

Dental variability in the domestic dog (*Canis familiaris*) Implications for the Variability of Primates

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Abstract

The dentition of a sample of *Canis familiaris*, the domestic dog, has been statistically analyzed using methods that have been employed by other workers to determine variability in other species. The results presented here suggest that the dog sample includes several species. If the domestic dog were extinct and we did not know all that we do about its progressive variation in historical times, we would probably view it as a group of species. Our knowledge about dog dentition may therefore be useful in determining the boundaries of other holobaramins (created kinds).

My results obtained from dog teeth suggest that the extinct Australopithecines and *Homo habilis* (which I have also analyzed here) manifest a variability in the first and second molar that is less than the variability found in dog molars. By these standards, therefore, the Australopithecines and *H. habilis* can be included as part of one and the same holobaramin.

Several *Homo erectus* fossils of diverse origin have likewise been subjected to similar analysis of variability. The *H. erectus* results do not support the division of *H. erectus* fossils into two or more different species but are compatible with the belief that they are all part of one species.

It has been possible here to use the variability in the dentition of a living monobaramin (the domestic dog), to show that the Australopithecines and *H. habilis* should be lumped into one kind and that a *Homo erectus* is in a holobaramin distinct from them. I intend to carry this analysis of dentition further to study the affinities between the extinct *Homo erectus* kind and living *Homo sapiens*. Whether these two groups would appear distinct or united by this method remains to be determined. The degree of variability in domestic dog dentition (a living monobaramin) can thus become an important tool for creationists in assessing the limits of extinct kinds.

Introduction

The process of morphological variation in the wolf (*Canis lupus*) that has led to the more than 400 races in the domestic dog monobaramin can shed light on the limits of variability within the human holobaramin and the boundaries separating it from extinct fossil primates. A study of variability in domestic dog teeth will assist us in knowing where the boundaries of the human holobaramin lie in relation to the fossils of various extinct hominids. In an artificial manner, the races in the domestic dog monobaramin have been separated for aesthetic and economic reasons. The effect of this has been equivalent in many aspects to a natural diversification event (Scott, 1968; Clutton-Brock, 1992).

In this article the dental variability in the dog, *Canis familiaris*, is studied with respect to other species in its holobaramin. The results, although limited, may be used to determine the range of variability in other kinds, living or fossil, but mostly mammals.

Teeth constitute the most abundant mammal fossil remains. Their natural hardness allows them to endure better than bones. This has made teeth items of special importance for the study of variability in fossil and living animals.

The post-canine teeth in the definite dentition are the best ones to study (Gingerich, 1974; Cope, 1993) and they are the ones studied here. The first and second molars are the least variable of all, showing hardly any sexual dimorphism even in species which manifest dimorphism otherwise (Simpson, Roe, and Lewontin, 1960; Gingerich, 1974; Gingerich and Shoening, 1979; Gingerich and Winkler, 1979).

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An analysis of variability in different teeth has been made by means of the coefficient of variation, the range expressed as a percentage of the average, and the index of the minimum and maximum value. The results point to a degree of variation in the domestic dog that is equivalent to, or greater than the variation otherwise found in crossing various near species. If we did not believe that domestic dogs are all in one species, then the amount of dental variability between the different varieties would suggest that they were a group of several distinct species.

When we mix the data from *Australopithecus* and the heterogeneous taxon *Homo habilis*, their dental variability is less than that which we find in domestic dog. The dental variability in the mix of *Australopithecus* and *H. habilis* does not exceed the variability (CV) which is generally considered the maximum for a single mammal species. In the same way, a group of *Homo erectus* from both Asiatic and African regions does not exceed in dental variability the range of the species. The *H. erectus* specimens were all evidently part of one holobaramin. In addition, the *H. habilis* specimens belong in the same species as *Australopithecus* and are not part of the genus *Homo*.

Materials and Methods

The set of dog teeth from which the measurements have been taken belong to the author. Similar dental measurements from other canids have been taken from the published work of Kurtén (1965, 1974) and Martin (1974). Both works provide the maximum and minimum values of different dental parameters, corresponding to the actual measurements of specific animals. From those minimum and maximum values I have constructed the "populations" with which I have compared the population of domestic dogs. The usage of maximum and minimum values involves a deficiency that is translated as a minor statistical distortion.

The data from both authors have not been mixed because possible errors could arise since different methods were used when taking the measurements.

For the dental measurements of the Australopithecines, *Homo habilis* and *Homo erectus*, the data have been taken from Wood (1991). The list of fossils studied is found in Table I, and the number of teeth analyzed for each case appears in the tables.

Whenever possible the measurements have been taken from the right side dental pieces of the canids and primates. Because of the lower variability, the post-canine teeth in the samples have also been analyzed so the possible existence of several species is made clear. The dimensions measured in the dog are chosen for their relevance and ease of handling, and are described in Table II and Figure 1.

Table I. List of primates included in this study.

<i>Australopithecus africanus</i> : MLD 6; SE 1508; Sts 1, 8, 17, 21, 22, 28, 32, 37, 52, 53, 56, 57; Stw/H 128; Taung 1; TM 1511, 1512.
<i>Australopithecus robustus</i> : SK 13, 14, 17, 46, 47, 48, 49, 52, 55, 83, 98, 102, 134, 826, 829, 831, 832, 834, 837, 838, 872, 1590, 1591, 14129; TM 1517, 1602.
<i>Australopithecus boisei</i> : KNM-CH 1; KNM-ER 403, 404, 729, 733, 801, 818, 1171, 1509, 1804, 1816, 1820, 3230, 3737, 3890, 15930; KNM-WT 17400; OMO 47-46; Peninj 1.
<i>Homo habilis</i> : KNM-ER 807, 808, 809, 1502, 1506, 1508, 1801, 1802, 1805, 1813, 1482, 1590, 3734; OH 6, 7, 13, 16, 21, 24, 39, 44; OMO K7-19, L26-1g, L28-31, L894, P933-1, SH1-17, 75s15, 75-14.
<i>Homo erectus</i> : KNM-BK 67; KNM-ER 730, 806, 820, 992, 1507, 1808, 3733; KNM-WT 15000; OH 22; Sangiran 1, 4, 5, 6, 8, 9; Tighenif 1, 2, 3; Trinil 4; ZKD AN 517, AN 518, A1-1, A2-2, A2-54, A3-56, B1-3, B1-63, B1-67, B3-9, B4-75, B4-79, C1-4, C2-62, C3-45, C3-53, D1-28, D1-43, D1-51, D2-50, F1-5, G1-6, G1-7, H4-83, I1-PA87, K1-96, L2-PA99, M3-310, N1-312, O1-PA313, O2-314.

For the analysis of variability we have used the variation coefficient, CV; the range, expressed as a percentage of the average, R%; and the index between the maximum and minimum value, $I^{\max/\min}$. These statistics are used frequently in paleontology with the purpose of determining if there are different species included in a fossil sample (e.g. Gingerich, 1974; Cope and Lacy, 1992; Cope, 1993; Martin and Andrews, 1993; Teaford, Walker, and Mugaisi, 1993; Thomson, 1996).

The CV is frequently used when analyzing measurements of more or less homogeneous morphologic samples of mammal fossils remains. Some have doubted the usefulness of this statistic for assuring that a sample is made of the mix of several species (e.g. Plavcan, 1989; 1993). Even so, with random sampling from a mix of different present day species (Cope and Lacy, 1992), and the combined use of CV, R%, and $I^{\max/\min}$ (Martin and Andrews, 1993), various workers have demonstrated the efficiency of the CV for discriminating between present day species. The criteria that have been used in this study to determine whether the variability in the domestic dog exceeds the variability of the species taxon, are based on the work of Martin and Andrews (1993); Thomson (1996) who uses mixes of species similar to the one being studied as reference; and Simpson, Roe, and Lewontin (1960) who give a value of 10 for the CV as the maximum value of variability belonging to a single species. We will be using this value of 10 later in this paper.

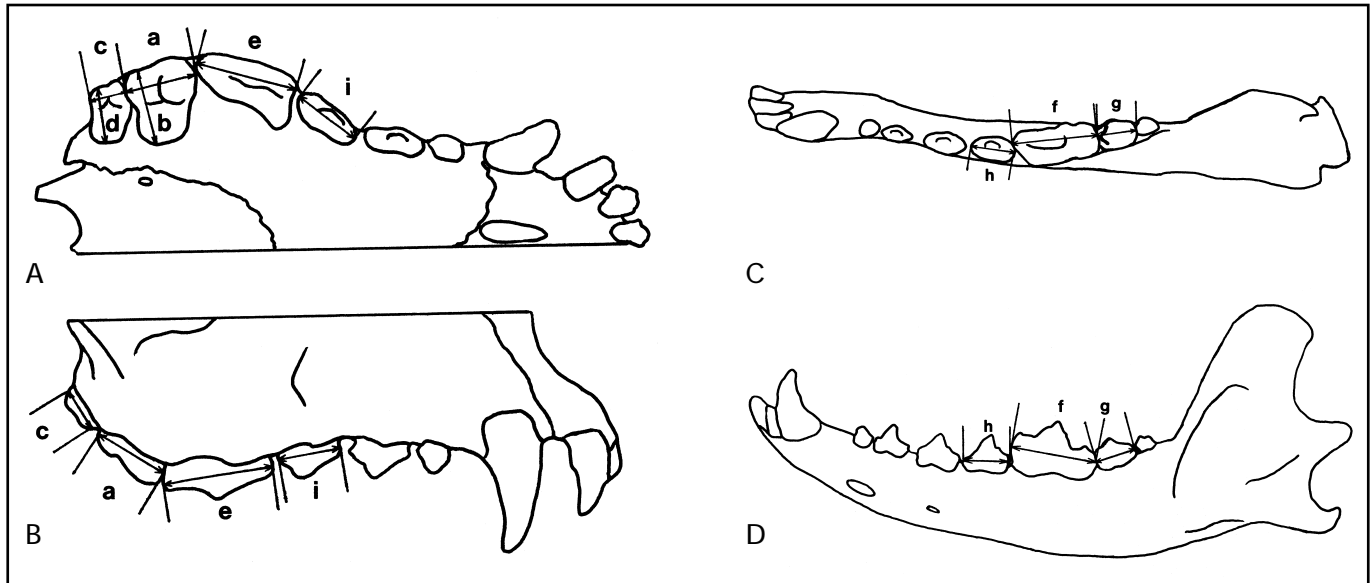


Figure 1. Dental measurements taken. A: Occlusal view in maxilla teeth. B: Buccal view in maxilla teeth. C: Occlusal view in mandible teeth. D: Buccal view in mandible teeth.

Table II. Description of the dental measurements taken from the domestic dog sample.

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- (a) M¹L Mesiodistal crown diameter of superior first molar. Approximately coincide with longitudinal axis metacone to paracone.
 - (b) M¹W Buccolingual crown diameter of superior first molar. Approximately coincide with longitudinal axis metacone to protocone.
 - (c) M²L Mesiodistal crown diameter of superior second molar. Approximately coincide with longitudinal axis metacone to paracone.
 - (d) M²W Buccolingual crown diameter of superior second molar. Approximately coincide with longitudinal axis metacone to the farthest point of the buccal edge.
 - (e) P⁴L Mesiodistal crown diameter. Approximately coincide with longitudinal axis metastyle to parastyle.
 - (f) M₁L Mesiodistal crown diameter.
 - (g) M₂L Mesiodistal crown diameter.
 - (h) P₄L Mesiodistal crown diameter.
 - (i) P³L Mesiodistal crown diameter.
 - (j) P³W Buccolingual crown diameter.
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It is true that the statistics used in this study present different problems. In small samples, the CV can be distorted with respect to the CV of samples actually representative of the species (Sokal and Braumann, 1980). A value of 10 for the CV may not be applicable to every metric trait. In a small sample the variability is underestimated when analyzed through the R%. The R% is even less reliable than the CV (Martin and Andrews, 1993) and the same is true of the I^{max}/min . The use of all the three statistics together, how-

ever, provides an increase in the precision with which we can measure variability (Martin and Andrews, 1993). Despite these problems, from the data obtained in a sample we can recognize the presence of more than one species with more or less certainty. We can never say with absolute certainty that a particular sample is composed of just one species (Martin and Andrews, 1993).

Results

Table III compares the CV of different genera of canids. It is obvious that the domestic dog generously exceeds the dental variability of the species belonging to the genera *Vulpes* (red fox), *Alopex* (arctic fox), or *Lycan* (African wild dog) with which it has been compared. Dog variability also exceeds that found in *Canis aureus* (the golden jackal), *Canis latrans* (the coyote), and *Canis lupus* (the gray wolf), the latter being a progenitor of dogs (Vilà, et al., 1997).

Table IV contains the comparisons between the CV of the dental measurements of dogs and of different mixes of canids. In the mix of *Canis lupus* and *Canis latrans*, the greater variability of the dog is evident (Table IV and Figure 2). In the mix of *Canis lupus* and *Canis aureus*, created from the data of Dyan, Simberloff, Tchernov, and Yom-tov (1992) (as proposed by Gingerich, 1974) for the combination of isolated data for males and females, the CV of M₁L is 14.8 which is similar to the mix of *Canis lupus*, *Canis latrans*, and *Canis aureus*, and similar to domestic dog (Table IV and Figure 3). Another mix of the genus

Table III. Comparison of the coefficient of variation between dental pieces of different canids.

CV	a	b	c	d	e	f	g	h	i	j
Dog	14.0	15.9	15.3	17.2	14.5	14.8	17.7	14.2	16.1	20.7
<i>C. aureus</i>	-	-	-	-	5.5(1)	4.0(2)	-	-	-	-
<i>C. latrans</i>	-	-	-	-	5.0(1)	-	-	-	-	-
<i>C. lupus</i>	5.1(3)	-	-	-	5.5(3)	4.6(2)	-	4.6(2)	-	-
<i>A. lagopus</i>	5.3(4)	4.7(4)	8.3(4)	8.0(4)	4.5(4)	4.9(4)	6.3(4)	4.9(4)	5.3(4)	7.1(4)
<i>L. pictus</i>	3.9(5)	-	-	-	3.4(5)	-	6.7(5)	5.1(5)	-	-
<i>V. vulpes</i>	4.0(6)	4.3(6)	7.2(6)	11.5(6)	3.7(6)	4.2(6)	5.3(6)	4.3(6)	4.9(6)	6.2(6)

(1) Morey, 1992. (2) Dayan et al., 1992. (3) Jolicoeur, 1959. (4) Pengilly, 1984. (5) Girman et al., 1993. (6) Gingerich and Winkler, 1979.

The letters correspond to the teeth measurements given in Table II. The number of analyzed specimens is always greater than 20, starting at the 29 specimens analyzed for P⁴L of *C. aureus* and the 499 of M¹L and P⁴L in *C. lupus*. The only exception is in the case of *Lycaon pictus* where only eleven specimens are analyzed. The exact number can be found in the references.

Table IV. Comparison of coefficient of variation between domestic dog teeth and other different mixes.

CV	a	b	c	d	e	f	g	h	i	j
Dog	14.0(42)	15.9(42)	15.3(35)	17.2(37)	14.5(43)	14.8(37)	17.7(34)	14.2(36)	16.1(29)	20.7(31)
Mix1	12.1(15)	13.4(15)	-	8.4(12)	11.7(16)	13.3(14)	13.3(14)	10.3(14)	6.2(6)	-
Mix2	-	-	-	-	-	14.4(20)	13.9(20)	13.2(20)	-	-
Mix3	12.0(18)	11.2(18)	-	-	12.7(18)	-	-	-	-	-

The letters correspond to the teeth measurements given in Table II. The number of analyzed individuals for each case is in brackets besides the CV. Mix1 is formed by *C. lupus* y *C. latrans* (Kurtén, 1965; 1974). Mix 2 is obtained from *C. lupus*, *C. latrans*, and *C. aureus* (Kurtén, 1965; 1974). Mix3 is formed by *C. ayersi*, *C. milleri*, *C. armbrusteri*, *C. dirus* and *C. lupus* (Martin, 1974).

Canis, that includes five different fossil species was: *Canis dirus*, *Canis ayersi*, *Canis milleri*, *Canis armbrusteri*, and *Canis lupus*, (Martin, 1974), which shows a variability in three dental measurements, less than the CV of the dog (Table IV and Figure 4).

The analysis through the R% and the I^{max}/_{min} presents the greatest variability in the domestic dog with respect to the mix of *Canis lupus* and *Canis latrans* in all the measurements compared, except in the M₁L. The analysis of variability executed through R% and the I^{max}/_{min} exposes the lesser variability in the dog than in the mix of *Canis lupus*, *Canis latrans*, and *Canis aureus* for two measurements (Tables V and VI). The analysis through the R% and the I^{max}/_{min} presents the greater variability in the domestic dog with respect to the mix that includes five species (Tables V and VI).

In the order Primates, the analysis of the mix of species *Australopithecus africanus*, *Australopithecus robustus*, *Australopithecus boisei*, and *Homo*

habilis presents a variability in the dental measurements M¹L, M¹W, M₁L, M₁W, M²L, M²W, M₂L, M₂W lower than that found in the sample of domestic dog, using the CV, R%, or the I^{max}/_{min} (Tables III, V, VI, and VII). Only the CV of M₂L and M₂W are greater than 10. In a pongid (*Pongo pigmaeus*, the orangutan), M²L exceeds the variability of the mix of Australopithecines and *Homo habilis*

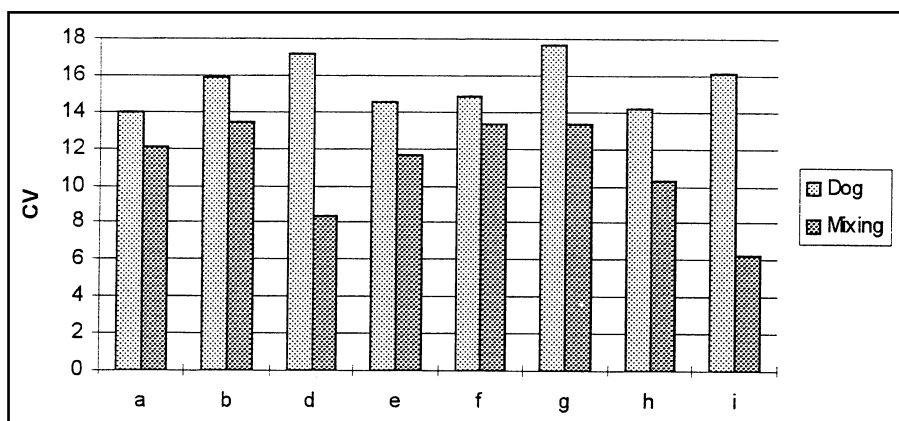


Figure 2. Comparison of the coefficient of variation between dental pieces of domestic dog and mix *C. lupus* and *C. latrans*(Kurtén, 1965; 1974). A: M¹L, b: M¹W, d: M²W, e: P⁴L, f: M₁L, g: M₂L, h: P₄L, i: P³L.

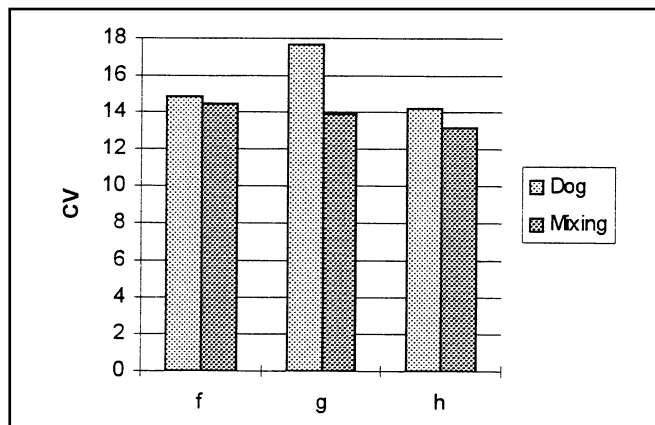


Figure 3. Comparison of the coefficient of variation between dental pieces of domestic dog and mix *C. lupus*, *C. latrans* and *C. aureus* (Kurtén, 1965; 1974). f: M₁L, g: M₂L, h: P₄L.

(Martin and Andrews, 1993). However, the R% and the I^{max}/_{min} are greater in this *Australopithecus* plus *H. habilis* mix with respect to any of the measurements taken in pongids (Martin and Andrews, 1993), and lesser than in dog (Tables V, VI, and VII). If we take a CV of 10 as a point above which a sample represents two or more species, then the CV for *Australopithecus* and *H. habilis* would support these being in the same species (Table VII).

In the case of the mix of *Homo erectus* I have studied, where the variables analyzed are the same as in the mix of *Australopithecines* and *Homo habilis*, a lesser variability in M₂L and M₂W than in *Pongo pygmaeus* is evident (Table VIII, Martin and Andrews, 1993). M₂L presents less variability than in orangutan and gorilla (Table VIII, Martin and Andrews, 1993). The rest of the measurements in *Homo erectus* are greater than the variability of the different pongids (Table VIII, Martin and Andrews, 1993). The CV values here for *H. erectus* specimens are

Table V. Comparison of the range, expressed as a percentage of average between domestic dog teeth and various mix.

R%	a	b	d	e	f	g	h
Dog	58	64	74	56	54	64	52
Mix1	45	48	25	45	57	50	36
Mix2	-	-	-	-	70	59	54
Mix3	51	38	-	49	-	-	-

The letters correspond to the teeth measurements given in Table II. The number of analyzed individuals for each case is in table IV. Mix1 is formed by *C. lupus* and *C. latrans* (Kurtén, 1965; 1974). Mix2 is obtained from *C. lupus*, *C. latrans* and *C. aureus* (Kurtén, 1965; 1974). Mix3 is formed by *C. ayersi*, *C. milleri*, *C. armbrusteri*, *C. dirus* and *C. lupus* (Martin, 1974).

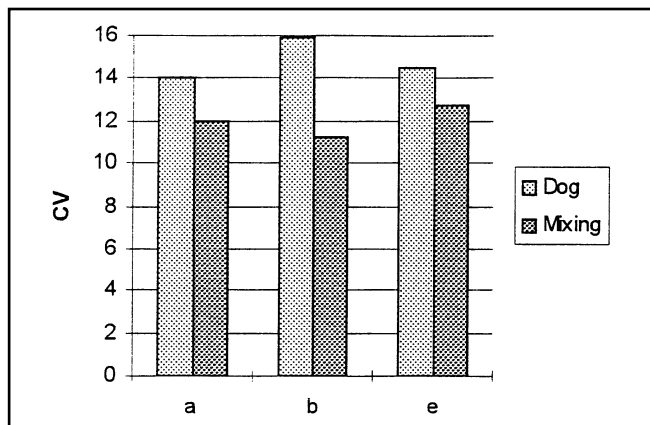


Figure 4. Comparison of the coefficient of variation between dental pieces of domestic dog and mix *C. lupus*, *C. milleri*, *C. dirus*, *C. ayersi* and *C. armbrusteri* (Martin, 1974). a: M¹L, b: M¹W, e: P⁴L.

likewise all below 10, supporting that they are all part of one species.

The CV obtained by Wood (1993) in *Homo erectus* generally exceeded the ones I have obtained, although both are below those that can be compared with the dog (Table III and VIII). In this group of *Homo erectus* the R% and I^{max}/_{min} are lower in M¹W and M²L with respect to *Pan paniscus* (the bonobo), *Gorilla gorilla* (the gorilla), and *Pongo pygmaeus* (the orangutan). In M₂W the *H. erectus* are lower than in *Pan paniscus* and in M¹L they are lower than *Gorilla gorilla*. In M₁W the variability expressed as R% is equivalent in *Homo erectus* and *Pan paniscus*. M₁L as well as M₂L present a greater variability expressed as R% or as I^{max}/_{min} in *Homo erectus* than in any of the pongids (Martin and Andrews, 1993). However, in *H. erectus*, the R% and the I^{max}/_{min} are lesser than in domestic dog (Tables V, VI, and VIII).

Table VI. Comparison of the index between the maximum and minimum value between domestic dog teeth and the various mix.

I ^{max} / _{min}	a	b	d	e	f	g	h
Dog	1.8	1.9	2.1	1.7	1.7	2.0	1.7
Mix1	1.6	1.6	1.3	1.6	1.7	1.6	1.4
Mix2	-	-	-	-	2.0	1.8	1.8
Mix3	1.7	1.5	-	1.7	-	-	-

The letters correspond to the teeth measurements given in Table II. The number of analyzed individuals for each case is in table IV. Mix1 is formed by *C. lupus* and *C. latrans* (Kurtén, 1965; 1974). Mix2 is obtained from *C. lupus*, *C. latrans* and *C. aureus* (Kurtén, 1965; 1974). Mix3 is formed by *C. ayersi*, *C. milleri*, *C. armbrusteri*, *C. dirus* and *C. lupus* (Martin, 1974).

Table VII. CV, R% e $I^{\max}/_{\min}$ of different dental sizes in the mix of Australopithecines and *H. habilis*.

	M ¹ L	M ¹ W	M ² L	M ² W	M ₁ L	M ₁ W	M ₂ L	M ₂ W
CV	6.8(50)	8.8(50)	8.2(38)	9.3(39)	8.3(49)	8.6(48)	10.2(52)	10.7(47)
R%	31	40	39	48	35	40	41	47
$I^{\max}/_{\min}$	1.4	1.5	1.5	1.6	1.4	1.5	1.5	1.6

The numbers between parentheses correspond to the specimens used in this study.

Table VIII. CV, R% e $I^{\max}/_{\min}$ of different dental sizes in a group of *H. erectus*.

	M ¹ L	M ¹ W	M ² L	M ² W	M ₁ L	M ₁ W	M ₂ L	M ₂ W
CV	8.0(10)	6.5(8)	8.9(12)	7.0(12)	7.7(29)	7.2(29)	6.4(24)	6.9(25)
R%	27	16	28	24	39	27	30	28
$I^{\max}/_{\min}$	1.3	1.2	1.3	1.3	1.5	1.3	1.3	1.3

The numbers between parentheses correspond to the specimens used in this study.

Discussion

Despite the difficulties that we find when interpreting the data, (because of the limited samples, which always seems to be the case when studying fossils), dental variability found in the domestic dog corresponds with what would be expected in a more than one species had been combined.

The CV of all the dental measurements that have been compared is greater than 10 in the dog and much less in the rest of canids (see Table III). A CV that is greater than 10, in lineal measurements, is generally considered as an indication of the existence of several species in the sample according to the proposal of Simpson, Roe, and Lewontin (1960). In this research the value of 10 has been used as a reference, even when it may not always be applicable for every measured trait.

The dental variability in the domestic dog is greater with respect a "population" composed of a mixture of data representing different species (Tables IV, V, and VI). The lower variability in the mix of *Canis lupus* and *Canis latrans* in comparison to that of domestic dog may be the result of the similarity in size of both species (Sheldon, 1992), in addition to the limited size of the sample studied. On the other hand, the greater difference in the sizes when *Canis aureus* is added to the mix does not determine a greater variability with respect to domestic dogs (Table IV).

The two statistics used as complementary (R% and the $I^{\max}/_{\min}$), generally, corroborate the degree of variability obtained by the CV. In the case of the mix of the *Canis lupus*, *Canis latrans*, and *Canis aureus*, the R% and the $I^{\max}/_{\min}$ highlights the greater variability of M₁L and P₄L in this mix compared to the domestic dog (Tables V, and VI). From the comparison of the dental variability in the dog and the corresponding variability of the different

mixes of species, it seems that in the domestic dog, dental variability is inside the limits of the genus.

These results support the idea that the Australopithecines and at least a few fossils attributed to *Homo habilis* all belong to the same monobaramin just as has been suggested by some authors (Mehlert, 1992, 1996; Lubenow, 1996; GarcíaPozuelo-Ramos, 1997). A recently found cranium of *Australopithecus boisei* which shares characteristics with *Australopithecus robustus* and *Australopithecus aethiops*, casts doubt upon the need to differentiate these as separate taxa (Suwa, et al. 1996), and supports (at least in part), the idea of mixing the data from *Australopithecus* and *Homo habilis* in this study to produce only one kind.

I have not studied data from *Australopithecus afarensis*, *Australopithecus anamensis*, *Australopithecus bahrelghazali*, or *Ardipithecus ramidus*. Nevertheless, the variability amongst the Australopithecines that I have studied in this research is still substantially less than the variability of the domestic dog (Tables III and VII). On the contrary, the variability expressed among the Australopithecines as R% and $I^{\max}/_{\min}$ is greater than the variability of any pongid (Martin and Andrews, 1993), but less than the corresponding variability we find in the domestic dog (Tables V, VI and VII).

The variability, expressed as CV, in *Homo erectus* is also less than that of the dog (Tables III and VIII) and is comparable to the variability found in the orangutan (Martin and Andrews, 1993). It is greater, however, than the variability of the gorilla and bonobo (Martin and Andrews, 1993). It is true that the geographical diversity of *Homo erectus* included in the analysis is much greater than the diversity of any pongid. On the other hand, in the measurements M¹L, M¹W, M²W, M₂W, the vari-

ability expressed as $R\%$ and $I^{\max}/_{\min}$ for *Homo erectus* is less than that of the great apes, (with only M_1L and M_2L presenting greater variability in *Homo erectus* - Martin and Andrews, 1993).

Kramer (1993) has also found that the variability of certain cranial measurements of *Homo erectus* is smaller than what is considered the limit of the species, being close to that found in modern man. Hence, the studied dental variability seems to accentuate the idea that *Homo erectus* does not need to be subdivided into several species as several authors believe (Jacob, 1976; Alexeev, 1986; Rightmire, 1990; Wood, 1992) but that it represents one coherent group.

A famous fossil, KNM-ER 1470, has not been included in the study as Australopithecine, *Homo habilis*, or *Homo erectus* because of the difficulty in assigning it with precision to any of these taxa. There is no agreement between evolutionist researchers concerning the status of 1470 (Brace and Montagu, 1977; Coon, 1984; Bromage, 1992), or between the creationist researchers (Hummer, 1977; Lubenow, 1992; Mehlert, 1994). We should not be surprised by the existence of remains that we cannot easily attribute to humans or pongids. Between the chimpanzee and man there is a likeness of 99% for their polypeptide sequences (King and Wilson, 1975, Bruce and Ayala, 1979). The chromosomal likeness between any of the pongids and man is also substantial (Yunis and Prakash, 1982). Hence, there can be a morphologic likeness between an extinct pongid and man. Moreover, if the fossil remains are scarce, or reconstructions are made from remains that are too fragmented and incomplete, the likeness will be exaggerated. Lubenow (1992) had already pointed out the possibility that the taxon *Homo habilis* could include Australopithecines as well as humans. Bowden (1984) has noted the possible mistakes of reconstruction in different taxa.

In any case, the metric dental variability is not enough to determine the holobaramins. It is necessary, therefore to perform a more in depth study of different traits, especially in the cranium. Studies must include not only the continuous metric traits that are measurable in a continuous sequence, but also those traits that are difficult to measure and that can only be described, or that must be scored as "present" or "absent".

The variability inside one holobaramin should be greater than the variability evident in the domestic dog. We have to keep in mind that possibly that all current canids may belong to only a single holobaramin (Crompton, 1993). Moreover, we have added fossils to the list of present day canids. This raises the question of whether the present variability is equivalent to the variability in the past. Some evolutionist researchers have challenged uniformitarianism and consider that there could have been different variability in some fossil spe-

cies (Kelley and Xu, 1991; Kelley, 1993). In the species of modern mammals it seems there is a constancy with respect to the variability of certain physical traits; this is the case in the dimensions of the first molar. This same constancy could have existed in prehistoric species, but I think that the limits of variability may have been different in the fossils. The variability we are interested in is the intrabaraminic, and in this variability we must include fossil species that have no current species equivalent.

From an evolutionary point of view, there are difficulties in delimiting any taxa when including fossil and living organisms. It is an evolutionary principle that life is a continuum from primeval beings to all current beings. Variability from a creationist perspective is different, since living beings are grouped in compartments or holobaramins that are discontinuous from each other. To delimit the holobaramins, the variation in the present and in the past have to be determined, and one must find the total variability. We know that prediluvian men and those that survived the flood, enjoyed a greater longevity than is true now. Other living animals may have also experienced greater longevity before the flood. This could have determined an ontogeny different in many cases from current living beings. Such longevity could have produced morphologic variations, as could have also happened with the different prehistoric human shapes, and sizes (*Homo erectus*, and *Homo sapiens neandertalensis*) (Beasley, 1992, 1995; Cuzzo, 1994). The gigantism in certain dinosaurs, as well as the huge size of the pongid *Gigantopithecus* and of *Carcharodon megalodon* in sharks (Froede, 1995) could be examples of what would have been an inordinate growth perhaps caused by greater longevity. However, the relationship between life span and species variability is uncertain and deserves further investigation.

I think we can delimit the different holobaramins with reasonable precision. The application of the baraminologic criteria of ReMine-Wise (ReMine, 1990; Wise, 1990, 1992) seems to be the most accurate methodology to establish a taxonomy in accordance with reality, especially through the use of hybridization criteria (Marsh, 1976; Scherer, 1993; García-Pozuelo-Ramos, 1997). The knowledge of possible hybridizations between species can allow us to calibrate other baraminologic criteria (García-Pozuelo-Ramos, 1997), including the morphologic criteria. But hybridization criteria are applicable only to present day species, not to fossils, and therefore these hybridization criteria have to be complemented by other criteria. Those criteria which refer to transitional forms in the fossil record and to traits that are shared by two or more taxa but are not primitive (Wise, 1992), are the criteria that can be of greatest help.

Conclusion

The study of the dental metric variability in a sample of domestic dog (*Canis familiaris*) makes it clear that: (1) the dental metric variability in the domestic dog corresponds with the variability we would expect in a combination of more than one species of wild dogs, (2) the dental metric variability of the first and second molars in Australopithecines suggests that these specimens should be grouped into a single monobaramin, (3) the dental metric variability of the first and second molars in a mixture of Australopithecines and the heterogeneous taxon *Homo habilis* suggests that they should all be grouped into a single monobaramin (even so, it is almost certain that some of the remains that have been attributed to *Homo habilis* really belong to *Homo erectus* or even to *Homo sapiens* - Lubenow, 1992), and (4) the dental metric variability of the first and second *Homo erectus* molars of different origins confirms the interpretation that they all belong to a single species. The problem of whether or not *H. erectus* and *H. sapiens* belong in one and the same species deserves further work using these same dental criteria.

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Book Reviews

***The Origins Solution—An Answer to the Creation Evolution Debate* by Dick Fischer**
Fairway Press, Lima, OH. 1996. 382 pages. \$20
Reviewed by Don B. DeYoung

Author Dick Fischer is retired from a distinguished military career. He holds degrees in both science and theology. The book title promises final answers to the origins question. The reader may evaluate the following barrage of statements from Fischer.

Once upon a time two sets of apes had strange looking offspring (Adam and Eve's evolutionary parents) who took a liking to each other (p. 27). Fischer calls his particular theistic evolution view *creaolution* (p. 370). He declares that young-earth creationists ignore the evidence

for billions of years (p. 25) and their Scripture interpretation is tortured (p. 18). Fischer calls creationists radical right, utter nincompoops (p. 43). Sticks and stones! Interpreting the creation days as 24-hour time periods somehow violates God's Word (p. 162). The Genesis Flood occurred only in the Mesopotamian valley (p. 284). Someone should have told Noah about this! Categorize this book under the key words *day age* and *confusion*. No index is provided.

***There's a Hair in my Dirt* by Gary Larson**
Harper Collins Publishers, New York. 1998. 63 pages. \$16.00
Reviewed by Don B. DeYoung

This is a disappointing book for Gary Larson fans. His Farside comics have brought smiles to many of us. In retirement Larson now has written this illustrated children's novel. The Foreword by Harvard evolutionist Edward O. Wilson raises immediate questions. Wilson claims that all creatures including mankind live totally by mutual exploitation. As one example he says that we have made slaves of cows and dogs (shame!). Apparently Wilson is unfamiliar with altruism, veterinary science, and animal protection legislation.

Larson's story is about competition in nature as seen by a family of worms. With his zoology interest, the author teaches some basic biology. Several politically incorrect animals are vilified. These include aggressive Gray squirrels, Amazon ants, "winged-assassin" dragonflies, and Golden eagles which toss weaker siblings from their nest. The point seems to be that predators and victims are connected in an endless circle of life and death. The worm family, of course, recycles everything that hits the ground.

There are several people in the story, all uncaring of nature. Lumberjack Bob has little education and cuts down old growth trees. He dies beneath a fallen timber. Then a fisherman is eaten by bears. A lady named Harriet steps on insects and kills a snake. She then gets a viral infection from a rodent and dies. Larson attempts to incorporate humor throughout but some topics are just not funny. The final page shows Harriet's skeleton slowly sinking into the earth. Her hair gets into the worm's food, hence the book title. And this is a children's story.

This book is not like Larson's earlier comics. The evolutionary themes are clear: death is good and humans are dumber than animals. Any innocent enjoyment of the Creation is questioned. Flowers are said to have color to bring about a maniacal, sexual, reproductive battlefield (p. 17). Bird song is not an expression of joy but "an array of insults, warnings, and come-ons" (p. 23).

Your original humor is missed, Gary Larson. But surely you can do better than this effort to impress evolutionary biologists.