

ON THE RELATIVE LENGTHS OF THE FIRST AND SECOND TOES OF THE HUMAN FOOT, FROM THE POINT OF VIEW OF OCCURRENCE, ANATOMY AND HEREDITY.

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I. *The Study of the Foot in the Living Subject.*

THE following research was undertaken in the hope of discovering the method of inheritance of two types of feet which were known to occur commonly in England. As might be expected, however, the work branched off into a study of the anatomy of the foot, and into an enquiry into the percentages of these types of feet in the population.

An examination of the living feet of adults and of children, soon showed the existence of three types, of which two only are common. These types are represented diagrammatically in Fig. 1, and photos of three of the types are shown in Plate XIX.

These types are :

1. (Figs. 1 and 2, 1) in which the first or great toe projects beyond all the others, so that the outline of the toes is a comparatively straight line. This type will be referred to as *L* (long great toe). Park Harrison (1885) stated as a result of examining only 120 persons, that

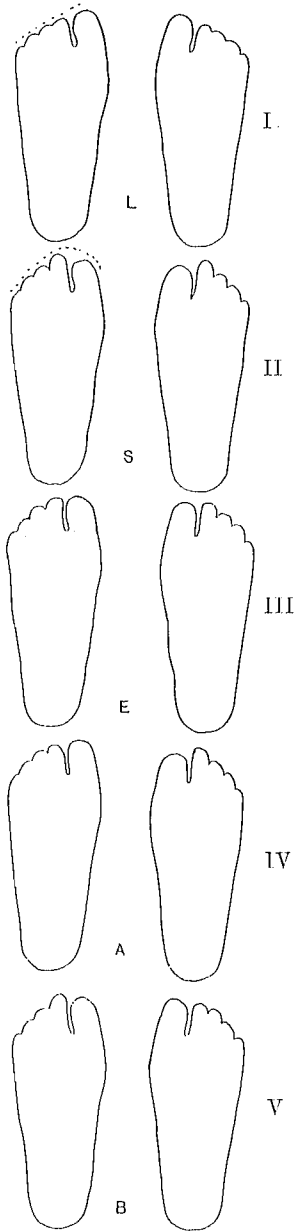


Fig. 1. Diagrammatic Drawings to show Toe-types.

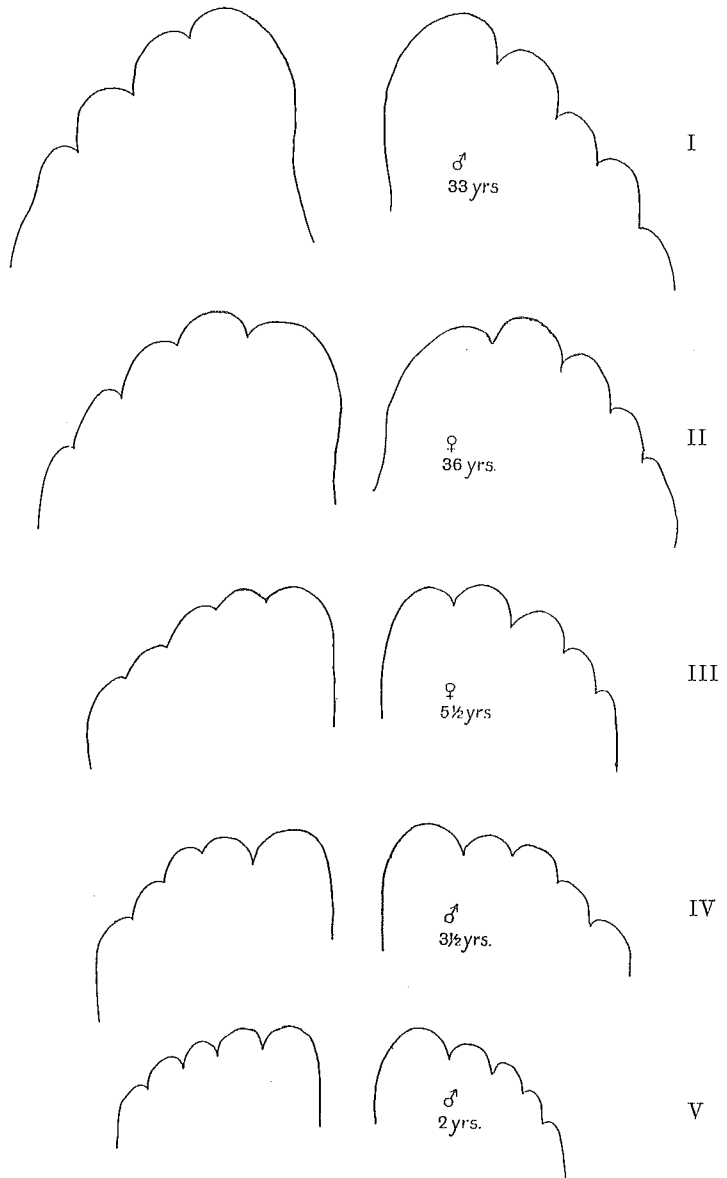


Fig. 2. Toe-tracings made by method described on page 255. Photos of these feet are found on Plate XIX and Radiographs on Plates XX and XXI.

the *L* type was the commonest and his results are confirmed by my examination of over 2000 persons. Pfitzner (1901 et seq.) and Weissenberg (1895) found this the commonest type in Germany.

2. (Figs. 1 and 2, II) in which the second toe protrudes not only beyond the 3rd, 4th and 5th toes, but also beyond the first. Hence the outline in this case is an arc. This type of foot will be called *S* (short great toe). It is much less common than the *L* type; but, in spite of this, it occurs constantly in ancient and modern statues and in nearly all pictures, although usually in an exaggerated form.

3. (Fig. 1, III) in which the first and second toes are of the same length but longer than toes 3, 4 and 5. This type is called *E*. Even a superficial observer would gather the impression that this type seldom occurs and careful observation shows it to be very unusual.

The feet of the same individual are usually of the same type, but not very rarely one foot may be *L* and the other *S*. For convenience the combination of right *S* and left *L* is called *A* (Figs. 1, IV and 2, III), and left *S* and right *L* is called *B* (Fig. 1, V). Combinations of *E* with another type have not been met with.

The analysis was made as the result of examining 2301 persons, 1461 males and 840 females, found in 22 institutes and schools. (See Table II.)

It was desirable to see the feet of adults as well as of children, but as adults are curiously unwilling to show their feet, I was obliged very largely to confine myself to persons under 18. This limitation, however, need not invalidate the results, for, as will be seen, the proportions are not materially changed with increasing age.

TABLE I.

(Taken in a simplified form from Weissenberg (1895), Table VII, p. 98.)

Age ..	5 to 10		11 to 20		21 to 30		31 and over	
Number of Persons ..	198		552		160		99	
	Percentage		Percentage		Percentage		Percentage	
Right foot:								
I > II	137	69.2	350	63.4	93	58.1	67	67.7
I < II	56	28.3	164	29.7	58	36.3	27	27.3
I = II	5	2.5	38	6.9	9	5.6	5	5.0
Left foot:								
I > II	135	68.2	361	65.4	96	60.0	67	67.7
I < II	58	29.3	155	28.1	56	35.0	28	28.3
I = II	5	2.5	36	6.5	8	5.0	4	4.0

Weissenberg (1895) analysed, as shown in Table I, the feet of 1009 Jewish children and adults and found that there was no measurable

TABLE II.

Type of Toes	Age	L		S		A		B		E		Totals
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
School in Birmingham...	8-13	66	23	11	8	8	—	—	—	—	—	116
"	8-13	45	43	17	10	2	4	4	1	—	1	127
"	7-13	48	19	4	11	5	4	1	—	—	1	93
Women at Hospital	over 21	—	5	—	7	—	4	—	—	—	—	16
Boys at Hospital	8-10	5	—	—	—	—	—	—	—	—	—	5
Various adults ...	over 21	4	5	—	2	1	1	—	1	—	—	14
Women at College	19-21	—	8	—	6	—	—	—	1	—	—	15
Factory Girls ...	14-17	—	16	—	4	—	1	—	2	—	—	23
Blind Institute ...	8-15	12	16	1	1	2	1	—	—	—	—	33
Various children	5-9	2	7	1	—	—	—	—	—	—	—	10
Two Board Schools	7-13	284	296	18	29	28	20	4	5	—	—	684
Children in Orèche	2-3	4	3	1	3	1	—	—	—	—	—	12
Blind Asylum ...	6-14	52	39	2	1	1	1	—	2	—	—	98
Rescue Home ...	16-20	—	13	—	—	—	—	—	—	—	—	13
Feeble-minded Home	8-16	105	5	8	—	7	1	1	—	—	—	127
Orphanage ...	7-15	95	82	2	7	5	6	1	1	—	—	199
Industrial Home	8-14	121	—	1	—	2	—	—	—	—	—	124
Rescue Home ...	8-16	56	30	—	2	1	1	—	—	—	—	90
Orphanage ...	4-17	97	78	2	2	1	—	1	—	—	—	181
Orphanage ...	2-14	211	—	3	—	1	—	2	—	1	—	218
Industrial Home	8-17	96	—	1	—	5	—	1	—	—	—	103
Total Number ...	...	1303	688	72	93	70	44	15	13	1	2	2301
Percentages ...	...	89.117	81.93	4.928	11.07	4.79	5.23	1.02	1.54	.068	.23	1461 ♂ 840 ♀

An analysis of the types of toe found in above institutions.

variation in the comparative length of the toes, on account of age. But, as the epiphyses unite with the shaft bones of the feet at 17 to 21 years in males and 14 to 18 in females, those ages must be considered adult as regards the feet, so that the female children examined by me were approximately adult. During the last four years I have had 19 children under observation from birth. Six of these babies altered from *A*, *B* or *S* types to *L* during the first two years of life, but in no case did a child obviously an *L* type at birth or slightly later (1 month) change to any of the other types. Never have I found a change of toe-type taking place after two years of age. These observations suggest that the adult condition as regards toe-type is reached by the age of two years. That a change does take place can be seen by comparing the radiograph of a child of one (Fig. 3) with the toe-tracing of the same child at two years (Fig. 2, v). The final position of the bones depends upon the period at which the child walks, the flexed position of the bones being retained in the foetal condition until the foot is flattened by some months of standing and walking.



Fig. 3. Radiograph of child of one year, showing *S* type. (Foot held down by an adult.)

The persons examined may be considered as fairly average of the population, as they came from some schools in Birmingham, two in Lancaster and a number of institutions in the Midlands, in which the children were drawn from all parts of England. The analysis shows the scarcity of all types except *L* and *S*. It is noticeable that there is a distinct sex bias in the *S* type, the females being twice as numerous as the males.

My method of examination was to have the person under observation stand upright with the mesial surfaces of the feet together. I then looked down upon the feet, my eyes being as nearly as possible above the middle of the metatarsal bones. In most cases the toe-type could be easily and rapidly determined, but, in a number of cases, the second toe had to be held flat down during the examination and, in some persons, the first toe had also to be held in its undeformed and primitive position. My method differed little from that of Weissenberg (1895), which he describes thus, "I lay the foot on the ground or on a stool and hold the leg upright, and after laying flat the toes, observe them from above in a line parallel with the *crista tibiae*." This appears to me the correct method of observation, when the sight falls in the middle of the foot."

It must be emphasised that what has been studied is the relative apparent length of the first two toes, or, in other words, the protrusion of one toe beyond the other. When beginning the research it was hoped that not only would the relative protrusion be noted, but that exact measurements of the amount of the protrusion would be obtained. This was abandoned for several reasons. Measurements on the living foot could have been made with considerable accuracy by first arranging the toes in their normal position, but it would have been impossible to take such measurements, as I was only allowed to examine the feet of persons in Institutions after undertaking to spend the minimum of time in the examination. This compelled me to resort to a personal decision as to which toe was the longer. In the great majority of cases the decision is obvious and easy and hence the error from the personal equation is very small.

Owing to the distortion of the average foot (p. 256) measurements were quite impossible from the toe-tracings (Fig. 2, p. 250), upon which the hereditary part of the work depended. A study of even a few family trees indicated that it was the actual protrusion and not the amount of the protrusion which was of fundamental importance and therefore the lack of measurement was not as important as it appeared.

As a problem in genetics the question of the inheritance of toe-type had the interest of being a *normal* human character, whereas most of those previously considered from the Mendelian standpoint have been pathological. I wished to attack the problem simultaneously from three points of view—first, an anatomical study was made by dissection, by examination of skeletons, of living feet of child and adult, the foetal foot and of radiographs; second, statistics were collected as to the percentages of the various types that occurred, and third, a study of family histories was made by means of toe-tracings (Fig. 2). In order to obtain these tracings, 7000 cards were circulated, each card having printed on it, name (not for publication) and in another corner, right foot. With the cards went the following instructions:

“I am doing a piece of research upon the human foot, and I should be very grateful if you would help me by doing as follows:—Place your bare foot on the enclosed card, and with a pencil held upright draw an outline of the toes. Do not draw between the toes. One side is for the right foot, the reverse for the left. Please press the second toe *out well*, until flat, before drawing, as this toe is frequently not flat owing to pressure of boots.

I enclose cards also for each member of your family, parents, brothers, sisters, children and grandchildren.

Please put name on each card and state whether child or adult, male or female.”

There are certain possibilities of error in the drawings: (1) the pencil may not be held in the same upright position throughout the drawing; (2) the second toe may not be pressed out flat; (3) the toe nails may protrude beyond the toes and be of unequal proportional lengths. The paper did not state the point to be studied, so that there could not have been any prejudice in the mind of the recorder: particular directions are given as to how the pencil should be held and there is small likelihood of the position becoming changed in doing the first two toes. That the direction “press the second toe out well” was duly considered, was evidenced by the number of persons who explained that it was difficult or impossible. In some cases, when the outline was blurred or uncertain, it has been repeated and then the subject was requested to note the relative protrusion. As a control over the accuracy of the drawings, 97 persons (over two years of age) were examined after their toe-tracings had been made and amongst these only one error occurred.

The paper circularised probably contains one error, viz. the statement that "the second toe is frequently not flat owing to pressure of boots." That was the idea held when the work was started, but it is not supported by observations on the naked feet of children and adults. It seems probable that the first toe is the only one which is flat in repose, the flexed position being the normal one for the others, which flatten out only when in use. The wearing of boots with a stiff sole has much reduced the use of the toes, so that the tendency is for them to remain in a flexed position, with possibly a consequent small degeneration of the toe muscles. These observations bear a certain relation to those of Pfitzner (1902) on the degeneration of the little or fifth toe. (Plate XXI, Right foot of Fig. III *a*).

As a rule, boots are too narrow for our feet, and there is therefore a lateral pressure which compresses the toes together: but boots are very rarely too short, at any rate among the middle classes, from whose feet these toe-tracings were principally made. The curled up second toe cannot therefore be accounted for as a result of foot-gear, especially as the majority have the first toe longest, and that, because of its very bulk, determines the length of the boot. The chief deformities are due to the unnatural curve of the inner margin of the boot, which presses the great toe outwards and then consequently produces an enlarged joint. There is a considerable difference in deformity between the feet of men and women (Plate XIX, I, II), the boots of women being by far the less natural. It is just this lateral displacement that makes the difficulty in judging the living foot and the tracings. Indeed, the toe-type of the tracings can only be determined accurately after an examination of a considerable number of feet, the experience with the living foot acting as a guide in determining the character of the tracings.

Both *S* and *L* types of feet occur among races which have never worn any foot-covering, so that neither the one nor the other type of toe can be exclusively due to the effects of foot-gear. Flower (1881) gives some very bad cases of deformed feet but I have not met any foot whose toes could not be arranged flat except in the case of congenital hammer toe. The few persons who had this deformed condition were not enumerated.

In passing, one may note that Park Harrison (1883) states that the third toe is never longer than the second, but this is certainly not the case as I have found it so in 19 persons. Weissenberg (1895) says "the third toe longer than the second may be hereditary or due to bad boots." How such a condition could arise from the latter cause is

difficult to conceive, but I have a series of tracings which seem to indicate that it is a hereditary character.

Weissenberg (1895) states that the first toe protrudes from 10 to 13 mm., but the second toe seldom more than 5 mm. In these statements I am at one with Weissenberg as regards measurements on 43 persons.

I regret not having been able to work out the relation of toe-type to height.

II. *The Study of the Foot of the Foetus.*

The only age factor of any importance is the foetal period, as shown by an examination of 91 embryos. (Table III.) This table shows that the *S* type is the commoner at this age, as it represents 50 per cent. of the females and 41·3 per cent. of the males. It is interesting to observe that, in spite of the smallness of the numbers, no *L* type appears in females until the fifth month, whilst it is found in males of four months. Perhaps, here too, there is evidence of the female retaining the primitive

TABLE III.

An analysis of the result of examining 91 foetuses.

Female Foetuses			Male Foetuses		
No. of Specimens	Age	Type	No. of Specimens	Age	Type
1	2 months	<i>S</i>	2	2 months	<i>S</i>
4	3 "	<i>S</i>	1	3 "	<i>S</i>
1	4 "	<i>S</i>	2	4 "	<i>S</i>
1	5 "	<i>S</i>	2	4 "	<i>B</i>
1	5 "	<i>L</i>	1	4 "	<i>L</i>
2	6 "	<i>S</i>	1	5 "	<i>S</i>
1	8 "	<i>L</i>	1	5 "	<i>B</i>
1	8 "	<i>S</i>	2	5 "	<i>L</i>
3	7—9 months	<i>A</i>	2	6 "	<i>L</i>
5	7—9 "	<i>B</i>	3	6 "	<i>S</i>
10	7—9 "	<i>S</i>	8	7—9 months	<i>S</i>
9	7—9 "	<i>L</i>	3	7—9 "	<i>B</i>
3	9 months	<i>S</i>	1	7—9 "	<i>A</i>
2	9 "	<i>L</i>	6	7—9 "	<i>L</i>
1	9 "	<i>A</i>	3	9 months	<i>L</i>
			1	9 "	<i>B</i>
			1 pair twins	9 "	<i>A</i>
			1 "	9 "	<i>S</i>
			1 set triplets	9 "	<i>B</i>
45=13 <i>L</i> , 23 <i>S</i> , 4 <i>A</i> , 5 <i>B</i> .			46=14 <i>L</i> , 19 <i>S</i> , 3 <i>A</i> , 10 <i>B</i> .		

character longer than the male. These results by no means agree with the observations of Braune (1884), who stated that the second toe was always the longest in the embryo. Volker (1905) supports this contention when he writes that, "in all its elements as well as in its position, the foot of the new-born child is analogous with that of the monkey." P. Harrison (1883) examined the feet of fifteen foetuses (8 male and 7 female) and found them to be 11 *L*, 3 *E*, 1 *S*. He does not state the ages or the relation of the type to the sex. It would be valuable to have radiographs of foetal feet and babies' feet at intervals from the sixth foetal month to the age of two, thus showing the change from the foetal to the adult condition.

The result of the examination of 14 foetal skeletons is shown in Table IV, from which it appears that there was not one *L* type. This result is probably incorrect, as 11 of the 14 are over six months old. The error is probably due to the difficulty of preparing and mounting a foetal skeletal foot, for, to get accurate results as regards the relative lengths of the toes, it would be necessary to retain the foot in the flexed position and certainly not to place it flat on the ground.

TABLE IV.

Skeletons of Foetuses.

No. of Specimens	Age	Type
1	4 months	<i>S</i>
2	5 "	<i>S</i>
3	6 "	<i>S</i>
1	7 "	<i>S</i>
1	7 "	<i>B</i>
1	8 "	<i>S</i>
2	9 "	<i>A</i>
3	9 "	<i>S</i>
Total number		14

III. *The Relation of the Toe-types to the Anatomy of the Foot.*

There has been considerable diversity of opinion as to whether type *L* or *S* was the more common. Thus, in the plates of Vesalius' anatomy (1543) the second toe is generally represented as the longer, but in one diagram, the two feet differ. Unfortunately it is impossible to state how far these diagrams are conventional or actually represent Italian conditions. Passing on to the "Anthropologia Nova" of Drake in 1707, one finds the woman of Table XXI and the man of Table XXII both

represented with the second toe longest (type *S*) but the text reads, "*Pollex pedis* is longer than the other toes." In 1864 Vogt, in *Lectures on Man*, refers on p. 153 to "the length of the great toe which generally exceeds in man, that of the other toes," but the skeleton on p. 56 shows the second toe as the longest. Marshall in *The Human Body* (1875), makes no statement, but the skeleton represented shows the *S* type and the drawings of the feet are *L*, *S*, *A* and *B*. Flower in 1881 writes: "The first or inner toe is much larger than either of the others and its direction is parallel with the axis of the foot....It seems to be a common idea with artists and sculptors as well as anatomists, that the second toe ought to be longer than the first in a well proportioned human foot....Among hundreds of bare and therefore undeformed feet of children I lately examined in Perthshire, I was not able to find one in which the second toe was the longest." Braune in 1884 stated that the second toe was always the longer in the foetus and also among 70 per cent. of adults and this statement is repeated as authoritative by Stratz in 1903. Kollmann, agreeing with Braune, says that 30 per cent. only of the population of civilized countries have the *L* type of foot, whilst Holden on the other hand says that the majority are of the *L* type. Weissenberg in his important paper of 1895 finds that the majority have the *L* type of foot. Lazarus in 1896 published complex tables of the exact measurements of the foot bones, but does not give their relation to the relative lengths of the toes of the foot. Dunlop in *Anatomical Designs for Art Students* (1899) represents the foot and the skeleton with the second toe decidedly the longer. Pfitzner in his papers from 1901 to 1903 recognises the existence of both types. Thomson in *Anatomy for Art Students* (1906) makes no statement but writes, "in regard to the length of the toes, there is much diversity of opinion." Volker (1905) did not examine the living foot nor does he state the appearance of the skeleton, but makes it clear, that for most Europeans, the first toe appears the longest. Volker was limited by examining only the skeleton of the foot, very few of which are prepared sufficiently well for careful work. Undoubtedly radiographs give a truer idea of the relation of the bones than the dried skeleton. Dwight (1907) in *Variations of the Bones of the Hand and Foot* did not touch on the point now under consideration. An examination, however, shows both *S* and *L* types among his radiographs, but the majority of them were so taken that no conclusion can be reached as regards the relation of the toes to one another. From the above summary of the literature, it becomes obvious that a further enquiry was needed for England.

The examination of a number of skeletons showed that, compared with the results of a study of the living foot, too large a proportion had the *S* type of foot. In order to discover to what this discrepancy is due, it would be necessary to make an examination of a large number of fresh feet, the fresh skeletons of these feet and the same skeletons when carefully dried. As I was only able to carry out this work in one instance, this question must be left to future investigators.

In consequence of the existence of a number of types of feet, it has become necessary to discover to what factor the difference in the apparent length of the toes is due. It was important from the Mendelian point of view to decide whether this difference was due to variations in length of one or more of the skeletal elements or to the terminal soft tissue. In other words, is it due to some unit character or is this difference, like height, due to a group of characters too complex to be analysed, or, though due to a complex of factors, may it still be inherited as a "unit"?

For the purpose of this research radiographs were taken of two complete families, each consisting of two generations. In one family there were the two parents and four sons; in the other (Fig. 2, and Plates XIX—XXI), the two parents and three children, two boys and a girl. In both these families the feet of the two parents were different, whilst the children were of various types. The only difficulty which attended the taking of the photos was in keeping the second toe flat, but this was overcome in the case of the young children by means of a board placed on the toes. The radiographs were taken by placing the naked foot on a plate and arranging the centre of focus to fall about one-third from the distal end of the third metatarsal. The arch of the foot makes the radiographs slightly incorrect as the distal ends of the metatarsals are nearer to the plate than the proximal ends. As the arch increases with the length of the bones, that is, from childhood to maturity, there would be the same proportion of error for each foot. Hence the error may be considered negligible when making comparisons between a series of radiographs, all taken under the same conditions. The only condition which might have detracted from the results would have been a bad case of flat-footedness, but of this, no instance was found.

A comparison of Fig. 2, with Plates XIX, XX and XXI, shows the correctness of the toe-tracings in these cases. But, it is apparent that the outline of the foot is not exactly the same as the outline of the skeleton. If the skeleton of the feet as shown by the radiographs had alone been examined, the feet would, with one exception (not illustrated), have

appeared of the same type as indicated by the toe-tracings. In this exception, the foot when judged by the outline appeared *L*, but appears as an *E* when judged by the skeleton.

Measurements of the thickness of the soft tissue at the ends of the first and second toes were made and are shown in Table V. These measurements show that the soft tissue at the end of the great toe is constantly longer than that of the second toe and that this difference increases with age. Thus, the average length of the soft tissues for the first toe is 0.535 cm. and for the second toe is 0.396 cm. On further analysing the results, it appears that the excess in length of the soft tissue of the first toe is 0.111 cm. for the *L* type of foot and 0.177 for

TABLE V.

Measurement of Length of Soft Tissues at end of First and Second toes, taken from Radiographs.

Type of Toe	Sex	First Toe	Second Toe	Reference to Radiograph
<i>S</i>	♂	0.6	0.35	
<i>L</i>	„	0.7	0.4	
<i>L</i>	„	0.5	0.4	
<i>L</i>	♀	0.55	0.3	
<i>L</i>	„	0.55	0.4	
<i>S</i>	♂	0.5	0.4	
<i>S</i>	„	0.55	0.4	
<i>S</i>	♀	0.4	0.4	Plate XXI, III <i>a</i> and III <i>b</i>
<i>L</i>	„	0.4	0.35	
<i>S</i>	„	0.6	0.4	Plate XX, II <i>a</i> and II <i>b</i>
<i>S</i>	„	0.6	0.45	
<i>S</i>	♂	0.7	0.4	
<i>L</i>	„	0.6	0.45	
<i>L</i>	„	0.52	0.45	Plate XX, I <i>a</i> and I <i>b</i>
<i>L</i>	„	0.5	0.5	
<i>S</i>	„	0.4	0.3	Figure 3
<i>L</i>	„	0.45	0.3	
<i>L</i>	„	0.4	0.35	
<i>L</i>	„	0.55	0.5	Plate XXI, IV <i>a</i> and IV <i>b</i>
<i>L</i>	„	0.55	0.45	
<i>L</i>	„	0.5	0.45	
<i>L</i>	„	0.5	0.45	
<i>S</i>	♀	0.65	0.3	
<i>S</i>	„	0.6	0.3	
<i>L</i>	♂	0.55	0.4	
<i>S</i>	„	0.5	0.45	
Average length		0.535	0.396	
Average length of <i>L</i> type		0.521	0.41	
Average length of <i>S</i> type		0.554	0.377	

First and Second Toes in Man

the *S* type. The importance of these measurements is, that the *L* type is not, at any rate in these cases, due to the extra length of the soft tissue, and the *S* type of foot has the second toe longest, *in spite of* the excess of soft tissue at the end of the great toe. These observations by no means aid in explaining why so large a proportion of skeletal feet are of the *S* type—except that they suggest that the discrepancy is due to careless preparation of the feet. Volker met the same difficulty in that his measurements of the skeletal elements contradicted “les résultats de plusieurs mensurations prises sur les vivants...Je dois avouer que dans ce moment je n’ai pas de données pour expliquer cette contradiction. Peut-être faut-il la chercher dans l’épaisseur des tissus graisseux au bout du gros orteil chez les vivants, ou peut-être aussi dans ce fait que beaucoup de mensurations ont été faites sans appuyer sur le deuxième orteil presque toujours plus plié, pour le redresser en toute sa longueur.” Unless, however, the toes tabulated are unusual, the explanation certainly does not lie in the soft tissues.

Table VI gives the measurements of the phalangeal bones, of the metatarsal bones and of the complete column or digit, in 26 radiographs. The measurements have been taken along the median axis of each bone by means of a transparent glass cm. rule. The axes of the digits are not naturally parallel to the main axis of the foot. When a digit was displaced from its correct position, each bone was measured separately in order to obtain the correct undistorted length.

The most striking result is, that in all cases, except one, the first phalanges are longer than the second, whether the foot be of the *L* or *S* type. In this one instance, the female of the first family in Table VI, the bony toes of the left foot are equal and on the right foot the second toe is 0.1 cm. longer than the first. It is hence obvious that the factor for toe-type does not lie in the toe alone.

Lazarus gives a table with the lengths of the phalanges in 13 cases, of which 11 show the first toe-bones longer, in one the skeletal toes are equal, and in the thirteenth case the second phalanges were longer than the first. He, however, makes no statement concerning the appearance of the living foot. Volker, who also dealt only with the skeleton, made extensive measurements, and he writes: “The first toe in all races is longer than the second, except it appears among the Melanesians, among whom the two toes are of equal length.”

Table VI shows further, that in every case the second metatarsal is longer than the first. Lazarus also found this to be the condition in 15 cases, which varied in age from a foetus of 3½ months to an adult.

TABLE VI.

Giving lengths in cm. of the Metatarsals (Mt), Phalanges (Ph), and complete Digit (Dg), of the Left and Right feet of two complete families and of four other persons.

Person	Toe type	Left					Left					Left				
		Mt 1	Mt 2	Mt 3	Mt 4	Mt 5	Ph 1	Ph 2	Ph 3	Ph 4	Ph 5	Dg 1	Dg 2	Dg 3	Dg 4	Dg 5
Parent ♂	... B	7.1	7.8	7.2	6.1	5.5	6.0	5.8	5.1	4.8	4.0	13.3	13.9	12.6	11.1	9.9
Parent ♀	... S	6.55	7.1	6.7	6.45	6.2	4.9	4.9	4.1	3.8	3.2	11.5	12.1	10.9	10.4	9.5
Son ...	... S	6.8	7.7	7.4	6.4	5.8	5.7	5.2	4.8	4.2	3.3	12.7	13.1	12.6	11.0	9.2
Son ...	... L	6.2	7.3	7.1	6.7	6.0	5.15	4.8	4.5	4.0	3.0	11.6	12.1	11.7	10.8	9.2
Son ...	... B	6.2	7.4	6.9	6.8	5.1	5.0	4.7	4.5	4.2	3.3	11.3	12.3	11.7	11.1	9.6
Son ...	... L	4.0	4.8	4.5	4.4	4.0	3.8	3.45	3.3	3.0	2.6	8.3	8.8	8.4	7.9	7.3
Parent ♂	... L	7.0	8.4	8.0	7.4	6.9	6.4	5.8	4.8	4.3	3.7	13.5	14.3	13.2	11.8	11.0
Parent ♀	... S	—	—	—	—	—	5.3	4.9	4.25	3.7	2.9	—	—	—	—	—
Daughter	... A	4.2	4.9	4.8	4.5	4.3	3.7	3.2	3.0	2.7	2.3	8.3	8.5	8.2	7.6	7.2
Son ...	... L	3.45	3.55	3.2	3.15	3.25	3.3	3.2	3.05	2.5	2.3	7.4	7.5	7.05	6.6	6.3
Son ...	... S	2.5	2.6	2.4	2.25	2.2	2.55	2.4	2.15	1.95	1.85	5.6	6.1	5.5	5.1	5.0
Odd ♀	... L	7.8	8.4	8.2	7.5	7.2	6.7	5.8	5.1	4.8	3.6	14.5	14.4	13.4	12.2	11.0
Odd ♂	... L	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Odd ♂	... L	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Odd ♂	... S	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Average all types		5.61	6.36	6.44	5.6	5.13	4.87	4.51	4.05	3.66	3.0	10.72	11.19	10.47	9.6	8.65
Average L types		5.44	6.22	5.97	5.61	5.27	4.84	4.37	3.96	3.55	2.91	10.6	11.08	10.32	9.48	8.66
Average S types		5.83	6.52	6.12	5.6	4.96	4.91	4.65	4.15	3.77	3.09	10.88	11.38	10.66	9.74	8.64
L type	... 100	114.33					100	90.3				100	104.0			
S type	... 100	111.83					100	94.7				100	104.6			

Person	Toe type	Right					Right					Right				
		Mt 1	Mt 2	Mt 3	Mt 4	Mt 5	Ph 1	Ph 2	Ph 3	Ph 4	Ph 5	Dg 1	Dg 2	Dg 3	Dg 4	Dg 5
Parent ♂	... B	7.0	7.7	7.1	6.2	5.5	6.1	5.8	5.3	5.0	4.9	13.3	13.75	12.4	11.2	9.8
Parent ♀	... S	6.7	7.2	6.9	6.8	6.7	5.0	5.1	4.55	4.0	3.3	11.7	12.4	11.4	10.8	9.9
Son ...	... S	6.7	7.6	7.0	6.1	5.0	5.5	5.2	4.6	4.2	3.4	12.4	13.0	11.4	10.4	8.6
Son ...	... L	6.3	7.1	6.7	6.0	5.2	5.0	4.8	4.4	3.9	3.2	11.6	12.1	11.1	10.1	8.5
Son ...	... B	6.2	6.8	6.5	5.9	5.0	5.2	4.8	4.4	4.2	3.2	11.4	11.9	11.2	10.4	8.3
Son ...	... L	4.0	4.7	4.3	4.2	4.0	3.7	3.3	3.15	3.0	2.5	8.2	8.7	8.1	7.7	7.1
Parent ♂	... L	7.6	8.3	7.9	7.4	6.6	6.4	5.6	4.6	4.1	3.8	13.9	14.1	12.6	11.6	10.3
Parent ♀	... S	—	—	—	—	—	5.4	5.2	5.0	3.8	3.2	—	—	—	—	—
Daughter	... A	4.3	4.9	4.7	4.4	4.1	3.65	3.25	2.8	2.32	2.1	8.3	8.9	8.2	7.4	7.2
Son ...	... L	3.5	3.6	3.35	3.15	3.3	3.5	3.3	3.2	2.7	2.3	7.5	7.7	7.4	6.7	6.56
Son ...	... S	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Odd ♀	... L	7.95	9.0	8.6	8.0	7.5	6.3	6.2	5.2	4.4	3.8	14.5	15.3	14.1	12.1	11.3
Odd ♂	... L	6.8	7.8	7.8	7.7	7.3	6.2	5.2	4.8	4.7	3.7	13.1	13.2	13.0	12.8	11.0
Odd ♂	... L	6.8	8.1	7.8	7.4	7.1	6.4	5.5	4.6	4.3	4.0	13.3	13.75	12.7	11.8	11.2
Odd ♂	... S	6.4	7.1	6.9	6.8	6.6	5.4	5.4	4.7	4.2	3.5	12.15	12.9	12.0	11.25	10.6
Average all types		6.17	6.91	6.58	6.15	5.68	5.26	4.9	4.37	3.91	3.35	11.64	12.13	11.2	10.32	9.25
Average L types		6.24	7.01	6.67	6.21	5.72	5.42	4.94	4.4	4.03	3.48	11.86	12.27	11.4	10.48	9.34
Average S types		6.02	6.7	6.37	6.02	5.6	4.99	4.83	4.33	3.7	3.1	11.13	11.8	10.75	9.96	9.07
L type	... 100	112.3					100	91.14				100	103.45			
S type	... 100	111.3					100	96.8				100	106.0			

Volker, whose work extended to many races besides Europeans, found that in *all* races, the second metatarsal was longer than the first.

The next measurements taken were the total lengths of the toe bones plus the metatarsals, that is, the complete anatomical digit. Here again my findings agree with Volker, that the second digit (la colonne métatarso-phalangeale) is in all cases the longer, and this, *whether the foot is of the L or of the S type*.

The findings from the three sets of measurements, (1) that the average length of the first phalanges (bony toe) is always greater than the second; (2) that the second metatarsal is in all cases longer than the first, regardless of toe-type; and (3) that the whole second digit is constantly longer than the first, throw no light upon why there are *L* and *S* toe-types. Hence, the relations of the phalanges, metatarsals and digits have been calculated in percentages, the first digit or any of its constituent parts being reckoned as 100 (see last two lines of Table VI). From these numbers is obtained the important result *that both for right and left feet, the second digit in the S type is proportionately longer than in the L type*.

IV. *The Inheritance of Toe-types.*

In order to study the inheritance of toe-type, tracings were obtained, in the manner already described, of 808 persons (Table VII), of these 381 were offspring of known parents (Table VII, *A*), 150 had one known parent (Sub-tables *B* and *C*), 92 were members of fraternities (Sub-table *D*), and 185 were the parents of persons in Tables *A*, *B*, *C*, *D* who do not therefore appear in these tables. It is at once apparent that the proportion of the various types among these 808 persons is not the same as among the 2301 persons (Table II) I had personally examined. This discrepancy, however, is not due to the faultiness of the toe-tracings, but to the fact that these were made from selected cases, whilst the feet examined may be regarded as an average of the population. There were great difficulties in obtaining the tracings, as there are strong prejudices connected with the naked foot, so that, in order to see the inheritance in the hybrid generation, very special efforts were made to obtain families where *S*, *A* and *B* toe-types were known to exist, and other families had to be neglected. The large proportion of females among the tracings is explainable on the same ground, as it was possible for me to persuade more females than males to submit themselves to what appeared an ordeal. There is, therefore, for two reasons, selection and sex, a larger proportion of *S* type and therefore of *A* and *B* types than would normally occur in the general population.

TABLE VII.

*Tables A, B, C, D, E, analysing the Offspring of Various Matings.**Sub-Table A. In which both parents are known.*

Number of Matings	Type of Mating	<i>L</i>		<i>S</i>		<i>A</i>		<i>B</i>		<i>E</i>		Total Number
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
54	<i>L</i> ♂ × <i>L</i> ♀	85	65	—	—	1	2	1	—	—	—	154
2	<i>S</i> ♂ × <i>S</i> ♀	—	1	2	6	—	—	—	—	—	—	9
16	<i>L</i> ♂ × <i>S</i> ♀	18	12	1	5	3	1	1	2	—	—	43
9	<i>S</i> ♂ × <i>L</i> ♀	10	18	3	1	—	1	2	1	—	1	37
25	<i>L</i> ↔ <i>S</i>	28	30	4	6	3	2	3	3	—	1	—
14	<i>L</i> ♂ × <i>A</i> ♀	13	20	1	4	1	1	1	1	—	—	42
12	<i>A</i> ♂ × <i>L</i> ♀	15	20	1	2	—	2	—	2	—	—	42
26	<i>L</i> ↔ <i>A</i>	28	40	2	6	1	3	1	3	—	—	—
4	<i>L</i> ♂ × <i>B</i> ♀	5	5	—	2	1	—	1	—	—	—	14
1	<i>B</i> ♂ × <i>L</i> ♀	4	3	—	2	—	—	1	—	—	—	10
5	<i>L</i> ↔ <i>B</i>	9	8	—	4	1	—	2	—	—	—	—
0	<i>S</i> ♂ × <i>A</i> ♀	—	—	—	—	—	—	—	—	—	—	—
1	<i>A</i> ♂ × <i>S</i> ♀	2	—	1	—	—	—	—	—	—	—	3
1	<i>S</i> ↔ <i>A</i>	2	—	1	—	—	—	—	—	—	—	—
2	<i>S</i> ♂ × <i>B</i> ♀	4	3	—	4	—	1	—	—	—	—	12
3	<i>B</i> ♂ × <i>S</i> ♀	5	1	2	—	—	—	1	—	—	—	9
5	<i>S</i> ↔ <i>B</i>	9	4	2	4	—	1	1	—	—	—	—
0	<i>A</i> ♂ × <i>A</i> ♀	—	—	—	—	—	—	—	—	—	—	—
2	<i>B</i> ♂ × <i>B</i> ♀	1	1	—	—	1	—	—	—	—	—	3
1	<i>A</i> ♂ × <i>B</i> ♀	—	1	—	—	—	—	—	—	—	—	1
2	<i>B</i> ♂ × <i>A</i> ♀	2	—	—	—	—	—	—	—	—	—	2
3	<i>A</i> ↔ <i>B</i>	2	1	—	—	—	—	—	—	—	—	—
0	<i>E</i> ♂ × <i>E</i> ♀	—	—	—	—	—	—	—	—	—	—	—
123	—	164	150	11	26	7	8	8	6	—	1	381 (190♂ + 191♀)

Sub-Table B. In which mother only is known.

Number of Matings	Type of Parent	Toe Type of Offspring										Total Number of Offspring
		<i>L</i>		<i>S</i>		<i>A</i>		<i>B</i>		<i>E</i>		
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
24	<i>L</i>	16	29	1	7	1	1	—	2	—	—	57
14	<i>S</i>	6	12	1	3	3	2	—	2	—	—	29
5	<i>A</i>	3	5	—	—	—	1	—	—	—	—	9
43	—	25	46	2	10	4	4	—	4	—	—	95 (31 ♂ + 64 ♀)

Sub-Table C. In which father only is known.

Number of Families	Type of Parent	<i>L</i>		<i>S</i>		<i>A</i>		<i>B</i>		<i>E</i>		Total Number of Offspring
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
16	<i>L</i>	19	21	2	1	1	2	—	—	—	—	46
1	<i>S</i>	1	—	—	—	—	—	—	—	—	—	1
2	<i>A</i>	2	2	—	3	—	1	—	—	—	—	8
19	—	22	23	2	4	1	3	—	—	—	—	55 (25♂ + 30♀)

Sub-Table D. Families in which neither mother or father is known, designated by H. (homogeneous) and M. (mixed).

Number of Fraternities	Type	<i>L</i>		<i>S</i>		<i>A</i>		<i>B</i>		<i>E</i>		Total Number of Offspring
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
21	H.	21	31	—	—	—	—	—	—	—	—	52
11	M.	8	13	3	8	2	3	1	2	—	—	40
32	—	29	44	3	8	2	3	1	2	—	—	92 (35 ♂ + 57 ♀)

Sub-Table E. Tracings of persons (parents) who do not appear in A, B, C or D.

<i>L</i>		<i>S</i>		<i>A</i>		<i>B</i>		<i>E</i>		Total Number of Offspring
♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
57	57	11	23	13	15	3	6	—	—	185 (84 ♂ + 101 ♀)

Sub-Table F. Total of all persons appearing in above tables.

Total of Group		<i>L</i>		<i>S</i>		<i>A</i>		<i>B</i>		<i>E</i>		Total Number of Offspring
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
	<i>A</i>	164	150	11	26	7	8	8	6	—	1	381 (190 ♂ + 191 ♀)
„	<i>B</i>	25	46	2	10	4	4	—	4	—	—	95 (31 ♂ + 64 ♀)
„	<i>C</i>	22	23	2	4	1	3	—	—	—	—	55 (25 ♂ + 30 ♀)
„	<i>D</i>	29	44	3	8	2	3	1	2	—	—	92 (35 ♂ + 57 ♀)
„	<i>E</i>	57	57	11	23	13	15	3	6	—	—	185 (84 ♂ + 101 ♀)
		297	320	29	71	27	33	12	18	—	1	808 (365 ♂ + 443 ♀)
Percentages	...	81.09	72.23	8.22	16.02	7.39	7.44	3.28	4.06			

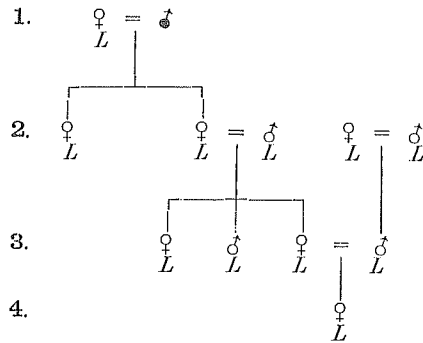
Table VII (Sub-table A) gives an analysis of the various types of matings and of the offspring. The total number of families consisting of two complete generations is 123, producing on the average about three offspring each.

Fifty-four matings of $L \text{ ♂} \times L \text{ ♀}$ were obtained, which produced 154 offspring, all of which were L except 4, which were A and B (Fig. 4, Trees B and C). This indicates that the L type practically breeds true. The persistence of the L type is seen in Fig. 4 (Trees A , B , C). It was not possible for me to see the four exceptional cases, but re-tracings in each case confirmed the type. An enquiry was made into the history of these four exceptions (3 A and 1 B). Tree C in Fig. 4 shows the family of one male A in which there is no trace of any departure from the L type. The one case of a male B , as shown in Fig. 4, Tree B , gives an L ancestry of both the male and female parents, but there is nothing here to show that one of the parents was not heterozygous. Consideration may next be given to the two females (Table VII, Sub-

FIGURE 4.

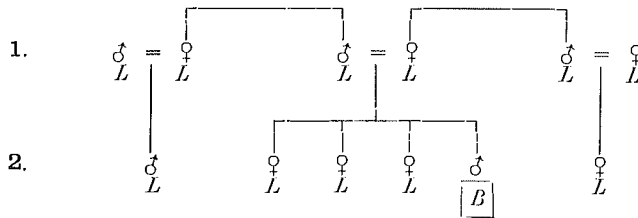
Showing three family groups (Trees A, B, C) in which there is persistence of the *L* toe-type.

Tree A.



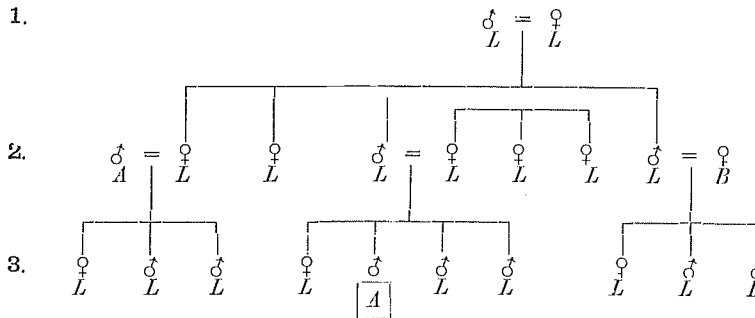
Four generations of *L* type.

Tree B.



Two generations of *L* type with the appearance of a *B* (one of the exceptions mentioned in text).

Tree C.



Three generations with persistence and dominance of *L*, but the appearance of an *A*.

table *A*) of the *A* type. In one case both parents had *L* toe-type, but the tracing of the father was unsatisfactory. Nothing is known of the ancestry or sibs of the parents. The sister and brother of this case were undoubtedly *L*. The second case of a female *A* is seen in Fig. 5, Tree *D*, where an *S* grandparent is known, and where, therefore, the *L* father may be a heterozygote.

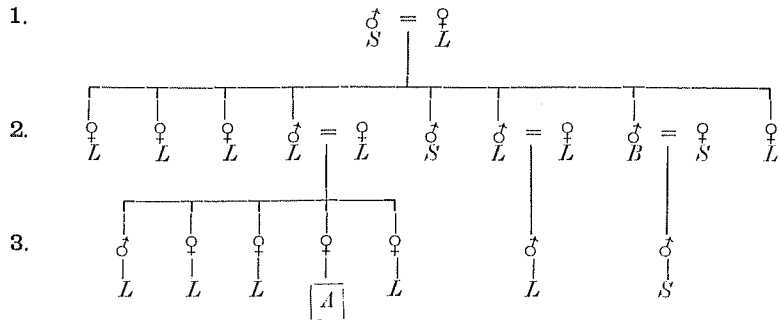
Unfortunately I only obtained two matings of $S \text{ ♂} \times S \text{ ♀}$; these produced nine offspring, eight *S* and one *L*. These numbers are far too small, but they seem to indicate a tendency to breed true. One of the families is seen in Fig. 5, Tree *E*, (iii). This tree shows side by side two family groups (ii and iii) which certainly suggest segregation, and here the offspring are numerous enough to make the results impressive.

The next mating analysed is $S \text{ ♀} \times L \text{ ♂}$ and $L \text{ ♀} \times S \text{ ♂}$. These 25 matings gave 80 offspring, divided thus, 58 *L*, 10 *S*, 11 *A* and *B*, 1 *E*, or 58 *L* and 22 of the other types; here there is partial dominance of the *L* over the *S* type, approximately $2\frac{3}{4}$ to 1, suggesting either that there are several factors which make up the final result, or that some *L* type parents were not pure. If *S* is the recessive type, as appears from this crossing and others yet to be studied, how can any *S* arise as the result of the $L \leftrightarrow S$ cross? The explanation is to be found in the probability that a few *L* types are heterozygous this would also account for the few *A* and *B* types found among the descents of $L \times L$. Of the 25 cross-matings, 9 only have any *S* offspring, and of these enough is only known in one case to suggest an explanation. This history is seen in Fig. 5, Tree *F*. The grandmother here is an *S*, so that the father may be a heterozygote.

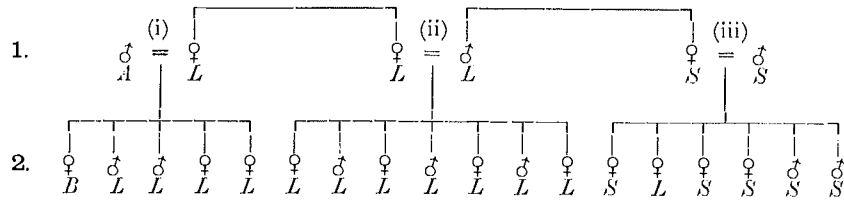
There were 31 matings of $L \times A$ and $L \times B$, producing 124 offspring, 85 *L*, 12 *S*, 11 *A* and *B*, or 85 *L* to 23 of the other types, approximately $3\frac{3}{4}$ to 1; again the *L* type shows its dominance, and as would be expected if *A* and *B* are the heterozygous forms, there is a larger proportion of *L* produced than in the $L \times S$ matings where the *L* offspring are to the "other" type offspring as $2\frac{3}{4}$ is to 1.

The appearance of any *S* type is not to be accounted for in this cross, unless again, some *L* are heterozygous. Amongst the 31 matings 9 only produced the 12 *S* offspring. In 7 of these matings nothing is known of the ancestry of the *L* parent; in the eighth case the *L* parent is one of a pure *L* fraternity and there is therefore no collateral history. In the remaining case, the *L* parent had a pure *L* ancestry but had a sister who was *A* type. It should be noted that of the 12 *S* offspring, a large proportion, 10, are females.

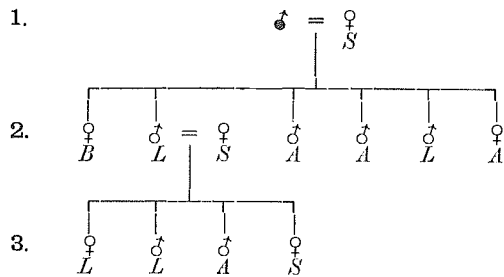
FIGURE 5.

Tree D.

Three generations showing an unexpected *A* and an expected *S* in third generation.

Tree E.

Two generations to show a hybrid generation (i), and pure breeding in (ii) and (iii).

Tree F.

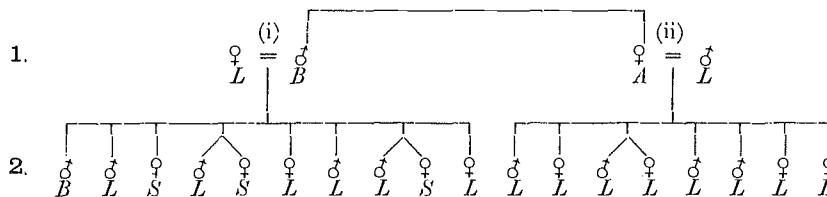
Three generations showing a variety of types.

Only 6 matings $S \times A$ and $S \times B$ were recorded, these produced 24 offspring, 15 L , 7 S , 2 A and B , or 15 L type and 9 of the other types. Again there is dominance of the L type, but the proportion, 15 : 9, indicates a very real genetic difference between this type of mating and $L \times (A \text{ or } B)$ in which the offspring are as $3\frac{3}{4} : 1$ or 15 : 4.

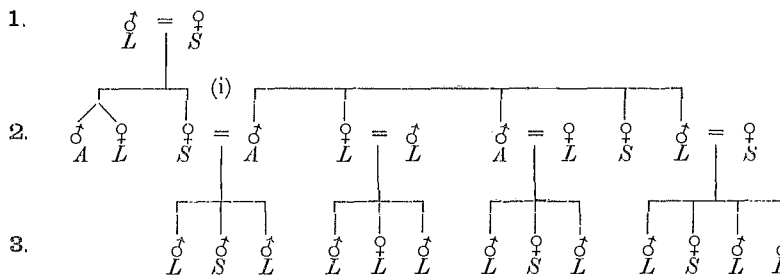
The five remaining matings between A and B types gave only 6 offspring, 5 L and 1 A , the L factor being preponderantly dominant. The behaviour of A and B with one another and with S and L respectively, makes it clear that they are heterozygous types, just as the matings $L \times L$ and $S \times S$ show that these are generally pure types for the character under consideration.

The net result of all these groupings is to show that the L toe-type is the dominant, the dominance being, so far as yet determined, irregular. The usual heterozygous forms are A and B , but some L types also behave as heterozygotes. That L may be both a hetero- and a homozygote is seen from Fig. 6, Tree G .

FIGURE 6.

Tree G.

Two generations to show the two values of L . Amongst the offspring are three pairs of ordinary twins.

Tree H.

Three generations.

Consideration must be now given to the possibility that S is sometimes a heterozygous form. The six matings $S \times (A \text{ or } B)$ produced 15 L and 9 of the other types, a very large proportion of L , unless S is sometimes heterozygous or unless the L factor is what may be described as an *excessive* dominant, and the matings $L \times S$ by no means indicate that. In this connection the family in Fig. 6, Tree H , (i), is interesting, where the mating $S \text{ } \text{♀} \times A \text{ } \text{♂}$ produced two male L . Now this female S may be a heterozygote, being the child of the mating $L \text{ } \text{♂} \times S \text{ } \text{♀}$, or the two male L of generation three may themselves be heterozygotes, a point which can only be settled during the next decade. This may be a case in which the heterozygote appears as an S because it is a female.

There is certainly a sex factor in the S type and this may be accounted for by the existence of certain female heterozygotes appearing as S type; on the contrary, there may be a tendency for the male heterozygote to appear as an L . It is possible that a comparison of the matings $L \text{ } \text{♂}$ with A, B or S , and $L \text{ } \text{♀}$ with A, B or S , may throw some light on the sex difference. Of the former, there are 34 matings, producing 72 L , 14 S , 13 A and B , or 72 L type to 27 of the other types, a proportion of 16 : 6. Of the latter ($L \text{ } \text{♀}$ with A, B or S) there are 22 matings producing 70 L , 9 S , 10 A and B , or 70 L to 19 other types or approximately 23 : 6. These results suggest at once that more male than female L are heterozygotes. Reference must here be made to Fig. 6, Tree G , in which it is the female L which appears heterozygous rather than the male L .

The above results must be controlled by an enquiry into the proportion of the sexes in the groups of offspring arising from the above two groups of matings. In both cases the A and B types will not be counted as they show no sex difference.

The mating $L \text{ } \text{♂} \times (A, B \text{ or } S)$ produces 86 L and S offspring, divided thus: L , 35 ♂ and 37 ♀ ; S , 3 ♂ and 11 ♀ , i.e. $\text{♂} : \text{♀} :: 3 : 4$, and there are 19.4 per cent. of S type.

The mating $L \text{ } \text{♀} \times (A, B \text{ or } S)$ produces 79 L and S offspring divided thus: L , 29 ♂ and 41 ♀ ; S , 4 ♂ and 5 ♀ , i.e. $\text{♂} : \text{♀} :: 3 : 4$, and there are 12.8 per cent. of S type.

The sexes in both cases are approximately the same, but a larger proportion of S is produced where the L parent is male rather than female. Thus, the above deduction is confirmed, that when the L type is heterozygous, it is more frequently male than female.

The results of the various matings may be summarised thus:

Type of Mating	Toe-Types				
	<i>LL</i>	<i>SS</i>	<i>A (LS)</i>	<i>B (SL)</i>	<i>E</i>
54 <i>L</i> × <i>L</i>	154	—	3	1	—
2 <i>S</i> × <i>S</i>	1	8	—	—	—
25 <i>L</i> × <i>S</i>	58	10	5	6	1
31 <i>L</i> × (<i>A</i> or <i>B</i>)	85	12	5	6	—
6 <i>S</i> × (<i>A</i> or <i>B</i>)	15	7	1	1	—
5 <i>A</i> × <i>B</i>	5	—	1	—	—

V. *Summary of General Conclusions.*

1. Three toe-types occur, but two are much more common than the other.
2. The commonest toe-type in England is one in which the first toe is longer than the others.
3. There is some limitation in regard to sex, the *S* type occurring more commonly in females than in males.
4. The *S* type of toe is commonest in the foetus.
5. The *S* or *L* types are produced by the comparative lengths of the digit, combined with an unknown factor.
6. The *L* type of foot is irregularly dominant over the *S* type of foot.
7. The heterozygous types are usually *A* and *B*, but some *L* types are heterozygous.
8. The male heterozygote tends to be *L*, the female heterozygote to be *S*.

DESCRIPTION OF PLATES.

PLATE XIX.

Photographs of feet of I. male parent, II. female parent, III. female child, IV. male child, outlines (toe-tracings) of which are represented in Figure 2.

PLATE XX.

Radiographs of feet of male (*I a* and *I b*) and female (*II a* and *II b*) parents represented in Plate XIX.

PLATE XXI.

Radiographs of feet of female (*III a* and *III b*) and male (*IV a* and *IV b*) children, represented in Plate XIX.

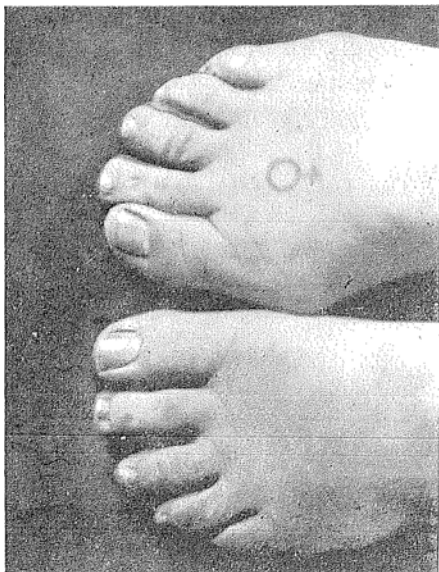


Fig. I.

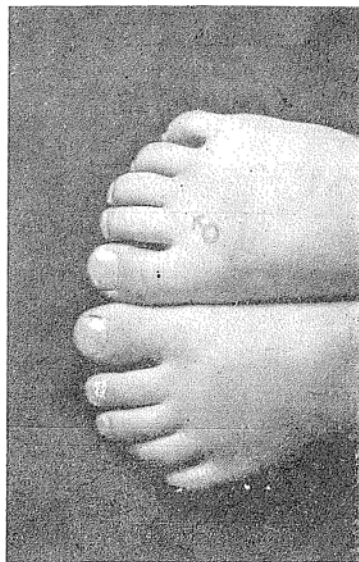


Fig. II.



Fig. III.

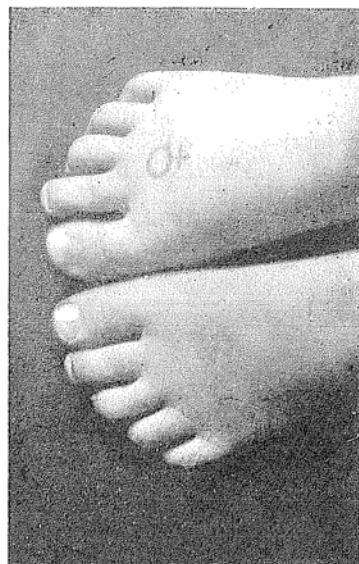


Fig. IV.



Fig. I *a*. Right foot of I. (Pl. XIX).

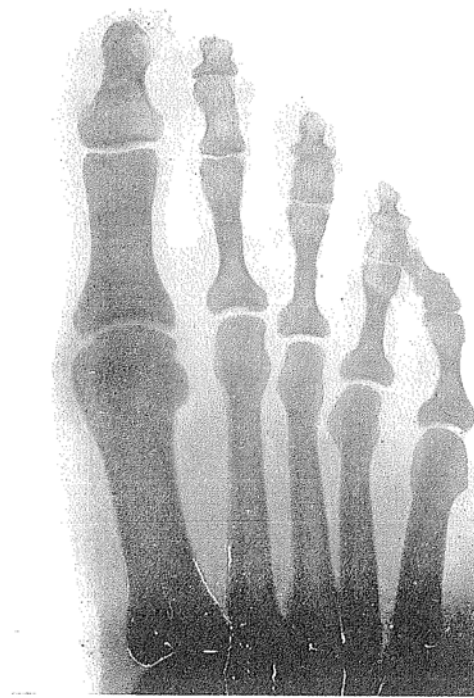


Fig. I *b*. Left foot of I. (Pl. XIX).



Fig. II *a*. Left foot of II. (Pl. XIX).



Fig. II *b*. Left foot of II. (Pl. XIX).



Fig. III *a*. Right foot of III. (Pl. XIX).



Fig. III *b*. Left foot of III. (Pl. XIX).

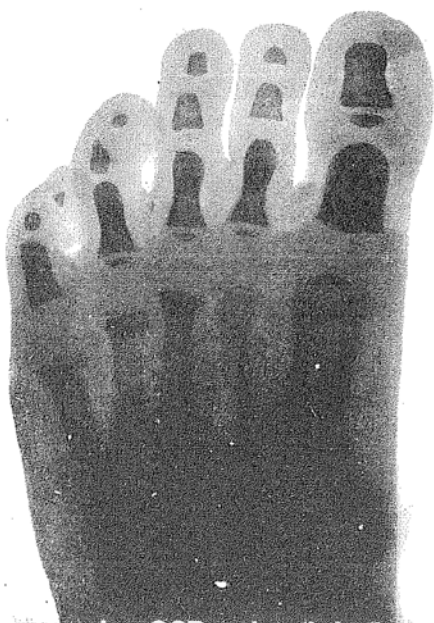


Fig. IV *a*. Right foot of IV. (Pl. XIX).

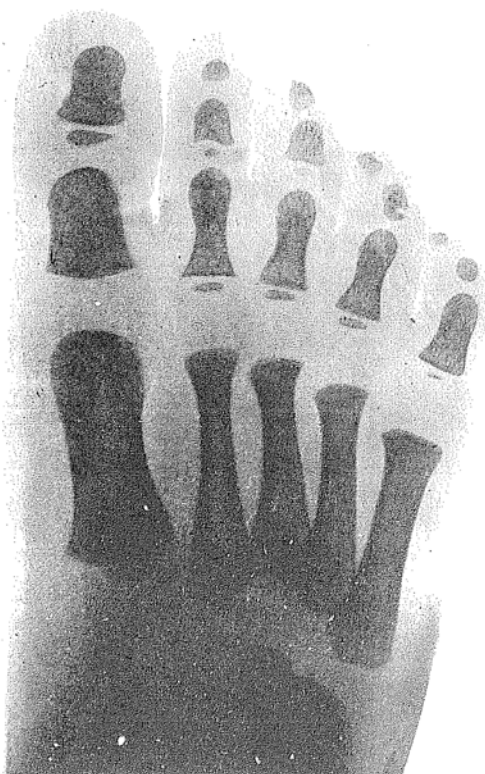


Fig. IV *b*. Left foot of IV. (Pl. XIX).

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