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Ancient Pompeian Dogs – Morphological and Morphometric Evidence for Different Canine Populations

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Summary

This article examines the morphological features of the dog during the Roman Age on the basis of osseous and dental remains dug up in Pompeii. The material, consisting of 113 canine bones and teeth, was subjected to both morphological and morphometrical analyses and was compared with modern canine breeds. In most cases, the age at death, shoulder height and other phenotypic features were ascertained. The examined Pompeian canine population fell mainly into two categories: small- and large-sized animals. Among the former, one brachycephalic and two dolichocephalic subjects were included. Such morphological features agree with what is described in numerous texts and appears in mosaics, bas-reliefs and frescoes of the Roman Age. As small-sized dogs cannot be classified as *Canes Venatici* (sporting dogs), *Canes Villatici* (watch dogs) and *Canes Pastorales* (shepherd dogs) according to Columella's *De re rustica*, these animals may be considered as lapdogs.

Introduction

The evolutionary history of the dog is closely linked to that of man. At present, over 400 canine breeds are recognized as the result of an artificial selection starting from a taxonomically similar wild ancestor.

Ethological studies, anatomical evidences and biomolecular investigations on mt-DNA revealed that the wolf, *Canis lupus* L. 1758, probably represents the main ancestor of dogs (Olsen and Olsen, 1977; Olsen, 1985; Masseti, 2002). Recently, there has also been proof of another wild ancestor, the golden jackal, *Canis aureus* L. 1758 (Zeuner, 1963; Macintosh, 1975; Koler-Matznick, 2002).

Investigators believe that the relationship between wolf and man might have been established around 40 000 yr BP – long before the biological and cultural traits of modern man were in place (Clutton-Brock, 1981). Competition for food between wolves and primitive hunters probably gave rise to a kind of co-operation between these two species (Zeuner, 1963; Clutton-Brock, 1984; Davis, 1987). The adoption of wolf cubs and the exploitation of adult wolves for hunting might have been an important stage in the introduction of these animals into human society. The early stages of domestication of the wolf brought about osteometric modifications of the skull such as a larger and stocky snout and mandibular shortening with consequent thronging of teeth (Azzaroli, 1984). Further important phenotypical changes regarding coat, ears and tail appeared about 10 000–15 000 yr BP, a period characterized by the settlement of prehistoric communities (Thurston, 1996; Vilà et al., 1997). Indeed, the cultural and social evolution of these communities gave rise to new selection criteria that constituted the basis for the fixing of canine phenotypical features (Hemmer, 1990; Helmer, 1992; Morey, 1992).

In the literature, biometrical data are reported from remains of primitive dogs found in 'Natufian' villages (Israel), dating back to 9000–12 000 yr BP (Davis and Valla, 1978; Davis, 1987) and other Middle-Eastern sites (Turnbull and Reed, 1974; Nobis, 1979; Lawrence and Reed, 1983; Thurston, 1996). These findings support the idea that morphological changes are due to both primitive selection and evolutionary adaptations to the human environment (Federoff and Nowak, 1997). Those modifications would have been linked to a progressive change of diet, given that the animals could feed on diversified and often abundant food such as leftovers (Masseti, 2002).

In the Neolithic Age, a canine breed, *Canis familiaris palustris*, has been documented, whose skeleton was dug up in 1854 when a Swiss lake receded (Rütimeyer, 1861). That dog used to live in lake-dwellings and then spread across the whole European continent. Other morphological types similar to wild canids shared the human environment in Neolithic Europe. Canine genomic stabilization had not yet occurred and dogs and wolves were not clearly distinguishable (Clutton-Brock, 1981). New and significant changes in morphology went on throughout the Bronze Age, leading to the ancestors of the present watch, shepherd and sporting breeds. Moreover, a large number of artistic representations from Ancient Egypt and the Mesopotamian area, such as statues and bas reliefs, clearly testify that greyhounds, Molossian hounds and small-sized dogs were well known and raised (Cesarino, 1975). In the Historical Age, new canine breeds appeared. The Greeks used to breed various sporting dogs as documented by Xenophon's *Cynegeticus*. However, it is commonly accepted that the Romans were the first in Europe to develop modern forms of selection. They bred several dog types showing their own morphological and functional features (Clutton-Brock, 1981; Masseti, 2002). According to Columella's *De re rustica* (1st Century AD) and Vergil's *Georgics* (1st Century AD), the Romans used to classify dogs into three types: *Canes Villatici*, *Canes Pastorales* and *Canes Venatici*.

Canes Villatici stand for modern watch dogs. This type had a stocky body, large chest, big head, big eyes, dropping ears and were mostly black. *Canes Pastorales* were shepherd dogs. They generally wore a typical collar and were strong, white

and aggressive. Finally, *Canes Venatici* were sporting dogs and were fast and supple like their current descendants. Strabo, Plinius S. (1st century AD) and Polienus (2nd century AD) wrote about the frightening *Canes Pugnaces*, that were war dogs, whose morphological characteristics might be related to those of present-day Molossian hounds. In addition, a lot of Roman mosaics, frescoes, bas reliefs and statues with a great deal of realistic details further testify the presence and diffusion of that type of dog (Giordano and Pelagalli, 1957).

The material found in Pompeii described in the present investigation provides the opportunity to study canine features on the basis of their biological remains. A comparison is attempted between Pompeian dogs and current canine breeds. Our results may offer new anthropozoological data in order to clarify the relationship between men and dogs in ancient Roman society.

Materials and Methods

Excavations

The material was brought to light during the archaeological excavations of Pompeii in the Bourbon Period (18–19th centuries). Excavations were carried out without any scientific approach as they were directed almost exclusively to the recovery of artistic and precious objects such as jewels, vases, coins, etc. Most materials like working and domestic tools, furniture, human and animal bones, as well as other biological remains were frequently discarded. Animal bones and teeth, examined in the present study, were stored in the thermal buildings of Sarnus, Pompeii.

Materials

The material consists of 113 remains. They were found, together with Roman coins and vessels, in the ruins of many private houses, public buildings and shops of Pompeii. The unit stratigrapy was formed by eruptive materials of the Vesuvius in 79 AD, and hence our materials surely belong to that time. Furthermore, all the specimens were adequately listed and classified as Roman remains in the 18th century. Unfortunately, other data about excavations, recovery and preservation methods are not available. The remains belonged to 10 different subjects. This number was calculated following the usual zooarchaeological procedures (Chaix and Méniel, 1996). Subjects are indicated by the letters A–J (Table 1), and the bones are named following the *Nomina Anatomica Veterinaria* (Schaller, 1992). Most bones and teeth, about 85%, were intact. Their good preservation state made it possible to reconstruct their original anatomical connections even in short and flat bones where articular processes were often defective. Bone surfaces were intact in subjects A, D, E, F, H, I and J; they were worn out in B, rough and encrusted with calcareous sediments in C, and with arthrosic lesions in G.

Morphological analysis

Morphological and metrical analyses were focused on skulls, mandibulae, teeth, and long, short and flat bones. The parameters of bones and teeth are indicated according to von den Driesch (1976), with few modifications. All measurements were carried out with an ordinary digital sliding calliper.

Table 1. Material sorted according to subjects A–J

	A	B	C	D	E	F	G	H	I	J	Total
Cranium										1	1
Maxilla	2		2								4
Mandibula	1	1	1					1			4
Axis				1	1	1					3
Vertebrae	1			13	13	18	2				47
Os sacrum	1				1	1					3
Costae	1			7		5					13
Scapula	1			2	2				1		6
Humerus	2			2	2				1		7
Radius	1			2	2						5
Ulna	2			1	2						5
Coxa	2				1				2		5
Femur	2			1					1		4
Tibia	2										2
Fibula	1										1
Talus	1										1
Calcaneus	1				1						2
Total	21	1	3	29	25	25	2	1	5	1	**113**

Determination of the age at death

The determination of the age at death was achieved according to the common standards (Barone, 1995). This approach takes into account the eruption and wear of teeth, as well as the ossification of metaphyses in long bones (Table 2).

Determination of shoulder height

Multiplication factors for estimating shoulder height from long bones were devised by Koudelka (1885). By this system, the greatest length of the humerus was multiplied by 3.37, the femur by 3.01, and the tibia by 2.92. Shoulder heights are expressed in millimetres (Table 2).

Logarithmic differences

Logarithmic size index was calculated following validated protocols (Simpson, 1941; Simpson et al., 1960; Meadow, 1999). The morphometric data obtained from the mandibulae of subjects A, B and H were compared with those from present-day canine breeds with different morphological features: large-sized dolichocephalic (German Great Dane), middle-sized dolichocephalic (Irish Setter), small-sized anacholimorphic (Dachshund) and middle-sized brachycephalic (Bulldog). In addition, logarithmic differences were calculated from a mandibula of a German Shepherd, taken as the standard of

Table 2. Summary of the results

Subject	Shoulder height (average)	Age at death	Morphologic features
A	287	12–24 months	Small-sized dolichocephalic
B	n.d.	Adult	Middle-sized
C	n.d.	Subadult	n.d.
D	592	>15 months	Large-sized
E	634	>24 months	Large-sized
F	n.d.	>24 months	n.d.
G	n.d.	>24 months	n.d.
H	n.d.	n.d.	Dolichocephalic
I	344	>24 months	Small-sized
J	n.d.	n.d.	Small-sized brachycephalic

n.d., not determined.

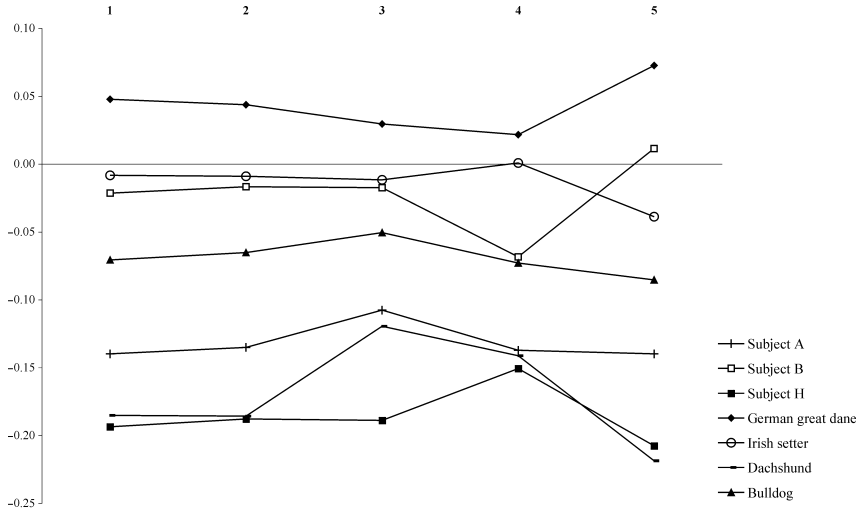

Fig. 1. Logarithmic differences of subjects A, B and H from a mandibula of a German Shepherd taken as a standard of comparison. 1 = total length; 2 = length from the angular process to the alveoli incisivi; 3 = length of the molar row; 4 = length of the premolar row; 5 = height of the mandibula behind M_1.

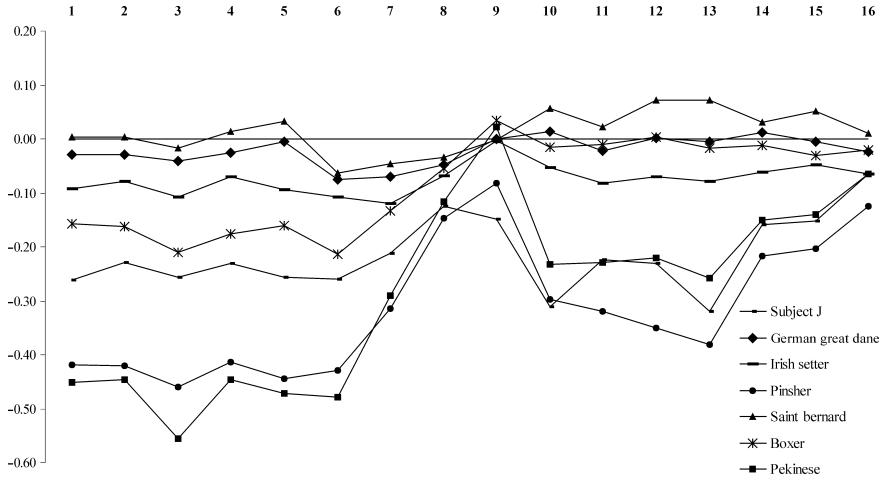

Fig. 2. Logarithmic differences of subject J from a whole skull of a wolf taken as a standard of comparison. 1 = total length; 2 = length from occipital condyles; 3 = length from foramen magnum; 4 = palatal length; 5 = length of the horizontal part of the palatine; 6 = length of cheek tooth row; 7 = greatest diameter of the auditory bulla; 8 = greatest neurocranium breadth; 9 = least breadth; 10 = least breadth between the orbits; 11 = greatest palatal breadth; 12 = least palatal breadth; 13 = breadth at the canine alveoli; 14 = greatest inner height of the orbit; 15 = total skull height; 16 = skull height without the sagittal crest.

comparison (Fig. 1). Similarly, the morphometric data from the skull of subject J were compared with those from the following present-day breeds: large-sized dolichocephalic (German Great Dane), middle-sized dolichocephalic (Irish Setter), small-sized dolichocephalic (Pinsher), large-sized brachycephalic (Saint Bernard), middle-sized brachycephalic (Boxer) and small-sized brachycephalic (Pekinese). Logarithmic differences were determined from a whole skull of a wolf, chosen as the standard of comparison (Fig. 2). Data of modern canine breeds and the wolf are according to Wagner (1939). In Figs 1 and 2, the logarithmic differences are reported only when they could be compared with modern breeds (Wagner, 1939).

Results

Subject A

The mandibula manifests many analogies with that of the Dachshund (Fig. 1). The length of the molar row (3) and premolar row (4) are almost overlapping. In contrast, the total length of the mandibula (1), the length of the mandibula measured from the angular process to the alveoli incisivi (2) and the height of the mandibula behind M_1 (5) were higher than those in the Dachshund. The mandibula is rather longer and higher than that of the Dachshund, but molar and premolar dental rows are proportionally less developed. These data suggest the thronging of lower teeth. In accordance with its development, this mandibula is presumed to belong to a dolichocephalic dog. From the eruption of permanent teeth, their modest wear, the integrity of premolar and molar teeth (Fig. 3), as well as the ossification of long-bone metaphyses, it can be established that the age at death was between 12 and 24 months. In accordance with the morphometrical features of the mandibula, this dog was probably small-sized, with a shoulder height of 268–306 mm.

Subject B

The logarithmic differences evaluated from the mandibula prove that this dog was morphometrically similar to the Irish

Fig. 3. Subject A, mandibula, lateral view. The slight wear of permanent teeth indicates that the animal died when subadult.

Setter, a dolichocephalic and mesomorphic dog. These common features are: total length of the mandibula (1), length of the mandibula measured from the angular process to the alveoli incisive (2) and length of the molar row (3). On the other hand, the length of the premolar row (4) was characteristic of a brachycephalic and brachymorphic dog, like the Bulldog. The logarithmic difference of the height of the mandibula behind M_1 (5) was characteristic of a mesocephalic and mesomorphic breed, like the German Shepherd. These data cannot be interpreted univocally. In fact, the present study shows that the mandibula of this dog shares morphometrical features of dolichocephalic, brachycephalic and mesocephalic breeds. The mandibula was rather long when compared with the shortness of the molar row. It can be argued that these features are linked to the process of selection, although they can also be correlated to a canine interindividual and interracial variability. According to its height, the mandibula probably belonged to a middle-sized dog.

Subject C

The slight wear of all the lower and upper permanent teeth indicates that this dog died when it was a subadult.

Subject D

The shoulder height was between 576 and 608 mm. According to this datum, subject D was large-sized. The complete ossification of the femur and humerus shows that this dog was over 15 months.

Subject E

The shoulder height was 634 mm showing that this animal was large-sized. The complete ossification of the humerus, radius, ulna, vertebrae and coxa indicates that this dog was over 24 months.

Subject F

As a result of the ossification of the cervical, thoracic, lumbar and sacral vertebrae it can be affirmed that this subject was over 24 months.

Subject G

On the basis of the ossification of the two lumbar vertebrae, this dog was presumed to be over 24 months or probably older

Fig. 4. Subject G, vertebra lumbalis, cranial view. Osteophytosis on the corpus vertebrale.

on account of the degenerative lesions on the bone surface. Moreover, the corpus vertebrale of both vertebrae is affected by arthrosis. Osteophytosis extends from the caput to the tuberculum ventrale. Bone surfaces are rough and irregular (Fig. 4).

Subject H

The logarithmic differences evaluated from the mandibula indicate that this subject was similar to the Dachshund. In particular, total length of the mandibula (1), length of the mandibula measured from the angular process to the alveoli incisive (2), length of the premolar row (4), height of the mandibula behind M_1 (5) are on the whole equivalent. However, the length of the molar row (3) is shorter. Furthermore, the thronging of lower molar teeth and reduced carnassial dimensions are the result of the selection carried out by humans.

Subject I

The shoulder height was 337–352 mm, in accordance with the data gathered from femur and humerus, so this dog was small-sized. On the basis of the ossification of long bones, the age was over 24 months.

Subject J

The logarithmic differences of the following osteometrical parameters from the skull are similar to those of the Boxer: total length (1), length from the occipital condyles (2), length from foramen magnum (3), palatal length (4), length of the horizontal part of the palatine (5), length of cheek tooth row (6), greatest neurocranium breadth (8), least breadth of the skull (9), skull height without the sagittal crest (16). Moreover, these logarithmic values are quite similar to those of the Pekinese. Thus, we can say that subject J shows the typical brachycephalic traits. In particular, the greatest neurocranium breadth (8), greatest palatal breadth (11), least palatal breadth (12), greatest inner height of the orbit (14), total skull height (15) and skull height without the sagittal crest (16) are completely corresponding. The greatest neurocranium breadth (8), greatest palatal breadth (11), least breadth between the orbits (10) are fairly similar to those of a dolichocephalic breed, such as the Pinsher. The values of the greatest diameter of the auditory bulla (7) and the breadth at the canine alveoli (13) are not univocal. Indeed, they are on the one hand among those belonging to the Pekinese and Boxer, and on the other among those of the Pekinese and Pinsher. On the whole, the skull of subject J probably belonged to a brachycephalic animal. Finally, on account of the skull size it can also be asserted that this dog was small-sized (Fig. 5).

Fig. 5. Subject J, skull, dorsal view. Length and breadth are suggestive of a brachycephalic animal.

Discussion

The early process of domestication of the dog has favoured its adaptability to different human environments. Thus, both in the past and nowadays, the dog represents the most integrated domestic animal. Our investigation provides information which may contribute to the knowledge of canine characteristics in Pompeii which is an ideal model in the study of the Roman world. A summary of the present results is shown in Table 2. Although the data obtained are often fragmentary, it can be asserted that two different morphological categories of dogs were present in Pompeii: small- and large-sized dogs.

Small-sized dogs seem to be prevalent. Indeed, three small-sized animals out of 10 have been definitely identified during our examination, and their shoulder height, measured in two cases, was 287 and 344 mm. Furthermore, on the basis of the skull features, it can be concluded that the group of small-sized animals included one brachycephalic and two dolichocephalic dogs. In contrast, in two large-sized dogs examined the shoulder height was 592 and 634 mm, respectively.

The present results are in concordance with a number of ancient sources, including several Latin texts and artistic representations, illustrating the features of dogs in the Roman Age. On the basis of these data, it can be asserted that dogs living in Pompeii had well-defined morphological characteristics. This confirms what is already known about the use in the Roman Age of modern methods of selection, directed at attaining, codified breeds with their own morphometrical and behavioural standards. The two large-sized dogs described above look like the *Canes Villatici* or *Canes Pastorales* cited by Columella in his *De re rustica*. These dogs belonged to the Molossian type and were probably employed as watch or shepherd dogs. This is supported by numerous artistic representations where similar animals are depicted, for example, the mosaics found in the houses of *Paquius Proculus*, *Cecilius Iocundus*, *Vesonius* and *Casellius Marcellus* in Pompeii.

As regards the small-sized dogs, it is quite difficult to classify them in the widely accepted Columella's categories. Indeed, these dogs cannot be included either in the category of watch dogs or in that of shepherd dogs, because they are too small. One could include them in the category of *Canes Venatici*, that is sporting dogs even though Columella never mentioned small-sized dogs among them. However, it is likely that they were pets which used to live together with men at home and were part of their owner's everyday life, as occurs today.

The literature reports a single study regarding Pompeian dogs (Giordano and Pelagalli, 1957). These authors describe one complete skeleton showing typical dolicomorphic features, so that it could be related to subjects A and H. Moreover, a wide variety of morphological types is documented in different coeval Roman settlements in Britain (Harcourt, 1974) and Italy (De Grossi Mazzorin and Minniti, 2000).

Conclusion

Our zooarchaeological investigation strengthens the hypothesis that the several canine breeds living in Pompeii were the result of a certain degree of selection and this may mean that the dog had, as it still has nowadays, a social role that can be undoubtedly defined central.

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References

Azzaroli, A., 1984: L'inizio dell'addomesticamento dei grandi mammiferi. Contributi del Centro Linceo interdisciplinare di Scienze Matematiche e loro applicazioni **68,** 29–93.

Barone, R., 1995: Anatomie comparée des Mammifères domestiques, Tome 1 (Ostéologie). Paris: Vigot Frères.

Cesarino, F., 1975: Il Molosso. Viaggio intorno al Mastino Napoletano. Napoli: Casa editrice Faustino Fiorentino.

Chaix, L. and P. Méniel, 1996: Eléments d'archéozoologie. Paris: Editons Errance.

Clutton-Brock, J., 1981: Domesticated Animals from Early Times. London: British Museum (Natural History)/Heinemann.

Clutton-Brock, J., 1984: Dog. In: Evolution and Domesticated Animals 1984 (I. Mason ed.). London: Longman, pp. 198–210.

Davis, S. J. M., 1987: The Archaeology of Animals. London: B. T. Batsford.

Davis, S. J. M., and F. R. Valla, 1978: Evidence for domestication of the dog 12 000 years ago in the Natufian of Israel. Nature **276,** 608–610.

De Grossi Mazzorin, J., and C. Minniti, 2000: Le sepolture di cani della necropoli di età Imperiale di Fidene-via Radicofani, Roma: alcune considerazioni sul loro seppellimento nell'antichità. Atti 2° Conv. Naz. Archeozool., 387–398.

von den Driesch, A., 1976: A guide to the measurement of animal bones from archaeological sites. Peabody Museum Bulletin, Harvard University, **1,** 1–137.

Federoff, N. E., and R. M. Nowak, 1997: Man and his dog. Science **278,** 205–209.

Giordano, C., and G. V. Pelagalli, 1957: Cani e canili nell'antica Pompei. Atti dell'Accademia Pontaniana, **8,** 180–190.

Harcourt, R. A., 1974: The dog in prehistoric and early historic Britain. J. Archeol. Sci. **1,** 151–175.

Helmer, D., 1992: La domestication des animaux par les hommes préhistoriques. Paris: Masson.

Hemmer, H., 1990: Domestication. The Decline of Environmental Appreciation. Cambridge: Cambridge University Press.

Koler-Matznick, J., 2002: The origin of the dog revisited. Anthrozoös **15,** 99–117.

Koudelka, F., 1885: Das Verhältnis der Ossa Longa zur Skeletthöhe bei den Säugetieren. Verhandlung der Naturforschung Ver. Brünn **24,** 127–153.

Lawrence, B. and C.A. Reed, 1983: The Dogs of Jarmo. In: Prehistoric Archaeology along the Zagros Flanks 1983. (L.S. Braidwood, R.J. Braidwood, B. Howe, C.A. Reed and P.J. Watson eds). Chicago, IL: The Oriental Institute of the University of Chicago, pp. 485–494.

Macintosh, N. W. G., 1975: The origin of the dingo: an enigma. In: The Wild Canids: their Systematics, Behavioral Ecology and Evolution 1975 (M. W. Fox ed.). New York: Van Nostrand-Reinhold Co.

Masseti, M., 2002: Uomini e (non solo) topi. Gli animali domestici e la fauna antropocora. Firenze: Firenze University Press.

Meadow, R. H., 1999: The use of size index scaling techniques for research on archaeozoological collections from the Middle East. In: Historia animalium ex ossibus 1999 (C. Becker, H. Manhart, J. Peters, J. Schibler eds). Rahden/Westf: Verlag Marie Leidorf GmbH.

Morey, D. F., 1992: Size, shape and development in the evolution of the domestic dog. J. Archaeol. Sci. **19,** 181–204.

Nobis, G., 1979: Der älteste Haushund lebte vor 14000 Jahren. Umschau **79,** 610.

Olsen, S. J., 1985: Origins of the domestic dog: the fossil record. Tucson, AR: University of Arizona Press.

Olsen, S. J. and J. W. Olsen, 1977: The Chinese wolf, ancestor of New World dogs. Science **197,** 533–535.

Rütimeyer, L., 1861: Die Fauna der Pfahlbauten in der Schweiz–Untersuchungen über die wilden und der Haus-Säugethiere von Mittel-Europa. Basel: Bahnmaier.

Schaller, O., 1992: Illustrated Veterinary Anatomical Nomenclature. Stuttgart: Henke F. Verlag.

Simpson, G. G., 1941: Large Pleistocene felines of North America. American Museum Novitates **1136,** 1–26.

Simpson, G. G., A. Roe and R. C. Lewontin, 1960: Quantitative Zoology. New York: Harcourt, Brace and World.

Thurston, M. E., 1996: The Lost History of Canine Race. Our 15,000-year Love Affair with Dogs. Kansas City, KS: Andrews & McMeel.

Turnbull, P. F. and C. A. Reed, 1974: The fauna of the terminal Pleistocene of Palegawra Cave, a Zerzan occupation site in Northeastern Iraq. Fieldiana, Anthropol., **63,** 81–146.

Vilà, C., P. Savolainen, J. E. Malonaldo, I. R. Amorim, J. E. Rice, R. I. Honeycutt, K. A. Crandall, J. Lundeberg and R. K. Wayne, 1997: Multiple and ancient origins of the domestic dog. Science **276,** 1687–1689.

Wagner, K., 1939: Rezente Hunderassen. Eine osteologische Untersuchung. Skriften utgitt av Det Norske Videnskaps-Akademi i Oslo, I. Mat.-Naturv. Kl., **9,** 1–157.

Zeuner, F. E., 1963: A History of Domesticated Animals. London: Hutchinson.