigs are not particularly common at most early Iron Age settlements, and hence sample size would be an issue if we wished to interpret small differences in the relative abundance of pig bones across different assemblages. However, the sharp contrast between the prominence of pigs at Miqne-Ekron and their paucity at every other early Iron Age settlement under consideration overrides the impact of sample size and is worth illustrating.[10] Camels are combined with equids in order to reduce

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[10] Note that specimens identified as wild boar, such as all of the published *Sus scrofa* remains from Rehov, are not included under pigs in these figures. A number of metric measurements were taken on bones from the Miqne-Ekron assemblage, but only one of the pig

TABLE 3. Summary Comparison of Faunal Assemblage Percents from Semiarid Settlements

Species	*KMA*	*Beersheba*	*Tel Masos*	*Tall al-ʿUmayri*	*Hesban Str 19 1976*
Cattle	4	14	19	14	22
Sheep/goats	82	84	78	83	71
Pigs	2	< 1	< 1	3	5
Equids/camels	9	2	2	< 1	3

TABLE 4. Summary Comparison of Faunal Assemblage Percents from Nonarid Settlements

Species	*Miqne-Ekron*	*ʿIzbet Sartah*	*Shiloh*	*Rehov*	*Dor*
Cattle	33	32	23	19	24
Sheep/goats	47	55	77	80	75
Pigs	15	0	< 1	0	0
Equids/camels	5	13	< 1	1	< 1

the impact of sample-size differences on this relatively rare species. The problem is that the single example from KMA (see above) and the 102 specimens from ʿIzbet Sartah (Hellwing and Adjeman 1986: 147) may be from post–Iron Age deposits. Hence, caution should be used in interpreting these figures.

As can be seen in figure 7, the settlements in tables 3 and 4 divide into three broad groups on the basis of the relative abundance of cattle and sheep/goat. KMA sits by itself on one end, with a relatively low proportion of cattle bones, while Miqne-Ekron and ʿIzbet Sartah sit at the other end with a relatively high proportion of cattle bones. All of the other settlements cluster along a continuum in the middle. Cattle and sheep/goats have different needs in terms of water and pasture, and they provide both different secondary products (e.g., traction vs. wool) and similar products, though in different quantities and at a different relative cost (e.g., meat, dairy). So, these distinct groupings may reflect distinct production strategies.

Certainly environment plays a role here, since both Miqne-Ekron and ʿIzbet Sartah straddle the transition from the coastal plain to the interior foothills (Shephelah). The availability of well-watered flat land with good grazing may have favored cattle production, while access to the relatively larger early Iron Age settlements of Philistia and the western Shephelah may have encouraged some production for market. Similarly, KMA is marginally located in a semiarid zone less suited to the raising of cattle. However, in this case, environment must be defined by more than just rainfall, as Beersheba and Masos are situated in similarly semiarid zones yet yielded notably more cattle bones in their faunal assemblages than KMA. Importantly, the terrain around KMA is very rough and unsuited both to the herding of cattle and to their use for traction, especially in comparison with sheep/goats and asses. In the middle group, we find that when measured by the relative abundance of cattle and sheep/goat, production strategies seem to cross-cut broad environmental zones. For example, al-ʿUmayri is most like Beersheba, while Masos is most like Rehov and Shiloh is most like Dor.

Examined more closely, differences in production regimes also become evident within these groups. Pigs are a prominent component of the Miqne-Ekron faunal assemblage, for example, but are completely absent from the ʿIzbet Sartah assemblage. At Dor, Raban-Gerstel et al. (2008: 44–45, 48) suggest that sheep and goats appear to have been acquired from local, nonspecialized, herds. At Rehov, in contrast, Marom et al. (2009: 70–71) suggest that sheep and goats were raised off-site in herds focused on meat production (or herd security) and acquired by exchange, with on-site consumption focused on meat-rich portions of young males. At al-ʿUmayri, sheep outnumbered goats by

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bones was large enough to have come from a wild boar (Lev-Tov 2000: 69–70, 197).

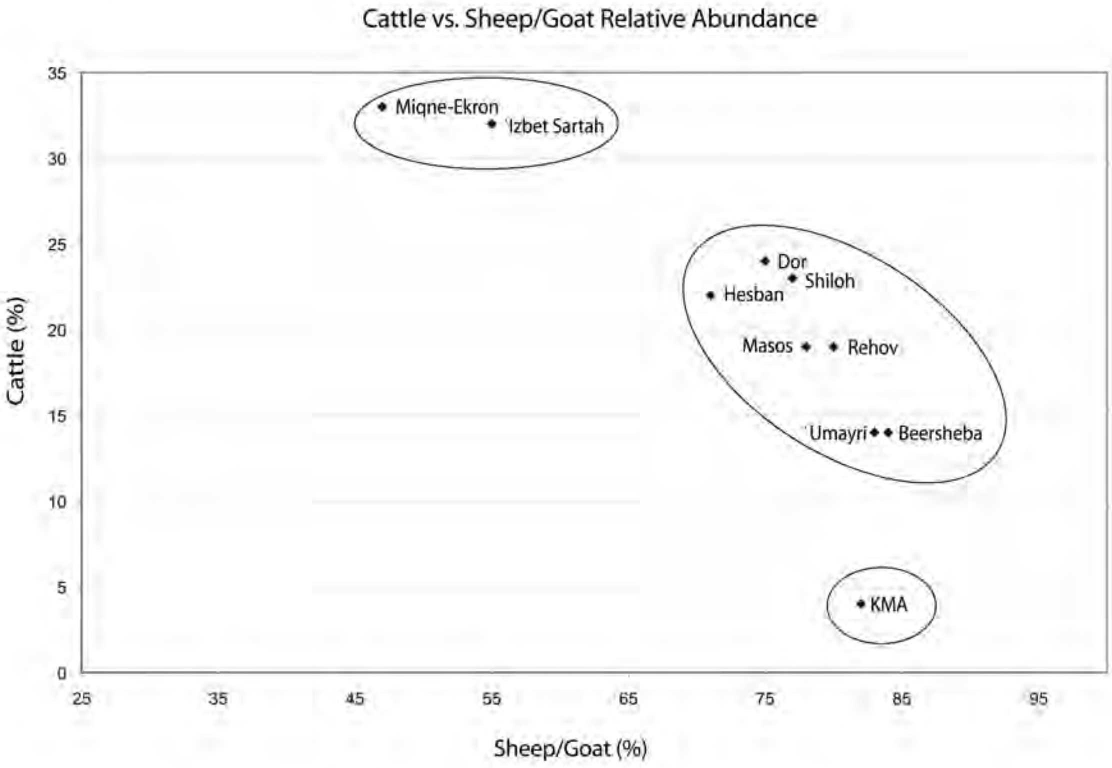

Fig. 7. Proportion of sheep/goats versus proportion of cattle in key early Iron Age faunal assemblages.

a margin of 2:1 when they could be distinguished (Peters, Pöllath and von den Driesch 2002: 312). A preponderance of sheep is normally taken by zooarchaeologists as evidence for specialized production of wool. In contrast, KMA, Dor, and Masos had ratios closer to 1:1, with goats being slightly more numerous, a pattern said to reflect a focus on herd security (cf. Redding 1981). At Shiloh, Hellwing, Sade, and Kishon (1993: 324–25) report a visible shift toward older animals in the mortality profiles of sheep/goats and cattle, between the end of the Bronze Age and beginning of the early Iron Age, presumably due to a new emphasis on secondary products (principally fiber and traction).

One might argue, in the case of Rehov, that evidence for specialized meat production for elite consumption illustrates the impact of increasing social complexity during Iron IIA, but this does not account for the differing levels of specialized production attested at early Iron Age settlements. Indeed, the available evidence argues against a simple linear development from unspecialized early Iron Age animal economies to specialized Iron II animal economies. Rather, in the absence of a regionally integrated economy during the early Iron Age, it appears that different production strategies (some more focused on subsistence security and self-sufficiency, others more focused on secondary products and production for exchange) were pursued in different settlements and subregions in response to rather local conditions and opportunities.

Comparing Faunal Assemblages: Summation

It is widely recognized that post-Neolithic communities in the Levant relied heavily on a common set of core domesticated species (Grigson 1998; Tchernov and Horwitz 1990), and in this very broad sense there is little to distinguish early Iron Age animal economies from those of the Bronze Age. However, by controlling for some of the methodological problems inherent in comparing faunal assemblages among settlements, we have highlighted at least three factors that intersect to shape the animal economy at any given early Iron Age settlement in distinct ways. First, the local availability and exploitation of wild resources is an important, and understudied, factor that highlights the degree to which local communities made practical and knowledgeable use of what was immediately on hand. Second, the relative abundance of core domesticated species (especially cattle vs. sheep/goats) highlights broad differences in local environments, overall production regimes (e.g., balancing primary and secondary products between species), and perhaps also food preferences. Finally, demographic patterns within core domesticated species (or closely aligned species in the case of sheep and goats) highlight differences in economic strategies and orientations, especially with regard to herd security, specialized production, and production for subsistence or market.

The three factors shaping early Iron Age animal economies are already individually well recognized in the literature. However, on their own, none of these factors can fully represent any given animal economy. If we are to move beyond the accurate, but blunt observation that post-Neolithic communities relied heavily on sheep and goats, with cattle and pigs varying in importance, then we need to focus clear and careful study on the integration of these three factors, both in relation to specific settlements and in comparative analysis. Good examples exist (e.g., Raban-Gerstel et al. 2008; Marom et al. 2009) but more are needed.

CONCLUSION

This article has demonstrated that KMA's animal economy centered on a number of domesticated and wild animals, totaling at least eight taxa utilized as food. Its organization seems to have been nonintensive and nonspecialized, designed to meet the community's subsistence demands rather than that of an extra-local market demand. This arrangement was particularly well suited to the characteristics of the area's semiarid environment, in which locally available resources needed for successful agropastoralism—productive soils, adequate precipitation, and fodder—were limited.

Comparing KMA's faunal assemblage with those of other settlements from the southern Levant raised a number of important issues relating to the diversity of early Iron Age animal economies. Most important is the recognition that it is impossible to predict the constitution of a community's animal economy based on its position in a particular environmental zone. Rather, as our comparison has demonstrated, the organization of a settlement's animal economy was a consequence of local contingencies. Naturally available resources, or the lack thereof, played a key role, but so did the presence of nearby markets, subsistence demands, and local traditions. Another implication is that settlements can organize a sustainable animal economy regardless of where they are positioned in the region. The absence of regionally integrated economies in the early Iron Age does not mean that everything was simple and subsistence-oriented, but it does mean that proximate settlements could organize their animal economies in very different ways. This could include a greater emphasis on herd security and subsistence or on secondary productions and small-scale production for market; it could mean an unusual emphasis on hunting deer or on raising pigs. Again, this recognition of difference suggests that close scrutiny of faunal data from individual settlements is necessary before passing judgment on the organization of animal economies.

Additionally, this investigation suggests that subsistence and the environment make equally, if not more, productive lenses through which to examine early Iron Age southern Levantine animal economies than do ethnicity and identity. Early Iron Age communities may have possessed distinct ethnic identities, but it is our opinion that in this instance it is unwise to interpret differences in animal economies among settlements as symptoms of ethnic differences.

Finally, we urge archaeologists working in historic periods in the southern Levant to adopt systematic and consistent collection methods that include intensive sieving with standardized mesh sizes (cf. Gordon 1993). A large part of this article was dedicated to navigating and resolving the very real problems of comparability generated by projects' varying collection methods. At KMA, the unusual prominence of freshwater crabs, a small species rarely attested in quantity in the published archaeological record, has in many ways transformed our view of the settlement and its local environment. Knowing where other such local resources (e.g., birds, small fish) were, and were not, exploited promises many interesting new perspectives on Iron Age subsistence and production, but only if we employ collection methods suited to examining these types of questions.

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