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Why domesticate food animals? Some zoo-archaeological evidence from the Levant

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Abstract

Zoo-archaeological remains from the southern Levant indicate two shifts in the pattern of animal exploitation from Palaeolithic to Pre-Pottery Neolithic times. These shifts were especially marked towards the end of this time span. One is the increased consumption of small animals and the other shift is an increased hunting of juvenile gazelles compared to adults. Both are interpreted in terms of an increased intensity of exploitation of environmental resources due, it is suggested, to population increase, which subsequently forced people to husband animals.

Keywords: Domestication; Population; Neolithic; Demography; Levant; Near East

"…the true cause that set in motion the great tide of northern emigration, and that continued to propel it till it rolled at different periods against China, Persia, Italy, and even Egypt, was a scarcity of food, a population extended beyond the means of supporting it." [33]

1. Introduction

Why did our ancestors domesticate food animals? For a long time, it was believed that the transition from hunting to husbandry was a move from a precarious existence to one providing greater security. The notion that hunting requires high expenditure of energy and that a major saving of effort can be gained by switching to farming is probably wrong. Pioneering work by Richard Lee [30], who studied modern hunter–gatherers in southern Africa, discovered that they enjoy a plentiful and balanced diet and spend a mere 2–3 days per week in their quest for food. Husbanding animals is, it would seem, more arduous than simply going out and hunting them. The view taken here is a more gradualist one in which a slow shift in the balance between people and their source of food has occurred. Clearly, in order to try and understand the background to domestication in the archaeological record, we need to clarify what happened during the millennia that preceded this change. One of the first studies that attempted to answer the question *why* people began domesticating plants and animals was Mark Cohen's *The Food Crisis in Prehistory* [6]. Cohen suggested that the period prior to domestication was characterized by increased strain on the environment due to rising demographic pressure. Amongst the evidence he cited is an increase in the occurrences of pathological conditions in human skeletal remains from archaeological sites – probably reflecting increasingly poor nutrition. He suggested that a rise in the human population at that time "forced"

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people to change their relationship with the natural world and to assume a greater degree of control over it.

Others too have linked domestication indirectly or directly to demographic pressure and the carrying capacity of the environment [21,43], and these factors combined with a trigger – deteriorating climate at the end of the last Ice Age [17]. But not all agree that population growth was a factor (see, for example, [41]), indeed it is quite likely that the causes varied depending upon which part of the world is considered. Hayden [25] has suggested a "socio-economic" explanation for the origin of domestication; domesticates were initially used as prestige commodities. These served to "enhance individual or corporate group power" in complex hunter–gatherer communities. Others like Isaac [27] and Cauvin [5] have sought a more religious/psychological explanation for the beginnings of domestication.

Before addressing the question of *why* animals were domesticated, we need to consider briefly *where* and *when* animal husbandry began. We now know of some nine independent areas where food production began. The "Fertile Crescent" of the Near East was undoubtedly the earliest Old World hearth of domestication of both animals and plants, although it is still unclear exactly where within this area it began [2,17,23,24,49,50]. Evidence from Cyprus and the southern Levant now indicates that bovids (cattle, sheep and goats) and pigs were first domesticated towards the end of the 9th millennium cal BC in the northern part of the Near East, and that during the 8th millennium BC, these animals were domesticated (or introduced as domestic stock) in the southern Levant [8,22]. Clearly, the 9th and 8th millennia, during the so-called Pre-Pottery Neolithic, were crucial times for the advent of husbandry; hence, we need to examine the relations between people and animals in the period before those millennia in order to answer *why* people began husbanding animals.

A possible zoo-archaeological answer to this major question first became evident to me when studying the fauna from the Natufian – Aceramic Neolithic site of Hatoula, in Israel, in the mid-1980s. It is especially gratifying to note that the last two decades have seen other zoo-archaeologists interpret their data in a similar way – measurements of bones and shells, and considerations of species' frequencies can reflect pressure on the environment in turn linked to demographic pressure. Most noteworthy for the Levant is the new study of the fauna from Hayonim and nearby sites by Natalie Munro [36,37]. She too suggests that population increased quite markedly in the Natufian. This paper, like earlier reports [11,12,14,15], considers other studies, as well as several from other regions. They have been and still are interpreted in a similar way. By including the faunal evidence from subsequent periods I hope to present a broader view of this major event.

I shall present two lines of evidence from the zoo-archaeological record of the Mousterian to the Pre-Pottery Neolithic in the Levant which corroborate the demographic pressure thesis. The first is a shift of people's prey in the course of time from big game to smaller mammals and ultimately fish and birds – which Flannery [19] recognised as a shift from a narrow spectrum of environmental resources to a broader one. Indeed, this "*spectrum shift*" is well attested in many regions where people "were forced to become even more eclectic in their food gathering, to eat more and more unpalatable foods, and in particular to concentrate on foods of low trophic level and high density" [6]. The second line of evidence has not, to my knowledge, been considered very much by zoo-archaeologists and is an increase in the proportion of juvenile prey – here gazelle – in these faunal assemblages. This I term the "*age shift*". (Legge [31] had observed an increase in numbers of juvenile gazelles at Mount Carmel. He suggested that this may signify their domestic status, a proposal he subsequently rejected; pers. comm. The gazelle is not generally considered to be amenable to domestication.) Both these changes occurred over a long time span from the Mousterian, some 50,000 years ago, to the Pre-Pottery Neolithic A of the 9th millennium BC. Moreover, these changes were even more rapid during the two or three millennia before domestic animals first made their appearance in the 8th millennium BC [11,15]. And, as I shall argue, the interpretation of these changes helps to explain why people had, to a large extent, to abandon hunting in favour of husbandry.

2. Material and methods

This article discusses two kinds of zoo-archaeological data from the Upper Pleistocene and early Holocene. Most come from Israel. They are counts of:

(a) Bones of different species of animals and
(b) Numbers of young versus adult gazelles.

The data presented here all derive from sites whose faunal assemblages were recovered by sieving (Fig. 1). Hence, biases against smaller bones such as unfused epiphyses that belonged to young animals are probably less serious than is often the case with hand-collected material [38]. Another problem sometimes encountered in zoo-archaeology is observer variation. Zoo-archaeologists may count bones and deduce the age-at-death of animals in different ways. One person studied all the assemblages discussed here using the same methods [15]. In brief, mandibles and a restricted suite of "*parts of the skeleton always recorded*" were counted. They consist of a predetermined suite of articular ends/epiphyses of girdle, limb and foot bones. This in part explains why the

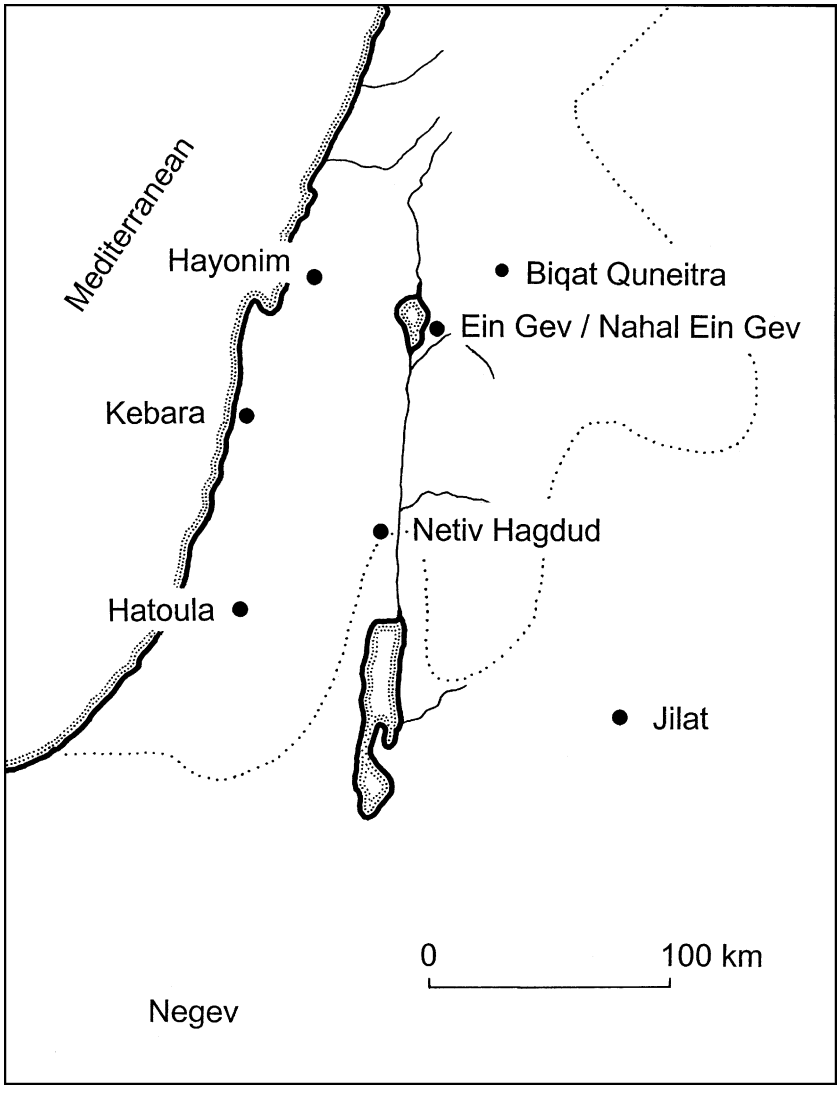

Fig. 1. Map of the southern Levant to show places mentioned in the text. The dotted line represents the present-day 200 mm isohyet.

sample sizes in many cases appear to be small. Since birds no longer have teeth and fish lack limbs, and in order to compare frequencies of mammals with those of birds and fish at one of the key sites considered here (Hatoula), the numbers of mammalian mandibles were compared with the minimum numbers of individuals of fish and birds. (This is admittedly not entirely satisfactory and has probably led to an under-representation of fish.)

The growing end of a mammal limb-bone is its epiphysis, which, at maturity, fuses to its respective shaft. For large assemblages of a particular species, an approximate estimate of the proportion of juveniles (that is osteologically immature) culled may be calculated by counting separately the unfused and fused epiphyses. A similar approach was adopted for mandibles. Premolar teeth replace their milk predecessors at a given age. In the case of the gazelle this occurs around 12–13 months, which is also the age when the third molar tooth erupts, and this is also very approximately the age when many of the limb-bones fuse [7]. Hence, it is possible to calculate the proportion of juveniles via the numbers of mandibles with milk teeth or unerupted third molars.

3. The "Spectrum Shift" (Figs. 2 and 3)

At the sequence of open-air sites, which extends from the Mousterian on the Golan Heights (Biqat Quneitra) to the late Natufian on the eastern side of the Sea of Galilee (Nahal Ein Gev II), we [14] observed a change from big game to gazelles, hares and foxes. Many of the animals hunted at Biqat Quneitra were very large and included species like rhinoceros, aurochs, red deer and horses. As time progressed, remains of these very large beasts became rare on archaeological sites and fallow deer and gazelle were clearly the most important animals exploited in Aurignacian and Kebaran times (i.e.

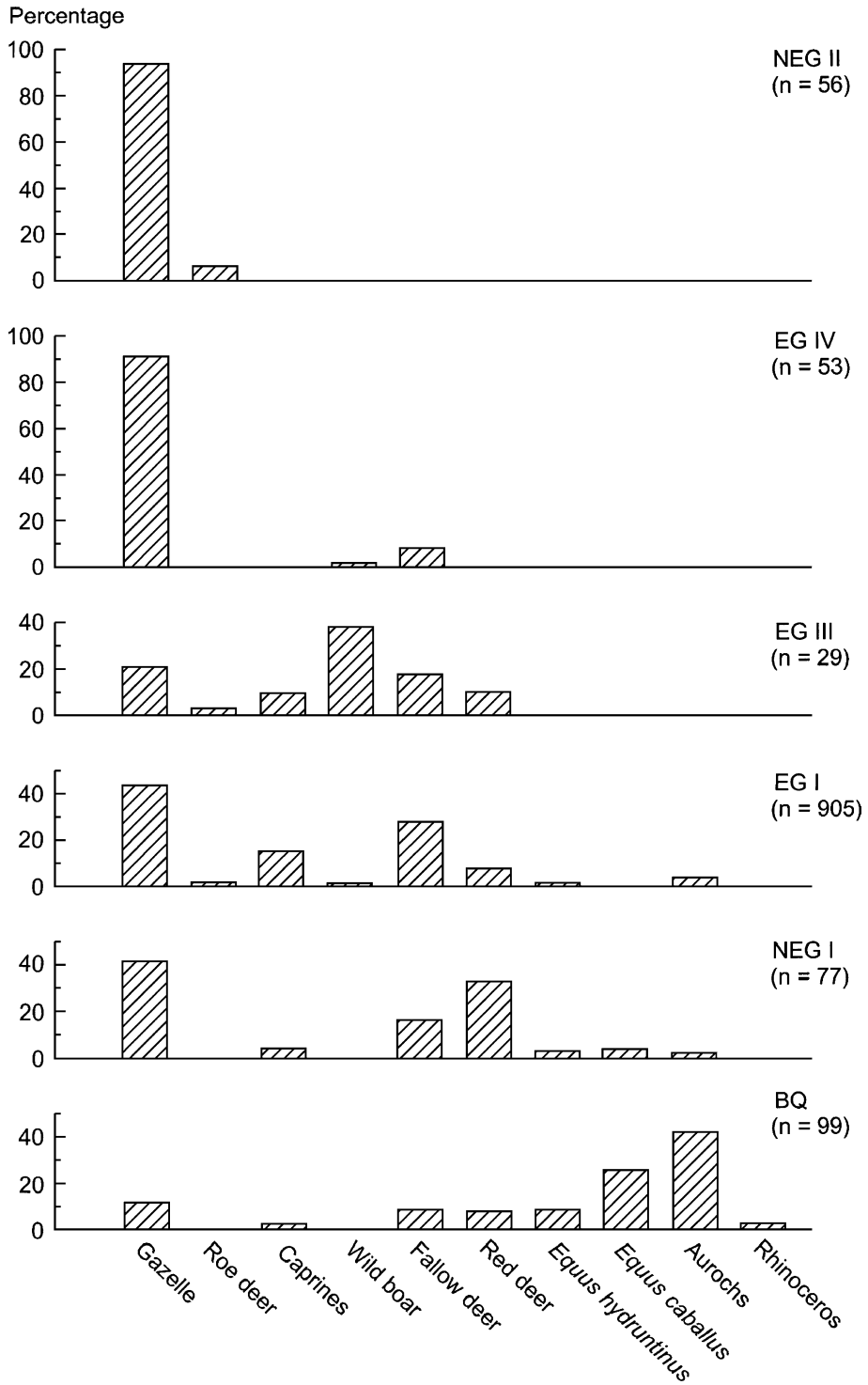

Fig. 2. The spectrum shift as seen in the series of open-air sites from the Mousterian at Biqat Quneitra to the Natufian at Nahal Ein Gev. Note the gradual shift with time from large game to gazelles. Key: BQ, Biqat Quneitra (Mousterian c. 54,000 bp); NEG I, Nahal Ein Gev I (Late Upper Palaeolithic c. 25–20,000 bp); EG I, Ein Gev I (Kebaran c. 16,000 bp); EG III, Ein Gev III (Geometric Kebaran c. 16,500–14,500 bp); EG IV, Ein Gev IV (Late Geometric Kebaran c. 14,500–12,750 bp); NEG II, Nahal Ein Gev II (Late Natufian/Khiamian c. 10,500–10,000 bp). The numbers in parentheses are the counts of identified and recorded bones.

between approximately 30,000 and 15,000 BC). Fallow deer appear to have become even scarcer as we approach the late Natufian when the most common medium-sized mammal represented is gazelle. At about this time, during the Epipalaeolithic, increasing numbers of small mammals such as fox and hare are also represented. Let us look now at what happened at a site in another part of this region – Hatoula, in central Israel – with its

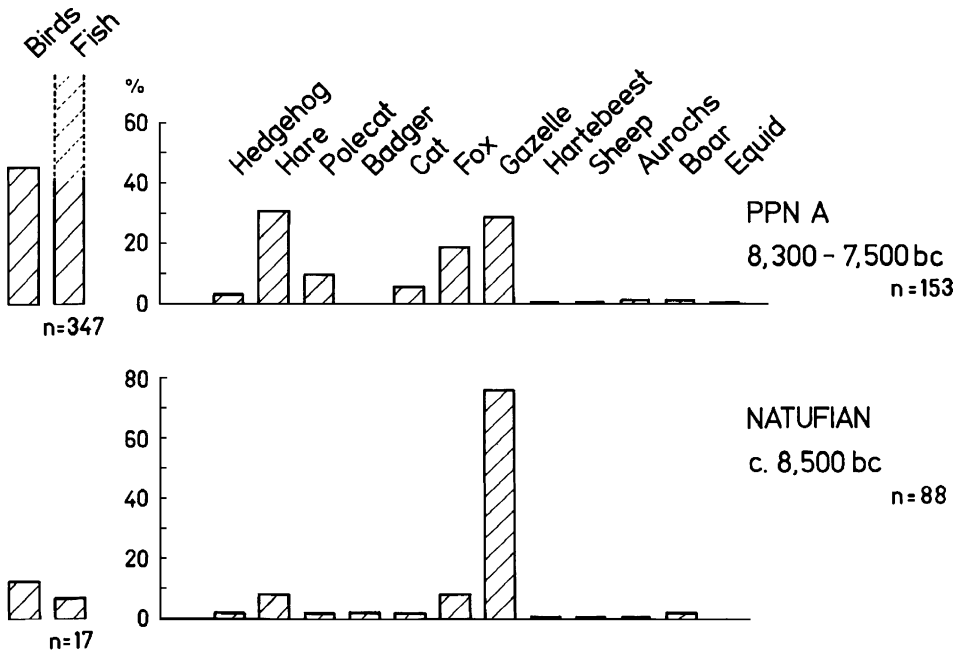

Fig. 3. The spectrum shift as seen in the Natufian–PPNA (Khiamian and Sultanian) sequence at Hatoula. Percentages of the different groups of animals, computed from mandible counts for the mammals, and minimum numbers of individuals for the fish and birds. Small mammals include hedgehog, hare, polecat, marten, badger, fox and cat only. Note the increase of small mammals, fish and birds in the PPNA.

sequence from Natufian to PPNA (the latter subdivided into Khiamian and Sultanian levels). Hatoula is located on the western slopes of the Judean Hills roughly midway between Jerusalem and Tel Aviv. The samples of animal bones recovered at this site are quite large, with 2540 bones recorded in the Natufian levels, and 1016 in the PPNA levels. Here the continued "downsizing" of animals represented is quite remarkable. Note the shift between the Natufian and PPNA levels, from gazelle to small mammals, fish and birds. It is tempting to regard this shift at Hatoula as the culmination of a long and more gradual move to smaller taxa, which had been happening since Mousterian times.

Whether this shift reflects local habitat degradation or a change in hunting techniques (or both) is difficult to determine. However, it is worth noting that although

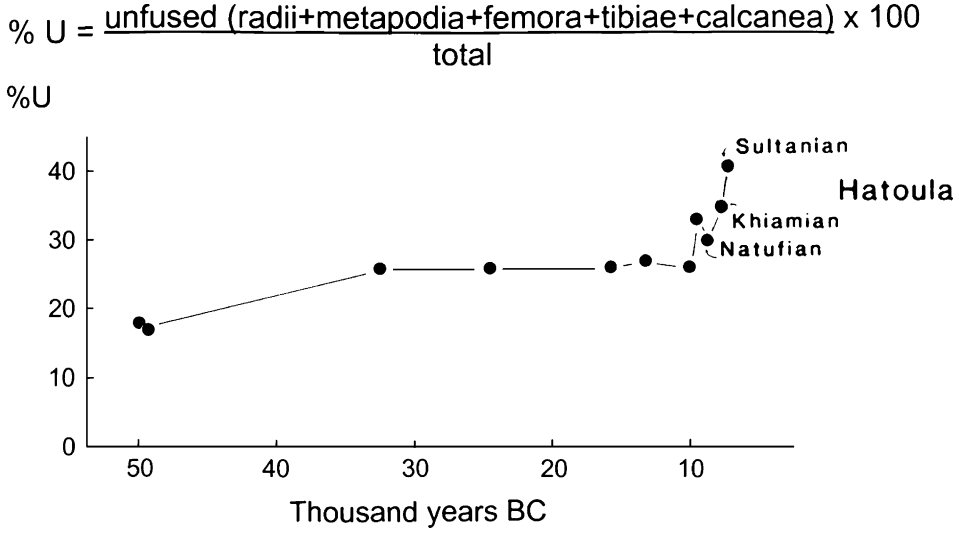

Fig. 4. The age shift of gazelles culled in Israel between Mousterian and PPN times. This is a plot of the percentages of unfused limb-bone epiphyses (distal radius, distal metacarpal, distal metatarsal, distal femur, distal tibia, and calcaneum-tuber calcis) plotted against time. *Total* includes these unfused epiphyses plus specimens of the same bone-parts with fused epiphyses. Data come from the following sites, from left to right: Mousterian: Kebara cave; Mousterian: Hayonim cave level E; Upper Palaeolithic: Kebara cave; Aurignacian: Hayonim cave level D; Kebaran: Ein Gev I; Kebaran: Hayonim cave level C; Natufian: Hayonim cave level B; Natufian: Hayonim terrace; Natufian: Hatoula; Khiamian (PPNA): Hatoula; Sultanian (PPNA): Hatoula. Data for Hatoula are in refs. [10,15]. Data for other sites are in ref. [9].

Table 1
The age-at-death of gazelles from late Pleistocene–Holocene Israel deduced from tooth eruption

Period	Site	Mandibles with M_3 "Unerupted"	Mandibles with M_3 "Erupted"	% Juvenile
PPNA	Hatoula	14	27	34
Late Natufian	Hatoula	8	41	16
Natufian	Hayonim terrace	27	135	17
Aurignacian	Hayonim cave D	13	115	10
Mousterian	Kebara cave	7	251	3

Numbers of mandibles with unerupted third molars (i.e. less than c. 13 months of age) and erupted M_3s from various large zoo-archaeological assemblages (see refs. [9,15]).

increasingly scarce in zoo-archaeological assemblages, the continuing presence of many very large animals in the Levant well after their apparent demise at Ein Gev makes it seem unlikely that the environment changed to any very great extent. For example, rhinoceros and red deer are known in the Kebaran (at Hayonim), hippopotamus is known in the Iron Age (at Tel Qassile), and the aurochs survived into the Early Bronze Age (at Tel Yarmouth; [8,13]). A shift in emphasis from very large animals to small mammals, birds and fish must have required the invention and development of new hunting techniques, but this was surely brought about by the increasing need to rely upon such smaller sources of sustenance.

Cohen [6], like Flannery [19], has amassed a wide range of evidence, which shows that in many regions just before the advent of animal and plant husbandry people began to expand their resource base. This included many smaller species of animals whose capture required a higher expenditure of energy for a given unit of flesh procured. On the limestone steppe in Jordan, Martin [34] studied a succession of small open-air sites, where she noted that hare increased dramatically in the early and middle PPNB levels (at Jilat). In the Jordan valley, Tchernov [48] too reported large quantities of hare and bird bones at the PPNA site of Netiv Hagdud. Elsewhere in the Mediterranean, others have observed a shift to smaller species of animals. For example at the caves of Franchthi in Greece and Nerja in Andalusia, Payne [39] and Morales et al. [35] found that fishing began in the Mesolithic and Magdalenian periods, respectively. Morales et al. [35] call this shift to exploiting marine resources the "Tardiglacial paradigm". The increased exploitation of marine resources and occurrences of shell middens in the archaeological record may to some extent be due to the encroachment of the seashore as sea levels rose after the Pleistocene [1]. Besides small game, birds and marine resources, Lubell [32] has recently pointed out that remains of land snails too become more abundant just prior to the advent of agriculture in the circum Mediterranean region. The most spectacular examples are the Capsian "escargotières" of Algeria and Tunisia. He suggests "the presence of abundant land snails represents part of a signature for the broad spectrum revolution". Stiner [44] has provided further evidence for a broadening of the spectrum of exploited species in the Mediterranean basin. Presumably big game had become scarce, but why? One explanation, and the one offered here, is simply that there were now many more mouths to feed; people were forced to exploit small game, fowl and fish in order to survive.

4. The "Age Shift" (Fig. 4 and Table 1)

The numbers of unfused (juvenile) limb-bone epiphyses compared to the fused (adult) ones in the sequence of Israeli zoo-archaeological assemblages indicate that some 20–25% of the gazelles hunted before the Neolithic were osteologically immature. Subsequently, in the PPNA, this percentage increased markedly to around 35–40%. The counts of mandibles with unerupted and erupted third molars indicate a similar trend in the course of time (Table 1). At Hatoula, the presence of milk or permanent teeth in the anterior part of the gazelle mandibles shows that the proportion of juveniles increased from 39% in the Natufian (13 have dP_4s and 20 have P_4s) to 59% in the PPNA (19 have dP_4s but only 13 have P_4s). In sum then, both limb-bones and mandibles indicate a substantial chronological trend towards increased culling of juvenile gazelles.

There are several interesting parallel examples from zoo-archaeological successions elsewhere. Perhaps of some relevance here, and certainly the inspiration for my interpretation of the Israeli data, is Elder's [18] study of deer mandibles from three 'prehistoric' (i.e. pre-European settlement) and two 'historic' Indian sites in Missouri, USA. At his 'prehistoric' sites, the age distributions of the culled deer showed moderate numbers of old and senile animals as well as young. Elder suggested that this pattern is similar to that observed in a stable population of ungulates. However, most of the mandibles from the two 'historic' or 'post-contact' sites dated between AD 1725 and AD 1780, derived from young individuals, with very few old and senile ones represented. This kind of age distribution is typical of a population undergoing rapid turnover caused by heavy predation. Elder suggested that a lucrative venison trade and more efficient hunting with firearms and horses (both the result of the arrival of European settlers) were the two main factors which caused this change in the age-profiles of Missouri deer. Three other studies are worth quoting. Between Middle and Late Stone Ages in South Africa, the limpets collected by people became smaller (i.e. younger), which Klein and colleagues [28,29] correlates with increasingly

heavy foraging. In northern Israel, Stiner et al. [45] recorded a size reduction of tortoises' limb-bone shafts (the girth of the shaft in reptile bones continues to increase with age) in the Epipalaeolithic at Hayonim, western Galilee, which they suggest, was due to an increase in the predation pressure on tortoises, in turn a reflection of human population increase. Surovell [46] simulated what can happen to fast reproducing species of small game like hares and partridges, and slow ones like the tortoise, when predation pressure rises due to increasing occupation density and population. He found that the faster reproducing species will increase in number in the archaeological record while slower reproducers will decrease and even become extinct.

5. Conclusion

What then do the changes in the zoo-archaeological record of the Levant mean? My interpretation of the gazelle age shift is similar to that which Elder proposed to explain his age shift in Missouri deer. What we observe in the Israeli sequence is a gradual increase in the intensity with which gazelles were hunted. This hunting intensity increased at an even greater rate in the PPNA as can be seen at Hatoula, and appears to have occurred alongside a shift towards exploiting smaller animals, and in the Natufian and PPNA, more extensive exploitation of marine and avian resources. I suggest that it was the same factor, an increasing imbalance between predator, that is man-the-hunter, and prey, which was responsible for both of these trends. Natalie Munro has restudied the Natufian fauna of Hayonim and two other more recently excavated Natufian sites. It is gratifying to note that she comes to similar conclusions to the ones suggested here. In concluding her thesis, Munro [36] writes "…in the Early Natufian phase, the southern Levant likely supported the densest and…probably the highest gross population sizes the region had seen to this point."

While it is possible to view population levels as being a *result* of food resource availability, Cohen [6] and Rowley-Conwy [42] see population levels as the *driving force* (at least in the Neolithic) behind the need to change from hunting to husbanding. In my opinion it was this factor – the ratio of human beings to wildlife – that *caused* Neolithic people to adopt husbandry. The human population of the Levant had undoubtedly been rising steadily since the Palaeolithic. With the adoption of sedentism in the Natufian as first suggested by Perrot [40], population increase must have become much more rapid. We know from modern examples of newly settled nomads, that sedentism leads to rapid population increase [47]. Goring-Morris's [20] archaeological survey of the Negev desert has shown a decrease in the number of PPNA sites there as compared with the Natufian. He attributes this "virtual abandonment" of the Negev to aridification at that time, and suggests that people moved northwards into the more fertile Mediterranean zone which may have exacerbated an already precarious balance between people and their resources.

Henry [26] cites archaeological data from that region such as site size and artefact densities that point to possible Natufian population increase. In their studies on the Natufian and PPNA, Belfer-Cohen and Bar-Yosef [4] note certain features on human skeletal size such as a reduction in the difference in male/female stature, as well as increasing site size that point to stress and demographic pressure at this time – just prior to the adoption of animal husbandry. Population density may have increased from 0.25 persons per km^2 in the Natufian to 1 person per km^2 in the PPNA and then 4 persons per km^2 in the PPNB [3].

In the southern Levant, probably during the PPNB, human population levels continued to rise rapidly and reached some critical threshold. The carrying capacity of the environment was exceeded – the ever-increasing number of human mouths could no longer be adequately fed. Gazelle and big-game stocks had become too scarce and fishing and fowling did not suffice either. It was then, during the PPNB, that people had to exert greater control over environmental resources and begin *husbanding* those species that were amenable to this kind of treatment such as cattle, sheep, goats and pigs – a strategy in which a given area can sustain many more herders and farmers than hunter–gatherers. (The switch to husbanding bovids and pigs in the course of the PPNB raises another question. Were these species, all present but admittedly not very common on Natufian and PPNA sites in the Levant, domesticated locally or introduced from other parts of the Near East? Given the imprecision of dates available it is probably still too early to answer this question with any degree of security. Their introduction from beyond the Levant as already managed stock is of course a strong possibility, and could help explain why sheep and goat were not *hunted* in increasing numbers in the Natufian and PPNA.) Perhaps it was the climate changes of the end of the Pleistocene, as Diamond [17] suggests, that acted as the last straw that "broke the camel's back".

People could no longer survive by hunting alone – they were now banished from the Garden of Eden: animal husbandry is hard work and domesticated animals require daily care and supervision. But with these four-legged resources under human control, people were able to become ever more "fruitful and multiply". The human population in the Near East rose even more rapidly. The stage was now set for further economic change, the spread of farming peoples across the world and all kinds of developments both welcome and unwelcome [16].

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