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The use of tarsometatarsi in sexing and ageing domestic fowl (*Gallus gallus* L.), and recognising five toed breeds in archaeological material

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Summary

A paper by Latimer (1927) is brought to the attention of readers to add information on the fusion of the proximal epiphysis of the tarsometatarsi of domestic fowl (*Gallus gallus* L.) to that given by West (1985). It shows that, in slower-maturing birds, the earliest age at which the fusion line had completely disappeared was 139 days for females and 195 days for males.

The difference between the description in the literature of the fusion of the spur core to the tarsometatarsus (Juhn 1952) and personal observations is discussed. It is suggested that, in birds with spurs, evidence from the tarsometatarsus that a spur is present develops relatively late. Such birds may therefore be older than was previously thought.

As birds were castrated mainly to provide better quality meat, and taking into account the information in the first two parts of the paper, it is felt that few capon bones will be recognised in archaeological material.

Five-toed fowl have been in existence since at least Roman times. Diagrams and descriptions of the differences between these and the more common four-toed breeds are given to help with their identification and to show some of the variations that may be found.

Introduction

In 1988 I acquired and buried the carcase of a bantam cock. The bird had been killed by a farmer because he was "being a nuisance" in the hen house. He was at least one year old with well developed spurs but when I dug the skeleton up and cleaned it, the tarso-metatarsals showed no sign of this fact. They were completely mature and as these bones, when found in archaeological collections, are generally sexed on the basis of the presence or absence of a spur or 'spur socket', I would have had no hesitation in saying that they were female. After studying as many fowl skeletons as I could find and the available literature I came to the conclusion that there are three problems for archaeologists:

(i) Male tarsometatarsi may not show any sign of a spur, such as a socket primordium, even when mature.

(ii) The way the spur core fuses onto the tarsometatarsus may mean that the period of the bird's life when there is no evidence on the shaft of the presence of a spur is longer than previously thought.

(iii) Capon tarsometatarsi found in archaeological material are likely to be unfused and therefore not measured and they are unlikely to have any sign of a spur.

In December of that year I wrote to eighteen establishments which keep rare fowl breeds and asked them to send me the lower limbs of any slow-maturing domestic fowl which died between the ages of four months and one year, and the lower limbs of cocks which died between the ages of one and three years. I was hoping to get some indication of the age at which the proximal epiphysis of the tarso-metatarsus of these slow-maturing birds unites with the metaphysis and a guide to the age at which the spur core fuses with the shaft of the tarsometatarsus. The response was dis-appointing. I received only four specimens, three of which were from Dorkings which are a five-toed breed. Whilst dissecting and cleaning these specimens, I made observations which are the basis of the fourth section of the discussion which follows.

Fusion of the proximal epiphysis of the tarsometatarsus.

It has often been stated in bone reports that mature unspurred tarsometatarsals are female but this is not always the case. Information from two studies on the postnatal growth of the chicken skeleton was studied. The data presented by Latimer (1927) are based on results using single comb white Leghorn chickens and those given by Church and Johnson (1964) (quoted by West 1985) on New Hampshire/Barred Rock crossbred birds. Latimer's work is more useful for the purposes of this paper as the breed used matures more slowly than those chosen by Church and Johnson and so are more likely to be similar to archaeological specimens. Also, individual weight variations became apparent after the age of six days in the birds used by Church and Johnson and was interpreted as resulting from the cross of the two breeds and might be expected from the fact that the Barred Rock averages a full pound heavier than the New Hampshire Red when mature (Church and Johnson 1964, 532). The fact that the offspring did not develop uniformly may have masked differences between male and female as some females will have been more influenced by their heavier mothers and some males will have grown more like their smaller fathers. Latimer found that the male skeleton was heavier than the female when mature but that the females matured earlier. The male tarsometatarsus stopped increasing in length at an average of 142 days (about five months) and the length was 102 mm. The same bone in the females stopped increasing in length at an average of 110 days (about four months) and the average length was 85 mm (Latimer 1927,

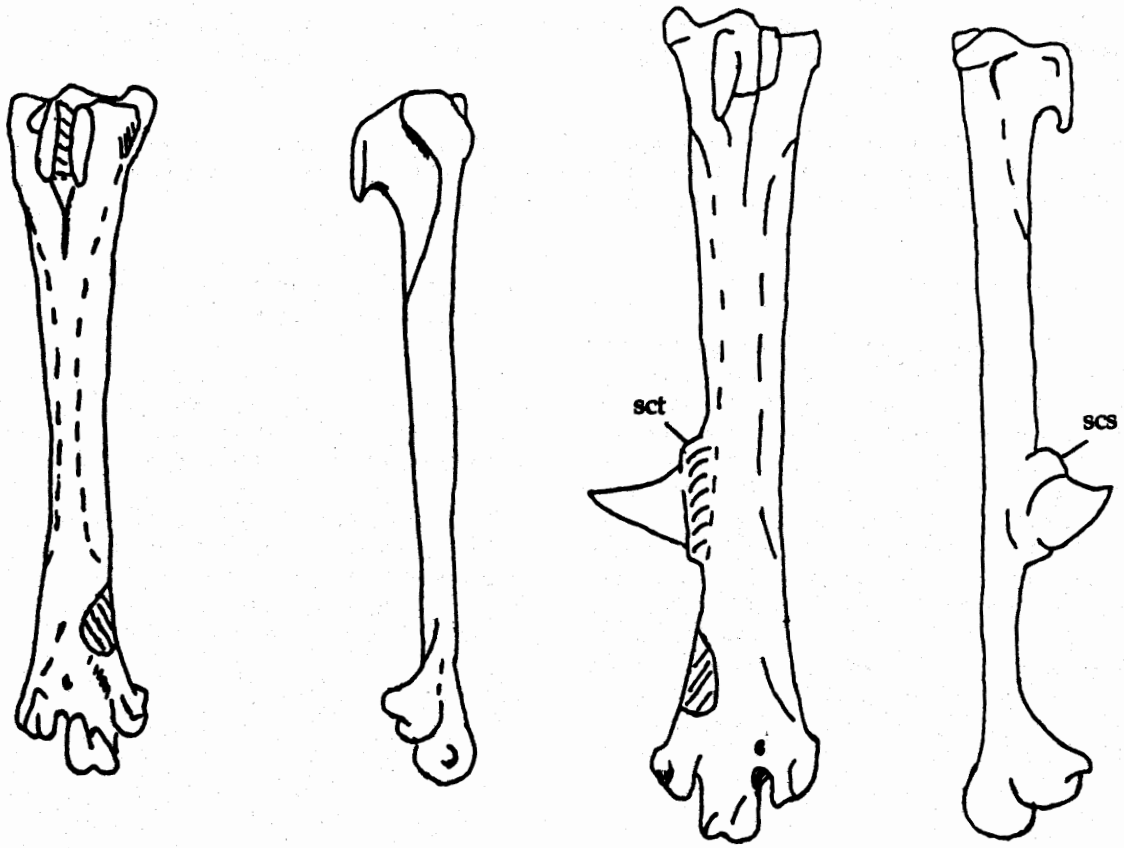

Fig. 11. fowl tarsometatarsi: (a) unspurred; (b) spurred. Key: sct—portion of spur core base curved around tendons, etc.; scs—portion of spur core base fused to shaft.

41). The birds were killed at various time intervals which were more frequent in the early stages of growth and, when the lengths were measured, the age at which the ossification of these bones was completed was observed and recorded. Latimer's table 4 (ibid., 53) shows the age in days of the youngest specimen in which the epiphysial line had completely disappeared. This was 195 days (about seven months) for males and 139 days (about five months) for females. For comparison, the faster maturing breeds used by Church and Johnson (1964) fused between three-and-a-half and four-and-a-half months.

Development of the spur core and its fusion to the tarsometatarsus

As mentioned above, domestic fowl tarsometatarsals from archaeological sites have often been sexed on the presence or absence of a spur. Whilst it is normally true that the female does not have a spur, there are rare exceptions caused by hormonal defects (West 1985, 14). The normal situation, illustrated in Fig. 11, is described by Lucas and Stettenheim (1972, 609):

> "The spur of the female retains a juvenile appearance throughout its entire life. The spur cap of the cock is not supported by bone until about the sixth month and soon thereafter the bone fuses with the os tarsometatarsus. Fusion occurs regularly in the male but only as an abnormal development in the female."

A paper by Juhn (1952) deals with spur growth and although the main interest of her investigations is the effect of thiouracil on the spur she also establishes the normal processes of spur calcification. The fowl used were New Hampshires, White Plymouth Rock/New Hampshire crosses and Barred Rock, which mature faster than the Leghorns used by Latimer (see above) and therefore probably faster than birds represented in archaeological material. Juhn used X-radiographs in her study:

> "The developments discussed in this paper are based entirely upon records furnished by X-ray films of the spur region of normal and experimental birds." (ibid., 150)

Describing the early development of the spur core, Juhn wrote:

> "Minute granules are visible at a distance of 4 mm from the tarsometatarsal surface in bird 735 and fragments are present in 755. The next stages show the organisation of a diminutive central core. The spur proper is gradually increasing in length with these developments and for a considerable period the distal apex of the central core tends to retain its relative position toward the spur tip while progressively extending its proximal margin toward the tarsometatarsal surface." (ibid., 152)

It appears that the new bone growth is being produced at the base of the spur core.

> "Next, at a certain point of its advance towards the shank, the core throws forward slight dorsal and ventral swellings. Simultaneously, the hitherto smooth surface of the shank gives rise to two small thickenings that project towards these paired lobes. The tarsometatarsal proliferations increase in size and expand to fuse with each other while leaving the centre free, thus forming a ring-shaped structure—the socket primordium. At the same time a delicate series of fibres arise connecting this primordium with the adverted core surface. These fibres are the scaffolding, so to speak, for the final developments, in which the socket wholly embraces the basal section of the spur core." (ibid., 153)

Whilst using X-radiographs may be a very useful method for recording the development of the spur core, it seems to be inadequate for observing and accurately describing the fusion of the spur core to the shaft. No spurred tarsometatarsal that I have seen shows the circular basal section of the core embraced by a socket. What is observed is that only a portion of the spur core contacts and fuses to the shaft whilst the remainder forms a curve around the tendons and soft tissues which extend down the posterior surface of the bone (see Fig. 11b). If the approaching spur core does not affect the shaft and fusion takes place when they are in contact, it is possible that even more of the male tarsometatarsi found will show no sign that a spur was present. Juhn (1952, 152, table 1) lists the distance between the core and the tarsometatarsus in 28 birds. In eight of them the core is in contact

with the shaft. Of these, three aged seven months have no socket recorded, i.e. there is no thickening around the base, but four aged eighteen months and one of 30 months are said to have sockets. This could be interpreted as showing that those aged seven months have only just reached the shaft and have not started fusing with it but the spur cores of the older specimens have spread as they came in contact with the shaft and the soft tissues, to form their support and to fuse with the tarsometatarsus. Examination of the plates at the end of the paper did not show any example of bone growth from the shaft before the spur core came into contact with it. Of the other 20 birds in Juhn's table 1 there are six aged seven months with an average distance of 3.5 mm still to grow to reach the shaft, and eight aged nine months with an average of 2.6 mm still to grow to close the gap. This very small sample suggests that fusion is likely to take place between seven and eighteen months in these faster maturing birds with tarsometatarsi that fuse proximally between three-and-a-half and four-and-a-half months.

Capons

Cockerels have been caponised from at least the 17th century. Aldrovandi (1600) (trans. Lind 1963, 410), quoted by West (1982), says:

> "Our farm wives pull out the testicles through the posterior parts after making a small incision with a knife. The wound is large enough to admit a finger above the genitals under the septum where the testicles adhere and is sufficient to draw

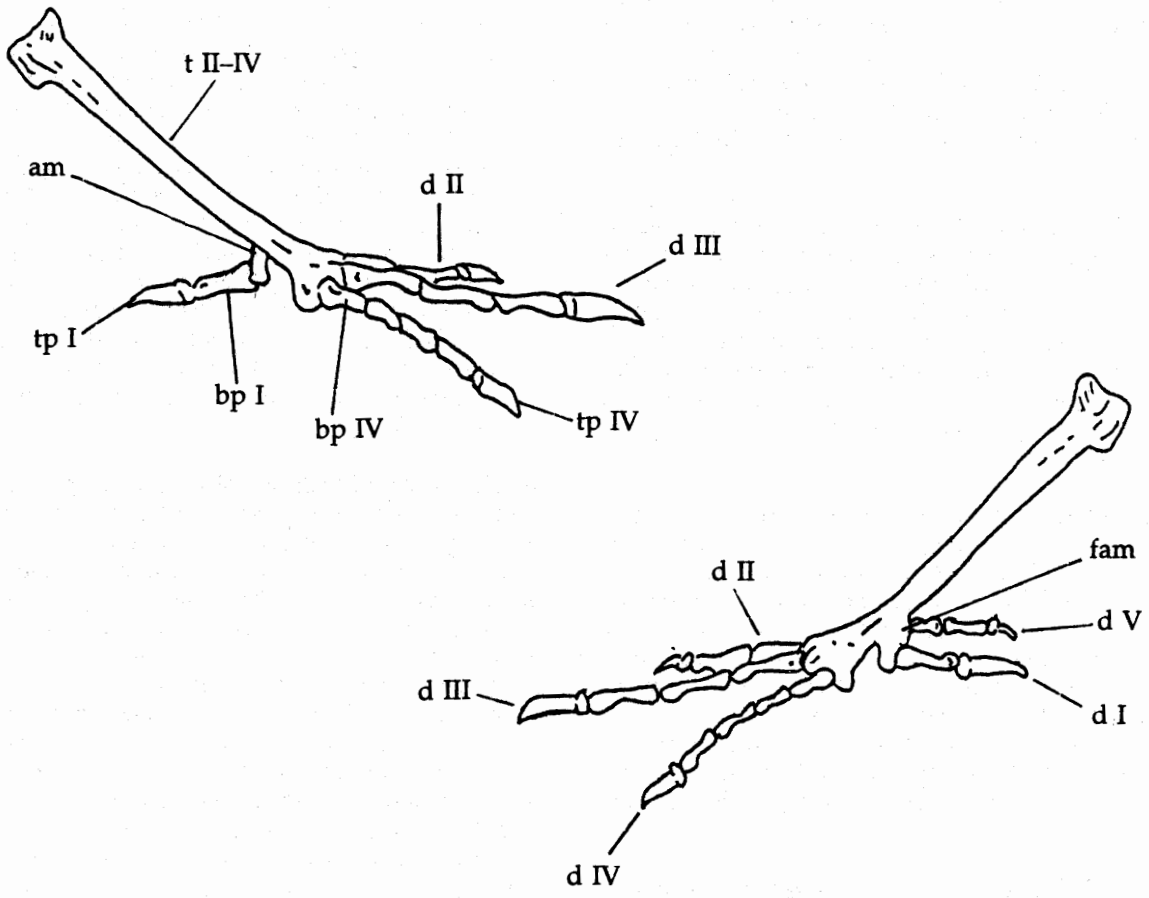

Fig. 12 (after Lucas and Stettenheim (1972, 35). (a) a four-toed fowl; (b) a five-toed fowl. Key: am—accessory metatarsus (os metatarsus I); bp I—basal phalanx of digit I; bp IV—basal phalanx of digit IV; d I–d V—digits I (hallux)–V; fam—fused accessory metatarsals; tp I—terminal phalanx of digit I; t II-IV—tarsometatarsus II-IV; tp IV—terminal phalanx of digit IV.

> them out one by one. When the testicles are removed they sew up the wound with thread and scatter ashes over it."

This implies that the chick was of a reasonable size when the operation was carried out. It is likely to have been between six weeks, which is the earliest age at which one can sex most birds, and the three months quoted by Coy (1983, 186). Surplus cocks and hens were also crammed for the table but the operation, which could be risky (Lind 1963, 411), was performed because the birds grew larger and the meat was thought to be of better quality. Varro recommended feeding twice a day for 20–25 days (Brown 1930, 169). This means that they are likely to be killed at three to four months, well before the proximal epiphyses or the spur cores fuse to the tarsometatarsi even though the core grows faster in the capon (Quigley and Juhn 1951, 901). In archaeological material therefore, few capon bones will be measured or represented with the male spurred tarsometatarsals.

Recognising five-toed fowl in archaeological material

All wild and most domestic fowl have four toes as shown in Fig. 12a. There is however, a fairly widespread variation in which a so-called fifth toe exists as shown in Fig. 12b. It is a breed characteristic in the Dorkings, Houdans, Faverolles, Sultans and Non-bearded Silkie Bantams. In these breeds the extra toe arises above the base of the hallux and projects upwards, never touching the ground.

Columella writing in the first century AD, described the best hens for breeding, then added:

> "Most noble of all are those who have five toes but not transverse spurs which stick out from their legs" (8.2.8.).

Pliny, writing at about the same time says:

> "Sometimes they have more than four toes, with one that runs transversely" (10.56.77.156).

Aldrovandi (trans. Lind 1963, 43) was aware of these comments by Columella and Pliny but said

> "I am at a loss what to say about such toes since we see in other respects that five-toed feet have not been observed in this genus of birds nor in any other except in freaks resulting from an abundance of matter, such as that five-toed male bird given to me by an unknown person and preserved in my museum" (ibid., 43).

It would seem that the value of the five-toed varieties as good breeders was not enough to make them commonplace in Italy by the 17th century although they had been present and even sought after in the first century AD. That they were present from at least the first century AD is certain and we should be able to recognise them when they are present in archaeological assemblages.

The following is quoted from Hutt (1949, 47):

> "The extra toe is not at all homologous with the fifth toe commonly found in other vertebrates. A cartilaginous rudiment of the fifth toe is found in the embryo on the outer side of the foot but it does not develop. The extra digit of polydactylous fowls arises from the metatarsal of the first toe, or hallux, on the inner side of the foot. Actually the fifth toe is not an extra digit but rather a duplication of the hallux and more comparable to the reduplication occasionally found in other parts of the body and in double monsters."

Polydactyly results from the action of a single dominant gene but its expression is extremely irregular (ibid., 50). Its effect can be enhanced, or completely or partially suppressed, by other genes contributing to the affected part so that the number of extra toes ranges from zero to three and the number of bones within an extra toe may also be variable.

A small group of specimens was collected, consisting of the lower limbs from:

> (i) a 4–5 year old Dorking cock (Figs. 13a, b) with two accessory metatarsals fused together but not to the main shafts and the spur cores supported on shields of bone which were starting to fuse to the tarsometatarsals;
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> (ii) a Red Dorking male 2 years 10 months old (Fig. 13d) with two accessory metatarsals fused to each other and to the

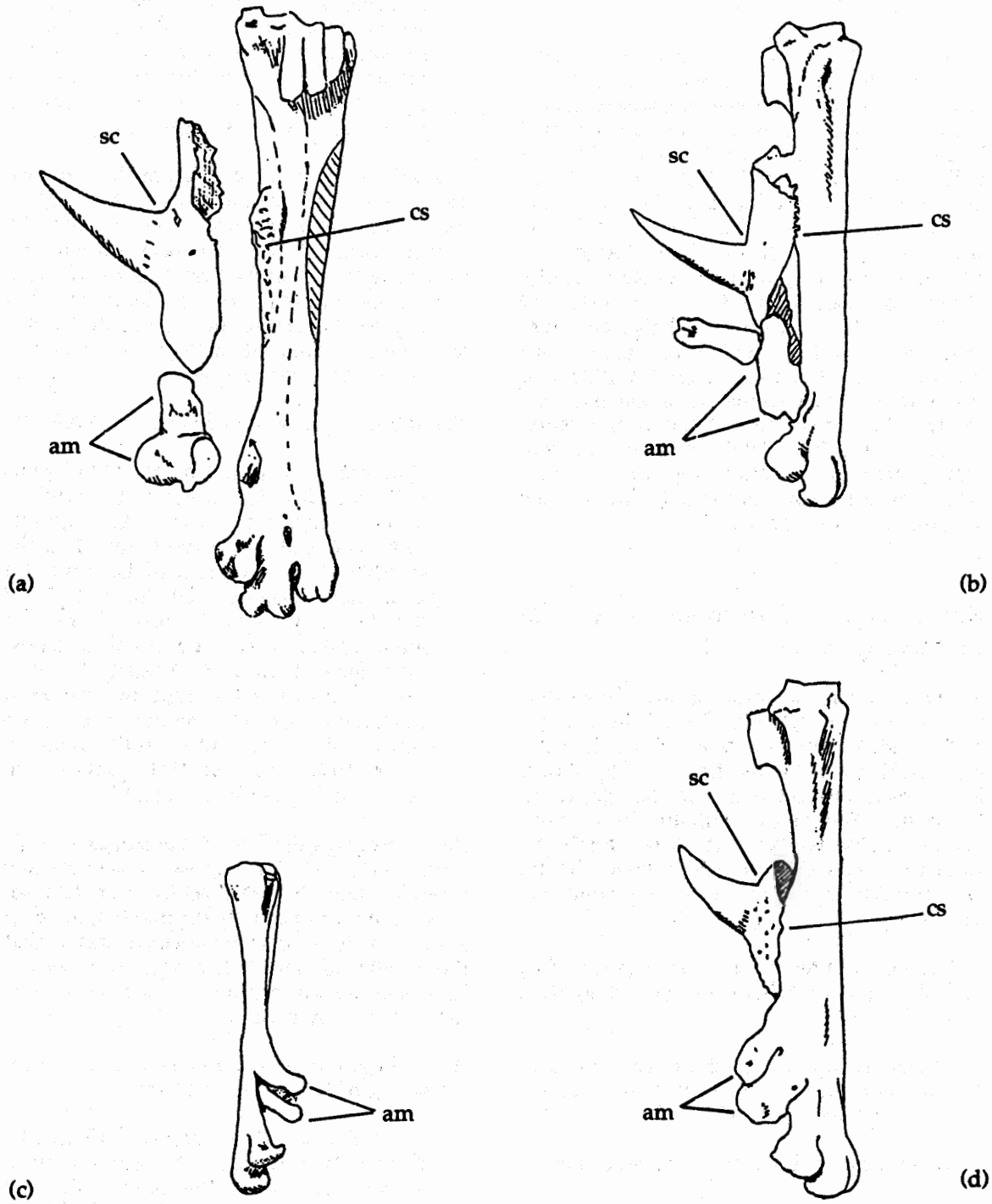

Fig. 13. (a), (b) Dorking cock, 4–5 years (a—right tarsometatarsus posterior view, b-left tarsometatarsus medial view; overall length 92 mm); (c) female Dorking, 4-5 weeks, overall length 39 mm; (d) Red Dorking cock, 2 years 10 months, overall length 118 mm. Key: am—accessory metatarsals; cs—area affected by contact with 'shield'; sc-spur core on 'shield' of bone.

main shafts and the spur cores supported on shields of bone which were starting to fuse to the tarsometatarsals;

(iii) and a female Dorking 4–5 weeks old (Fig. 13c) which already had one accessory metatarsal fused to the main shaft although the second was unattached.

The skeletons of a Dorking cock (reference 1868.2.19.54 C. Darwin) and a White Dorking hen (reference 1868.2.19.63 C. Darwin) were examined at the Ornithological Subdepartment of the British Museum (Natural History) at Tring. The female's lower legs were still partly covered in skin so it was impossible to study them closely but it appeared that there were two fused accessory metatarsals present as there were in the male skeleton. The male's spur core shield and the bony ridge on the tarsometatarsals were similar to those in Fig. 13a. I also examined specimen AML 450, a Silver Dorking male two years old, from the collection of the Ancient Monuments Laboratory in London. It was very similar to the 2 years 10 months old cock in Fig. 13d. In both, the natural ridge running the length of the tarsometatarsals was raised just above the accessory metatarsals.

These examples show very clearly the variation mentioned by Hutt (1949, 47) as being the most common, which is two separate digits, arising from two parallel metatarsals, one of which contains three or four phalanges, the other, two or three. Sometimes the two metatarsals are fused to each other. The left tarsometatarsus (not illustrated) of the young female shows a further variation in that the basal phalanx is single at the proximal end but bifurcated at the distal end.

The final development of the spur core appears to be different in the five-toed fowl from that in the four-toed bird. The circular basal surface of the spur core does not come into contact with the tarsometatarsal shaft (see Fig. 13a) as it does in the four-toed bird (see Fig. 11b) and the growth of new bone from the proximal surface continues to build a supporting shield for the horny spur around the bundle of tendons which run down the posterior region of the shaft.
In archaeological material, pointers to the presence of five-toed fowl are as follows:

(i) Accessory metatarsal(s) fused to the tarsometatarsal shaft.

(ii) If a site has been dug carefully, accessory metatarsals which have not fused to the shaft may be recovered in association with the tarsometatarsus.

(iii) A spur core on a shield of bone.

(iv) Ridges of raised bone on the shaft where the spur core shield was fusing onto the shaft.

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Note added in proof:

In March 1990, I prepared a skeleton of a six-year-old Faverolle cock. This is a composite breed, originally from France, made up of Dorking, Cochin and Houdan. It was interesting to note that it had the five toes of the Dorking and Houdan, and this was shown on the tarsometatarsus by the presence of two accessory metatarsals fused together and to the shaft (as is shown in Fig. 13d). The spur core, however, was fused to the shaft in the same manner as a four-toed breed and was not supported by a 'shield' of bone.

Abstract Abstract. Male chickens, Gallus gallus , produce aerial alarm calls in response to a broad range of stimuli movingâ€¦ Expand. Is this relevant?Â Abstract Although its adaptive properties are recognized, fear can harm the welfare and performance of intensively housed poultryâ€¦ Expand. Is this relevant? 1984. 1984. Genus specificity and extensive methylation of the W chromosome-specific repetitive DNA sequences from the domestic fowl, Gallus gallus domesticus.