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The Application of Discriminant Function Analysis to Archaeological Dog Remains as an Aid to the Elucidation of Possible Affinities with Modern Breeds

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ABSTRACT: The zooarchaeological analyses of dog remains are usually confined to estimating shoulder height and suggesting head shape. In some reports, references are made to modern breeds based on these and the visual appearance of the dog remains, e.g. 'collie-like'. However, the modern definition of dog breeds has also caused many workers to avoid using the modern dog measurements in comparative analysis. This paper demonstrates the use of discriminant function analysis in comparing similarities of dog crania and mandibles from three British late medieval to post medieval sites with modern dog breeds, providing an indication of the type of dog. By using these results in conjunction with historical evidence it is possible to suggest the appearance and size of these animals in addition to possible behavioural traits that may have been exploited in the past as they are today.

KEYWORDS: ZOOARCHAEOLOGY, OSTEOMETRY, MORPHOLOGY, DOG TYPE, MODERN DOG BREED, MEDIEVAL, POST MEDIEVAL, DISCRIMINANT FUNCTION ANALYSIS

RESUMEN: Los análisis arqueozoológicos de los restos de perros se restringen con frecuencia a estimaciones de la altura en la cruz y sugerencias relativas a la forma de la cabeza. En algunos informes se hace referencia a razas modernas basándose en estos datos y en el mero aspecto de los restos óseos (p. ej., «tipo collie»). La moderna definición de raza canina ha hecho, de todos modos, que muchos investigadores eviten utilizar medidas de perros modernos en sus análisis comparativos. Este trabajo pone de relieve la utilidad del análisis discriminante para evidenciar semejanzas entre tres cráneos y mandíbulas de perros procedentes de yacimientos tardo-medievales y post-medievales británicos con razas modernas. Esto nos permite afinar el tipo de perro y, conjuntando estos datos con los documentales sugerir el aspecto y alzada que estos animales tuvieron, así como ciertos rasgos de su comportamiento que pudieron haber sido aprovechados en el pasado del mismo modo que hoy se hace.

PALABRAS CLAVE: ZOOARQUEOLOGÍA, OSTEOMETRÍA, MORFOLOGÍA, TIPO CANINO, RAZAS CANINAS MODERNAS, MEDIEVAL, POST-MEDIEVAL, ANÁLISIS DISCRIMINANTE

INTRODUCTION

The definition of breed can be regarded as a modern concept. The modern classification of dog (*Canis familiaris*) breeds is based on ideas introduced in the 19th century by the Kennel Club (The Kennel Club, 2003). These use clearly described standards and stud books which apply categories such as colour, coat and temperament that obviously cannot be determined from the bones (Harcourt, 1974: 152). This has resulted in a cautionary approach in the consideration of breed when analysing archaeological bone (e.g. Harcourt, 1974; Clutton-Brock, 1987; Clark, 1995), which has contributed to the problems in the study of dogs in Britain (cf. Clark, 2000). General zooarchaeological analyses of dog bones use measurements to indicate size, (shoulder height and robustness: Harcourt, 1974: 153-154) and head features (cephalic index, snout index and snout width index: Sisson & Grossman, 1953: 196; Harcourt, 1974: 153-154). It has been suggested that since Harcourt's (1974) work little has been done by British faunal analysts to advance his work, instead they «have merely used his results as a convenient datum level and abdicated any responsibility for advancing understanding of the species in the context of British archaeology» (Clark, 2000: 168). Clark (2000: 164) suggests that valuable information on dogs may be lost through inappropriate measurement strategies. The reduction in the number of measured dogs in the medieval period when compared to earlier periods suggests that perhaps not even the recommended measurements are being taken for later periods in British assemblages (*ibid*). In view of this, and because the progenitors of many modern defined breeds were present in antiquity and therefore may be represented in archaeological assemblages, it would appear necessary to investigate archaeological dog remains when the opportunity arises. This could be considered particularly useful for later periods in Britain for which documentary evidence can be used in conjunction with archaeological studies. The use of discriminant function analysis in this paper has allowed morphological characteristics of modern dog breeds to be compared to archaeological specimens, providing an indication of phenotype resemblance. The comparison of archaeological dog remains to modern breeds has been carried out in previous studies (e.g. Baxter, 2006; MacKinnon & Belanger, 2006), and using discriminant function analysis (e.g. Walker & Frison, 1982; Morley, 1986; Benecke, 1987, 1994; Crockford, 1997; Clark, 1998). By using the results in conjunction with historical evidence it is possible to suggest similarities in appearance to modern breeds, which can be indicative of possible behavioural traits that may have been exploited in the past as they are today. Throughout this paper the direct assignation to breed has been deliberately avoided when describing the archaeological remains, instead similarities and comparisons to modern breeds are referred to.

The work detailed in this paper is the result of three separate analyses of archaeological animal bone assemblages, in which the opportunity to consider the appearance of three dogs occurred. As the assemblages were analysed independently, limitations have occurred in amalgamating the data and results. However, due to the use of the same method and analyst (Marc Nussbaumer), it was considered appropriate to present the results in a single paper with the aim of demonstrating how analysis beyond the conventional methods can take place and be beneficial to zooarchaeological studies.

Consideration of the type of dog present in an archaeological assemblage is particularly interesting for medieval and post medieval Britain due to the variety of dog types indicated in illustrations and written records. References to hunting dogs are most common, since hunting was the sport of kings, nobility and the clergy (Smith, 1998: 865). However, 'The Boke of St. Albans', a treatise on hunting (first published in 1486) also demonstrates the diversity of dogs in Britain during this time. Included in the list of types are «…a Grehoun, a Bastard, a Mengrell, a Mastiff, a Lemor, a Spanyel, Raches, Kenettys, Teroures, Butchers' Houndes, Myddyng dogges, Tryndel-taylles, and Prikherid currys, and small ladyes' poppees that bere awaye the flees» (Berners, 1901, cf. Smith, 1945 and Cummins, 1988). A more thorough classification is given in the 1570 work by Johannes Caius, «Of English Dogges», (translated by A. Fleming in Caius, 1993). English dogs were separated into three classes; those serving game, homely dogs (which serve a variety of uses) and currish dogs (such as mongrels that may be trained in many ways). The varieties of dogs listed include harriers, terriers, blood-hounds, and gazehounds which are recognisable as being the ancestors of the modern dogs of today.

MATERIALS AND METHODS

Two dog crania recovered during excavations at Witcham, Cambridgeshire and Floodgate Street, Birmingham, were measured for this analysis. Measurements of the articulating mandible to the Floodgate Street cranium and a mandible recovered during excavations of Botolph Bridge, Orton Longueville, Cambridgeshire were also used in this study.

The dog cranium from Witcham, Cambridgeshire belonged to a partial dog skeleton recovered from a boundary ditch dated to the 16th-18th century. The remains consisted only of the cranium, mandibles, atlas and scapulae. The boundary ditch also contained the incomplete post-cranial bones from a smaller dog and the femur from a very small dog standing 29 cm at the shoulder (following Harcourt, 1979). The partial articulated skeleton of a pig was also present. The site itself evidenced property boundaries from the 12th century onwards; despite the absence of structural evidence on the site, the finds recovered were consistent with 'back yard' activity in all phases.

The Floodgate Street cranium came from a partial skeleton of a large dog. Most of the bones from this site derive from industrial tanning operations closely dated to 1550-1650 AD (Phase 3), which include a series of water features, a large man-made pool L1 with feeder and drainage channels L2 and F227 and an overflow channel L3/L4, which filled up between 1600-1650 AD. The dog skeleton was found in the infill of pool L1 and has a *terminus post quem* of c.1650 AD.

The partial skeleton of a large dog was recovered from a pit dated to the mid 16th-17th century AD, in the grounds of a stone built farmhouse at Botolph Bridge, Orton Longueville, Cambridgeshire. The farmhouse replaced an earlier medieval manor house and was itself demolished in c.1650 AD. The cranium was fragmentary and incomplete, however the mandible provided measurements. Some remains of a second dog of similar type were found in another pit, but this had lower M3 congenitally absent and therefore could not be used in the present study.

Measurements were taken, when possible, on the two dog crania (Table 1, Figure 1); see Lüps (1974) for details. Using discriminant function analysis (SPSS 15.0 for Windows) these measurements were compared to measurements of known dog breeds held at the Albert Heim Foundation for Canine Research in Berne, Switzerland. The comparative data consist of dog crania and mandibles from known breeds dating from the beginning of the 20th century to the present day. Examples include both males and females. The Irish Wolfhound and the Great Dane were the largest breeds available for comparative analysis in the collection used in this study. The modern dog breeds used for comparison were chosen by the authors during the initial analysis of the crania and mandibles for their relevant animal bone assemblages. The choice was limited by the data avail-

Lüps (1974)	Driesch (1976) equivalent	MEASUREMENT
B	3	(Basilarlänge): length of skull base from back of incisiva[1] to front of foramen magnum = basal length
C	-	(Hirnstammbasis-Palatinumlänge): from the front of the foramen magnum to the suture palatine/maxilla
D	-	(Hirnstammbasis): length of brain-stem, from the front of the foramen magnum to the suture pterygoid/palatine where the palatine meets the presphenoid
E1	18	(Länge des oberen Reisszahnes): length of upper carnassial (P^4)
F	36	(Breite über den Eckzähnen): width over canini
G	30	(Grösste Breite): zygomatic breadth (cranial width)
H	-	(Breite über den Condyli): width over retroarticular processes
M	14a	(Caudale Palatinumlänge): caudal zone of palatine

TABLE 1

Details of cranium measurements following Lüps (1974) and giving Driesch (1976) equivalents when possible.

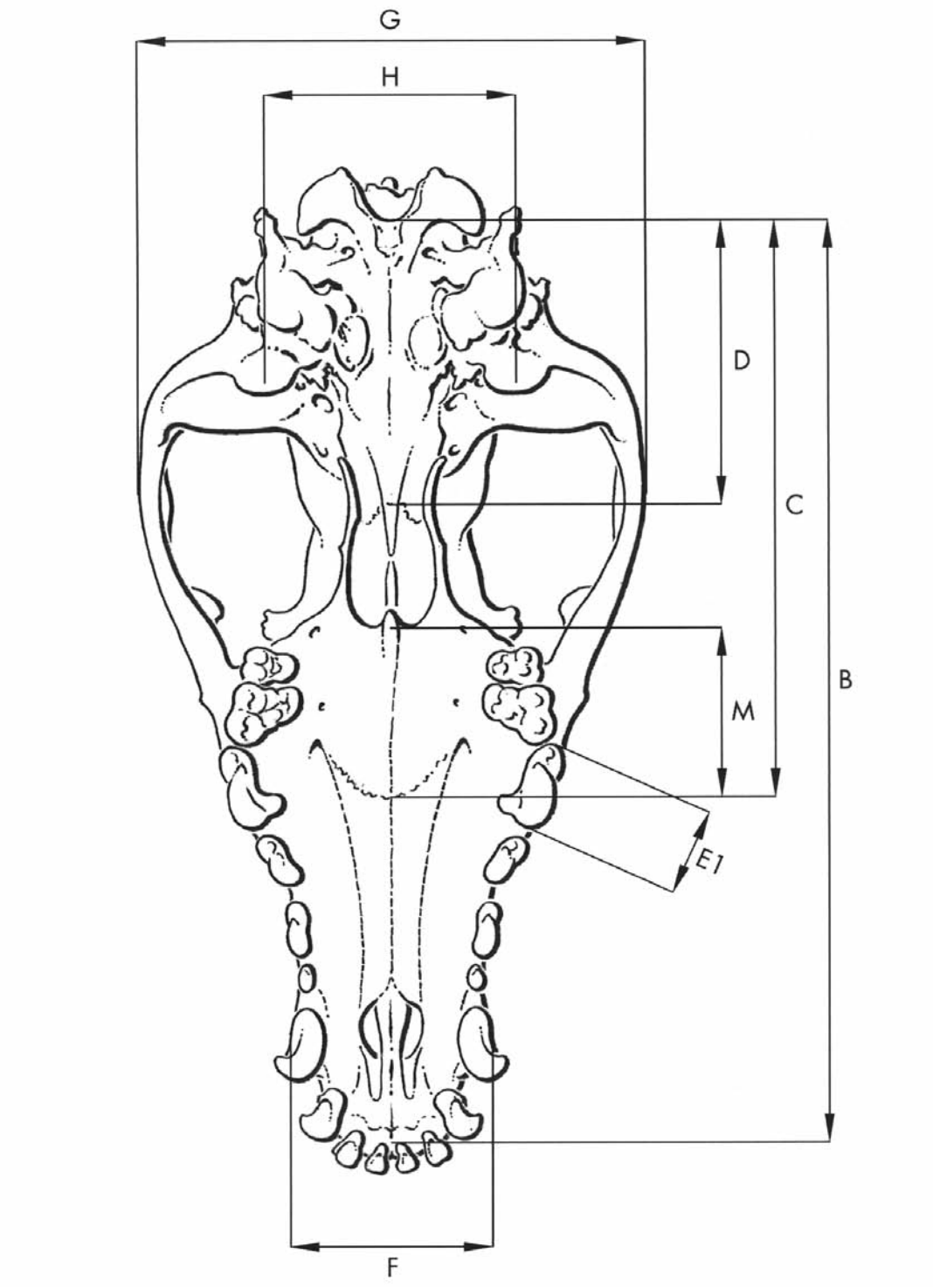

FIGURE 1
Details of cranium measurements following Lüps (1974).

able for comparison and to breeds that were thought to be relevant. These were considered using the length of the «Hirnstammbasis» as a reference for size, an established measurement for canids (Lüps, 1974; Fondon & Garner, 2004: 18058). This measurement is taken on bones which underlie the brainstem, which are of phylogenetically old chondral origin (Chondrocranium). This makes it more stable than for example using the bones around the choanae or those forming the bony palate, which are of more recent dermal origin (Dermatocranium) and which show a high modifiability. By using this measurement the problem of referring to brachycephalic skulls as being 'smaller' than same-sized normal skulls is avoided, which would be the case if total length of the cranium was used (Huber, 1974).

Mandibular measurements (Table 2) were also taken when possible on the associated mandible from Floodgate Street, Birmingham and the mandible from Botolph Bridge, Orton Longueville, Cambridgeshire. These measurements were analysed using the same method as the crania (see above).

Measurement	Driesch (1976) equivalent
Length of P4	-
Width of P4	-
Length of M1	13
Width of M1	-
Length of P2-M3	9
Length of P2-P4	12
Length of M1-M3	10

TABLE 2

Details of mandible measurements, giving Driesch (1976) equivalents when possible.

Due to these independent analyses, the crania and mandibles were not compared to one another in the same analysis and are therefore presented separately below.

RESULTS

The Witcham skeleton is likely to have belonged to a male dog, as suggested by the exaggerated saggital crest (The & Trouth, 1976). Due to an absence of long bones calculation of shoulder height was not possible. The scapulae provided the only other measurements in addition to cranial measurements. Although a complete length measurement was not possible, the right scapula has a GLP (greatest length processus articularis) measurement of 43.5 mm, a LG (length of glenoid cavity) of 36.6 mm and a BG (breadth of glenoid cavity) of 26.2 mm. It is possible that a cross bred animal from parents of significantly different statures can retain the larger parent's head dimensions (K. Clark per comm.). However, considering the large size of the scapulae, it is unlikely that mongrelisation is the result of the larger size of the Witcham skeleton skull.

The cranium therefore provided the main indicator of size and appearance (Figures 2 and 3), however, calculation of the cephalic index, snout index and snout width index was not possible as the zygomatic arches were missing. For this study all other measurements excluding those involving the zygomatic arches were taken (Table 3).

FIGURE 2

Lateral view of the cranium from Witcham, Cambridgeshire.

FIGURE 3

Dorsal view of the dog cranium from Witcham, Cambridgeshire.

Lüps (1974) cranium measurements	Witcham cranium	Floodgate Street cranium
B	221.7	200.5
C	147.3	130.4
D	83.7	67.1
E1	21.7	20.5
F	52.5	47.3
G	-	130.4
H	68.3	62.2
M	49.6	42.1

TABLE 3

Cranial measurements used in discriminant function analysis (see Figure 1 for details).

Results illustrate the position of the Witcham cranium in the vicinity of wolves, Irish Wolfhounds and Great Danes, clearly away from the molossoid group (Mastiff, Saint Bernard etc.) (see Chart 1, Table 4). Using modern wolf data is problematic and it should be emphasised that, as with the comparison of modern dog breeds to archaeological data in this paper, no other affinities to the modern palaearctic wolves used in these analyses are suggested other than pure phenotype. The size of the Witcham cranium carnassials (in comparison to the molar lengths following Clark, 1996: 214), suggests it is unlikely to be wolf. Although ideally a number of assessable characteristics would be used when differentiating dog from wolf (e.g. Pluskowski, 2006), analysis was limited by the survival of the remains. However, wolf remains are sparse in the British faunal assemblages from the medieval period (Pluskowski, 2006: 288-291). The wolf probably became extinct in England, due to sustained persecution, by the end of the 14th century (Yalden, 1999: 168; Pluskowski, 2006: 285). Even if wolves were not extinct, numbers were low and although hybridisation may have occurred, research has demonstrated that while there may be 10,000 wolf/dog hybrids (García-Moreno *et al*., 1996) in the USA [the history of hybridisation stretches back at least

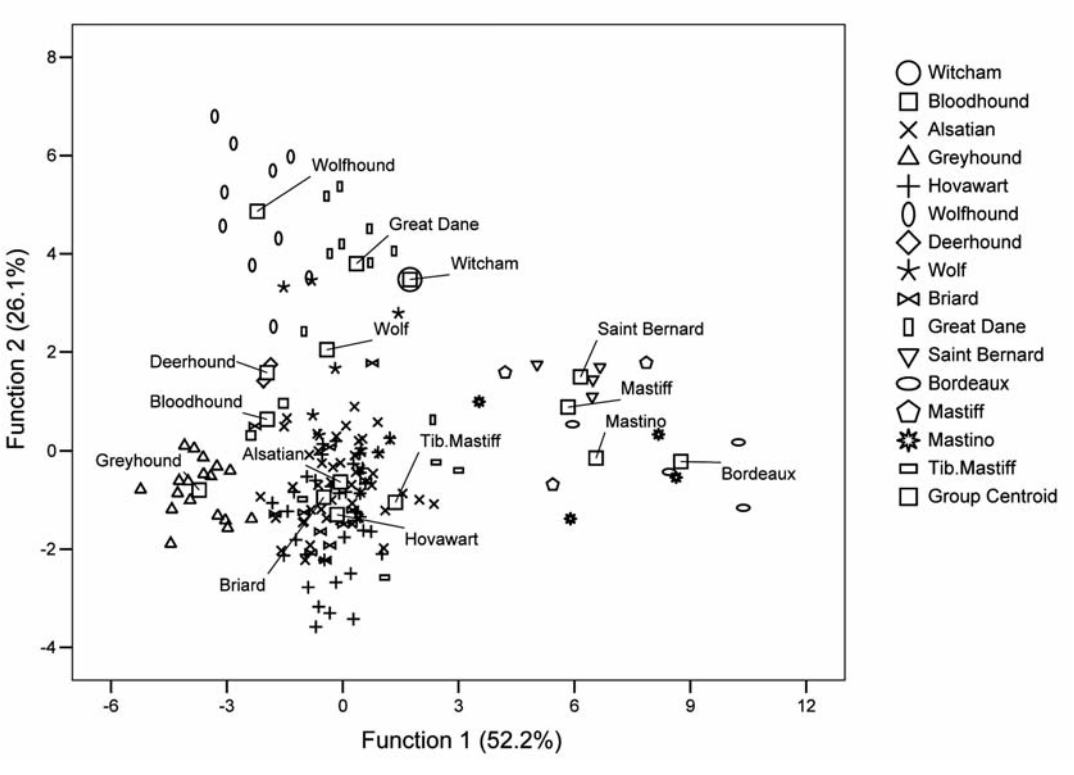

CHART 1

Scatter plot of individual crania according to their scores together with their respective group centroid values (breed means) on the two first canonical discriminant functions from selected dog breeds and the Witcham cranium. The percentages of variance for both functions accounting for 78.3% of total variance are shown.

	Function	
	1	2
Mass_c	-.012	.806
Mass_d	.050	.803
Mass_b	-.093	.692
Mass_h	.349	.545
Mass_e1	.050	.100
Mass_f	.596	.436
Mass_m	.042	.519

TABLE 4

The structure matrix shows pooled within-groups correlations between discriminating variables and standardised canonical discriminant functions of selected dog breeds and the Witcham cranium. Function 2 seems to discriminate mostly between lengths, function 1 between widths. Please note that no cranial widths (Mass_g) could be obtained from the Witcham cranium, therefore this measurement was not used in this analysis.

10,000 years (Schwartz, 1997)], wolf populations have not been affected to any significant degree by hybridisation with dogs (Vilà & Wayne, 1999). Even if hybridisation did occur in Britain due to the presence of a low number of wolves, it has been suggested that by the late medieval period the legislations targeting stray dogs would have reduced the number of hybrid animals significantly (Pluskowski, 2006: 286).

The Floodgate animal stood around 70 cm high at the shoulder based on the multiplication factors of Harcourt (1974). The msd Index (mid-shaft diameter x 100/total length) for the humerus is 8.3. By comparison the humerus of an 18th century Mastiff with a withers height of 73 cm in the collection of Leicester City Museums has an msd Index of 8.8. Compared with modern breeds of large dogs the Floodgate Street cranium is most similar in shape to that of an Irish Wolfhound. Discriminant function analysis of the cranial dimensions suggests that the Floodgate Street animal's affinities lie closest to the Scottish Deerhound and Irish Wolfhound among the selected large modern breeds of dog (Chart 2, Table 5). The Floodgate Street cranium is Deerhound-like but more robust, similar to a palaearctic wolf (Fig-

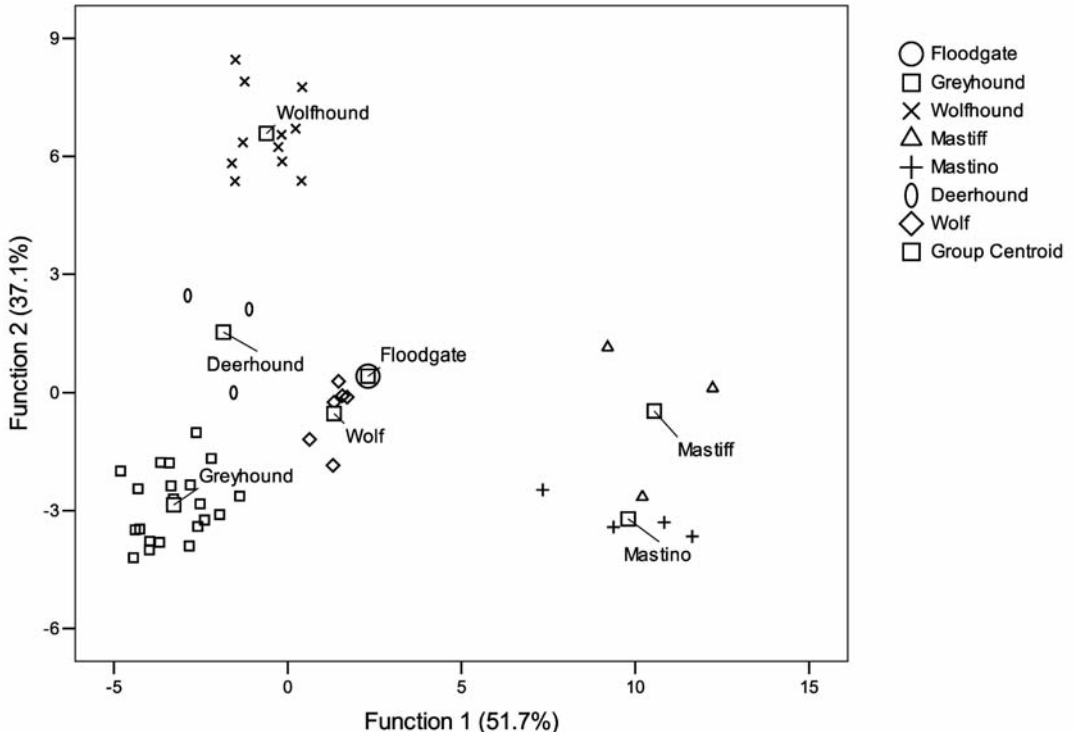

CHART 2

Scatter plot of individual crania according to their scores together with their respective group centroid values (breed mean) on the two first canonical discriminant functions from selected dog breeds and the Floodgate Street cranium. The percentages of variance for both functions accounting for 88.8% of total variance are shown.

	Function	
	1	2
Mass_f	.687	.425
Mass_g	.588	.194
Mass_b	.066	.626
Mass_c	.079	.530
Mass_e1	.178	.141
Mass_h	.309	.216
Mass_d	.090	.409
Mass_m	.113	.372

TABLE 5

The structure matrix shows pooled within-groups correlations between discriminating variables and standardised canonical discriminant functions of selected dog breeds and the Floodgate Street cranium.

ure 4). The size of the Floodgate Street carnassials are smaller than would be expected for wolf (see above). The extensive sagittal and nuchal crest together with the basicranial morphology of the Floodgate specimen suggests it was a male animal (The & Trouth, 1976).

FIGURE 4

Lateral view of the dog cranium from Floodgate Street, Birmingham.

Analysis of mandibular measurements were carried out on the mandible of the Floodgate Street dog and on the mandible from Botolph Bridge, Orton Longueville, Cambridgeshire (Table 6). The mandibular results are not considered to be as reliable as those from the cranial analysis, as the same level of diversity between dog types is not provided by the mandibular measurements used here. Further mandibular analyses may prove useful with an expansion of the data used, particularly the addition of measurements of the lengths and heights of the mandibles. This was not possible for

Measurement	Floodgate Street Mandible	Botolph Bridge Mandible
Length of P4	11.7	13.7
Width of P4	6.3	7.2
Length of M1	23.3	25.6
Width of M1	9.7	10.7
Length of P2-M3	77.5	79.8
Length of P2-P4	39.8	39.7
Length of M1-M3	39.5	42.9

TABLE 6

Mandibular measurements used in discriminant function analysis (based on Albarella & Davis, 1994).

the mandibles used in this study, due to data restrictions and the independent analysis of each mandible. The comparison of mandibles can therefore only be used as a rough guide for assessing similarities and with this in mind the results below should be considered with caution.

As indicated in Chart 3 (Table 7) the Floodgate Street mandible can clearly be compared with a modern Deerhound (not Greyhound and not Wolfhound) mandible. When compared to the cranial analyses (above, Chart 2, Table 5) these results support the conclusion that the affinities of the animal lie with the Deerhound.

	Function	
	1	2
P2-P4L	.051	.250
P4L	.664	-.198
P2-M3L	.135	.558
M1L	.413	.241
M1-M3L	.393	.573

TABLE 7

The structure matrix shows pooled within-groups correlations between discriminating variables and standardised canonical discriminant functions of mandibular teeth from selected dog breeds and from the Floodgate Street mandible. Please note that only five measurements were gained from this mandible. This presumably explains the difference in correlation strengths between both mandibles (cf. Table 8).

The sizes of the mandibular teeth of the Botolph Bridge dog were found to group with the Mastiff types (Chart 4, Table 8). The robusticity of the limb bones supports this. The msd Index of the humerus is 9.6 which is greater than the index of 8.8 for the same bone from the aforementioned 18th century Mastiff skeleton in the collection of Leicester City Museums. The mean of eleven

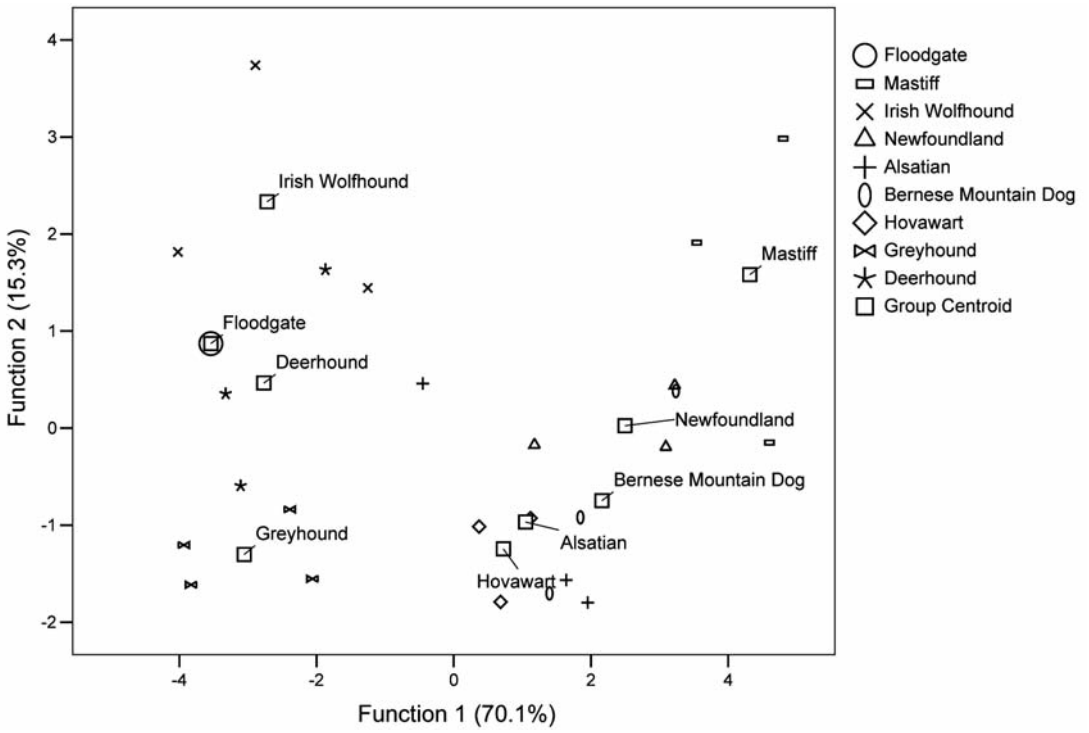

CHART 3

Scatter plot of individual lower jaws (teeth measurements) according to their scores together with their respective group centroid values (breed means) on the two first canonical discriminant functions from selected dog breeds and the Floodgate Street mandible. The percentages of variance for both functions accounting for 85.4% of total variance are shown.

withers height estimates for the Botolph Bridge dog is 75 cm (Harcourt, 1974; Clark, 1995). The limb bones of the Botolph Bridge animal are much more robust than those of the dog from Floodgate Street, Birmingham (see above).

DISCUSSION

The Irish Wolfhound and Deerhound fall into the modern group of hounds. Hounds were bred to chase a quarry by sight or smell, or a combination of both. The Irish Wolfhound and Deerhound are both sight hounds, with exceptional eyesight, in addition to the necessary size and stamina to catch their prey.

Historical records and sources indicate that the Irish Wolfhound was an established breed in antiquity. The Irish Wolfhound, as its name suggests, originated in Ireland. Records of 391 AD state that several Irish Wolfhounds (or wolf dogs as they were known) were sent to Rome to fight in arena contests (Hudson, 1981: 9). Their presence in Roman Britain is suggested by a bronze statue from the Roman Temple of Nodens at Lydney Park, Gloucestershire (irishwolfhounds.org). The Irish Wolfhound breed was at the height of its popularity in the 12th-16th centuries (Hudson, 1981: 13; Dobroruka, 1990: 148). However, by 1700 the breed began to die out, and this was apparently associated with the decline of wolves (Hudson, 1981: 13; Dobroruka, 1990: 148). Although numbers continued to decrease, in the 17th century written records praise these hounds for their size, strength and fine shape. Drawings of the ancient Irish Wolfhound closely resemble a rather thickset large and tall greyhound with a rough coat and very massive head (Hudson, 1981: 11). By 1790 it is said that only eight Irish Wolfhounds remained in Britain (Ritchie, 1981).

Revival of the breed occurred in the 19th century, resulting in the modern Irish Wolfhound. There is some dispute as to the origins of the modern Irish Wolfhound, some attribute the breed to the

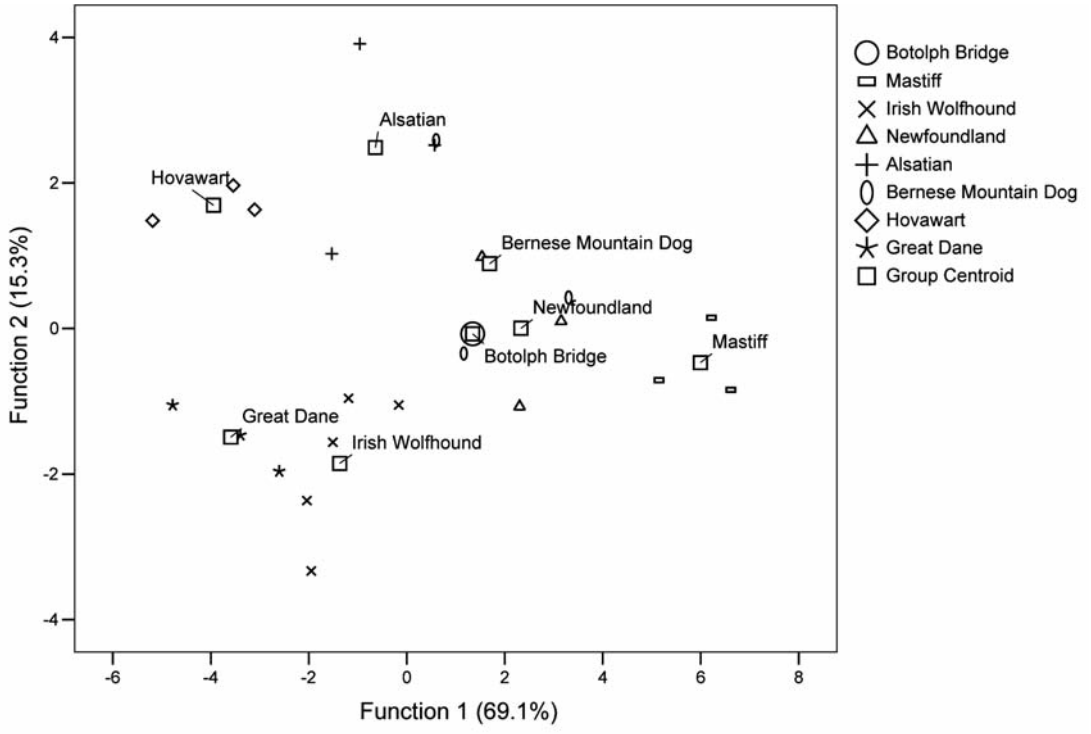

CHART 4

Scatter plot of individual lower jaws (teeth measurements) according to their scores together with their respective group centroid values (breed means) on the two first canonical discriminant functions from selected dog breeds and the Botolph Bridge mandible. The percentages of variance for both functions accounting for 84.4% of total variance are shown.

	Function	
	1	2
P4L	.226	.681
M1L	-.010	-.176
M1W	.033	-.070
M1-M3L	.134	-.449
P2-M3L	-.105	-.386
P2-P4L	-.184	-.177
P4W	-.028	.372

TABLE 8

The structure matrix shows pooled within-groups correlations between discriminating variables and standardised canonical discriminant functions of mandibular teeth from selected dog breeds and from the Botolph Bridge mandible.

FIGURE 5

Engraving of an Irish Wolfhound (1889/1887).

crossing of the remaining Wolfhounds with the Deerhound (Dobroruka, 1990: 148), others suggest a cross of the Scottish Deerhound with a similar, but much slighter breed (Hudson, 1981: 13) and the rough coated Greyhound is thought also to have contributed (Samaha, 1991: 4). Figure 5 illustrates a contestant in an Irish Wolfhound competition during the time of revival of this breed. It is described as a dog with more authentic Irish Wolfhound blood in him and more authentic shape and style than any of the other competitors (Dalziel,

1887). The deerhound-like head shape of this particular animal is noticeable. Although the origins of the modern Irish Wolfhound continue to be debated it is clear that it differs somewhat from the ancient breed.

The Great Dane is descended from the Irish Wolfhound, and was not an established breed until 1876 (Dobroruka, 1990: 148) and was not introduced into Britain until 1877 (The Kennel Club, 2003: 259). The similarity of the breeds was noted in the same year, when it was observed that many people have confused the Irish Wolfhound with the Great Dane, although the author suggests that the appearance of the two dogs varies considerably (Captain Graham cited in Stonehenge, 1887). Like the Irish Wolfhound it has been used for hunting large game. Modern Irish Wolfhounds, Great Danes and Deerhounds are all large breeds, standing (shoulder height) at least 71 cm for bitches and for dogs 76 cm (Great Danes, Deerhounds) and 79 cm (Irish Wolfhounds) (The Kennel Club, 2003).

The similarities of the Witcham and Floodgate crania to the Irish Wolfhound and Deerhound suggest they could have been similar types of dogs (see Figures 6-9 for examples of crania from these breeds). Considering the long history of the Irish Wolfhound it is plausible that both the Witcham and Floodgate dogs could be ancestors of the modern Irish Wolfhound and, like the Great Dane, a descendant of the original Irish Wolfhound breed. Like these breeds it seems reasonable to suggest that these dogs would have been sight hounds, with the ability to hunt large game, such as wolves, deer, wild boar and foxes.

FIGURE 6

Dorsal view of an Irish Wolfhound cranium from the collection at the Albert Heim Foundation for Canine Research in Berne, Switzerland.

FIGURE 7

Lateral view of an Irish Wolfhound cranium from the collection at the Albert Heim Foundation for Canine Research in Berne, Switzerland.

FIGURE 8

Dorsal view of a Scottish Deerhound cranium from the collection at the Albert Heim Foundation for Canine Research in Berne, Switzerland.

FIGURE 9

Lateral view of a Scottish Deerhound cranium from the collection at the Albert Heim Foundation for Canine Research in Berne, Switzerland.

The English Mastiff also has a long history in Britain. Like the Irish Wolfhound it was exported to Rome (from England), and was used for blood sports, such as bear-baiting, bull-baiting, dog fighting, and lion-baiting. 'The Boke of St Albans' records the Mastiff in Britain in 1486 (Berners, 1901). Historically Mastiffs were employed for hunting (they were serviceable against fox, badger and swine, Caius, 1993: 28), fighting and to protect homes as a bandog or tiedog (tied by day but loose at night) (Adleman 1997: 262). The breed nearly became extinct at the beginning of this century and again after the Second World War. The remaining animals were bred with other types of dog including Great Dane, Bullmastiff and shorthaired St. Bernard before the present breed standard was fixed (Mastiffweb.com). Consequently, archaeological Mastiffs, such as the Botolph Bridge dog, may be expected to have had an appearance differing from the dogs of today. Animals described as Mastiffs appear in the paintings of old masters such as Titian and Velasquez and in naïve 18th century depictions (MacDonagh, 1999). These were leaner, less jowly dogs than today's Mastiffs, characteristics also displayed by Victorian paintings and engravings (Figure 10).

FIGURE 10
Engraving of a Mastiff (1881).

It may be expected that the remains of large dogs such as the types found at Witcham and Floodgate Street, which may have originally been bred for their hunting abilities, would be associated with affluent sites. However, the Witcham and Floodgate sites were not affluent, suggesting that these large dogs were not predominantly owned and used by the wealthy classes. It is possible though, particularly considering the nature of the Floodgate site, that the dogs were deposited at these sites merely as a convenient means of disposal. The mastiff-like dog from Botolph Bridge, on the other hand, is associated with a stone built farmhouse replacing a medieval manor, which could relate to the use of this dog type to watch and keep houses from thieves and intruders as described by Caius (1993: 28). The presence of the bones from medium and small sized dogs in the ditch at Witcham is particularly illustrative of the variety of dogs in 16th-18th century Britain (see above). The small femur from a dog of 29 cm (shoulder height) clearly demonstrates the diversity of dog types when compared to the 71-79 cm shoulder height of modern Irish Wolfhounds. It is tempting to relate the small femur as possibly representing a dog type described as a «small ladyes' poppees» in the 'Boke of St Albans', or the gentle kind «sought to satisfy the delicateness of dainty dames, and wanton women's wills» (Caius, 1993: 23), although this would be speculative and based purely on the estimation of shoulder height rather more reliable parameters.

The above analysis is limited by the chosen breeds, crania and available parameters and does not consider other factors such as coat and temperament which are associated with defining modern dog breeds. It is also obviously based on phenotype resemblance and not genetic relationship. It does however highlight the similarity of these dog crania and mandibles to known modern breeds and by doing so provides indication of size and appearance which may not have been possible to achieve through the absence of other bones. Even with the presence of other bones, analysis of dog crania can provide further information than is achieved by just using conventional methods, by providing an indication of dog type due to the large amount of diversity of modern crania both within and between breeds. Measurements of archaeological mandibles can also be used, although with less reliability, to provide a rough guide for assessing similarities to modern dog breeds. As the results illustrate, future work in analysing archaeological dog remains beyond the conventional methods would certainly be useful. With regard to the sites discussed here, comparing the archaeological crania and mandibles with one another would be interesting. Expanding the mandibular measurements used would be particularly useful, perhaps in addition to omitting breeds and summarizing groups as for examples, molossoid, sighthounds and 'normal' modern breeds.

CONCLUSIONS

As the definition of breeds is a modern concept, caution should be applied when considering the breed of archaeological bones. However, it is perhaps unreasonable to consider the comparison of archaeological dog remains to modern breeds as too problematic to be of use to zooarchaeological analysis. If applied with caution it should be possible to compare similarities in the skeletal appearance of archaeological dog remains with modern examples of breeds. This can be used in conjunction with historical records and the abilities of the modern breed to suggest the type of dog present in the archaeological assemblage, providing an indication of the size, appearance and possible utilisation in the past.

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