A tale of two innominates

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Summary

Two new measurements on innominate bones were tested on a variety of mammals, using specimens of known age and sex. The potential value of these measurements in determining sexual dimorphism in archaeological material is discussed.

One winter's day (a long time ago), while examining two cattle innominates from a Saxon site in London, I was struck by the difference in pubis lengths, and attributed this to sexual dimorphism, because of similar characteristics in humans. Although the fact that the pubis is relatively longer in human females than in males is well known to human osteologists, this principle had not, to my knowledge, been applied to other animals (an opinion later revised). Two simple measurements were then devised to illustrate this sexual dimorphism (Fig. 19), and it was decided to test the idea on animals of known age and sex in distinct populations.

Figure 19. Diagram of measurements: PB - breadth of pubic symphysis; PL - pubic length.

Dr Juliet Clutton-Brock (British Museum of Natural History) generously allowed me to measure the collection of Soay sheep in her care in advance of her own publication on the material (Clutton-Brock et al. in press), in addition to the BMNH collection of dogs (Dennis-Bryan and Clutton-Brock 1988), Chillingham cattle, and African and Indian elephants. James Rackham (Museum of London) kindly offered to measure his private osteological collection of Border goats currently housed in Lincolnshire (Bullock and Rackham 1982) and Sebastian Payne (Ancient Monuments Laboratory, English Heritage) permitted me to measure his Cambridge collection of Turkish wild boar skeletons (Bull and Payne 1982; Payne and Bull in press).

The discussions engendered by this idea were both lively and fruitful. For instance, Juliet Clutton-Brock pointed out that, if extra room was needed in the female pelvis to accommodate offspring, the pubis was the logical place for bone expansion. Also, one of her conversations with Dr Andrew Kitchener (Royal Museum of Scotland) inspired me to try this method on elephants. Dr Kitchener subsequently sent me his measurements for the Indian elephants in the collections of his museum and the Anatomy Department of Edinburgh University. Sebastian Payne disclosed that he has tested a method for determining sexual dimorphism in sheep, using measurements for the midpoint of the pubis, which will be very useful for fragmentary material (Holmes, Legge and Payne in prep.). He also predicted that these measurements would not work for pigs or dogs, since they are multiparous animals, in which extra pelvic accommodation for large-headed offspring is not required.

Figure 20. Pubic lengths plotted against pubic breadth, using innominates of Soay sheep from the British Museum (Natural History) collection. Symbols as in Fig. 21.
Figure 21. Pubic index \( ((PB \times 100)/PL) \) plotted against pubic breadth of BMNH Soay sheep innominates.

Figure 22. Pubic index \( ((PB \times 100)/PL) \) plotted against pubic breadth, using innominates from the Chillingham cattle collection at the BMNH. Symbols as in Fig. 21.
The results shown in Figs 20-5 were presented in a way which emphasises that pubic breadth appears to be the crucial differentiating factor, rather than pubic length. James Rackham pointed out that, for archaeological samples of unknown sex, plots of pubic breadth against length (such as in Fig. 20) would probably show more of a gap between the sexes.

Because of the vagaries of morphology amongst species, the two measurements shown in Fig. 19 are meant merely as a general guide rather than an immutable law. In cattle, pigs and elephants, for instance, the pubic breadth was relatively easy to determine, whereas in sheep and goats the calipers were rotated to obtain the smallest breadth. Also, the acetabulum edge used in the pubic length measurement was not always well defined in some species. Other researchers may prefer to adapt these measurements to include some other points, such as the centre of the acetabulum. Consistency within species or population groups is the important thing.

At this point, all seemed clear and straightforward: this method would work well on all normally uniparous animals such as elephants, humans, equids, cervids and bovids (including caprines), but not on multiparous ones such as pigs, cats and dogs. Then, just as I was surveying the scene with smug satisfaction, along came Don Brothwell (University College London) to ruin it all by insisting that there must be other factors to consider, because Brown and Twigg (1969) had found sexually dimorphic innominates in small mammals. 'And what about the voles?' said he, which brings us to the next section.

Figure 23. Pubic index ((PB x 100)/PL) plotted against pubic breadth, using innominates of Turkish wild boar from Sebastian Payne’s collection. Symbols as in Fig. 21.
And what about the voles?

The results presented in Brown and Twigg's paper are indeed intriguing in that, although all the species of rats, mice and voles studied were multiparous, some species had sexually dimorphic innominates while others did not. In addition, one of the primary sexual differences found was that the pubis is longer and thinner in females:

'We consider that the need to enlarge the pelvic outlet may be related to three interrelated factors:

(i) the ratio of embryo size to mother size which will be higher in smaller species according to established allometric principles;

(ii) the precocity of the young at birth which is a feature of desert rodents and which might be assumed to be also a feature of Holarctic rodents;

(iii) the age and relative size at which females can become parous.

Essentially the problem is one of what sized head has to pass through what sized pelvic outlet...

(Brown and Twigg 1969, 129)
Amongst the mice, they found that the differentiation in female innominates was much more striking in the very small harvest mouse (Micromys minutus) than in the larger species (which supports the first factor quoted above). The second and third factors are supported by the following: although rats (Rattus spp.) and water voles (Arvicola terrestris) are similar in size, the latter exhibit marked pelvic sexual dimorphism while rats do not. Also, extreme sexual dimorphism exists in the innominates of the small voles Clethrionomys glareolus and Microtus agrestis. Brown and Twigg propose that all the voles have retained an adaptation to the rigorous conditions, short summers and reduced breeding season of northern climates during the later Pleistocene, by becoming parous at an early age and producing fewer young at a more advanced state of development.

In considering how these principles might be applied to other mammals, I thought that sexual dimorphism in the pubis would be more pronounced in small dogs than in large ones, for example, and decided to test this by measuring the BMNH collection mentioned previously. The results shown in Fig. 26 are interesting, in that the very large dogs such as Great Dane and Mastiffs do indeed show little sexual dimorphism, but a marked separation is found in large Bloodhounds, as well as small Bulldogs and Dachshunds. Amongst the smallest breeds, such as King Charles' Spaniels, the dimorphism was not as clear as expected, whilst the large Salukis were most annoying in showing a complete reversal of expected trends. Commenting on Fig. 26, Dr Clutton-Brock noted that Bulldogs are specially bred to have large heads and she agreed with Dr Kim Bryan's comment that dog breeders in this century have drastically manipulated the characteristics of each breed.

Figure 25. Pubic index ((PB x 100)/PL) plotted against pubic breadth, using innominates of African (marked 'A') and Indian elephants from the BMNH collection. Those marked 'S' are from the collections of the Royal Museum of Scotland and Edinburgh University. Symbols as in Fig. 26.
Figure 26. Pubic index \((PB \times 100)/PI\) plotted against pubic breadth, using innominates of dogs from the BMNH collection. Abbreviations as follows: Afghan - Afghan Hound; Aus. Grey - Australian Greyhound; Basset - Basset Hound; B. Mastiff - Brindled Mastiff; Blood - Bloodhound; Cocker - Cocker Spaniel; Dachs - Dachshund; Doberman - Doberman Pinscher; En. Grey - English Greyhound; Fox T. - Fox Terrier; G. Dane - Great Dane; Griffon - Griffon Bruxellois; Hairless - African Hairless; Ir. Wolf - Irish Wolfhound; It. Grey - Italian Greyhound; Jp. Span - Japanese Spaniel; K. Chas - King Charles' Spaniel; Peking - Pekingese; Pomer - Pomeranian; Sc. Deer - Scottish Deerhound; Scot. T. - Scottish Terrier; T. Mastiff - Tibetan Mastiff.
**A very brief conclusion**

To conclude, then, I suggest that the interpretations discussed above for rodents, and previously for domesticated animals, are generally applicable to mammalian species, and that measurements of the length and breadth of the pubis should be carried out on as many species as possible in order to test this, using both modern and archaeological samples.

**Acknowledgments**

I would particularly like to thank Dr Juliet Glutton-Brock (British Museum of Natural History), Dr Sebastian Payne (Ancient Monuments Laboratory, English Heritage) and James Rackham (Museum of London) for generously allowing me access to the osteological collections in their care, as well as Don Brothwell (University College London) and Dr Terry O'Connor (University of York), all of whose comments and encouragement greatly improved the first draft. Thanks are also due to Dr Kim Bryan (BMNH) for comments, as well as to Dr Caroline Grigson (Royal College of Surgeons) for promising to try this method out on camels, and Dr Andrew Kitchener (Royal Museum of Scotland) for bringing in the elephants (indispensable to any paper). Also, Dr Hezy Shoshani (Wayne State University, Michigan) has warned that he intends to compare my elephant results with his own new method for sexing mandibles on the same specimens, and if the results do not agree there will be fisticuffs.

**References**


Dennis-Bryan, K. and Glutton-Brock, J. (1988). Dogs of the last hundred years at the *British Museum (Natural History)*. London: British Museum (Natural History).


Revised manuscript received: 17th March 1989

Addendum; Simon Parfitt (Institute of Archaeology) has sent me a copy of a paper on sexual dimorphism in the pelvis of the squirrel monkey, in which ratios of pubis length to ischium length are used, as well as one of the measurements of the midpoint of the pubis also being tested by Sebastian Payne for sheep: Gingerich, P. D. 1971. The development of sexual dimorphism in the bony pelvis of the squirrel monkey. *Anatomical Rec.* 172, 589-96.