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Early domestic dogs

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Abstract

Evidence is presented to show that domestication of the dog occured at least as long ago as the tenth millenium B. C., well before the agricultural revolution. Rami and a cranial fragment from about 8,400 B. C. are described from a cave site high in Birch Creek Valley, Lemhi County, Idaho. These antedate the earliest presently reported specimens from the Old World. Since dogs were domesticated from an Old World, not a New World stock, and since the remains discussed are of a small animal with typical dog characters, domestication must have taken place at a considerably earlier date.

The antiquity of typical un-wolflike dogs in the Near East is further confirmed by the occurrence at a site in Southern Turkey of a pair of short, massive dog jaws from about 7,000 B. C.

Introduction

Additional evidence of the antiquity of the domestication of the dog has recently been unearthed at two very widely separated sites, the one in Lemhi County, Idaho, with two C—14 dates ranging from about 9500—8400 B. C., the other in south central Turkey with C—14 dates clustered around 7000 B. C. The finds are important for different but related reasons. On the one hand, the dates of the North American material are the oldest for known domestic dog anywhere; on the other, the typically *Canis familiaris* characters of both finds show that domestication must have taken place at an even earlier date to allow time for the appearance of characters which are essentially those of modern dogs — they are not even dingo-like.

Part I.

North American dogs

Studies of the origin of domestic dogs have centered largely around the Near East and Western Europe where true dogs have been reliably identified from as early as the 8th millenium B. C. from Europe (Degerbøl, 1961: 35—36), and the 7th millenium B. C. from Jericho (Zeuner, 1958: 52—53; Reed, 1960: 120, 128). The even greater age of a dog jaw from a postglacial, late Wisconsin alluvial gravel bed in Illinois (Galbreath, 1938: 307—308) has been largely ignored. This specimen was examined by Major E. A. Goldman and Mr. Gerrit S. Miller, Jr., both experts on canid identification. Though they were somewhat tentative in their statements, it is clear that they believed the specimen to be *Canis familiaris*. The additional material des-

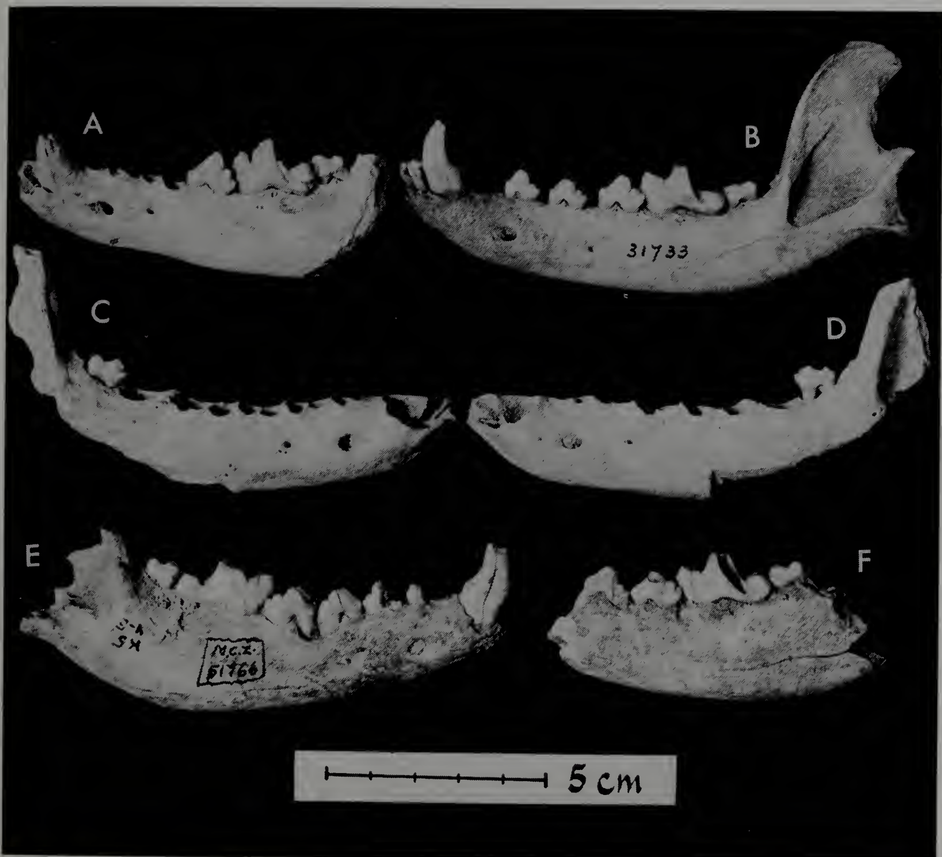

Fig. 1. Rami with the following Museum of Comparative Zoology numbers: A 51770, C and D, 51769, from Birch Creek Valley, Idaho; B, 31733, from La Plata, Colorado; E, 51766, F, 51767, from Çayönü, Turkey.

cribed in this paper from an archeological site in Idaho, called Jaguar Cave, is interesting confirmation of the occurrence of domestic dogs in the postglacial Wisconsin era.

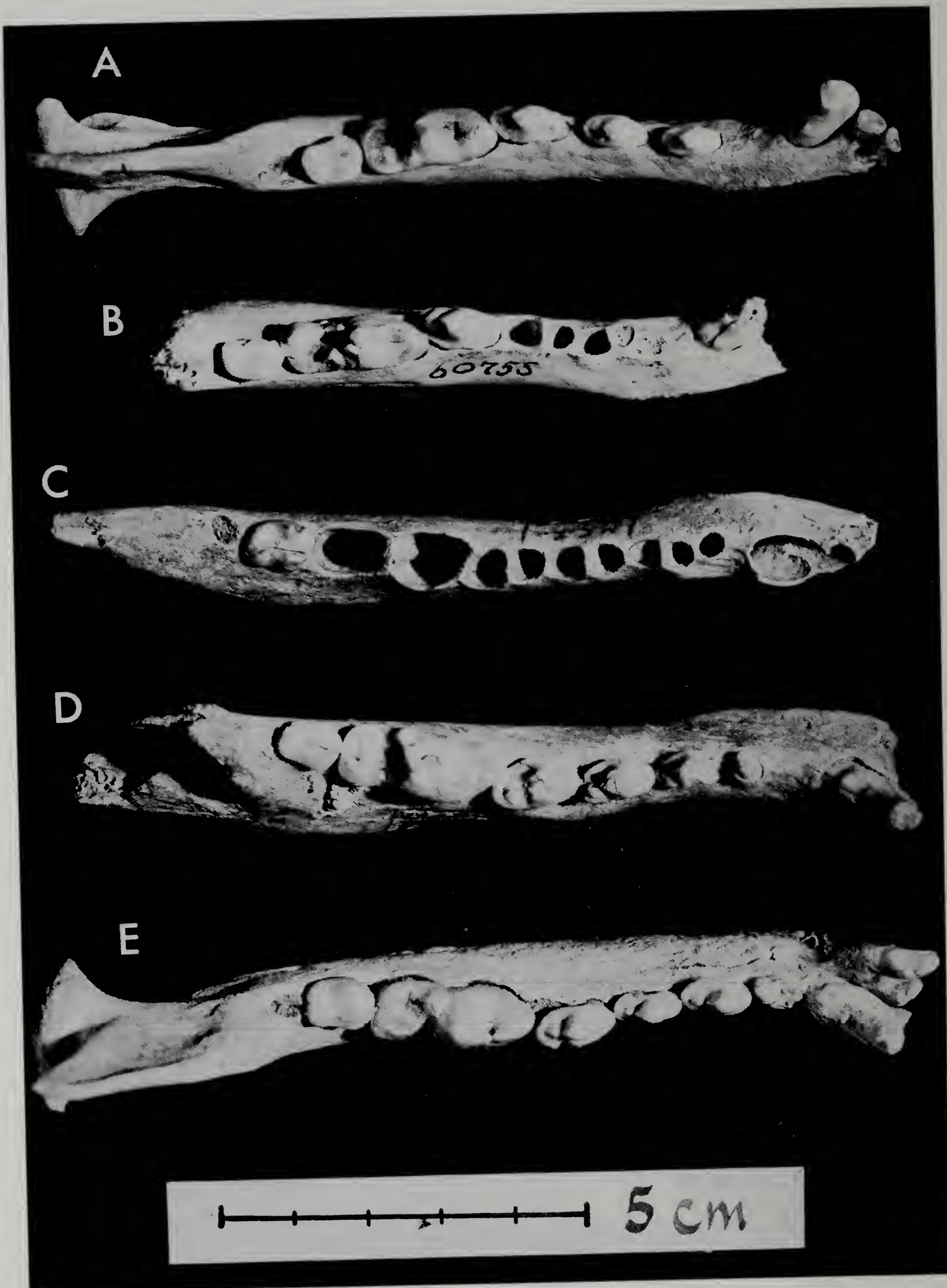

Fig. 2. Rami with the following Museum of Comparative Zoology numbers: A, 31733, from La Plata, Colorado; B, 51770, C, 51769, from Birch Creek Valley, Idaho; D, 51766, from Çayönü, Turkey; E, 51858, from Albuquerque, New Mexico.

Specimens examined. Idaho, Lemhi County, Birch Creek Valley, Jaguar Cave: Museum of Comparative Zoology 51769, a pair of mandibles; M. C. Z. 51770, left mandible; M. C. Z. 51771, right maxillary fragment. The material is from a site high in the side of a valley on the west slope of the Beaverhead Mountains, excavated by HIND SADEK-KOOROS during the summers of 1962 and 1963. DORT (1962: 14–16) gives maps and a photograph of the area. Detailed studies of the rest of the fauna are being prepared by HIND SADEK-KOOROS of the Peabody Museum at Harvard and by JOHN E. GUILDAY of the Carnegie Museum in Pittsburgh. Reports on other aspects of the site have been published by MILLER and SADEK (1965) and by DORT et al (1965). Two C-14 dates are available for the site, ± 10,370 and ± 11,580 BP; other evidence suggests that these may be too recent.

Of the two dates, the latest, 10,370 BP, is for a hearth in the same square and level as the paired rami M. C. Z. 51769. M. C. Z. 51770 probably is of the same age, and M. C. Z. 51771 may be slightly more recent.

Description. The paired mandibles, M. C. Z. 51769, figs. 1, 2, each have the ventral margin and most of the ascending ramus broken away and each lacks all the teeth except M_2; the single mandible, M. C. Z. 51770, figs. 1, 2, is broken at the level of M_3 but has the canine and $P_4 - M_2$ in place; the maxillary fragment, M. C. Z. 51771, fig. 3, is the posterior half of the tooth row of the right maxilla, including half of the alveolus of P^2; P^4 is the only tooth preserved. All of these specimens are much too small to be wolf, so comparison needs to be made only with coyote, which differs in a number of diagnostic features. Characteristically, the dog jaws are massive, both deep dorsoventrally and thick lateromedially, and the tooth rows are short compared with the size of the individual teeth (for measurements see Table 1). This shortening is accomplished partly by crowding, particularly of the anterior premolars so that their sockets do not lie in a straight line, and partly by the tilting upward of the level of the tooth row posteriorly so that a straight line from the posterior margin of the alveolus of M^3 to the anterior margin of the alveolus of P_1 passes above M_2. The jaws, as well as being shortened, are wide-spread in typical dog fashion. The ratio of width across the tooth rows at M_2 to alveolar length from P_1 to M_3 is 71.3 in the Jaguar Cave dog and 51. to 55.5 in six, recent coyotes, selected from a long series for having a relatively short, broad snout.

Width across lower cheek teeth and length of the tooth rows is obviously reflected in proportions of the rostrum, so it is possible to say that the animal in question was rather short-nosed with a broad palate and, since a short, broad nose in dogs is correlated with a steep forehead, one can further say that the animals in question had this most doglike of all characters well developed.

Further evidence that these dogs had rather short noses and broad palates is found in the maxillary fragment. Here the alveolus of P^3 lies at almost a 45° angle to the main axis of P^4, the former tooth having been crowded out of line by P^2. Posterior to this, the tooth row curves strongly inward so that a line from the inner margin of the alveolus of M^2 to that of the inner cusp of P^4 barely crosses the inner margin of the alveolus of M^1. The pinching in of the anterior part of the tooth row and curving inward of the posterior part are characteristic of dogs with short, broad palates. Dogs with long noses have well-spaced teeth and relatively straight tooth rows.

Teeth of the four fragments are less diagnostic. Each M_2 in the pair of rami has the cusps too chipped to show relative size of proto- and metaconid, which is sometimes characteristic. In the other jaw M_1 has the metaconid only moderately developed and, although the enamel is rather badly chipped, the hypoconid, the outer cusp of the heel, appears much better developed than the entoconid, the inner. P_4 has only one cusp between the main cusp and the cingulum. All of these are characters which help distinguish dog/wolf from coyote.

Table 1

Measurements Lower Jaw	Idaho Birch Creek Valley Jaguar Cave MCZ 51769	Idaho Birch Creek Valley Jaguar Cave MCZ 51769	Idaho Birch Creek Valley Jaguar Cave MCZ 51770
	right	left	
Alveolar length P_1 to M_3	67.6	67.9	63.2[1]
Alveolar length P_1 to M_2	64.0	64.3	59.5
Alveolar length P_2 to M_3	63.7	63.9	60.4[1]
Greatest thickness of jaw ventral to M_1	11.6	12.0	11.0
Maximum alveolar width across jaws taken at M_1	41.5		
Crown length P_4	—	—	11.2
Maximum width P_4	—	—	5.7
Crown length M_1 parallel to inner margin	—	—	19.8
Maximum width M_1 at right angles to length	—	—	7.5
Alveolar length M_1 along inner margin	20.8	21.0	19.4
Greatest length M_2	9.4	9.2	8.2
Maximum width M_2 at right angles to length	6.9	7.0	5.8

[1] Specimen lacks tooth, or alveolus broken, so measurement estimated.

Lower jaws that are unquestionably coyote *(Canis latrans)* also occurred at the site. These are all slimmer with longer, straighter tooth rows. In size of carnassial they fall well within the range of variation, as given by Jackson (1951: 281—282), for *C. latrans lestes,* although the smallest overlap slightly with dog. Cranial fragments of coyote include one entire left side of a rostrum. The teeth are broken or missing, but characteristic of coyote is the rather straight tooth row, and the wide spacing and slim alveoli of the premolars. A second maxillary fragment of coyote has the last three teeth in place. These show the following coyote characteristics: the carnassial is relatively slim; M^1 has the para- and metacones narrow latero-medially compared with the latero-medial width of the inner part of the tooth. Wear makes this latter difficult to measure really precisely, but in coyotes, measured at right angles to the main axis of the tooth, the greatest width of the paracone, including the cingulum, is less than the distance from the inner base of the paracone to the level of the inner margin of the tooth. In dogs and wolves the reverse is true. Since the teeth are cracked and partly broken, measurements showing these differences could not be made, but they are easily apparent to the eye.

Additional characters deduced from available fragments. Tooth size and jaw size vary independently in *Canis* so size of teeth does not necessarily indicate size of skull, as assumed by Zeuner (1958: 53). Length of the mandibular tooth row, however, is closely correlated with length of rostrum and crowding of either set of premolars may occur when the distance from the carnassial to the alveolus of the canine is too short to accommodate teeth in their normal alignment. When crowding occurs in the lower jaw, the spaces between the premolars are sharply reduced, although the small space between P_1 and the canine is usually maintained, probably because of the position of the root of the latter. In extreme cases of shortening, the tooth sockets are squeezed out of line and the normal slight overlap between P_4 and M_1 is increased. In the upper jaw where the premolars are more closely spaced, crowding of the tooth row causes the overlapping of P^2 and P^3. A diagonal position of P^3 is often found in short-nosed animals but is the result of a narrowing of the palate in front of the carnassials rather than shortening of the tooth row.

Essentially, crowding of the teeth is a result of one of three things:

1. Failure in captive animals for development of the jaw to be commensurate with that of the teeth. Such failure is probably from nutritional causes.
2. Young age of an animal so the jaw has not yet reached its maximum size. This is only a temporary crowding.
3. The inheritance of large teeth but of small jaws; this is an inharmonious pattern which does not show up in wild canids but is not infrequent in domestic dogs.

Table 2

Measurements Lower Jaw	Colorado La Plata Valley MCZ 31733	Arizona Canyon del Muerto MCZ 28764	New Mexico Governador MCZ 41172	New Mexico Albuquerque Coll. T. R. Frisbie MCZ 51858	New Mexico Albuquerque Coll. T. R. Frisbie Univ. N. M. 22913	Illinois Coles County Ashmore CNHM P15192	Turkey Çayönü Site MCZ 51767	Turkey Çayönü Site MCZ 51766 right ramus
Alveolar length P_1 to M_3	P_1 missing	P_1 missing	68.6	70.	71.	62.9	—	—
Alveolar length P_1 to M_2	—	—	64.2	65.	64.7	63.7	—	64.5
Alveolar length P_2 to M_3	61.8	59.4	63.9	64.5	64.3	59.4	—	M_3 missing
Greatest thickness of jaw ventral to M_1	10.6	10.	9.8	11.9	10.8	9.1	13.3	12.9
Maximum alveolar width across jaws taken at M_1	39.5	36.5	39.1	—	38.4[1]	—	—	—
Crown length P_4	10.4	10.2	10.8	11.	10.7	10.2	11.8	11.7
Maximum width P_4	5.3	5.6	5.8	5.8	5.8	4.9	6.8	6.9
Crown length M_1 parallel to inner margin	18.6	19.3	18.7	21.7	20.2	—	21.8	21.7
Maximum width M_1 at right angles to length	8.3	8.0	7.9	9.3	8.2	—	8.6	8.7
Alveolar length M_1 along inner margin	18.2	19.0	18.4	21.6	19.9	18.2	21.6	21.8
Crown length M_2	8.2	7.7	8.3	9.0	8.8	7.9	8.2	8.5
Maximum width M_2 at right angles to length	6.4	6.0	6.8	7.5	6.3	6.0	6.2	6.3

Except where indicated, measurements were taken on left ramus.
Where a tooth has never erupted, it is listed as "missing".
[1] Specimen lacks tooth, or alveolus broken, so measurement estimated.

An index for crowding (Degerbøl, 1961: 39–41), based on the relation of the combined lengths of the premolars to the distance from the posterior border of the alveolus of the canine to the anterior border of the alveolus of the carnassial, has been used by various workers to tell dogs and wolves apart. Actually, to the extent that it shows what happens to wolves in captivity, it is probably more useful as evidence of incipient domestication. Such modifications of skull form in the early stages of domestication would not be genetic but of the phenotype only and probably related to the reasons discussed under (1). In later stages of domestication, overlapping of the teeth, when it occurs, is a genotypic phenomenon as described in (3) and becomes a good diagnostic character for domestic dog, especially as compared with some of the smaller species of the genus *Canis*. An inherited shortening of the rostrum which results in crowding of the teeth is not uncommon in North American Indian dogs. The shortened tooth rows of the specimens at hand show that it is also an ancient trait in domestic dogs.

Fig. 3. Maxillary fragment, Museum of Comparative Zoology number 51770, from Birch Creek Valley, Idaho.

There is evidence that the individuals from the Jaguar Cave site were broad-headed. In canid skulls, the rostral, the cranial, and the interorbital regions all vary independently of each other in their shape and dimensions. Of these three regions, in normally ossified skulls, the cranial region is by far the most stable. The actual brain case varies least both in length-breadth proportions and in total size. Domestic dog skulls with about equal-sized brain cases may vary tremendously in length and breadth of rostrum, and in tilting and inflation of the interorbital region. Variation of wild canids, as wolves and coyotes, in the relative shape and dimensions of each of these parts of the skull is much less extreme, so that the entire skull appears more harmoniously proportioned. In these two species, the length-breadth proportions of the rostrum compared to those of the brain case, and the shape of the interorbital region are among the best diagnostic characters.

The lower jaw, spanning the length of the skull, gives at two points particularly rather precise information about cranial proportions. The occlusion pattern of carnassials and molars shows little variation in *Canis* so, in paired rami joined at the symphysis, distance across the molars and carnassials indicates width across the palate. Even more fixed is the relation of condyle to glenoid fossa at the articulation of the jaw. Since in skulls that are not abnormally heavily ossified the distance between these fossae indicates the width of the brain case, the distance across the condyles of the jaws is also indicative of this width. Attempts to establish anterior width of rostrum by measuring the space between the lower canines are less successful. A wide distance here is correlated with a wide rostrum but the converse is not necessarily true. Relative length of different skull segments may also be inferred from proportions of the lower jaw. As explained above, lengthening of the premolar region of the jaw is reflected in lengthening of the rostrum, similarly shortening of the distance from the back of

Table 3

Measurements Skull	Colorado La Plata Valley MCZ 31733	Arizona Canyon del Muerto MCZ 28764	New Mexico Governador MCZ 41172	New Mexico Albuquerque Coll. of T. R. Frisbie MCZ 51858	New Mexico Albuquerque Coll. of T. R. Frisbie Univ. N. M. 22913	Idaho Birch Creek Valley Jaguar Cave MCZ 51771
Condylo basal length from front of I^1 to occipital condyle	145.9	145.6	145.5	156.3	155.5	—
Palatal length from front of I^1 to median edge of palate	78.9	75.8	77.7	84.1	82.0	—
Length of rostrum from alveolus of I^1 to orbit	66.8	64.9	67.5	72.9	72.2	—
Alveolar length C to M^2	68.3	65.5	68.4	73.0[1]	71.0	—
Alveolar length P^1 to P^3	26.7	24.9	25.9[1]	27.5[1]	28.3	—
Alveolar length P^4 to M^2	30.4	29.7	30.2	34.0[1]	32.0	33.0[1]
Minimum distance from alveolus of M^2 to bulla at base of styloid process	36.8	38.3	37.5	37.5	38.8	—
Zygomatic width	92.6	88.0	88.9	—	89.2	—
Interorbital width	30.2	31.5	32.3	32.5	30.7	—
Width across postorbital processes	43.6	43.5	48.0	47.9	43.2	—
Minimum width between alveoli of P^1	22.9[1]	20.0	23.4[1]	24.0	21.8	—
Width of brain case at parieto-temporal suture	49.1	49.1	49.2	50.8	49.0	—
Width between inner margins of glenoid fossae at base of post-glenoid processes	39.8	38.0	39.6	—	39.7	—
Maximum alveolar width across tooth rows	58.8	54.1	56.5	60.0	57.0	—
Height of brain case, not including sagittal crest, taken from basi-occipital	45.0	47.0	49.5	49.0	47.0	—
Crown length P^4 along outer margin	16.8	17.0	16.8	19.1	18.0	19.0
Minimum width P^4 taken between roots	7.2	7.0	7.3	8.3	7.4	8.0
Maximum width P^4	9.8	9.2	8.7	10.3	9.6	9.6
Alveolar length P^4	15.7	15.3	15.8	18.7[1]	16.9[1]	18.6[1]

[1] Specimen lacks tooth, or alveolus broken, so measurement estimated.

M_1 to the condyle means that length of the posterior half of the skull has been reduced. Since the molars normally lie close together, such shortening is generally accomplished by a bending upward, behind M_1, of the posterior end of the jaw, as well as by a reduction of the space between M_3 and the ascending ramus. Sometimes indeed M_3 is entirely lost. Shortening of the posterior part of the skull may be accomplished by reduction in length either of the interorbital region or of the brain case. Since, as explained above, the length-breadth ratio of the brain case shows a relatively small amount of variation, the length of the brain case may be estimated, within certain limits, from its width. Once this is established, the length of the interorbital region may also be inferred from the length of the posterior part of the jaw. Precise, detailed dimensions, of course, can never be established in this way, but with the help of comparative material it is possible to arrive at quite a good understanding of the cranial proportions of certain types of dogs from a study of their lower jaws.

Jaws from archaeological sites are often not complete; if both rami are recovered, their angle of diversion at the symphysis is useful in estimating width of palate. When only one ramus is present, a good indication of this angle can be obtained by putting the symphysis on a flat surface and seeing how steeply the jaw slopes upward. Thick-

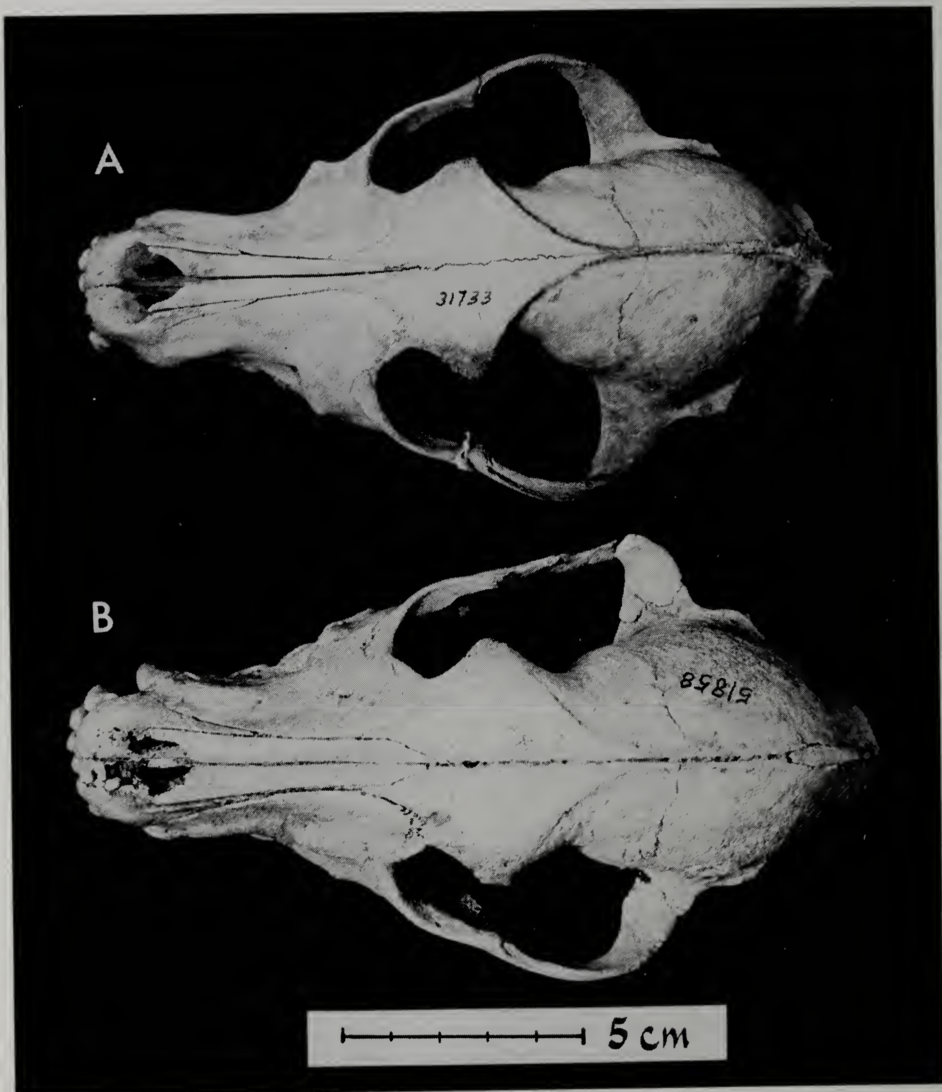

Fig. 4. Dorsal view of skulls of Indian Basket Maker dogs, with following Museum of Comparative Zoology numbers: A, 31733, La Plata, Colorado; B, 51858, Albuquerque, New Mexico.

ness of jaw and presence or absence of teeth make it difficult to measure this angle but by comparison with half of a complete pair of jaws, it can be estimated. Jaws which lack condyle and ascending ramus are still useful in estimating width (and hence length) of brain case if there is enough of the tooth row left to show to what degree it bends inward posteriorly. In dogs with a brain case rather narrow compared to the palatal width, the tooth row *posterior* to M_1 bends inward. This is especially true of short-nosed dogs; in longer nosed dogs a narrowing of the space between the condyles may be achieved entirely by the bend in the tooth row *anterior* to M_1. This latter bend in the tooth row and a related curve in the lower jaw are very characteristic of the dog/wolf group of canids as compared with coyotes.

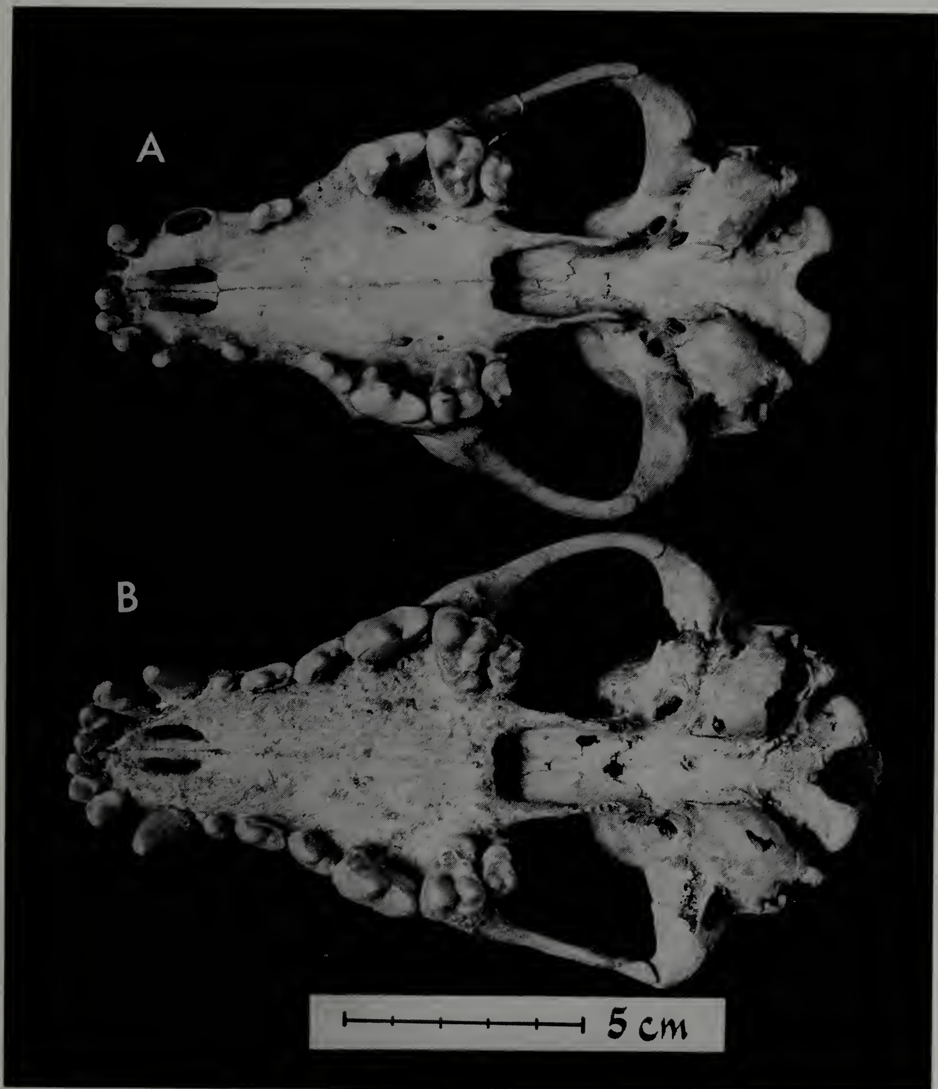

Fig. 5. Ventral view of skulls of Indian Basket Maker dogs, with following Museum of Comparative Zoology numbers: A, 31733, La Plata, Colorado; B, 51858, Albuquerque, New Mexico.

To summarize, occlusion of M_1 with P^4 and M^1 may be taken as a fixed point in the canid skull. Modifications of the lower jaw anterior to this are paralleled by changes in length and width of the rostrum; modifications of the jaw and molar series posterior to this reflect changes in the brain case primarily, and to a certain extent length (but not inflation) of the interorbital region.

Comparison with other Indian dogs. Some idea of the probable proportions of the skulls of the Jaguar Cave dogs may be obtained by comparing them with a series of specimens of Indian dogs of much more recent date from the Southwest. These individuals belong to the kind of dog described by G. M. ALLEN (1920: 481–490) as the "small Indian dog or Techichi", and further discussed by LAWRENCE (1944: 74–75) as Basket Maker dogs. In his excellent paper, ALLEN's thesis (1920: 440) is that in the

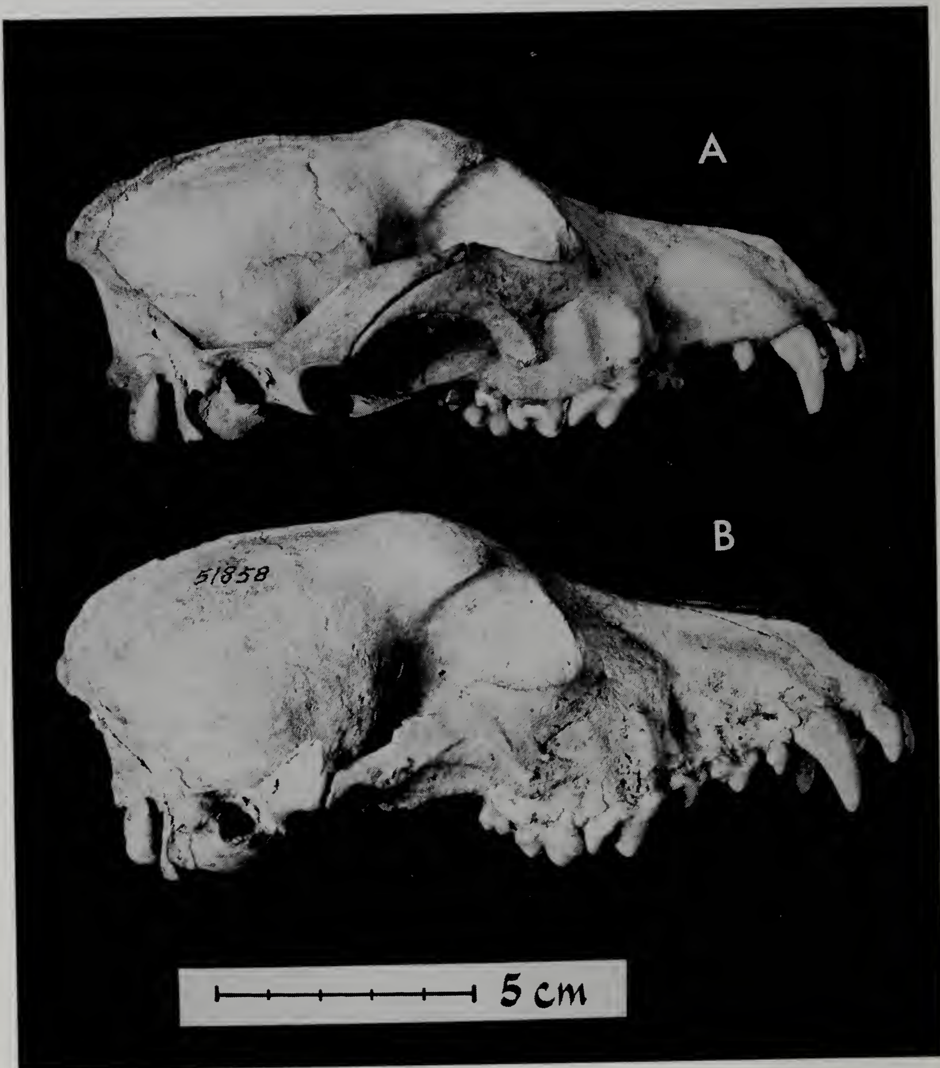

Fig. 6. Right, lateral view of skulls of Indian Basket Maker dogs, with following Museum of Comparative Zoology numbers: A, 31733, La Plata, Colorado; B, 51858, Albuquerque, New Mexico.

Western Hemisphere the Indians had three types of dog: a large wolf-like Eskimo dog, a smaller type of varying proportions, and a much smaller animal of about terrier size, usually with a shortened rostrum. The two latter forms occurred together over much of their range and were referred to by travellers as wolf-like and fox-like. ALLEN distinguishes a number of local varieties of each of these. The present author has confirmed this tendency, in some areas, for dogs to form local, fairly well-defined breeds of which the Basket Maker dogs, figs. 4—6, are an example. These are shown to average somewhat larger than ALLEN's Techichi, although they clearly belong in his third group. Additional finds by THEODORE R. FRISBIE, University of New Mexico, of dogs in a Basket Maker III-Pueblo I site near Albuquerque, New Mexico, include two skulls with jaws of even larger individuals (see measurements Table 2). These confirm this upward revision in size of the Basket Maker dogs to make it truly intermediate between the Techichi and the Plains Indian dog, although the total range of variation is not great. All agree in having the bone rather heavy for the size of the skull, the muzzle shortened and rather narrow, a moderately steep forehead and, in the fully adult individuals, jaws which range from heavy to very heavy. There is considerable variation in tooth size, but even in the ones with the smallest teeth the lower tooth row is crowded, and tilted upward posteriorly.

Of all of these specimens, the one which most closely resembles the Jaguar Cave pair of mandibles is the larger of the two individuals from Albuquerque, MCZ 51 858, fig. 2. The actual size of its massive jaws, and the crowded, rather large teeth are very similar to those of the ancient dog. In the Albuquerque jaws, the symphysis is eroded away so neither angle of diversion nor width across the lower molars can be established; the skull, however, has a broad palate. In the five other Basket Maker skulls the ratio of alveolar width across jaws at M_1 to width across upper check teeth varies between 68.0 and 70., with a mean of 69. Using this ratio, a skull with the width across the upper molars of the Albuquerque skull, 60. mm, would have a width across M_1 of 41.5. As closely as can be determined, this is the width across M_1 of the Jaguar Cave paired jaws, MCZ 51769, and further confirms that the proportions of palate and rostrum of this individual were similar to those of the Albuquerque specimen.

The brain case of the Jaguar Cave specimen was probably somewhat broader than that of the Albuquerque animal. Although the condyles and upper part of the ascending rami are missing in the former, enough remains to show that the space between them is wider than in our broadest-skulled Basket Maker dog.

The second Jaguar Cave specimen is smaller and relatively more massive than any of our Basket Maker dogs, with the premolar alveoli crowded out of line and with an angle of diversion about equal to that of the paired jaws. The cranial fragment also has the premolars more crowded out of line and the posterior end of the tooth row more bent inwards than in our Basket Maker dogs. Both suggest that the range of variation in these early animals was from a small, short-nosed animal with a broad palate and rather large brain case to a slightly larger, longer-skulled form. In other words, these animals clearly belonged to the smaller Indian dog group.

Comparison has also been made with the jaw referred to earlier from Coles County, Illinois and reported by GALBREATH (1938: 307—308). No Carbon-14 dates are available but in a letter Dr. GALBREATH says, "definitely later than Shelbyville Moraine time (19,000 BP) and possibly not younger than Valders Time (11,000 BP)", though he goes on to give a more conservative estimate of 8,000 BP as the recentest it could be. The jaw is about the length of the smallest of the Jaguar Cave specimens (see measurements Table 2) but is conspicuously slimmer and the angle of diversion is less. The smaller teeth are less crowded and the back of the tooth row less tilted — a line from the posterior margin of the alveolus for M_3 to the anterior margin of the alveolus for P_1 does not pass above M_2. These characters of the lower jaw indicate that this individual had a slightly smaller, more slender skull, with a longer rostrum in relation to length of brain case, than did the Jaguar Cave animals.

Part II

Old world dogs

Degerbøl, in his careful analysis of specimens of *Canis familiaris* from Star Carr (1961), summarizes our knowledge to date of the occurrence and relative size of the earliest Old World remains. According to him, the specimen from Star Carr, with a Carbon-14 date of 7538 ± 350 BC, is the oldest known domestic dog and is of a small, obviously young adult animal with relatively large teeth. Another specimen from Frankfurt am Main, usually called the Senckenberg dog and of about the same geological age, is an animal with smaller teeth. Neither of these have teeth as small as those of the early post-glacial, North American specimens. In the Star Carr skull, however, the crowding of the premolars and curving in of the posterior end of the upper molar series as figured (Degerbøl, 1961:pls. 2, 3) resemble the arrangement of teeth found in the shortened tooth rows of the Indian dogs.

Material from Japan reported by Shikama and Okafuji is not discussed by him. These specimens came from late Pleistocene deposits in Akiyosi District, Yamaguti Province, Japan and were identified as "*Canis* sp. aff. *familiaris* L.". The authors state (1958: 89) that they "cannot find any different characteristics of these specimens from that of recent dog, so that it may be interesting to note from the viewpoint of the history of the Japanese wild dog that in the latest Pleistocene wild dog was living in Japan." Certainly their measurements and figures seem to be of small, heavy-jawed animals, very similar to the ones discussed in this present paper. The specimens were found in the same level in four different caves, and, in one, rami of these were associated with rami of the larger *Canis lupus hodopylax*. Possibly these animals were truly wild; no human remains were found associated with them, but antiquity of true domestic dog remains from North America suggests that they were in fact domestic.

An additional find of approximately the same age as the European material should be reported. This comes from a site called Çayönü near Ergani in the Province of Diyarbakir, Turkey, excavated by the University of Istanbul-University of Chicago Prehistoric Project in 1964. Detailed reports on other aspects of this excavation are currently being prepared at the participating institutions. Two rami, probably a pair, fig. 1 E and F, were found of a rather small animal apparently about the size of the largest Basket Maker dogs but more heavy-boned. The jaws are remarkably thickened latero-medially (see Table 2). The teeth are large and plump with the anterior premolars crowded. The right ramus, which is the most complete, lacked a third molar, and the tooth row bends steeply up posterior to M_1. Although the ascending ramus and angle of the jaw are missing, enough remains of the ventral border to give further evidence of the shortening of that part posterior to M_1. The cranial-interorbital length implied by this is very like that of the Basket Maker dogs.

Unfortunately the anterior part of the left ramus is missing, but from the symphysis of the right ramus it is possible to determine that the angle of diversion of the jaws, though a little less than in the broadest-skulled of the Basket Maker dogs, was well within the range of these latter. The combination of shortened tooth row, and heavy jaws modified, posteriorly as described is the best evidence that the animal in question was *C. familiaris*, not a small *C. lupus*. Additional characters indicative of domestication are a pathological condition of the margin of the right jaw involving externally the alveolus of the anterior root of P_4 and the posterior of P_3, fig. 1 E.

As with the Jaguar Cave material, these two jaws are important because they belong to a strain of dog which had been domestic for long enough to have lost its wolf-like appearance. Though the dates for the site are around 7,000 BC, domestication had taken place earlier. This is no malnourished, campfollowing wolf, but true dog.

A jaw with very similar proportions collected by Carleton S. Coon in Morocco from a neolithic layer in a site at Mugharet el 'Aliya is additional evidence that these smallish, heavy boned dogs occurred over rather a wide area.

Comparison of these early specimens with the series of recent skulls and jaws from near Haditha, Iraq (Lawrence, 1956: 80—81), identified as a "smaller form which may be *arabs*," shows this later group to be larger animals, with a relatively longer interorbital/brain case region and jaws which are slimmer in proportion to length of tooth row; the heaviest jaw has a P_1 to M_2 alveolar length of 70.2 and a jaw width of 12.1.

Re-examination of this material in the light of considerably more experience with the dog-wolf problem leads the author to believe that they are probably *C. familiaris* with a possibility of some *arabs* hybridization. In the series as a whole, this is suggested by the combination of: the wide range of variation in skull and tooth size, the rather high proportion of skulls lacking teeth either at the anterior or posterior end of the tooth row, and the number of specimens with heavily and sometimes asymmetrically worn teeth. Domestication is further suggested by two skulls which show, in the frontal region, slight damage of a sort that is often seen in more extreme form in skulls of Eskimo dogs. Such damage is probably caused by clubbing the animals across the forehead. One of these two skulls also has the frontshield unusually wide both actually and as compared to width of brain case.

Ancestry of domestic dogs

Evidence, summarized by Degerbøl (1961) and La Baume (1962), that the nearest ancestor of the domestic dog is a small race of *Canis lupus* is very good. In characters that distinguish between jackals, coyotes, and wolves there is a close resemblance between rather unmodified breeds of dog, as well as dingos, and such small races as *C. l. pallipes* (Lawrence, 1956:80—81), and apparently also the Pleistocene form *C. l. variabilis* from China (Pei, 1934:13—18, fig. 1, pls. I, II). Characteristically, northern races of *lupus* are larger than southern and show no overlap in tooth size with dogs. New World wolves all belong to subspecies which are larger than the southern Old World races *pallipes* and *arabs* (if the latter is indeed a wolf and not a hybrid). Because of this, North American dogs cannot have been domesticated from North American wolves. They must have arrived with man and apparently, from the evidence presented here, early in his migration into the continent.

Theories of the origin of domestic dogs have centered around the Near East and Western Europe, largely because, until now, it has been thought that the chronologically oldest specimens have come from these areas. The antiquity of the North American finds, clearly antedating the agricultural revolution, suggests that we should scrutinize more carefully evidence from Turkestan and from southeastern Asia. In the light of all this, the reported dog from Belt Cave (Coon, 1951:44; Reed, 1960:120, 127) on the shores of the Caspian Sea from possibly 9,000 BC takes on additional importance. Unfortunately this material has disappeared and it is not now possible to ascertain what characters were used to identify it as dog not wolf.

Additional evidence of the antiquity of dogs in the Near East is furnished by the small figurines with curly tails found at Jarmo. In the absence of positively identifiable dog remains from this site, Reed (1960: 128) has been reluctant to identify them as definitely C. *familiaris*. With the present discovery that the dogs at Çayönü had skulls which were already strongly modified, it is perfectly reasonable to suppose that the typically curly tail of domestic dogs may also have developed by this time. Such modifications, together with the antiquity of the North American finds, indicate that domestication of the dog probably took place at least as early as 9—10,000 BC.

Summary

Tle antiquity of the North American specimens establishes beyond doubt a proposition that has often been suggested: that dogs were the earliest of man's domestic animals. Whether or not a now extinct form, as *Canis lupus variabilis* of China, or the living *Canis lupus pallipes* of farther west, was the ancestor of domestic dogs, it must have taken considerable time for dogs both to have made their way with man so far south in the Rocky Mountains, and for them to lose so completely their wolf-like characters. While dingos and certain mongrel dogs resemble small wolves in a number of ways, early North American Indian dogs, as described above, show evidence of the differences in kind and degree of variation of different regions of the skull which are one of the most conspicuous features of domestication. The cave in which the specimens were found was apparently a hunting camp and occupied when the climate was somewhat colder than at present. A detailed report on the site is being prepared by Dr. Hind Sadek-Kooros.

The Turkish find is the oldest positively identifiable dog from the Near East. Confirming as it does the identification of the Jarmo figurines, it indicates that a population of dogs closely associated with man was probably well established in the early village-farming communities. The animals in question were not occasional tame small wolves, but true dogs that had already been domesticated for a considerable period of time. The occurrence of only slightly larger dogs at about the same time in England and in Germany is further evidence that domestication must have taken place while man was still in the hunter-gatherer stage.

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Beobachtungen zum Jugendverhalten von Kob-Antilopen

Von Walter Leuthold

Eingang des Ms. 29. 10. 1966

Während einer längeren Freilandstudie[1] im Semliki-Gebiet (Westuganda) über Verhalten und Fortpflanzung des Uganda-Kob *(Adenota kob thomasi;* siehe Buechner, 1961, 1963; Buechner and Schloeth, 1965; Buechner et al. 1966; Leuthold, 1966 a, b) zogen wir (Buechner und Verf.) mehrere Kitze mit der Flasche auf. Dabei beobachteten wir einiges über Verlauf und Stärke der Prägung, wobei hier nicht diskutiert werden soll, ob dieser Terminus im strengen, ursprünglich von Lorenz (1935) gebrauchten Sinne auf die beschriebenen Vorgänge anwendbar ist.

Da wir uns auf andere Aufgaben konzentrierten, beobachteten wir nicht systematisch und führten auch keine Experimente aus. Für einschlägige Literaturangaben verweise ich auf Kurts (1967) eingehende Darstellung der künstlichen Aufzucht und des Mutter-Kind-Verhaltens beim Reh *(Capreolus capreolus)*.

Herrn Prof. Dr. H. K. Buechner, Smithsonian Institution, Washington, danke ich herzlich für die Überlassung des Themas und für mannigfache Unterstützung während der Arbeit im Feld. Den Herren Dr. F. Walther und F. Kurt danke ich für das Durchlesen eines ersten Manuskripts und für zahlreiche Anregungen.

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