

# Early Domesticated Dogs of the Near East

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(Received 29 March 1993, revised manuscript accepted 15 November 1993)

Domestic dogs in the Near East have been identified on the basis of cultural criteria, but identifications based on morphological criteria are controversial. Measurements of carnassial teeth and of the facial region of the cranium and mandible reveal that wolf/dog remains from the Natufian (c. 12,000 BP) and later cultures of Israel exhibit a morphological pattern that is the opposite of that expected under natural selection, but that conforms well to that expected in early domestication. The Geometric Kebaran wolves preceding the Natufian domesticates are very large individuals, probably in response to the climatic conditions of the period, and this may indicate one of the following: (a) the wolves domesticated in Israel were of a large race, contrary to previous theories on the roots of dog domestication; (b) the dog was domesticated at a period earlier than the Natufian.

**Keywords:** NEAR EAST, UPPER PALAEOLITHIC, ZOOLOGY, DOG, WOLF, DOMESTICATION.

## Introduction

The geographic origins of dog domestication remain a puzzle (Morey, 1992), although there is widespread agreement that the dog was domesticated from a small subspecies of wolf. The earliest recognizable domestic dogs were similar in size and cranial capacity (Hemmer, 1983) to the small wolf races: the Indian (*Canis lupus pallipes*) or Arabian (*Canis lupus arabs*) races (e.g. Lawrence, 1967; Scott, 1968; Olsen, 1985), or the Chinese wolf (*Canis lupus chanco*) (Olsen & Olsen, 1977; Olsen, 1985).

It is therefore surprising that so little evidence for early domestic dog remains originates from the Near East, where the Indian and Arabian wolves are found. An early dog find dated to c. 12,000 BP (Davis & Valla, 1978) was recently contested by Olsen (1985). Olsen's (1985) chief criticism of this and other studies was that they report a single, or few, perhaps aberrant specimens. He similarly criticized the report of a single canid jaw from the Pelegawra cave (northeastern Iraq) ascribed to *Canis familiaris* (c. 12,000 BP) (Turnbull & Reed, 1974). Uerpman (1982), who reanalysed the Pelegawra faunal remains, does not question the domestic status of the Pelegawra dog, but suggests that it is several millennia younger than its published dates.

Other early canid specimens remain controversial. Canids from the Epipalaeolithic of the Mount Carmel caves, and from the Pre-Pottery Neolithic of Jericho have been subject to several studies that yielded conflicting results (Bate, 1937; Zeuner, 1958; Degerbol, 1961; Clutton-Brock, 1962, 1969, 1979; Kurten, 1965). It has been suggested that the small size difference between the small west Asian wolves and early domestic dogs hampers the morphological differentiation

between them, and that the presence of the large Egyptian jackals in the same general region exacerbates this problem (Clutton-Brock, 1962). Cultural criteria have therefore been considered preferable for the diagnosis of early domesticates; the finds of wolves or dogs buried with human skeletons from the Natufian of Israel (Davis & Valla, 1978; Valla, 1990) are therefore of great significance (Clutton-Brock, 1992).

However, it is still important to recognize early specimens of morphologically distinct domesticated dogs. One of the first changes that indicates the domestication process of wolves is the shortening of the facial region. The reduction in tooth size is considered to follow at a slightly slower rate, and therefore at this stage there is some crowding of teeth (e.g. Olsen, 1985; Benecke, 1987; Clutton-Brock, 1992). Thus a morphological pattern of mandibular and maxillary reduction accompanied by a lesser reduction of tooth size can be taken as a sound indication of domestication in process (Morey, 1992). To recognize wolves undergoing this process we must understand the selective processes affecting carnivore size and shape and the resultant patterns of morphological variation of the larger Near Eastern canids: the wolf (*Canis lupus*), golden jackal (*Canis aureus*) and red fox (*Vulpes vulpes*) (Harrison & Bates, 1991).

Several ecogeographic rules—empirical generalizations describing parallels between morphological variation and features of the physical environment—are now widely recognized. The best known of those is Bergmann's rule, which originally stated that warm-blooded vertebrate species from cooler climates tend to be larger than congeners from warmer climates (Bergmann, 1847). However, it is better known as redefined by Mayr (1956, 1963) to deal with size clines

within single species. Davis (1978, 1981) depicted a Bergmannian cline in lower carnassial length of wolves and foxes, populations from colder regions tending to be larger than those of warmer regions. For wolf skull lengths, Mendelssohn (1982) describes a similar pattern within Israel. In the Middle Palaeolithic of Israel, extremely large wolf and fox specimens are found; their size has been considered a Bergmannian response to the colder climatic conditions of this period, in light of their recent geographic size gradient (Kurten, 1965; Davis, 1981). They co-occurred with a large form of jackal that was identified, because of its size, as the Egyptian jackal (Bate, 1937; Kurten, 1965). The Egyptian jackal of Egypt and Libya is commonly considered the largest race of recent golden jackals (*Canis aureus lupaster*) (Ellerman & Morrison-Scott, 1951), but it has also been given a different specific status (*Canis lupaster*) (e.g. Bate, 1937; Kurten, 1965).

The evolutionary role of interspecific interactions, on the other hand, has been a major source for dispute in evolutionary ecology in the 1980s (e.g. Lewin, 1983; Pimm & Gittleman, 1990). For many years numerous studies have interpreted morphological size relationships among sympatric animal species of similar ecological requirements as indirect evidence for competition. Coexistence of competitors has been viewed as leading to coevolutionary change. Brown & Wilson (1956) defined character displacement as the situation in which, when two animal species overlap geographically, the differences between them are accentuated in the zone of sympatry, and weakened, or lost entirely, in parts of their ranges outside this zone. Hutchinson (1959) theorized that competition for food might impose a limit to the similarity between the trophic apparatus of potentially competing species. He saw different sizes as enabling different species to use different sizes of food. A number of studies on groups of three or more species reported equal size ratios between species adjacent in size ranking (see references in Simberloff & Boecklen, 1981). Strong *et al.* (1979) termed this phenomenon "community-wide character displacement".

Recently, much of the ecological literature on size relationships has been reconsidered and contested. For a large fraction of claimed instances of size displacement, observed sizes did not falsify a hypothesis of independence between species (Grant, 1972, 1975; Strong *et al.*, 1979; Roth, 1981; Simberloff & Boecklen, 1981).

Dayan *et al.* (1989a,b, 1990, 1992a) studied morphological size change and size ratios in carnivores, and suggested that ecological character displacement (Brown & Wilson, 1956) and community-wide character displacement (*sensu* Simberloff & Boecklen, 1981) are important factors affecting carnivore size. Patterns in several carnivore guilds attest to a coevolutionary morphological response between different species within a guild (*sensu* Root, 1967; see Simberloff & Dayan, 1991); the different species maintain a pattern

of equal size ratios that is significantly different from random (Dayan *et al.*, 1989a,b, 1990, 1992a). The pattern is particularly evident in the specialized dentitions of carnivores, and in the carnassial teeth of canids; other characters, such as body size and skull length, may be more affected by other factors, such as climate. A selective force that affects teeth bears heavily on palaeontological research that relies heavily on the study of dental characters (Dayan *et al.*, 1991).

The wolf, jackal and red fox are members of the canid guild, defined on the basis of limb morphology that reflects and affects their foraging behaviour (Dayan *et al.*, 1992b). Dayan *et al.* (1992a) interpreted the large size of the Egyptian jackal as a case of character release in the absence of the wolf in North Africa. Likewise, they suggested that the large jackal of the Middle Palaeolithic of Israel may be related either to the prevailing climatic conditions or to character displacement, a coevolutionary response to the size increase of the wolf and fox of the period. The carnassial length of jackal skulls from the Middle Palaeolithic increases to the same degree as that of the wolf and red fox. Thus a pattern of both equal (community-wide character displacement) and constant size ratios among all three species obtains, notwithstanding temporal fluctuations in overall size (Dayan *et al.*, 1992a).

Understanding these morphological patterns and selective forces suggests the following research guidelines:

1. The marked pattern of geographic size variation dictates that fossil wolves should be compared to their recent local populations. Recent specimens from the Arabian Peninsula that were previously used as a reference collection (see Kurten, 1965) are in fact significantly smaller than recent Israeli wolves, and thus unsuitable.
2. Wolf size reduction related to the process of domestication should not be confounded with the size reduction at the end of the Pleistocene that relates to the climatic warming of this period (Davis, 1981).
3. Temporal size change should be interpreted not only in light of palaeoclimatic change (cf. Davis, 1981) but also in relation to changes in guild composition (Dayan *et al.*, 1991). Large canids are extremely rare in the fossil record preceding the Natufian period, when wolf/dog remains are controversial. However, it appears that the wolf, jackal and red fox coexisted during the Upper Pleistocene and Holocene of Israel (Dayan, 1989). In the absence of changes in guild composition, size change in one of these species may indicate the microevolutionary trend to be expected in other guild members. While jackals differ morphologically in their dental characteristics from wolves and thus large Pleistocene jackals cannot be mistaken for early dog remains (see Davis &

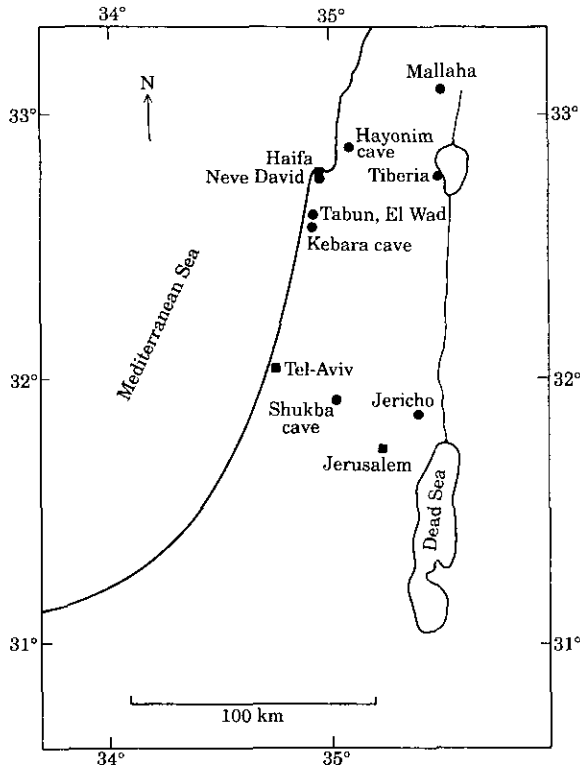


Figure 1. Map of the Near Eastern sites with dog/wolf remains.

Valla, 1978; Payne, 1981), it is important to understand patterns of variation in other canids so as to understand the temporal patterns of variation of the wolf, their guild associate.

Here fossil wolf and possible dog remains from Israel are studied; the earliest date to the Middle Palaeolithic of Tabun Cave, Mt. Carmel (c. 54,000 BP) and the latest to the Early Bronze Age of Jericho (see Figure 1 for site distribution). I follow their pattern of temporal variation in relation to palaeoclimatic change and to morphological change in the red fox and the golden jackal, the other members of the canid guild in Israel.

## Materials and Methods

Recent museum specimens were studied at the Tel Aviv University Zoological Museum, Israel; the zoological collections of the Hebrew University of Jerusalem, Israel; Beth Ussishkin Museum, Kibbutz Dan, Israel; the Natural History Museum, London; and the Harrison Zoological Museum, Sevenoaks, Kent. Mixed populations of males and females were studied.

Most of the fossil specimens were studied at the Natural History Museum, London; at the Department of Paleontology the Mt. Carmel canid remains from el-Wad and Tabun caves (Bate, 1937), Kebara (Turville-Petre, 1932), and Shukbah (Bate, 1942) were studied. At the Mammal Section the Jericho canids

[published by Clutton-Brock (1979)] were studied. The Mallaha specimen [published by Davis & Valla (1978)] was measured at the collections of the Centre de Recherche Francais de Jerusalem and the Neve David (Kaufman & Ronen, 1987) specimen in the collections of the Department of Prehistory, Haifa University, Israel. No absolute dates are available for the Mount Carmel and Jericho material, and therefore cultural sequences and their approximate datings for these specimens are relied upon.

The upper and lower carnassial lengths were measured as well as characters that serve as measures of mandibular and maxillary length, and the height of the mandibular ramus, which can be taken as a measure of its strength.

Measurements were taken with digital calipers to 0.01 mm precision and according to von den Driesch (1976):

1. Length of the lower carnassial, measured at the cingulum ( $M_1L$ ).
2. Length of the premolar row  $P_1$ – $P_4$ , measured along the alveoli ( $P_{1-4}$ ).
3. Height of the mandible behind  $M_1$ , measured at right angles to the basal border (MH).
4. Length of the upper carnassial, measured at the cingulum ( $P^4Le$ ).
5. Length of the upper cheektooth row ( $P^1$ – $M^2$ ).

Non-dental characters were measured only for adult specimens with fully erupted dentitions and complete closure of the dorsal cranial sutures.

Mendelssohn (1982) describes the two populations of the Indian wolf (*Canis lupus pallipes*) in Israel:

1. Desert pallipes—wolves from areas with under 400 mm rainfall.
2. Mediterranean pallipes—wolves from areas of over 400 mm rainfall.

The desert pallipes were found to be significantly smaller for Skull length (Mendelssohn, 1982).

Sample statistics for the characters measured for samples of the Desert pallipes and the Mediterranean pallipes wolves were calculated separately, and the means for both were compared using Student's *t*-test (e.g. Simpson *et al.*, 1960). In characters for which no significant difference was found the two populations were grouped. When a significant difference was found, the fossil canids were compared to the recent population of the appropriate region. For the Mt. Carmel, Neve David and Mallaha specimens the "Mediterranean pallipes" population was used as a reference collection; for the Jericho material the population of wolves from more arid areas was used.

## Results

Table 1 presents the sample statistics for the Israeli populations of recent wolves. For only one character

Table 1. Sample statistics ( $N$ =sample size, S.D.  $\approx$  standard deviation) for the Mediterranean pallipes and Desert pallipes wolf populations in Israel. Sample means are compared by means of a  $t$ -test and whenever the difference is not significant (*n.s.*) the samples were pooled as *Canis lupus pallipes*

	M <sub>1</sub> L	P <sub>1-4</sub>	MH	P <sup>4</sup> Le	P <sup>1</sup> -M <sup>2</sup>
Mediterranean pallipes					
$N$	10	10	10	10	10
Mean	24.66	47.30	25.89	22.62	76.51
S.D.	1.15	1.83	1.42	1.31	2.78
Desert pallipes					
$N$	26	21	21	24	21
Mean	24.32	45.95	24.62	22.34	75.21
S.D.	1.13	2.67	1.64	1.03	2.76
$t$ -test	<i>n.s.</i>	<i>n.s.</i>	$P < 0.05$	<i>n.s.</i>	<i>n.s.</i>
<i>Canis lupus pallipes</i>					
$N$	36	31	—	34	31
Mean	24.41	46.39	—	22.42	75.63
S.D.	1.13	2.48	—	1.10	2.79

(the height of the mandibular ramus M<sub>1</sub>) is there a significant difference between the means for the northern and southern populations, and therefore for all other characters the Israeli wolves were treated as a single population. Table 2 and Figures 2–6 present the measurements of the fossil material.

For the length of the lower carnassial, specimens A and E (Mousterian and Geometric Kebaran) are significantly larger than the Israeli recent wolf sample, and fall well within the range of a small sample of central and north European wolves (range 27.87–31.86,  $N=6$ , mean=28.96, S.D.=1.49). Specimens B and D (Aurignacian and Kebaran) do not differ significantly from recent Israeli wolves. Neither does the Natufian specimen I, but the Natufian specimen G is signifi-

cantly smaller than the recent sample. Specimens M, N and O [Pre-Pottery Neolithic A (PPNA) and disturbed level between PPNA and Pre-Pottery Neolithic B (PPNB)] are also significantly smaller than the recent Israeli wolf sample, as are two of the Neolithic dogs (specimens P and Q) and the Early Bronze Age dogs (T and U). Neolithic specimens R and S, on the other hand, were not significantly different from the sample of recent Israeli wolves.

For the length of the lower premolar row all fossil specimens are significantly smaller than the mean for the recent Israeli wolves ( $P < 0.01$  or lower).

For the height of the mandibular ramus, specimens B, D, E and I were compared to the Mediterranean pallipes sample, and while specimens B and E

Table 2. The early wolf and dog remains, the cultural settings, approximate datings (absolute dates are available only for Mallaha and Neve David), and results of measurements. Measurements that differ significantly ( $P < 0.05$ ) from the mean of a recent sample of wolves from Israel are denoted with an asterix

	Context	Culture	~ Years B.P.	M <sub>1</sub> L	P <sub>1-4</sub>	MH	P <sup>4</sup> Le	P <sup>1</sup> -M <sup>2</sup>
A	Tabun B	Mousterian	45,000	29.03*	—	—	—	—
B	Kebara E	Aurignacian	30–25,000	25.10	—	27.09	—	—
C	Wad C	Levantine Aurignacian C	20,000	—	—	—	24.25	—
D	Kebara C	Kebaran	24–14,000	23.23	—	21.30*	—	—
E	Neve David	Geometric Kebaran	13,000	28.82*	—	28.17	—	—
F	Kebara B	Lower Natufian	12,000	—	—	—	20.25	68.23*
G	Mallaha	Early Natufian	12,000	21.94*	38.53*	—	—	—
H	Wad B	Natufian	11–11,500	—	—	—	20.80	71.94
I	Shuqba B	Upper Natufian	11,000	23.19	38.84*	20.28*	—	—
J	Shuqba B	Upper Natufian	11,000	—	38.76*	—	—	—
K	Jericho	Proto Neolithic	10,000	—	—	21.20*	—	—
L	Jericho	PPNA	10–9500	—	—	—	19.70*	—
M	Jericho	PPNA	10–9500	20.53*	35.63*	22.01	—	—
N	Jericho	Disturbed level	9500–8000	20.62*	—	21.97	—	—
O	Jericho	btn PPNA & PPNB	9500–8000	20.55*	—	—	—	—
P	Jericho	Neolithic	8000–6300	21.55*	—	—	—	—
Q	Jericho	Neolithic	8000–6300	21.75*	—	—	—	—
R	Jericho	Neolithic	8000–6300	22.36	33.80*	21.59	—	—
S	Jericho	Neolithic	8000–6300	23.16	—	—	—	—
T	Jericho	EBA	5300–5000	21.50*	—	—	—	—
U	Jericho	EBA	5300–5000	—	—	20.45*	—	—
V	Jericho	EBA	5300–5000	21.53*	37.97*	22.05	—	—

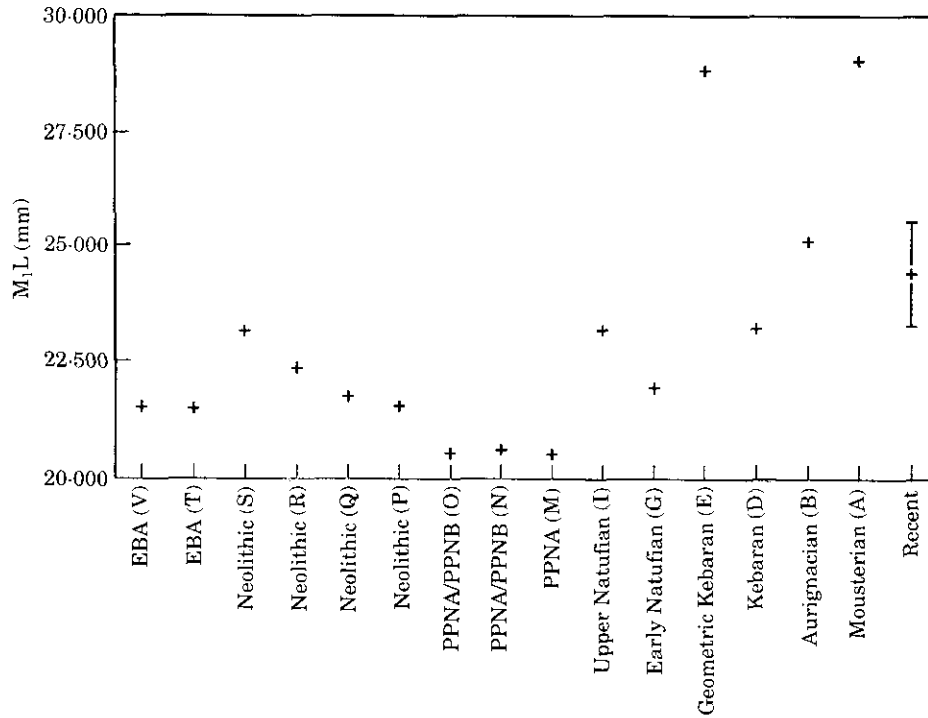


Figure 2. Measurement of lower carnassial length ( $M_{1L}$ ) of the fossil specimens, and mean  $\pm$  S.D. of the recent Israeli sample.

(Mousterian and Geometric Kebaran, respectively) were not found to differ significantly from it, specimens D and I (Kebaran and Upper Natufian, respectively) were significantly smaller. The Jericho canids were compared to the desert pallipes sample. Specimen K (Proto-Neolithic) is significantly smaller, as is Early Bronze Age specimen U, but Pre-Pottery Neolithic and Neolithic specimens M, N and R, and Early Bronze Age specimen V do not differ significantly from the recent sample of desert pallipes.

For the length of the upper carnassial the Levantine Aurignacian C specimen C did not differ significantly from the recent Israeli wolves. Specimens F and H (Natufian) were not, each, significantly different from the recent sample. Specimen L (PPNA) is significantly smaller than recent Israeli wolves.

For the length of the maxillary toothrow, specimen F (Natufian) was significantly smaller than the recent wolf sample, while specimen H (Natufian) was not found to differ from the recent Israeli sample.

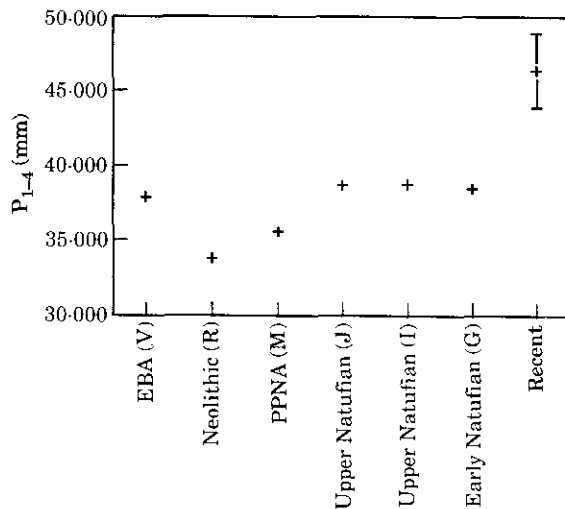


Figure 3. Measurement of mandible length ( $P_{1-4}$ ) of the fossil specimens, and mean  $\pm$  S.D. of the recent Israeli sample.

### Discussion

The Natufian sample consists of individuals that display the classical characteristics of early domestication: slight diminution of the carnassials alongside a marked reduction of mandibular and maxillary length (e.g. Clutton-Brock, 1981; Olsen, 1985; Benecke, 1987). This phenomenon is the beginning of a trend that can be followed through later periods. In the PPNA and Neolithic of Jericho, specimens with still smaller carnassials in short mandibles, that can be easily distinguished from recent Israeli wolves, are found.

This pattern of slight tooth size reduction and disproportionate shortening of the facial region conforms with the criteria for early domestication. The possibility that the Natufian specimens are simply small wolves should not be overlooked, but it is not likely. The Natufian period enjoyed a cooler and more humid climate than reigns today (e.g. Horowitz, 1989; Baruch

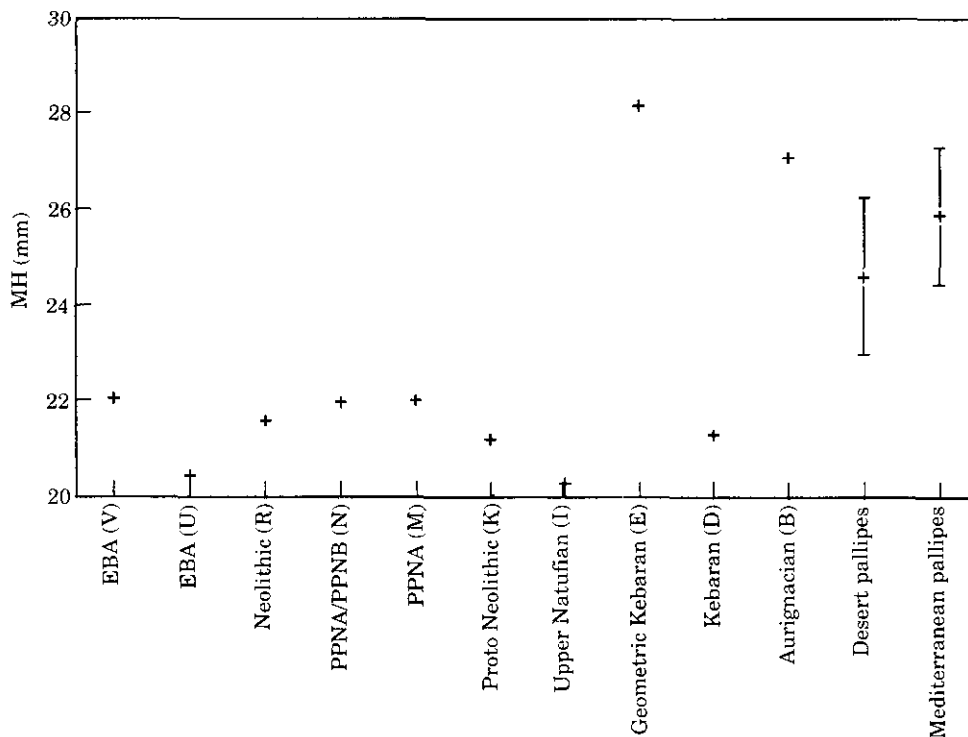


Figure 4. Measurement of mandibular height (MH) of the fossil specimens, and mean  $\pm$  s.d. of the recent Israeli sample.

& Bottema, 1991). The wolf is a species that follows Bergmann's rule both in time and in space (Davis, 1981). Pleistocene specimens A and E strongly attest to

that, as do wolf carnassials from Ksar 'Akil, Lebanon (Hooijer, 1961), and from the Geometric Kebaran of Ein Gev IV, Israel (Davis & Valla, 1978). We should not expect a size reduction under Natufian climatic conditions, certainly not a reduction that would result in wolves being significantly smaller than the recent Israeli sample.

This pattern of size reduction in the Natufian period does not conform to our expectations based on

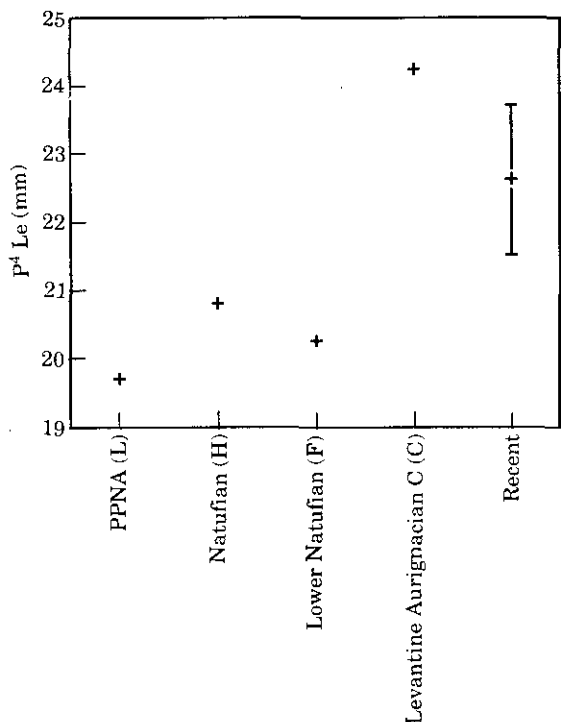


Figure 5. Measurement of upper carnassial length (P<sup>4</sup>Le) of the fossil specimens, and mean  $\pm$  s.d. of the recent Israeli sample.

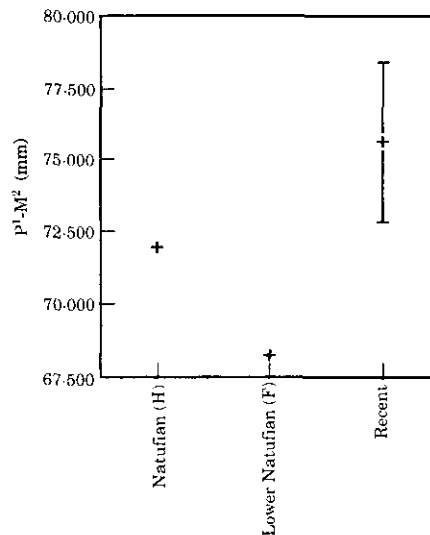


Figure 6. Measurement of maxillary length (P<sup>1</sup>-M<sup>2</sup>) of the fossil specimens, and mean  $\pm$  s.d. of the recent Israeli sample.

Bergmann's rule. How do we view it in light of Dayan *et al.*'s (1990, 1992) studies of character displacement in carnivores? In the Middle Palaeolithic the red fox, jackal and wolf carnassials were larger than those of the recent population, maintaining a pattern of both equal and constant size ratios between them (Dayan *et al.*, 1992). Davis (1977) found the carnassial size of the red fox of the Natufian and Kebaran periods to be significantly larger than the recent population. The size difference is considerable. Thus we should expect the carnassials of the Natufian wolf to be larger than those of the recent population to a degree similar to that in the red fox. It appears then that the size reduction in the Natufian specimens is opposite to that expected both as a response to climatic conditions and a response to coevolution with other competitors. On the other hand, the morphological pattern is precisely what we would expect of newly domesticated wolves. Thus in the Natufian of Israel we find several specimens that conform to the morphology expected of domesticated wolves; clearly the Davis & Valla (1978) publication does not deal with an aberrant specimen.

Slightly earlier, in the Kebaran level of Kebara cave, a single specimen is found: a mandible whose carnassial length compares with the smallest recent wolves of this country, and that exhibits a significant reduction in the height of the ramus. This trend of reduction also follows in later specimens of dog and could therefore be taken as a result of domestication, perhaps an early sign of the weakening of the jaw. This find should be treated cautiously because the working methods at this early excavation may not have been fine enough to discern between the thin Kebaran level and the Natufian level.

This small mandible (D), if it is indeed properly dated, could be explained in either of two ways. If it is a wolf mandible, we must assume the existence of a small, slender jawed wolf in the Kebaran period, a short time before the appearance of the enormous specimens from the Geometric Kebaran. This interpretation would counter our expectations in light of the large size of the red fox during this period (see Davis, 1977), and in light of the extreme cold at this period (e.g. Horowitz, 1989). This slender jaw could, however, indicate that the domestication process begins prior to the Natufian, during the Kebaran, and specimen D is an extremely early dog, or tame wolf. The Geometric Kebaran specimen here and that published by Davis & Valla (1978) are wild wolves whose great size shows the influence of climatic conditions, in accord with Bergmann's rule.

The dating of the Kebaran wolf remains to be resolved. At present it is suggested simply that specimen D allows us to consider the possibility that dogs were domesticated before the Natufian period.

It is often assumed that the dog was domesticated from a small subspecies of wolf (e.g. Lawrence, 1967; Scott, 1968; Hemmer, 1983; Olsen, 1985). If the Natufian sample represents the earliest domestic dogs

in this region, then the dog was domesticated from a large race similar to that of the preceding Geometric Kebaran wolves. If so, there seems to be no reason to search for the origin of domestic dogs in regions where present day wolves are small. I would likewise expect the domestication of large wolves in other regions where they occur and would therefore not be surprised at some very early domestic dog finds from Europe (see Nobis, 1981; Benecke, 1987).

If, on the other hand, we recognize the single Kebaran specimen (D) as an early dog or tame wolf then we may search for the progenitor of the domestic dog in this region at an earlier period. Earlier specimens from the Aurignacian and Levantine Aurignacian C periods (B and C) are not very large and fall within the range of recent Israeli wolves, although they would rank amongst the largest. This fact accords well with the data on the relatively small size of the red fox in the Aurignacian period (Davis, 1977). It is perhaps this smaller wolf that was domesticated in this region. This hypothesis would perhaps better explain the relatively small size of early domestic dogs and is more consistent with current theories.

The latter hypothesis throws the origins of early dog domestication in the Near East back to *c.* 15,000 BP.

## Acknowledgements

I thank J. Clutton-Brock, S. Davis, R. Klein, S. Lev-Yadun, D. Simberloff, J. Speth, E. Tchernov, and two anonymous referees for their helpful comments, and I. Zohar for help with the figures. During this study I was supported by a Buchman Fellowship and an Alon Fellowship.

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