

CHAPTER XIII.

LINEAR SERIES—*continued.*

MINOR SYMMETRIES : DIGITS.

ALL the cases considered in the foregoing chapters have illustrated Variation of parts whose repetition is disposed in Linear Series along the chief axis of the body, being thus arranged directly and immediately with reference to the Major Symmetry of the body. We have now to consider cases of the Meristic Variation of parts which are also repeated in Linear Series but normally possess in some degree the property of symmetry partially completed within the limits of their own series, thus forming a Minor Symmetry.

Of Linear repetitions thus occurring there is a great diversity, and evidence will here be produced regarding two of the chief examples, namely, the digits of vertebrates and the segmentation of antennæ and tarsi of Insects.

In each of these groups of organs the parts are frequently formed in such a way as to make an approach to symmetry, about one or more axes within the limits of the appendage to which they belong. This fact will be found to lead to consequences apparent in the manner in which numerical Variation takes place in limbs of the various types.

In these Minor Symmetries Linear Repetition may occur in two forms: there may be repetitions of digits or other parts in lines forming an angle with the axis of an appendage; and there may be repetitions in the form of joints &c. along the axis of the appendage itself.

The cases of Variation in number of joints in the appendages of Insects are chiefly interesting as examples of manifest Discontinuity in Variation, and from the conclusions which they suggest as to the supposed individuality of segments. This latter question arises also in considering the relation of the two phalanges of the pollex and hallux to the three phalanges of the other digits, but the evidence which can be gained from a study

of Variation with reference to this question is so intimately connected with the subject of the variation of digits in general that it cannot be considered apart. Other cases referring to repetitions in the line of the axis of appendages will be taken in a subsequent chapter.

In studying numerical Variation in the digits of certain animals, especially the Horse and the Pig, we shall meet with forms of Variation which are peculiar to structures having a bilateral symmetry. In examining the evidence as to Meristic Variation of Bilateral Series further reference to these cases will have to be made, but it appears simplest to describe the facts in the first instance in connexion with the subject of digits.

From the evidence as to Meristic Variation in digits I propose to make a selection, taking certain groups of cases having a direct and obvious bearing on the general problems of Variation. It will be understood and should be explicitly stated that unless the contrary is declared the principles of form which can be perceived as operating in special cases are not of universal application in the Variation of digits, but are enuniated as applying only to the special cases in which they are perceived. In the human subject, for example, cases of polydactylism will be quoted which when arranged together form a progressive series illustrating the establishment of a novel and curious Symmetry; but though these cases are valuable as illustrations of the way in which the forces of Division and growth can dispose themselves to produce a symmetrical result, yet it must always be borne in mind that very many variations of the digits have been seen in Man, whether consisting in increase in number of digits or in decrease, of which the result is almost shapeless. The case of polydactyle Cats is thus especially interesting from the fact that in this animal the polydactyle condition, though differing in degree of expression in various specimens, yet, in the greater number of cases, occurs in ways which may be interpreted as modifications of one plan, or rather of one plan for the hind foot and of another for the fore foot.

I arrange the evidence primarily according to the animal concerned, Cat, Man and Apes, Equidæ, Artiodactyles, &c. To these are added a few facts as to digital variations in Birds, but from the scantiness of the evidence and the difficulty of determining the morphology of the parts I have not found it possible to give a profitable account of these phenomena in other vertebrates below Mammalia.

In most of the groups increase in number of digits may be seen to occur in several distinct ways; and, just as in the case of teeth, mammæ, &c., it is possible to recognize cases of division of single members of series, and cases of addition to the series

either at one of its ends (often associated with remodelling of other members of the series) or in the middle of the series.

Reduction in number of digits, or ectrodactylism as it is often called, is usually so irregular in the manner of its occurrence that little could be done as yet beyond a recitation of large numbers of cases amongst which no system can be perceived. For the present therefore the interest of these observations for the student of Variation is comparatively small and they are for the most part omitted.

To the irregularity of ectrodactylism in general certain cases of syndactylism are a marked exception and of these an account will be given.

After stating the morphological evidence as to numerical Variation in digits in the several groups, reference will be made to some collateral points of interest concerning such variations.

There is a good deal of evidence respecting the recurrence of digital variations in those lines of descent wherein they have appeared. Facts of this kind have been frequently seen in the case of Man, and other examples are known in the Cat, the Pig, the Ox, Deer, Sheep, &c. References to these cases will be given.

It will be seen that the facts contained in this section of evidence are of consequence rather as indicating the limits set on Variation, and from their bearing on the question of the nature of Symmetry and of Homology, than from any more direct application to the problem of Species, but even this cannot be said with much confidence.

There are in certain groups limbs such as the pes of Macro-podidæ or that of Peramelidæ whose appearance forcibly recalls what is seen in some teratological cases and the possibility that they may have had such a sudden origin may well be kept in view¹.

CAT.

The apprehension of the chief features in the evidence as to digital variation in the Cat will be made more easy if a general account of the subject be given as a preliminary. In order to understand the peculiar phenomena seen in the limbs of poly-dactyle cats certain points of normal structure are to be remembered. Of these the most important relate to the claws and their disposition with regard to the second phalanx; for it is by this character that the relation of digits to the symmetry of the limb may be determined.

¹ In the case named this is all the more likely from the circumstance that according to THOMAS, *Cat. Marsup. Brit. Mus.*, p. 220, there is reason for supposing that the extraordinary condition of the digits II and III was attained independently in these two groups.

Hind foot.

The phenomena seen in the case of the hind foot are in some respects simpler than those of the variations in the fore foot, and for this reason they may conveniently be described first.

If the phalanges of the index of the hind foot, for example, be examined, it will be seen that the proximal phalanx is nearly bilaterally symmetrical about a longitudinal axis, but that the second phalanx is deeply hollowed out upon the external or fibular side. Into this excavation the ungual phalanx is withdrawn when the claw is in the retracted position. The retraction is chiefly effected by a large elastic ligament running from the outside of the distal head of the second phalanx and inserted into the upper angle of the last phalanx (see OWEN, *Anat. and Phys. of Vert.*, III. p. 70, fig. 36). The same plan is found in the digits II to V both of the fore foot and of the hind foot. By this asymmetrical retraction of the claw a digit of the right side may be differentiated at a glance from one of the left side, for the claw is retracted to the *right* side of a right digit and to the *left* side of a left digit. The importance of this fact will be seen on turning to the evidence, for it is found that with variation in the number of digits there is a correlated variation in their symmetry.

With respect to the tarsus little need be said. The proximal part of the tarsus contains three bones, the calcaneum, astragalus and navicular. The distal row consists of four bones, the cuboid and three cuneiform bones. In the majority of polydactyle cats that I have seen in which the tarsus is affected, the cuboid is normal and the ecto-cuneiform is also normal and recognizable; internal to the latter there are *three* small cuneiforms articulating with the navicular instead of two, making four cuneiforms in all. In some specimens there is no actual separation between the two innermost of these cuneiforms, but the lines of division between them are clearly marked.

In the normal hind foot of the Cat there are four fully formed toes, commonly regarded as II, III, IV and V, each having three phalanges. In the place where the hallux would be there is a small cylindrical bone articulating at the side of the internal cuneiform. As usually seen, all the four digits are formed on a similar plan, each having its claw retracted to the external or fibular side of the second phalanx, the four digits of a right foot being all right digits and those of left feet being all left digits. The rudimentary hallux has of course no claw.

Starting from this normal as the least number of digits, it will be found that a large proportion of cases are such that they may be arranged in an ascending or progressive series. In this series the following Conditions have been observed.

In the schematic representations of the limbs the words 'Right' or 'Left' signify that a digit is shaped as a right or as a left. The Roman numeral

indicates that the digit to which it is assigned has the tarsal or carpal relations of the digit so numbered in the normal. For brevity each is described as a *right foot*.

I. The normal, consisting of four three-phalanged digits, each retracting its claw to the external, viz. *right* side, and a rudimentary hallux with no claw. In this foot therefore the digits enumerated from the external side are

Right.	Right.	Right.	Right.	Rudiment.
V	IV	III	II	I

II. Five digits, each with three phalanges. Of these the *minimus* and *annularis* borne by a normal cuboid are normal and are formed as *right* digits. The *medius* is borne by a normal ecto-cuneiform and is also a true right digit. Internal to this is a full-sized digit having the relations of an index and borne by a bone placed as a middle cuneiform. But the claw of this digit cannot be retracted to the external side of the limb, for the second phalanx is not excavated on this side. There is on the contrary a slight excavation on the *internal* side of the second phalanx, but this is very incomplete and the claw cannot be fully retracted, being in fact almost upon the middle line of the digit when bent back. This digit is thus intermediate between a right and a left. Nevertheless it is truly the index of this right foot, for it has the tarsal relations of an index.

Internal to this digit is another, which by all rules of homology should be the hallux, but it has three phalanges and is fashioned as a *left* digit, retracting its claw to the left (*internal*) side of the digit. This digit (Fig. 85, II, *d'*) is borne jointly by *two* cuneiforms, *c'* and *c''*, as shewn in the figure. There is thus one cuneiform more than there is in the normal. In this foot therefore the digits enumerated from the external side are as follows :—

Right.	Right.	Right.	Indifferent.	Left.
V	IV	III	II	I

Such a specimen is No. 472, right pes.

Between this state and the normal I have as yet met no intermediate. It might perhaps have been expected that a foot having four three-phalanged digits and a hallux with *two* phalanges would be a common form of variation. Such a condition has not however been seen, so far as I know.

III. The foot shewn in Fig. 85, I exemplifies the next condition. In it the three external digits, which are structurally the *minimus*, *annularis* and *medius* of a normal foot are normal in form, position and manner of articulation with the tarsus. Internal to the *medius* are three digits, of which the innermost has *two* phalanges (Fig. 85, I, *d'*) and a claw which cannot be retracted, like the *pollex* of the normal fore foot. The other digits, *d''* and *d'''*, are fashioned as *left* digits, retracting their claws to the internal or left side of the limb. It will be seen that of them *d''* has the

relations to the tarsus which an index should have. The tarsus is as in the last Condition.

In the specimen seen, c^1 and c^2 were not actually separate from each other, but there was a distinct line of division between them.

Here then the digits enumerated from the external side are as follows:—

Right. V	Right. IV	Right. III	Left. II	Left digit	Hallux-like digit
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IV. The stage next beyond the last is shewn in Fig. 87, II. [The drawing is from a *left* foot.] Here there are six digits, each with three phalanges. The three externals are normal and true rights as before. The other three are all formed as *lefts*. Tarsus as before.

This foot may be represented thus:—

Right. V	Right. IV	Right. III	Left. II	Left digit	Left digit
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As far as I have seen the last or fourth Condition is the commonest. There are doubtless many variants on these plans. No. 477 is an especially noteworthy modification of the third Condition and the cases of the hind feet in No. 478 must also be specially studied as not conforming truly to either Condition.

Fore foot.

I. The normal right fore foot has four digits II—V each with three phalanges all differentiated as rights, and a pollex with two phalanges, the last being non-retractile but bearing a claw. It may be represented thus:—

Right. V	Right. IV	Right. III	Right. II	Pollex. I
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Departures from this normal are more irregular than they are in the case of the hind foot. Those given in this summary being only a selection. For the others the evidence must be examined.

II. One specimen, No. 474, has the four external digits normal. The pollex however has three phalanges and is formed as a digit of the other side, thus:—

Right. V	Right. IV	Right. III	Right. II	Left. I
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III. The next Condition seen was as follows:—

Right. V	Right. IV	Right. III	Right. II	Meta- carpal space.	Left digit	Indifferent digit
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IV. In the majority of polydactyle cats the manus has the digits II—V normal in shape and symmetry. Internal to the digit II are two digits more or less united in their proximal parts; sometimes the metacarpal only, sometimes the metacarpal and first phalanx are common to both. Of these two digits the external,

that is, the one next to the digit II, is in some degree shapeless and imperfect, but the external branch is as a digit of the other side in form. Internal to this double digit is a seventh digit, sometimes with two phalanges, sometimes with three, but in either case the claw is as a rule non-retractile, and the digit is in this respect not differentiated as either right or left. Such a manus may be thus represented (cp. Fig. 86 a *left manus*):—

Right. V	Right. IV	Right. III	Right. II	Amorphous digit	Left digit	Indifferent digit
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As regards the carpus its changes are like those of the tarsus. When there are six metacarpals there are three carpals in the distal row internal to the magnum. That next the magnum may be supposed to be trapezoid, and the other two may be spoken of as first and second trapezium. In correspondence the length of the sapho-lunar is increased.

No comment can increase the interest of these curious facts. In the pes, as has been stated, with change in the number of digits there is change in the grouping and symmetry of the series of digits, and in particular the digit having the relations of the index or digit II is formed as the optical image of its neighbour III instead of forming a successive series with it. There is thus a new axis of symmetry developed in the limb, passing between the parts which form the digits II and III of the normal.

The evidence of the above statements may now be given.

- *472. **Cat** having the digital series of each extremity abnormal, being that preserved in the Coll. Surg. Mus., *Teratological Catalogue*, 1872, Nos. 305 and 306.

Right pes (Fig. 85, II). Digits III, IV and V normal right digits. Internal to these are two digits each having three phalanges and claws. That lettered d^1 is formed as a *left* digit but d^2 is almost indifferent, the second phalanx being slightly hollowed on the *inside*. Internal to the external cuneiform there are three small bones, of which the inner two together bear the digit d^1 . [This is the Condition II of the pes.]

Left pes has the same structure as the right so far as can be seen from the preparation (in which the muscles remain). The digits III, IV and V are normal left digits, but internally to them there are two digits each with three phalanges, of which the external is an indifferent digit, while the internal is formed as a right. [Condition II of the pes.]

Left manus. The digits II, III, IV and V are normal. But the carpal of the distal series (trapezoid) which bears the digit II is imperfectly separated from a similar bone placed internal to it. This second part of the trapezoid bears a metacarpal which articulates with a full-sized digit of three phalanges formed as a *right* digit. From the external side of the first phalanx of this

digit there is given off a rudimentary digit, which has however a complete claw, but its bones do not differentiate it as right or left.

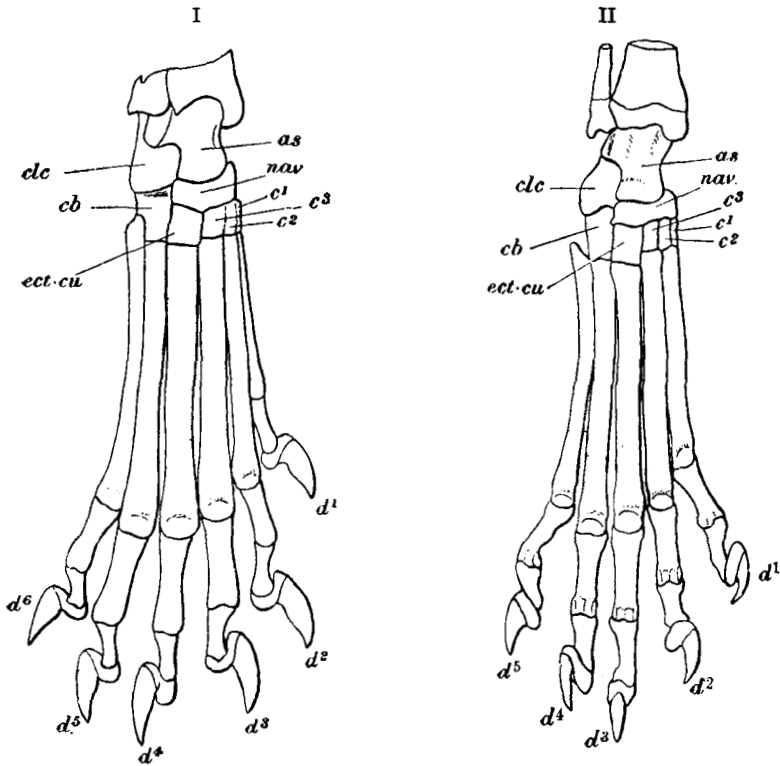


FIG. 85. I. Right pes of Cat No. 473, shewing condition III of the pes.

II. Right pes of Cat No. 472 shewing Condition II of the pes.

as, astragalus. *c*¹, *c*², *c*³, three ossifications representing the ento- and meso-cuneiforms of the normal. *cb*, cuboid. *clc*, calcaneum. *d*¹—*d*⁶, the digits numbered from the inside. *ect, cu*, ecto-cuneiform. *nav*, navicular.

(From specimens in Coll. Surg. Mus.)

The “pollex”, *d*¹, has two phalanges and is rather slender. The trapezium which bears it is not separated from the scaphoid. (Fig. 86). [Condition IV of the manus.]

Right manus. This is exactly like the left manus so far as can be seen from the dissection, except for the fact that the rudimentary digit borne by the large digit external to the “pollex” is much more reduced than in the case of the left manus. The digit which supports it is fashioned as a *left* digit. [Condition IV of the manus.]

*473. **Cat** having digital series of all feet abnormal, being the specimen in Mus. Coll. Surg., *Teratol. Catalogue*, 306 B.

Right pes. The digits III, IV and V (Fig. 85, I) are normal and are fashioned as right digits. The cuboid and external

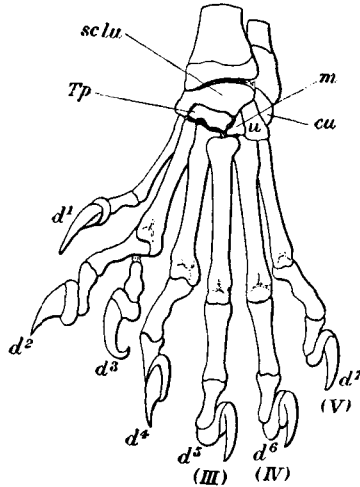


FIG. 86. Left manus of Cat No. 472, shewing Condition IV of the manus.
cu, cuneiform. *d*¹—*d*⁷, digits numbered from the inside. *m*, magnum. *sclu*, scapho-lunar. *Tp*, trapezoid.
 (From a specimen in Coll. Surg. Mus.)

cuneiform (*cb* and *ect. cu*) are also normal. Internally to the external cuneiform there is a long flat bone which is grooved in such a way as to divide it into three parts (*c*¹⁻³) and each of these bears a digit.

Of these digits, *d*² and *d*³ have each three phalanges, but *d*¹ has only two phalanges and may therefore be called a hallux. The digits *d*² and *d*³ are fashioned not as right digits but as *left* digits, and their claws are thus retracted towards the *internal* side of the second phalanges, which are hollowed out to admit of this.

The bones of the hallux are not thus differentiated as right or left, for the claw is not retractile. The navicular is enlarged in correspondence with the presence of the fourth cuneiform element and the astragalus and calcaneum are normal. (Fig. 85, I). [Condition III of the pes.]

Left pes. This foot is almost exactly like the right. As in it, the digits III, IV and V are normal and are left digits. Internal to this are three digits, viz. a hallux and two long digits with three phalanges which are both made as *right* digits. The bones of this foot have not been cleaned. [Condition III of the pes.]

Right manus. This is formed on the same plan as the manus of the last animal, differing from it in details of the carpus, chiefly in the presence of two separate trapezoidal elements. The four digits on the external side, II—V are shewn by their claws to be true

right digits. They articulate in a normal way with the trapezoid, magnum and unciform, and are thus clearly II, III, IV and V. The metacarpals of the "pollex" and of the double digit corresponding to d^2 and d^3 of Fig. 86 articulate with two separate carpal bones of the distal row. The external of these bears a rather thick metatarsus which peripherally gives articulation to two digits. Of these the internal is well formed and bears a claw which slides up on its internal side, and thus shews it to be formed as a *left* digit. The other is misshapen in its proximal phalanx which perhaps contains two phalangeal elements compounded together and aborted; hence the relation of this digit to the symmetry of the limb is not apparent. The claw and last phalanx are well formed. The innermost carpal bone is nearly normal and bears an almost normal "pollex." [Condition IV of the manus.]

Left manus. This foot has not been dissected, but from examination it appears that the digits II, III, IV and V are normal like those of the right manus. As in it, there is a "pollex" with two proper phalanges, but the metacarpal of the "pollex" is in its proximal part united with the metacarpal of an imperfectly double digit corresponding to d^2 and d^3 of Fig. 86. The division between the two parts of this double digit is not so complete in the left manus as it is in the right and from external examination it appears that the phalanges of the two are not separate. There are two claws of which one is rudimentary and the pads of the two are separated only by a groove. There is nothing to indicate whether these digits are formed as right or left digits. [Approaches Condition IV of the manus.]

*474. **Cat** having supernumerary digits. This specimen belonged to the strain of polydactyle Cats observed by Mr POULTON (see No. 480) and I am indebted to Mr J. T. CUNNINGHAM for an opportunity of examining it.

Left manus. Five digits, the normal number. The "pollex" however is a long digit, composed of *three* phalanges, which reaches very nearly to the end of the index. The claw of this digit is not retracted to the outside of the second phalanx, like that of a normal digit, but to the *inside*, and the chief elastic ligament is on the inside of these joints instead of being on the outside as in a normal digit. This pollex therefore may be said to be fashioned as a *right* digit, bearing the same relation to the others as a right limb bears to the left. The flexors and extensors of this digit were fully developed. The carpal series was normal. [Condition II of the manus.]

Right manus. Six digits fully formed, one bearing an additional nail on the third digit from the inside. Beginning from the outer or ulnar side, there are four normal right digits, placed and formed as V, IV, III and II respectively. Internal to these are two digits, the outermost having three phalanges, being shaped as a *left* digit and bearing a minute supernumerary nail in the skin

external to the normal nail. The innermost digit has two phalanges, and is formed like a normal pollex, excepting that its claw was very deep and looked as if it were formed from the germs of two claws united and curving concentrically. The carpus as regards number of elements was normal, but the trapezium and trapezoid were both of rather large size, and the pollex articulated partly with the trapezium but chiefly with the downward process on the radial side of the scapho-lunar. [This approaches Condition IV of the manus, but in it the external of the two united digits is only represented by the minute extra nail.]

Left pes. Six digits, each having three phalanges. The three outer digits were formed as left digits, but the three inner digits were shaped like right digits. The internal cuneiform is double the normal size, but is not divided into two pieces. It bears the two internal digits, of which the innermost is ankylosed to it. [Condition IV of the pes.] Compare Fig. 87, II.

Right pes. Same as the left, except for the fact that the two internal digits are completely united in their metacarpals and first phalanges, and the cuneiform series consists of four bones, two of which correspond to the internal cuneiform of double size described in the left foot. (Compare Fig. 85, I, c^1 and c^2 .) [Condition IV of the pes, save for the union of the metacarpals of the two internal digits.]

475. **Kitten** belonging to Mr Poulton's strain (see No. 480) and kindly lent by him to me for examination. The specimen was very young and the carpus and tarsus were not dissected.

Left manus. Six digits, all with three phalanges. The two internal digits are separated by a space from the others so as to form a sort of lobe. The claw of the innermost digit is retracted on the top of the second phalanx and not to the side, so that this digit is not differentiated either as a right or a left. The next digit is a *right* and the four external digits (II, III, IV and V) are normal lefts. [Condition III of manus.]

Right manus. Same as left.

Left pes. Same as left pes of No. 474 [sc. Condition IV of the pes].

Right pes: same as the left [Condition IV of the pes].

476. **Cat** having its extremities abnormal, the property of the Oxford University Museum and kindly lent for examination; bones only preserved.

Right pes. Like the left pes of No. 474, but c^1 not separated from c^2 . [Condition IV of pes.]

Left pes. Like the right, but c^1 separate from c^2 . [Condition IV of pes.]

Right manus. The four external digits II—V normal. The double digit like that of No. 472. The innermost digit with three

phalanges, but the claw not retracted to one side more than to the other. [Condition IV of the manus.]

Left manus. The same as the right. [Condition IV of the manus.]

*477. **Cat** having all extremities abnormal, also the property of the Oxford University Museum.

Left pes. Like the left pes of case No. 474 [sc. Condition IV of the pes] represented in Fig. 87, II.

Right pes a peculiar case (Fig. 87, I). The digits V, IV and III are normal right digits. The digit II marked 3 in the figure is

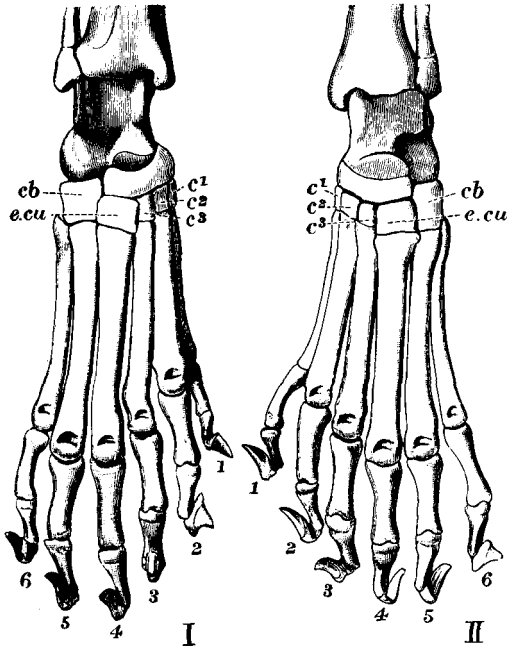


FIG. 87. Hind feet of Cat No. 477.

I. Right pes not truly conforming to any of the Conditions numbered.

II. Left pes shewing the ordinary form of Condition IV of the pes.

Lettering as in Fig. 85. (From a specimen in Oxford Univ. Mus.)

very slightly differentiated as a right digit, but the excavation on the external side is very slight, and the claw when retracted is almost on the middle of the second phalanx. The digit 2 of the figure is a *left*, and internal to it is a *three-phalanged* digit of which the claw is not retracted into any excavation. [Not conforming to any of the Conditions specified.]

78. **Cat** having all feet abnormal, kindly lent to me by Mr Oldfield Thomas.

Left pes. Digits V, IV, III normal lefts. The next internally (II) is a three-phalanged digit formed as a right. The next is a thick three-phalanged digit *with a partially double nail and double pad*. This is not differentiated as either right or left. The innermost digit is a two-phalanged hallux-like digit, not differentiated as right or left. [Not conforming to any condition in my scheme.]

Right pes. The same as the left except that the digit II is only slightly differentiated as a left. The next has a double nail, and the innermost is hallux-like as described for the other foot. [Not conforming to any condition of my scheme.]

Right manus. As in No. 472. "Pollex" with two phalanges. [Condition IV of the manus.]

Left manus. Same as right, but the "pollex" is only represented by a single bone not differentiated or divided into metacarpal and phalanges and bearing no claw. [Approaches Condition IV of the manus.]

479. **Cat.** A *left pes* bearing abnormal digits. The digits II, III, IV and V are normal and are true left digits. Internal to these are two metatarsals which are united centrally and peripherally but are separate in their middle parts. These two metatarsals by their common distal end bear amorphous phalanges belonging to three digits. There are two large claws and one rudimentary one. [For details the specimen must be seen.] The navicular bone is divided into two distinct bones, of which one carries the external cuneiform and a small cuneiform for the digit II, the metatarsal of which is rather slender and compressed in its proximal part. The internal part of the navicular bone bears two cuneiforms, one for each part of the united metatarsals. The digits borne by these metatarsals are so misshapen that it is not possible to say anything as to their symmetry. Mus. Coll. Surg., *Terat. Catal.*, No. 306 A. [This specimen does not conform to any of the Conditions of my scheme.]

- *480. In the case of the Cat the polydactyle condition has been observed by POULTON (*Nature*, xxix. 1883, p. 20, *figs.*; *ibid.*, xxxv. 1887, p. 38, *figs.*) to recur frequently in the same strain. A female cat had six toes on both fore and hind feet. The mother of this cat had an abnormal number of toes not recorded. The grandmother and great-grandmother were normal. Two of the kittens of the 6-toed cat had seven toes both on the fore and hind feet [no 7-toed *pes* among specimens examined by me]. Many families produced by the 6-toed cat, and among them only two kittens with 7 toes on *all* feet, but between this and the normal numerous varieties seen. The abnormality is not in all cases symmetrical on the two sides of the body. The pads of the different toes are sometimes compounded together. In some cases an extra pad was present on the hind foot behind and interior to the central pad. The second pad was sometimes distinct from the central pad and sometimes was united with it. [From the figures it appears that the secondary

central pad in the pes bore to the digits internal to the axis of symmetry a relation comparable with that which the chief central pad bears to the digits III—V, but the secondary central pad is at a higher level than the primary one.] It was especially noted that the details in the arrangement of the pads were inherited in several instances.

The history of the descendants of the 6-toed cat was followed and a genealogical tree is given shewing that the abnormality has been present in a large proportion of them. This was observed in five generations from the original 6-toed cat, so that including the mother of the 6-toed cat the family has contained polydactyle members for seven generations. It may reasonably be assumed that in most of these cases the fathers of these kittens have been normal cats and a good deal of evidence is adduced which makes this likely.

It was observed also that some normal cats belonging to this family gave birth to polydactyle kittens. In the later period of the life of the original 6-toed cat she gave birth to kittens which were all normal.

I know no case of reduction in number of digits or of syndactylism in the Cat.

MAN AND APES.

INCREASE IN NUMBER OF DIGITS.

Increase in the number of digits occurs in Man in many forms. Among them may be distinguished a large group of cases differing among themselves but capable of being arranged in a progressive series like that described in the Cat. These cases are all examples of amplification or proliferation of parts internal to the index of the manus.

Taking the normal as the first Condition, the next in the progress is a hand having the digits II—V normal, but the thumb with three phalanges, or as the descriptions sometimes say, "like an index." (Condition II.)

In the next condition a two-phalanged digit is present internal to the three-phalanged "thumb." (Condition III.) In the next Condition the digit internal to the three-phalanged "thumb" has itself three phalanges. (Condition IV.) A variant from this occurred in the left hand of a child (No. 488) of parent having hands in Condition IV. In the child the right hand was in Condition IV, but in the left there were the usual four digits II—V, and internal to them two complete digits, each of three phalanges, but of these the external had a small rudimentary digit arising from the metacarpus. Hence the hand may be described as composed of two groups, the one containing four and the other three digits.

In one case, No. 490, the right hand was in Condition IV, but the left hand was advanced further. For in it the metacarpal of the innermost digit bore a 2-phalanged digit internally to its 3-phalanged digit. This may be considered as a Condition V.

The number of phalanges in the digits in these Conditions may be represented thus. The || marks the metacarpal space. (The hand is supposed to be a right.)

Condition I	2		3 3 3 3
” II	3		3 3 3 3
” III	2 3		3 3 3 3
” IV	3 3		3 3 3 3
” V	2 3 3		3 3 3 3

Distinct from these Conditions are the states sometimes described as “double-hand.” In the full form of this there are eight digits, each of three phalanges. The eight digits are arranged in two groups, four in each group. The two groups stand as a complementary pair, the one being the optical image of the other; or in other words, the one group is right and the other is left.

Besides the double-hand with eight digits there are also forms of double-hand with six digits, arranged in two groups of three and three.

Lastly, there are cases of double-hand having seven fingers, an external group of four and an internal group of three. Thus expressed these cases seem to come very near that mentioned as a variant on Condition IV, but in one and perhaps both of these double-hands there was in the structure of the fore-arm and carpus a great difference from that found in the only recorded skeleton of Condition IV.

At first sight it would naturally be supposed that these double-hands in one or all kinds stand to the other Conditions in the same relation that Condition IV of the pes in the Cat does to the other polydactyle conditions in the Cat. But the matter is complicated by the fact that the evidence goes to shew that in the human double-hands the bones of the arm and carpus may be modified, and in DWIGHT'S example of seven digits (No. 489) at all events, and perhaps in other double-hands, an *ulna-like bone takes the place of the radius*, or in other words, *the internal side of the fore-arm is fashioned like the external side*. In the polydactyle cats the bones of the fore-arm were normal, as are they also substantially in cases of the human Conditions III and IV, which have been dissected. Further, in some of the human cases of eight digits the abnormality was confined to one hand, which is never the case in the higher condition of polydactylism in the Cat, so far as I know. These circumstances make it necessary to recognize the possibility that some at least of the human double-hands are of a different nature from the lower forms of polydactylism. This subject will be spoken of again after the evidence as to the variation of digits has been given (Chap. XIV. Section (4).)

In addition to cases more or less conforming to schemes that can be indicated are several which cannot be thus included. These will be duly noticed when the more schematic cases have been described. That any of the cases can be arranged in a formal sequence of this kind is perhaps surprising, and the relations of some of the Conditions, II and III for instance, to each other must at once recall the principle seen already in other examples of addition of a member at the end of a successive series of parts, notably in the case of Teeth (see p. 272). It was then pointed out that when a new member is added beyond a terminal member whose size is normally small relatively to that of the normal penultimate, then the member which is normally terminal is raised to a higher condition. Now this same principle is seen in Condition III of the polydactyle manus.

Attention must nevertheless be forthwith called to the fact that a two-phalanged digit¹ may be present internal to the thumb (usually arising from it) though the thumb has still but two phalanges. But generally these cases may properly be described as examples of *duplicity* of the thumb; and as was well seen in the case of Teeth, any member of a series may divide into two though the rest of the series remain unaltered. Duplicity of a member without reconstitution of the series is to be recognized as one occurrence, and change in number associated with reconstitution of other members especially, of adjacent members, is another. In Teeth and other Meristic series these two phenomena are both to be seen, though as was pointed out (p. 270) they pass insensibly into each other.

Another feature to be specially mentioned in this preliminary notice is the difference in the manner in which the higher forms of polydactylism appears in the human foot from that seen in the human hand. In the hand there is this strange group of cases forming a progress from the normal hand to Condition V, besides the distinct series of double-hands. Polydactyle feet on the contrary do not in Man, so far as they have been observed (with the doubtful exception of Nos. 499 and 500), develop a new symmetry.

CASES OF POLYDACTYLISM ASSOCIATED WITH CHANGE OF SYMMETRY.

A. *Digits in one Successive Series.*

- *481. Man having a "supernumerary index" on each hand. *Left hand.* No "thumb" present. In its stead there is a digit having three phalanges which "performs its office." The middle phalanx was abnormally short. The first intermetacarpal space was not great. [Degree of opposability not stated.] *Right hand.* In addition to four normal fingers there was a three-jointed digit

¹ A case in which a 3-phalanged digit was placed on the radial side of the pollex is mentioned by WINDLE, *Jour. Anat. Phys.*, xxvi. p. 440, but has not yet been described. No other such case is known to me. This perhaps should be classed with double-hands. Cp. No. 502.

which could be opposed to them and could perform all the movements of flexion, &c. Internal to this three-jointed digit was a rudimentary thumb having only one phalanx and no nail. [Relations of metacarpals to each other not particularly described.] GUERMONPREZ, F., *Rev. des mal. de l'enfance*, IV. 1886, p. 122, figs. [Left hand Condition II; right hand almost Condition III.]

482. **Girl** having a three-jointed thumb, resembling a long fore-finger. ANNANDALE, *Diseases of the Fingers and Toes*, p. 29, Pl. II. fig. 19. [Condition II.]
483. **Man** having a thumb with three phalanges on each hand. Feet normal. In the thumbs the metacarpal is $2\frac{1}{4}$ in. long; the first phalanx $1\frac{3}{4}$ in., being longer than usual. The second phalanx is longer on the radial side than on the external side, causing the distal phalanx to curve towards the index. On the internal it measures $\frac{5}{8}$ in., in the middle $\frac{1}{2}$ in., and on the ulnar side $\frac{1}{4}$ in. The distal phalanx is 1 in. long. When the left thumb is straightened it passes $\frac{1}{8}$ in. beyond the joint between the 1st and 2nd phalanx of the index. In the right hand the thumb scarcely reaches that joint. The utility of the thumb is not impaired. A maternal aunt had a similar thumb on right hand. STRUTHERS, *Edin. New Phil. Journ.*, 1863 (2), p. 102, Pl. II. fig. 6. [Both hands Condition II.]
- *484. **Father** and three children, each having 3-phalanged thumbs shaped as indices and not opposable. [Full description *q.v.*] Paternal grandmother had double-thumb. FARGE, *Gaz. hebd. de méd. et chir.*, Ser. 2, II. 1866, p. 61.
- *485. **Man** having the following abnormalities of the digits. (Fig. 88). *Right hand*. The number of digits was normal, but the

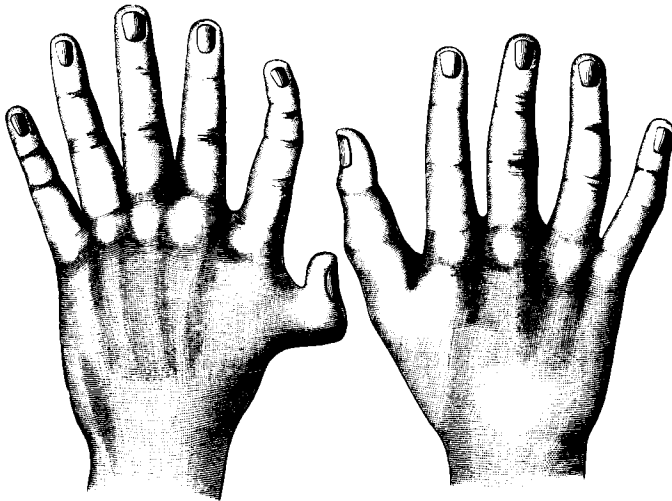


FIG. 88. Right and left hands of No. 485. Right hand in Condition II; left hand in Condition III. (After WINDLE.)

radial digit or thumb had three phalanges in addition to the metacarpal, all the articulations being moveable. Relatively to the others their digit was placed as a thumb. *Left hand.* The digit corresponding with the thumb was composed of three phalanges like that of the right side, and though finger-like in form it was functionally a thumb. On the radial side of this 3-jointed digit there was a supernumerary digit composed of two phalanges articulating with the metacarpal bone of the 3-jointed thumb. This supernumerary digit had a well-formed nail. The 3-jointed thumb of the left hand was longer than that of the right hand (measurements given), WINDLE, B.C.A., *Journ. of Anat.* xxvi. 1891, p. 100, Pl. II. [Right hand, Condition II; left hand, Condition III.]

*486. Man having 3 phalanges in the thumb of the left hand together with a supernumerary digit. (Fig. 89.) This case in several respects resembles the left hand of the subject described by WINDLE. The four fingers were normal. The thumb stood in its normal relations to them, but was finger-like in form, having three phalanges in addition to the metacarpal. On the radial side of

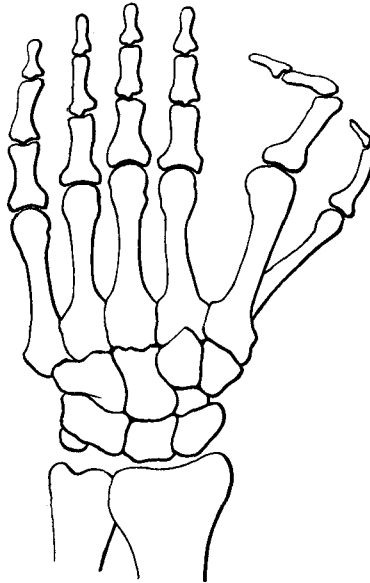


FIG. 89. Bones of left hand of No. 486, shewing Condition III.
(After RIJKEBÜSCH.)

this 3-phalanged digit there was a supernumerary digit, having two phalanges and a separate metacarpal, which articulated with the head of the metacarpal of the thumb and the trapezium. In the carpus of this hand there was a supernumerary bone which is described as an *os centrale*. The bones and muscles of this limb

are described in detail. The thumb and the supernumerary digit were closely webbed together and were very slightly moveable. Specimen first described by RIJKEBÜSCH, *Bijdr. tot de Kennis der Polydactylie*, Utrecht, 1887, *Plates*, and subsequently by SPRONCK, *Arch. néerl.*, XXII. 1888, p. 235, Pl. VI.—IX. [Condition III.]

- *487. Woman having 6 digits on each hand and foot as follows. In *each hand* the thumb has three phalanges, and internal to it articulating with the same metacarpal is an extra digit having two phalanges [measurements given] webbed to the three-phalanged thumb. [Condition III of the manus.] *Right foot* has six complete metatarsals and digits very regularly set, one of them being internal to but *longer* than the hallux which has two phalanges as usual. The digit internal to it has also two phalanges. *Left foot* has also an extra digit with two phalanges longer than the hallux, placed internal to and articulating with the metatarsal of the hallux which has two phalanges as usual. Many members of family polydactyle [particulars given]. STRUTHERS, *Edin. New Phil. Jour.*, 1863 (2), p. 93. [Note in this case that in the feet the digits added internally to hallux are *greater* than it, and they thus stand as the largest terms in the series, the other members being Successive to them. The series thus does not decline from the hallux both internally and externally in the way seen in most other cases of extra digits on the internal side of the limb.]

488. Man having six digits, each with three phalanges, on each hand.

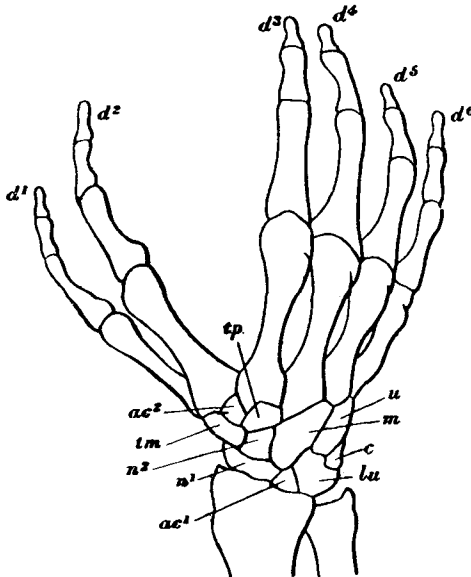


FIG. 90. Bones of right hand of No. 488 shewing Condition IV.
 n^1 and n^2 represent the scaphoid. *lu*, lunar. *c*, cuneiform. *tm*, trapezium.
td, trapezoid. *m*, magnum. *u*, uniform. *ac¹*, *ac²* are supernumerary bones.
 (After RÜDINGER.)

The digits were arranged in two groups, which were to some extent opposable to each other. The digits II, III, IV and V stood in their normal positions and were properly formed. In the place where the thumb should stand there were two digits, each with three phalanges. Of these the external (d^2) was of about the length and form of the index finger while the internal, d^1 , was a good deal shorter and more slender. The bones of the carpus are shewn in Fig. 88. The scaphoid was represented in the right hand by two bones n^1 and n^2 , and there were two accessory bones, ac^1 and ac^2 placed in the positions shewn. The two hands were almost exactly alike, save for slight differences in the carpal bones [see original figures], and for the fact that in the left hand the internal of the two digits of the radial group was rather more rudimentary. RÜDINGER, *Beitr. zur Anat. des Gehörorgans, d. venösen Blutbahnen d. Schädelhöhle, sowie der überzähligen Finger*, München, 1876, Plate. [Both hands in Condition IV.]

489. A female child born to the last case, No. 488, had the right hand in the same condition as that of the father, while the left hand differed from it in the presence of an additional rudimentary finger arising from the ulnar side of the digit d^2 . This additional finger bore a nail but it appeared to consist of two joints only and to be attached to the metacarpus by ligamentary connexions. RÜDINGER, *ibid.* [Right hand in Condition IV; left hand departing from the Conditions enumerated. Compare with manus of Cat, Fig. 84.]
- *490. Man. *Right hand* bore six digits and metacarpals. The most external digit was a normal minimus, succeeded by digits IV and III webbed together. Next to III there was an index. Internal to this and separated from it by a small metacarpal space was a 3-phalanged long digit much as in Windle's case, No. 481, and internal to it is a 2-phalanged thumb of nearly normal form like that of No. 485. *Left hand* bore seven digits but six metacarpals. Minimus normal. IV, III and II webbed together. Internal to II was a 3-phalanged digit much as in the right hand; but internal to this there was a metacarpal bearing two digits, an external having 3 phalanges and an internal having 2 phalanges. Each foot had six digits and six metatarsals (*q. v.*). Redescribed from the account and figures given by GRUBER, *Bull. Ac. Sci. Pét.*, XVI. 1871, p. 359, *figs.* [Right hand Condition IV, left hand Condition V.]
491. Child having six fingers on each hand. The fingers were united together. In the thumb [? both] there were three phalanges and the length of the thumb was as great as that of the "other fingers." DUBOIS, *Arch. génér. de Méd.*, 1826, *Ann.* IV. T. XI. p. 148; this case is quoted by GEOFFROY ST HILAIRE, *Hist. des Anom.*, I. p. 227, *Note.* [? Condition IV.]
- 491, a. New-born male child having on the right hand two "thumbs" each with three phalanges. OBERTUEFFER, J. G., *Stark's Arch. f. Geburtsh.*, 1801, xv. p. 642. [Condition IV.]

(No more cases known to me.)

B¹. *Digits in two homologous groups, forming "Double-hands."*

*492. DOUBLE-HAND I. *Seven digits in two groups of four and three.* Male: left arm abnormal, having seven digits arranged in two groups, the one an external group of four normal digits, and the other an internal group of three digits². (Fig. 91.) Described from a dried specimen in Mus. of Harvard Med. School. The man was a machinist and found the hand not merely very useful to him in his business, but he also thought that it gave him advantages in playing the piano.

"The fore-arm consists of the normal left ulna and of a right one in the place of a radius. The left one shews little that calls for comment, excepting that there is a projection outward at the place of the lesser sigmoid cavity to join a corresponding projection from the other ulna. The upper surface of this projection articulates with the humerus. At the lower end the styloid process is less prominent than usual, and the head rather broad. The right or extra ulna is put on hind side before, that is, the back of the olecranon projects forward over the front and outer aspect of the humerus. If the reader will place his right fore-arm on the outer side of the left one he will see that it is necessary for the

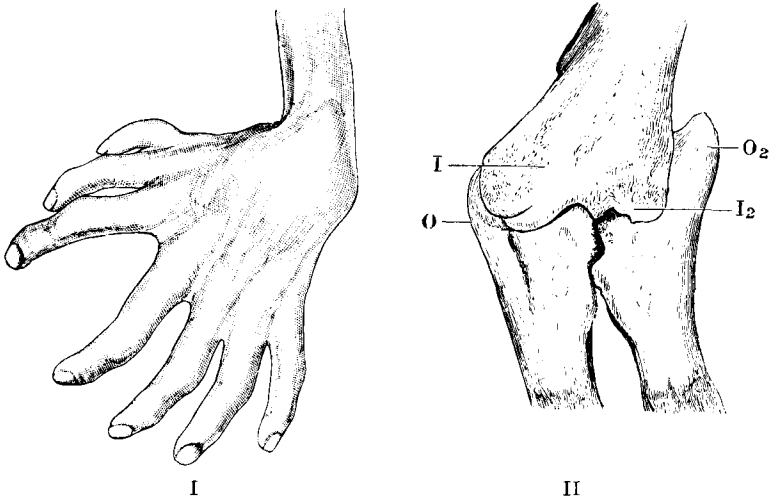


FIG. 91. I. The left hand of No. 492 from the dorsal surface.
 II. The humerus and two bones of the fore-arm at the elbow of the same case.
 O, olecranon. O², the secondary "olecranon". I, the inner condyle of the humerus. I², the second or external "inner condyle."
 (After DWIGHT.)

ulna to be thus inverted if the thumbs are to touch and the palms to be continuous. This olecranon is thinner, flatter, and longer than normal. The coronoid process is rudimentary. From the side of this process and from the shaft just behind it arises the projection already

¹ Every case known to me is given.

² This is the case reported by Jackson, to *Bost. Soc. of Med. Imp.*, 1852.

referred to which meets a similar one from the normal ulna [Fig. 89, II]. On the front of this there is a small articular surface looking forward which suggests a part of the convexity of the head of the radius. The upper articular surface shews a fissure separating it from the side of the olecranon which is not found in the normal ulna. These projections which touch each other are held together by a strong interosseous ligament. The lower end of this ulna is very like the other, only somewhat broader. The mode of union of the lower ends could not be seen without unwarrantable injury to the specimen. There can hardly have been any definite movement between these bones. Perhaps the ligaments may have permitted some irregular sliding, but it is impossible to know. These bones have been described first because their nature is very clear and, once understood, is a key to the more difficult interpretation of the lower end of the humerus."

The upper end of the humerus presented nothing noteworthy. A detailed description and figures are given, from which it appears that the lower end of the humerus had such a form as might be produced by sawing off the greater part of the external condyle and applying in place of it the internal condyle of a *right* humerus.

The carpus seen from the dorsal side had the structure shewn in the diagram (Fig. 92). The proximal row consisted of three bones besides the two pisiforms (p^1 and p^2). There was a cuneiform at either side of the wrist, and between them a bone evidently composed of a pair of semilunars, having a slight notch in its upper border. At each end of

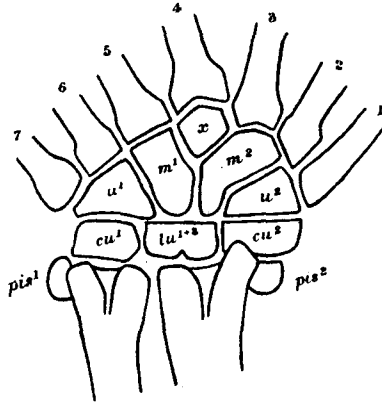


FIG. 92. Diagram of the carpal bones in the left hand of No. 492 from the dorsal surface.

pis^1 , cu^1 , u^1 , m^1 , pisiform, cuneiform, unciform and magnum of the external or normal half of the hand consisting of four fingers; pis^2 , cu^2 , u^2 , m^2 , the similar bones for the internal group of three fingers. lu^{1+2} , the compounded lunar elements corresponding to the two groups. x , bone placed as trapezoid.

(After DWIGHT.)

the second row is an unciform bearing the middle and ring fingers. Next came two ossa magna very symmetrically placed, each bearing the metacarpal of a medius. Between these is a bone which DWIGHT states

to have clearly represented the trapezoid of the left hand, bearing an index finger. The metacarpals and phalanges needed no description.

The muscles are described in detail [*q.v.*]. Some of the features in the distribution of the arteries and nerves are of interest, and I transcribe Dwight's account in full. It appears that, like the bones, the vessels and nerves proper to the radial side of a normal left arm have in a measure been transformed into parts proper to the ulnar side of a right arm.

“**THE ARTERIES.** The brachial divides at about the junction of the middle and lower thirds of the humerus. The main continuation, which is the ulnar proper, runs deeply under the band thought to represent the *pronator radii teres*, to the deep part of the fore-arm where it gives off the interosseous. Above the elbow there is a branch running backward between the internal condyle and the olecranon. The interosseous branches are not easy to trace. There seems to be an anterior interosseous and three branches on the back of the forearm, one running on the membrane and one along each bone. At least two of them share in a network on the back of the carpus. Having reached the hand the ulnar artery runs obliquely across the palm to the cleft between the two sets of fingers, supplying the four normal fingers and the nearer side of the extra middle finger. The other branch of the brachial crosses the median nerve and runs, apparently superficially, to the outer side of the fore-arm. It supplies the little and ring fingers and the corresponding side of the middle finger of the supernumerary set. There is no anastomosis in the palm between the superficial branches of the two arteries. Each gives off a deep branch at the usual place, which forms a deep palmar arch from which some interosseous arteries spring. There is also an arterial network over the front of the carpal bones. The arteries of the deep parts of the hand cannot all be seen.

THE NERVES. The ulnar nerve proper pursues a normal course and supplies the palmar aspect of the little finger and half the ring finger of the normal hand. Near the wrist it gives off a very small posterior branch, which is not well preserved, but which seems to have had less than the usual distribution. The median nerve is normal as far as the elbow, running to the inner side of the extra condyle. It is then lost in the dried fibers of the *flexor sublimis*, from which it emerges in two main divisions near the middle of the fore-arm. The inner of these soon divides into two, of which one supplies the adjacent sides of the ring and middle fingers and the other those of the middle and index fingers of the normal hand. The outer division of the median supplies the outer side of the index and both sides of the extra middle finger and one side of the extra ring finger. One of the branches to the index gives off a dorsal branch, and there is a doubtful one for the extra middle finger. The musculo-spiral nerve passes behind the humerus as usual. A nerve which is undoubtedly continuous with it emerges from the hardened muscles over the fused outer condyles. It seems to be the radial branch changed into an ulnar. It runs with the extra ulnar artery to the hand and sending a deep branch into the palm, goes to the ring finger. There is a detached branch on the other side of the little finger which in all probability came from it. The deep branch sends a twig along the metacarpal bone of the ring finger. It probably

supplied the side of the ring finger left unprovided for, but this is uncertain. Assuming this to have been the case, each ulnar nerve supplies the palmar surface of one finger and a half, the median supplying the remaining fingers of both hands. Unfortunately no dorsal branches except those mentioned have been preserved."

DWIGHT, T., *Mem. Boston Soc. of N. H.*, 1892, Vol. iv. No. x. p. 473, Pls. XLIII and XLIV.

[This is a case of high significance. We shall come back to it hereafter. Meanwhile it will be noted that in it we meet again the old difficulty so often presented by cases of Meristic Variation. In this fore-arm there is already one true ulna. Internal to it is another bone also formed as an ulna. We may therefore, indeed we must, call it an ulna. But *is* it an "ulna"? To answer this we must first answer the question *what* is an ulna? Similarly, is the second pisiform a "pisiform," or is the second ulnar nerve an "ulnar" nerve? These questions force themselves on the mind of anyone who tries to apply the language of orthodox morphology to this case, but to them there is still no answer. Or, rather, the answer is given that an "ulna," a "pisiform" and the like are terms that have no fixed, ideal meaning, symbols of an order that we have set up but which the body does not obey. An "ulna" is a bone that has the form of an ulna, and a "pisiform" is that which has the form of a pisiform. If we try to pass behind this, to seek an inner and faster meaning for these conceptions of the mind, we are attempting that for which Nature gives no warrant: we are casting off from the phenomenal, from the things which appear, and we set forth into the waste of metaphysic.]

493. Boy having abnormalities in the left hand as follows. The four outer fingers II—V are normal in form and proportions. Internal to these is firstly an opposable digit with a single metacarpus and single proximal phalanx but having two distal phalanges side by side webbed together. Internal to this partially double thumb are two digits in series, each with a metacarpal and three phalanges, respectively resembling the annularis and minimus of a *right* hand. STRUTHERS, *Edin. New Phil. Jour.*, 1863 (2), p. 90, Pl. II. fig. 5. [Not representing any of the Conditions.]

494. Male infant, one year and five months, examined alive, having the right hand abnormal, possessing seven digits, arranged in two groups, an ulnar group of four and a radial group of three. Each digit had three phalanges, but the ring and middle fingers of the ulnar group are webbed in the region of the proximal phalanges. The ulnar group seemed to articulate with the carpus in the usual way. The radial group probably formed joints with more than one facet on the trapezium, and possibly also with a surface on the lower end of the radius. It did not seem that the carpal bones were increased in number, for the right wrist had the same circumferential measurement as the left, which was normal. The lower end of the ulna did not seem to articulate normally with the carpus. The elbow was also abnormal, and it seemed "as if the ulna were dislocated inwards." BALLANTYNE, J. W., *Edin. Med. Jour.*, 1893, CDLI. p. 623, fig. [Possibly this condition approached to that found in the last cases.]

495. DOUBLE-HAND II. *Eight digits in two groups of four and four.* Woman (examined alive) having eight fingers in the left hand arranged as follows (Fig. 93). With the exception of the left arm the body was normal. The limb was very muscular. The shoulder-joint was natural. The external condyloid ridge of the humerus was strongly defined. The muscles and tendons of the fore-arm were so prominent that it was not easy to decide whether there was a second radius or ulna, but Murray eventually came to the



FIG. 93. Left hand of No. 495. (After MURRAY.)

conclusion that there was no such extra bone. The fore-arm could be only partially flexed. The eight fingers were arranged in two groups of four in each, one of the groups standing as the four normal fingers do, and the other four being articulated where the thumb should be. There was no thumb distinguishable as such, but it is stated that there was a protuberance on the dorsal side of the hand, between the two groups of fingers, and this is considered by Murray to represent the thumbs, for according to his view the limb was composed of a pair of hands compounded by their radial sides. In the figure of the dorsal aspect which is given by Murray taken from a photograph, this protuberance cannot be clearly made out. The four radial fingers in size and shape appeared to be four fingers of a *right* hand. In the radial group of fingers, the "middle" and "ring" fingers (6 and 7) were webbed as far as the proximal joints, and the movements of the fingers of this group were somewhat stiff and imperfect. Between the two groups of fingers there was a wide space as between the thumb and index of a normal hand, and the two parts of the hand could be opposed to each other and folded upon each other. The power of independent action of the fingers was very limited. No single finger could be retained fully extended while the other seven fingers were flexed, but if both "index" fingers (4 and 5) were extended,

the other six fingers could be flexed, or the four fingers of either group together with the "index" of the other group may be extended, while the other three are flexed. The "index" fingers could not be flexed while the other fingers were extended, nor can the "little fingers" be extended while the others were flexed. MURRAY, J. JARDINE, *Med. Chir. Trans.*, 1863, XLVI. p. 29, Pl. II.

496. Female child, five weeks, having a hand of eight digits on the right side (Fig. 94). The digits were disposed in two groups of four in each. [No further

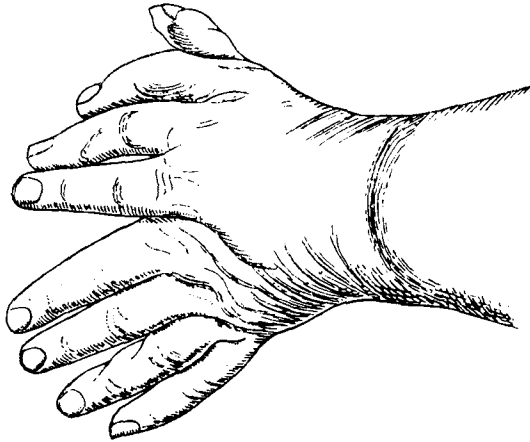


FIG. 94. Right hand of No. 496. (After GIRALDES.)

description.] GIRALDES, *Bull. soc. de Chirurg., Paris*, 1866, Ser. 2, vi. p. 505, fig. The same case referred to again, GIRALDES, *Mal. Chir. des Enfants*, 1869, p. 42, fig.

497. Female child having right hand almost exactly like MURRAY'S case, but without syndactylism. The two halves could be folded on each other. The four extra digits articulated with an imperfect metacarpal which was annexed to the normal metacarpal [of the index]. FUMAGALLI, C., *Annal. Univers. di Med. Milano*, 1871, vol. CXXVI. p. 305, fig.

Girl's right hand having eight fingers, represented in a wax model. LANGALLI, *La scienza e la pratica*, Pavia, 1875 [Not seen: abstract from DWIGHT, l. c.].

498. DOUBLE-HAND III. *Six digits in two groups of three and three.* Man having abnormalities of left arm as follows (Fig. 95). The left hand was composed of six digits with three phalanges, which were disposed in two groups of three digits in each. The two middle digits were the longest (d^3 and d^4), and the length of the digits on either side of them diminished regularly. The appearance was as of a hand composed of the middle, ring and little fingers of a pair of hands united together. The two groups of fingers were to some extent opposed to each other and all the digits could be flexed and extended. The digit d^3 though single in its peripheral parts articulated with two metacarpals, its proximal phalanx having two heads. Upon the radial side of the

carpus of this hand there was a soft tumour about 2.5 cm. in height, resembling a cyst with a firm wall.

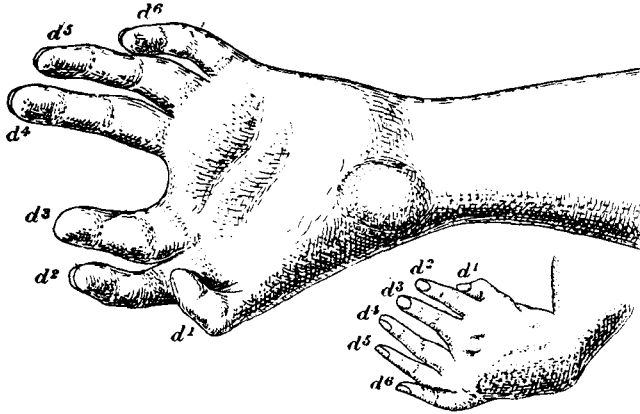


FIG. 95. Dorsal and palmar aspects of the left hand of No. 498. The digits are numbered from the inside.

(After JOLLY.)

The structure of the bones of the arm and fore-arm could not be made out with certainty in the living subject, but it appeared that the humerus was formed by two bones partially united together.

As regards the skeleton of the fore-arm an ulna could be felt extending from the upper arm to the *processus styloideus*. The existence of a radius could not be made out with certainty, but a second bone could be felt which was in very close connexion [with the ulna]. JOLLY, *Internat. Beitr. z. wiss. Med.*, 1891.

499. Male child, three years old, twin with a normal female child, having all extremities abnormal. *Right hand*. Six metacarpals arranged in two groups of three in each group. Each bore a three-phalanged digit, none resembling a thumb. The first and sixth were alike, resembling a minimus, while the two median fingers resembled middle fingers. On the radial side the three digits were completely united together. The next was free, and the two external to this were also united. *Left hand*. Like the right, but all the fingers united together in two groups of three in each group. *Feet*. Each foot had nine metatarsals and nine digits, the central being like a hallux and having two phalanges perhaps, but thicker than a hallux. The externals were like minimi. The four toes on each side of the "hallux" were united two and two. The tarsus was of about double size. The right leg was shorter than the left. GHERINI, A., *Gaz. med. ital.-lombard.*, 1874, No. 51, p. 401, *figs.*

Complex and irregular cases of Polydactylism associated with Change of Symmetry.

*500. Man (examined alive) having abnormalities in the digits of hands and feet (Fig. 96). The case is very briefly and inadequately described, but the condition was apparently as follows.

Right hand. Beginning from the ulnar side, there were three normal digits (6, 5, 4). Beyond the third of these, which must be

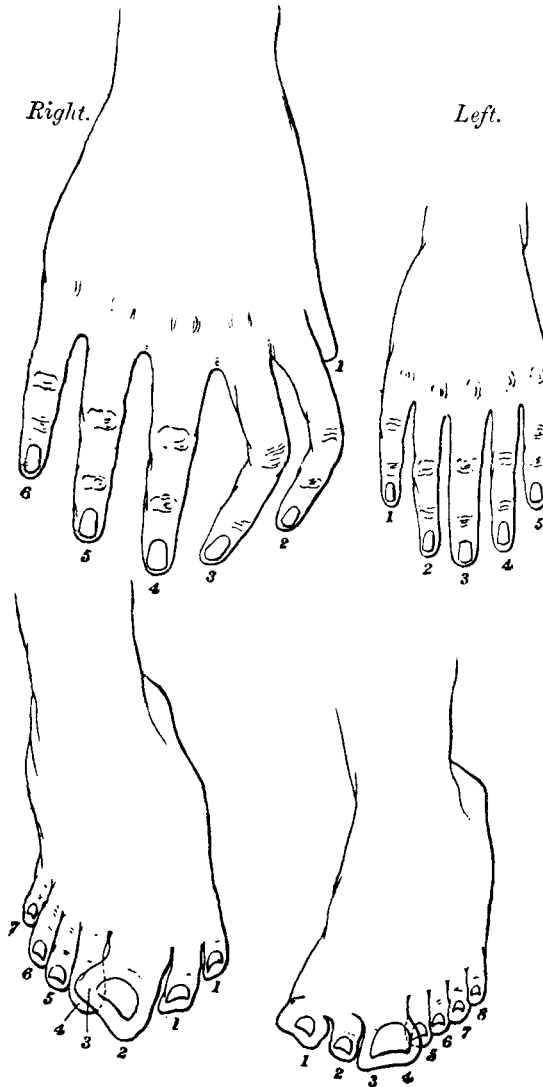


FIG. 96. Hands and feet of No. 500. (After KUANT.)

regarded as the medius, there were two complete digits (3, 2) each having three phalanges: and on the radial side of the innermost of these digits there was a stump-like rudiment (1), apparently representing another digit. [This case therefore differed from those of Windle and Rijkebüsch in the fact that both the digits internal to the medius (*m*) were disposed as though they belonged to a *left* hand, and KUHNT, in fact, states that each hand was, as it were, composed of parts of a *pair* of hands, thus agreeing with JOLLY's case, No. 499.]

Left hand. In this hand there were only five digits, each of which had three phalanges. None of them was fully opposable, but that on the radial side (1) could to some extent be moved as a thumb. Of these five digits the middle one was the longest, and on each side of it there were two similar digits, those next to the middle finger being the longest and those remote from it being a good deal shorter and having the form of little fingers, which KUHNT considers them to have been. [This hand is perhaps in Condition II.]

Right foot. The hallux (2, 3) was of abnormal width and its bones were to some extent double, the ungual phalanx being completely so. [The nail however is drawn as a single structure and the double character of the toe was not apparent in its external appearance.] On the internal (tibial) side of the hallux there were two supernumerary toes (1, 1) having, so far as could be ascertained, a single metatarsus. The number of phalanges in these toes is not distinctly stated.

Left foot. The hallux (3, 4) was to some extent double, like that of the right foot. Internally to it were two supernumerary toes (1, 2) having apparently a common metatarsal. [Of these the most internal is represented as being very wide and resembling a hallux, but this feature is not mentioned in the description and the number of phalanges is not given].

[It is greatly to be regretted that no fuller account of this important case is accessible. According to KUHNT's view each hand and each foot were structurally composed of parts of a complementary pair of hands and feet. As regards the hands the facts agree with this description and with what has been seen in other cases, but the condition of the feet is more doubtful, and without more knowledge of the details no opinion can be given. It should be remembered that the original description is very brief and Dr Kuhnt offers an apology for the imperfection of the figures.] KUHNT, *Virch. Arch. f. path. Anat. u. Phys.*, lvi. 1872, p. 268, Taf. vi.

501. Case of a foot with eight toes, stated to have resembled KUHNT's case (No. 501). EKSTEIN, *Prager Wochens.*, No. 51, 1891.
502. Man whose right arm beside the normal hand bore an extra thumb and finger. The two thumbs were united and had a common metacarpal joint. They were of equal size. They were flexed and extended together and had the power of spreading apart. The extra finger was beyond the extra thumb and was shaped like an index. Besides the radius and ulna of the normal arm there was an extra radius on the outer [? internal] side of the normal radius. This bone had a joint of its own at its elbow. The wrist was broad, suggesting the presence of additional bones. Nothing is said of a metacarpal bone for the new index. CARRÉ, *Séance publ. de la soc. roy. de Méd., Chir. et Pharm. de*

Toulouse, 1838, p. 28. [Not seen by me. Abstract taken from DWIGHT, *l. c.*, *vide* No. 492. Cp. p. 326, *Note*.]

503. Girl, new-born, having the left foot "double," bearing eleven toes.

The left labium majus was twice as large as the right, and the left leg and thigh were much thinner than the corresponding parts on the right side [measurements given]. The extra parts were all on the *plantar* side of a foot which had toes of nearly normal shapes and sizes. This foot was bent into a position of extreme talipes equino-varus, and the great toe was bent so that it pointed inwards at right angles to the metatarsal.

Upon the plantar side of this foot there was a series of six well-formed, small toes, arranged in a series parallel to that of the 'normal' five, and having their plantar surfaces in opposition to those of the latter. Of the series of six toes that facing the normal little toe exactly resembled it. The second was the longest of the six, but did not resemble a great toe. The third and fourth were equal in length, the fifth and sixth being shorter, as are the external toes of a normal foot. None of the toes were webbed. BULL, G. J., *Boston Med. and Surg. Jour.* 1875, XCIII. p. 293, *fig.* [This figure copied by AHLFELD, *Missb. d. Menschen*, Pl. xx. *fig.* 2.]

[The case described by GRANDIN, *Amer. Jour. of Obstetrics*, 1887, xx. p. 425, *fig.*, is probably a case of a pair of limbs composing a Secondary Symmetry attached to and deforming the limb belonging to the Primary Symmetry and corresponding with that of the other side. The nature of this case will be better understood when evidence as to the manner of constitution of Secondary Symmetries has been given.]

*504. **Macacus** sp. A monkey, full-grown, having nine toes on the left foot; right foot normal, upper extremities not preserved. The specimen is described as No. 307 in the *Catalogue of the Teratological Series* (1872) in the Mus. Coll. Surg. (Hunterian specimen). Though I am disposed to agree in the main with the view of the nature of the specimen given in the *Catalogue* it is not in my judgment possible to decide confidently in favour of this view to the exclusion of all others. For this reason the specimen is here described afresh. This is the more necessary as the account of the *Catalogue* is incorrect in some particulars.

Extra parts are present in the limb and in the pelvic girdle. (Figs. 97 and 98.) The names to be given to the parts depend on the hypothesis of their nature which may be preferred. In general terms it may be stated that the ventral or pubic border of the girdle and the internal (tibial) border of the limb are nearly normal. The external (fibular) border of the limb is also normal, but between these there are in addition to the normal parts other structures, whose true nature is somewhat uncertain.

The appearances may be realized best in the following way. Suppose that two similar left feet lie in succession to each other, the "posterior" having its hallux next to the minimus of the "anterior," so that the digits read I, II, III, IV, V, I, II, III, IV, V. Now if the two feet could interpenetrate so far that the minimus of the "anterior" foot took the place of the hallux of the "posterior," this

second hallux not being represented, the condition of this specimen would be nearly produced. In the same way the left pelvic girdle is just what it would be if two left innominate bones were placed in succession, the ischium of the "anterior" superseding the pubis of the posterior. As in the foot, so in the innominate, of the portions which coincide the parts belonging to the anterior are alone represented. Something very like this was seen in the case, for instance, of the imperfect division of vertebræ in *Python*, No. 7.

The chief difficulty attending this view of the nature of the case is the fact that as regards the tarsus the "anterior" foot

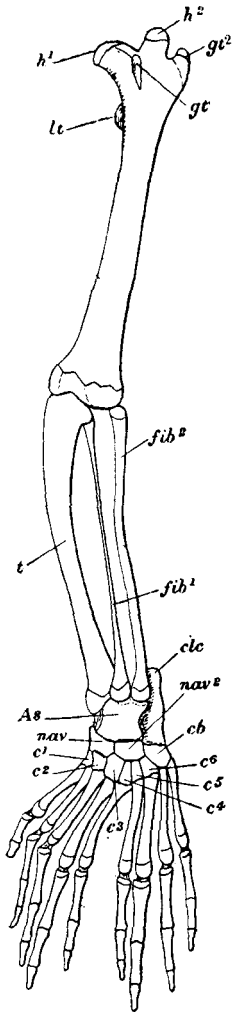


FIG. 97. *Macacus*, No. 504, left leg.
C. S. M. 307.

h^1 , head by which femur articulates.
 h^2 , supernumerary head (?). gt , great trochanter. gt^2 , "posterior" great trochanter.
 lt , lesser trochanter. t , tibia. fib^1 , "anterior fibula." fib^2 , "posterior" fibula (?). clc , calcaneum. As , astragalus. nav , navicular. nav^2 , supposed second navicular. c^1 — c^6 , six cuneiform bones. c^3 , the ecto-cuneiform of "anterior" foot. cb , cuboid.

lacks the external (fibular) parts of a tarsus, viz. the cuboid and calcaneum. There is a cuboid, *cb*, and a calcaneum, *c*, for the "posterior" foot, but none for the "anterior." The bone *c*³ might of course be called a cuboid; but if this is a cuboid there is no ecto-cuneiform for the anterior foot. The account given in the *Catalogue* avoids these difficulties by the statement that each foot has three cuneiforms and a cuboid, declaring that there is a second cuboid between the two sets of cuneiforms. This is nevertheless incorrect, for the whole distal series in the tarsus contains only seven bones and not eight. The mistake has no doubt arisen by counting *c*³ twice over. The *Catalogue* is also in error in neglecting the fact that the tarsal articulation of the digit 2 is quite abnormal.

Similarly in the crus, there is no good reason to affirm that the bone *fib*¹ is a fibula rather than a tibia. The *Catalogue* regards it as a second tibia, but I incline to speak of it as the fibula of the 'anterior' foot following the view already indicated. As I have said, the leg is almost normal in the structure of its external border and almost normal in its posterior border, but between these the nature of the parts is problematical. All that can be done is to describe the parts as they are seen.

Beginning at the external (fibular) border of the foot there is a nearly normal series of three digits, 9, 8, 7, fashioned as V, IV and III

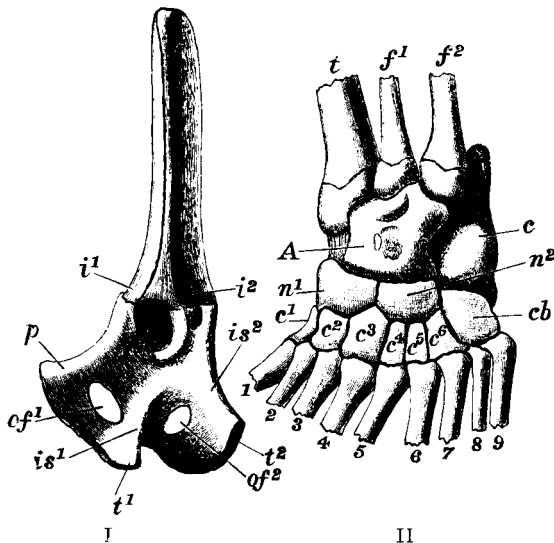


FIG. 98. I. Innominate bone of *Macacus*, No. 504. *i*¹, *p*, *is*¹, *t*¹, *of*¹, ilium, pubis, ischium, ischial tuberosity and obturator foramen of the supposed anterior part of the girdle; the parts marked 2 being the corresponding structures of the supposed posterior part.

II. Details of tarsus of the same. Digits numbered 1—9 from the inside. *A*, astragalus. *c*, calcaneum. *n*¹, navicular of "anterior" foot. *n*², navicular of "posterior" foot. *cb*, cuboid. *c*¹—*c*⁶, six bones placed as cuneiforms.

respectively, the V and the IV articulating with the cuboid (*cb*) and the III with an external cuneiform, c^6 , as usual. There is a middle cuneiform, c^5 , bearing a digit, 6, which is almost exactly formed as a II. Internal to this point the parts can only be named with hesitation. The tarsal bone, c^4 , of the distal series internal to c^5 is shaped like another c^5 , but the digit which it bears rather resembles a minimus. This is succeeded by a tarsal bone, c^3 , shaped like the external cuneiform, c^6 , but it bears a digit of the length suited to an annularis. Internal to this are two tarsal bones of the distal row, c^2 and c^1 , which bear three digits, 1, 2, and 3. Of these the most internal is undoubtedly an internal cuneiform; it bears firstly a slender but otherwise normal hallux with two phalanges, and secondly, it contributes (abnormally for an internal cuneiform) to the articulation of a digit, 2, which is thinner than all the others and resembles rather a minimus than an index. The digit, 2, also articulates with c^2 which chiefly supports the third digit.

Between the metatarsals of the digits 5 and 6 there is a considerable space, owing to the fact that the head of the metatarsal of 6 is prolonged upwards like that of a normal metatarsal V.

In addition to those described are four other tarsal bones: firstly, a calcaneum c , which is rather *smaller* than that of the normal right leg. It articulates with the cuboid, *cb*, with the astragalus, A , and with the bone, n^2 . The astragalus is very large in its transverse dimension but its length is less than that of the normal astragalus. Peripherally it bears two bones, firstly, a navicular, n^1 , and secondly, a bone of uncertain homology, marked n^3 in Fig. 96. The navicular articulates with c^1 , c^2 and c^3 , together with the bone n^2 . The latter, n^2 , articulates with c^3 , c^4 , c^5 , c^6 , and also with the cuboid, *cb*, the astragalus and calcaneum and navicular. From its form and relations it is probably a second navicular.

The bones of the crus are three. Firstly, a tibia, *tib.*, which is rather thinner than the normal bone and is somewhat bowed inwards. Passing as a chord to the curve of the tibia there is a thin bone, *fib*¹, which is tendinous in its upper part. External to this, articulating with the external condyle of the femur there is a third bone, *fib*², which has nearly the form and proportions of a normal fibula. All three bones articulate with the large astragalus.

There is a small patella.

The femur is about half as thick again as that of the right leg. Its head is nearly normal in form, articulating with the rather shallow acetabulum. The lesser trochanter and the internal border of the femur are nearly normal. Anteriorly and externally there are the following parts. Upon the external border there is a projecting callosity, clearly being a great trochanter in its nature. Internal to this there is a knob-shaped, rounded protuberance, which in texture so closely resembles the head of a femur that it is almost certainly of this nature. It is rounded and smooth as though for articulation with an acetabulum, though it stands freely. Between this tuberosity and the real head of the femur there is a third tuberosity, apparently representing the end of the great trochanter of that limb which has been spoken of as "anterior." The peripheral end of the femur is nearly normal on its inner side, while on the outside it is considerably enlarged. The ex-

ternal condyle is thus much larger than that of the normal femur, but there is in it only a very slight suggestion of a division into two parts.

The innominate bone has an ilium which anteriorly is normal, but which posteriorly enlarges and to some extent divides into two parts, i^1 and i^2 . Of these the ventral part, i^1 , unites with a nearly normal pubis, p , and bounds the shallow acetabulum with which the femur articulates. The rest of this acetabulum is made up by the ischium, is^1 , of the "anterior" limb, which together with the pubis bounds an obturator foramen, of^1 . Dorsal to these parts the ilium has a partly separated portion, i^2 , which forms part of the wall of a cavity apparently representing the acetabulum of the "posterior" limb. Dorsal to this a complete ischium arises which bears a normal ischial tuberosity and curves round a second smaller obturator foramen, of^2 .

In so far as the foregoing description involves conceptions of homology it is merely suggestive, but the structure of the innominate bone leaves little doubt that the nature of the parts is much as here described. Nevertheless the appearance of the digits 5 and 6 and of the tarsal bones c^3 to c^6 somewhat suggests that there is a symmetry about an axis passing between the digits 5 and 6; but if 5 were a minimus and if 6 were fashioned as an index, which it is, the appearance of a relation of images would to some extent exist in any case. This appearance is however confined to the dorsal aspect of the foot and is not present on the plantar aspect.

This case, if the view of it proposed be true, differs from other examples of double-hand (*e.g.* Nos. 491 to 499) in that the Repetition is Successive and is not a Repetition of images; for the digits stand I, II, III, IV, V, II, III, IV, V, and not V, IV, III, II, [I], II, III, IV, V as in those other cases. In this respect it is so far as I know unique.

Those who have treated the subject of double-hand generally make reference to the following records. RUEFF, *De conceptu*, Frankfurt, 1587, Pl. 41; ALDROVANDI, *Monstr. Hist.*, 1642, p. 495; KERCKRING, *Obs. anat.*, Amst. 1670, Obs. xx. Pl., but the descriptions are scarcely such as to be useful for our purpose. A case quoted by DWIGHT, *Mem. Bost. Soc. of N. H.*, iv. No. x. p. 474, from DU CAUROI, *Jour. des Scavans*, 1696, pub. 1697, p. 81 [originally quoted by MORAND and misquoted by many subsequent authors], is probably *not* an example of double-hand (see No. 522).

Cases of Polydactylism in Man and Apes not associated with definite change of Symmetry.

From the evidence as to polydactylism in general the foregoing cases have been taken out and placed in association as exhibiting the development of a new system of Symmetry in the limb. It will have been noticed that in all of them the external (ulnar or fibular) parts of the limb remain unchanged, and the parts not represented in the normal are on the internal (radial or tibial) sides. In the remaining cases of polydactylism, which constitute the great majority, there is no manifest change in the general symmetry of the limb.

These general phenomena of polydactylism have been observed from the earliest times and the literature relating to the subject is of great extent. Most cases known up to 1869 [not including STRUTHERS' cases] were collected by FORT, *Difformités des Doigts*, Paris, 1869, and independently by GRUBER, *Bull. Ac. Sci. Pét.*, xv. 1871, p. 352 and p. 460, and good collections of references have subsequently been published, especially by FACKENHEIM. *Jen. Zeits.*, xxii. p. 343. Of the whole number of cases the majority fall into a few types, and a great part of the evidence may thus be easily summarized and illustrated by specimen-cases. The forms of polydactylism thus constantly recurring may be dealt with conveniently under the following heads.

- (1) Addition of a single digit, complete or incomplete.
 - A. external to minimus, in series with the other digits.
 - B. in other positions.
- (2) Duplication of single digits, especially of the pollex and hallux.
- (3) Combinations of the foregoing.

Besides these are a certain number of cases not included in the above descriptions, and of them an account will be given under the heading

- (4) Irregular examples.

As bearing upon the frequency of the several forms of polydactylism it may be stated that in this irregular group are included all cases which I have met with that exhibit any feature of importance in departure from the cases otherwise cited. For the purpose of this list I have examined every record of polydactylism to which access could be obtained.

- (1) A. SINGLE EXTRA DIGIT EXTERNAL TO MINIMUS IN HAND OR FOOT.

- (a) *Incomplete form.*

This is one of the commonest forms of extra digit. In the great majority of such cases the extra digit is not complete from the carpus or tarsus but arises from the metacarpal or metatarsal, less often from one of the phalanges, of the minimus. The attachment may be either by a direct articulation upon the side of one of these bones, or they may give off a branch bearing the extra digit. In a not uncommon form of the variation the extra digit has no bony attachment to the hand, but is a rudimentary structure hanging from some part of the minimus by a peduncle. Of these several forms the following are illustrative cases.

505. *Extra digit hanging from minimus by a peduncle.*
Manus. ANNANDALE, *Diseases of Fingers and Toes*, 1865, p. 30, Pl. II. fig. 20;
 TARNIER, *Bull. Soc. de Chir.*, Paris, vi., 1866, p. 487; and numerous other examples.
Pes. BUSCH, quoted by GRUBER, *l.c.*, p. 470: this form in the pes is rare.

506. *Extra digit arising from one of the phalanges of minimus.*
ANNANDALE, *l. c.*; OTTO, *Monstr. seac. Descr.*, Taf. xxv. fig. 7; CRAMER, *Wochens. f. d. ges. Heilkunde*, 1834, No. 51, p. 809; GAILLARD, *Gaz. méd.*, 1862. This form seems to be comparatively scarce.

507. *Extra digit arising from metacarpus or metatarsus of minimus.*
The great majority of cases are of this nature but exhibit many differences of degree. The articulation may be on the *side* of the metacarpus V (see MORAND, *Mém. Ac. Sci. Paris*, 1770, p. 142, fig. 4; *Coll. Surg. Mus., Catal. Teratol. Ser.*, 1872, No. 308, and numerous other cases), or of the metatarsus V (see GRUBER, *l. c.*, p. 476, Note 23) but in the pes this is less common. Frequently also the articulation of the extra digit is on the *head* of the metacarpus V (GAILLARD, *l. c.*) or metatarsus V (*Mus. Coll. Surg., Terat. Ser.*, No. 310).

In the foregoing cases the extra digit articulates immediately with the side or head of metacarpal or metatarsal, but sometimes in the manus and often in the pes the digit articulates at the end of a branch given off by the metacarpus (MORAND, *ibid.*, fig. 3, and numerous other records), or by the metatarsus (MORAND, *l. c.*; STRUTHERS, *Edin. New Phil. Jour.*, 1863 (2), p. 89; MECKEL, J. F., *Handb. d. path. Anat.*, II. Abth. 1, p. 36, and many more.

*508. ***Hylobates leuciscus*** (Fig. 99) having an extra digit in the left manus articulating externally with the metacarpus V and in the right manus articulating with a branch from it. *Mus. Coll. Surg., Teratol. Ser.*, No. 307, A.

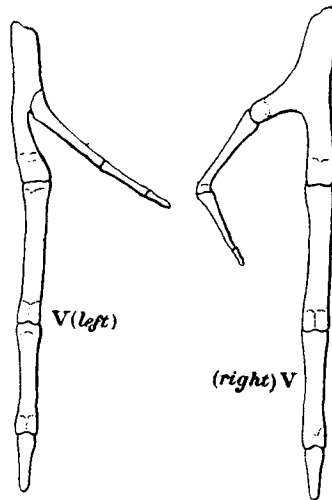


FIG. 99. *Hylobates leuciscus*, No. 508, minimus of right and left manus bearing a supernumerary digit articulating with the metacarpals.
(From specimen in Coll. Surg. Mus.)

(b) *Complete digit having metacarpus or metatarsus external to minimus.*

Extra digits external to the minimus are occasionally complete, having a metacarpal or metatarsal and three phalanges, standing truly in series with the other digits, but to judge from the records this complete form is decidedly rare. In the first of the following examples given it should be noted that the digit standing fifth,

that is to say, as minimus, was itself rather longer than it should be in the normal, thus illustrating the principle with regard to the Variation of a small terminal member of a Meristic Series on becoming penultimate which was predicated especially in regard to Teeth (see p. 272). In MORAND's case the interesting fact of the partial assumption by the sixth digit of anatomical characters proper to the minimus is commended to the attention of the reader.

- *509. Girl: one extra digit on the external side of each hand. The normal little fingers are rather longer than usual and the extra fingers have nearly the same length. Each has three phalanges. Neither of the extra fingers can be moved separately from the finger adjacent to it. In the *left* hand the extra finger is borne on a supernumerary metacarpal which lies parallel with the normal metacarpal V. Each extra digit can be opposed to the pollex. In the *right* hand the extra finger is borne on the enlarged head of the fifth metacarpal. BÉRANGER, *Bull. Soc. d'Anthrop.*, Paris, 1887, Ser. 3, x. p. 600.
- *510. Man (parents normal, one brother had six digits on each extremity, six other members of family normal) having an extra digit external to minimus on both hands (Fig. 100) and both feet, in series with the normal digits.

Left hand: unciform abnormally large, having two articular facets, one for the metacarpal of the fifth and the other for that of the sixth digit. The sixth metacarpal bears a digit of three phalanges of which the second and third were very short. [It does not appear that V was of increased length.] *Right hand*: metacarpals normal in number, but the fifth is very thick, having in its peripheral third on the external

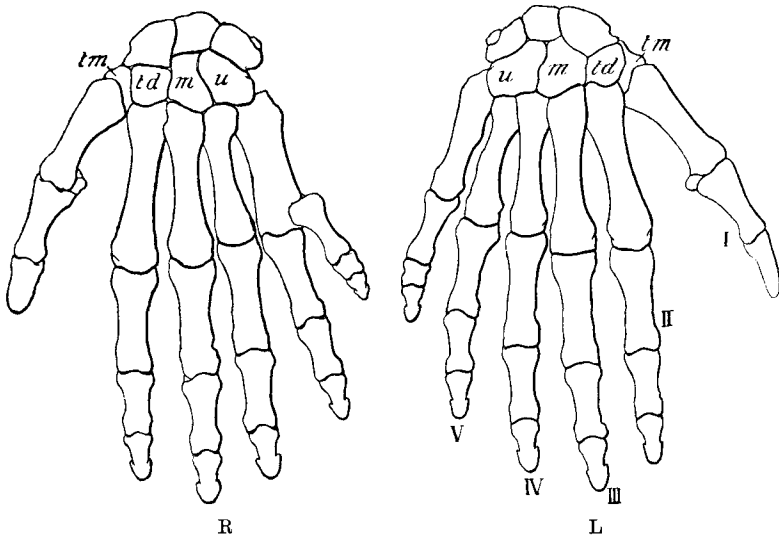


FIG. 100. Palmar views of the bones of the hands of No. 510.
(After OTTO and MORAND.)

surface an articulation for a short digit of three phalanges, the second and third being very small. *Feet*: well formed; cuboid of size greater than the normal, bearing the proximal end of two united fifth and sixth metatarsals. Each of these is separate peripherally and bears a digit [of 3 phalanges to judge from the figure (fig. 6)] in series with the normal toes, but shorter than the minimus.

Muscles. In the *left hand* the sixth digit was fully supplied with muscles. There were two extra *interossei* and the *extensor communis* sent tendons to the sixth digit. The abductor, the flexor brevis and the flexor ossis metacarpi which in the normal are proper to the minimus were all inserted into the sixth digit instead.

In the *right hand* the *extensor communis* gave a tendon to the sixth, which also possessed a proper abductor, but the fifth had no special extensor. Of the flexors the *sublimis* gave a tendon to each of the digits index, medius and annularis, none to the fifth, but a small slip to the sixth. The flexor profundus gave four tendons as usual, but from that going to the fifth a small tendon passes off laterally and piercing the *sublimis* is inserted as usual.

In both feet the muscles were similar. The *extensor longus* gave a tendon to the sixth digit, and the *extensor brevis* does not. The flexor longus has four tendons as usual, none going to the sixth digit; the flexor brevis has four normal tendons and an extra one for the sixth. The two tendons proper to the fifth (*minimus*) go to the sixth. The *interossei* are normal and there are only two *lumbricales*, one for the second digit and one for the fourth. MORAND¹, *Mém. de l'Acad. Roy. des Sci.*, Paris, 1770, p. 142, Figs. 1, 2, 4, 5 and 6. [The condition of the muscles in regard to the fifth and sixth digits in this case is worthy of special attention. If the morphologist will here propose to himself the question *which* is the extra digit, he will find it unanswerable. In the right hand, judging from the bones, it may seem evident that the fifth with its complete metacarpal is the *minimus* and that the sixth is a new structure; but the condition of the feet and the right hand taken with that of the left, make a series or progression from which the similarity of the variation in each of the three states is evident; hence, if it is thought that the most external digit in the right hand is the extra part, it must also be held that the external or sixth digit in the left hand is the extra digit. But this digit in respect of its muscles has some of the points of structure peculiar to a *minimus*, while the fifth digit or supposed *minimus* on the contrary is without these characters. Hence neither digit is *the minimus*. Just as in the Condition III (see p. 326) of the hand, we saw that on the presence of a digit internal to the pollex, the pollex itself may be promoted to be a finger-like digit with three phalanges, so may the fifth digit be partially fashioned as a more

¹ The similar descriptions and figures given by OTTO, *l. c.*, Pl. xxv. figs. 9—11, SEERIG, *Üb. angeb. Verwachs. d. Finger u. Zehen*, AMMON, *Die angeb. Kr. d. Mensch.*, all refer, I believe, to this one original case of Morand's, though the fact is not stated and though several authors (GRUBER, &c.) quote them as separate cases. Seerig states that his figures are from preparations in the Breslau Museum. These figures agree exactly with those of Otto, which again agree closely with those of Morand but give more detail as to the carpi, taken no doubt from the actual specimens which had been acquired by the Breslau collection. I have therefore copied Otto's figures, though taking the important descriptions from Morand.

central digit on the presence of a digit external to it. If therefore it be still called the "minimus" this term can only be applied to it by virtue of its ordinal position.]

For other cases of complete digits in this position see AUWARD, *Arch. de Tocologie*, xv. 1888, p. 633; MARSH, *Lancet*, 1889 (2), p. 739.

(1) B. SINGLE EXTRA DIGIT IN OTHER POSITIONS.

Apart from cases of extra digit external to the minimus, cases of duplication of the pollex or hallux (to be considered below), and cases of extra digits internal to the pollex or hallux associated with change of symmetry of the digital series, the remaining cases of single extra digit are very few. In other words, it is with digits as with Meristic series in general, when a new member is added, the addition taking place in such a way that homologies may be recognized, it is most often at one of the ends of the series that the addition is made. Cases of extra digits in other positions are in Man and Apes very rare, and even in some of the few recorded cases of a new digit arising on the *inner* side of the minimus (No. 511) it should be remembered that this inner digit is judged to be the extra one rather than the outer mainly by reason of its smaller size. I can only give particulars of few such cases, and of the remainder no details are available.

*511. *Simia satyrus* (Orang-utan), having a rudimentary extra digit arising from the *internal* side of the minimus of each hand; feet normal. In the *left* manus the minimus has all joints moveable as usual; the first phalanx is normal, but the second is bent outwards nearly at right angles, thus making room for an extra digit arising from the first phalanx and directed inwards. This digit is fixed and has no articulation and no nail, but it is in its outer part bent back again towards the minimus with which it is webbed. The structure in the *right* manus is almost the same but the extra digit is larger and in its outer part free from the minimus, bearing a nail. BOLAU, *Verh. naturw. Ver. Hamburg*, 1879, N. F. III. p. 119.

512. Woman: left pes bearing an extra digit articulating by an imperfect metatarsal with outside of metatarsal of IV. The extra digit stands obliquely to the others, sloping outwards and being attached by ligaments to the normal V. [The *Catalogue* states that the extra digit resembles a *right* digit, but I see no sufficient evidence of this.] C. S. M., *Ter. Cat.* 312.

[A case perhaps similar to foregoing is briefly quoted by GRUBER, *l. c.*, p. 471, note 83, as being in the Vienna Museum of Anatomy.]

512a. Child: left metacarpal IV bore a supernumerary digit on external side. This digit was shorter than the digit IV and was completely webbed to it. BROCA, quoted by FORR, *l. c.*, p. 66.

*512b. Fœtus (otherwise abnormal): left hand bore extra digit attached by peduncle to first phalanx of digit IV. The minimus was separated from IV by a metacarpal space, standing almost at right angles to it. HENNIG, *Sitzb. naturf. Ges. Leipzig*, 1888, Oct. 9.

[AMMON (*Die angeb. Krankh. d. Mensch.* p. 101, Pl. xxii. fig. 7) describes a case of rudimentary finger appended to the "ring-finger" and is so quoted by GRUBER; but the figure apparently represents the appendage as attached to the minimus.]

(2) *Duplication*¹ of single Digits, especially of the Pollex and Hallux.

*513. Duplication of the pollex or of the hallux is one of the commonest forms of polydactylism and numerous cases have been described by all who have dealt with the subject. It consists in the development of two digits, complete or incomplete, in the position of the usually single series of bones composing the pollex (or hallux). In the section dealing with polydactylism associated with change of Symmetry (p. 326) we saw how upon the appearance of an extra digit in this position the thumb itself may have three phalanges. In these cases the extra digit may properly be considered as arising in Successive Series with the

¹ A few cases are thought by some to shew *triplication* of digits, but it seems doubtful whether there is a case of division of one digit into three really equivalent digits, perhaps excepting the thumb of No. 521.

pollex. But in a large majority of cases of the presence of an extra digit on the radial side, the thumb has two phalanges as usual. Upon a review of the evidence it is I think clear that we shall be right in considering that in most of these cases the extra digit is not really in *Succession* to the thumb, but that the two radial digits together represent the thumb, the increase in number being achieved by duplication and not by successive addition.

Most authors (GRUBER, &c.) thus speak of these formations as "double-thumbs" and recognize them as examples of duplicity, but it should be remembered that this view of their nature is not consistent with any statement that either of the two digits is the extra one. If these thumbs are instances of duplicity then both together represent the normally single thumb.

In clear cases of double-thumb the two thumbs are equal or nearly equal in size and development, as commonly happens in cases of true duplicity. Double-thumbs are known in every degree of completeness. The division between the two may occur at any point in their length. Thus the duplicity may be confined to the nail and first phalanx (OTTO, *Monstr. sexc. Descrip.*, Taf. xxv. fig. 1; BIRNBAUM, *Monatsschr. f. Geburtsk.*, 1860, xvi. p. 467); or it may include both first and second phalanges (GRUBER, *Arch. f. path. Anat. Phys.*, xxxii. 1865, p. 223); or both phalanges and the greater part of the metacarpal (GAILLARD, *Mém. Soc. de biol.*, 1861, p. 325); or even the whole digit and metacarpus, the two thumbs separately articulating with the trapezium (JOSEPH, quoted by GRUBER, *l. c.*, p. 463, *Note 37*). It would be interesting to know which of these conditions is the most frequent, for it is likely that between the degrees of this variation there is Discontinuity, but the point is not easy to determine. As regards records the conditions first and last named are much the rarest, and the double-thumbs with two sets of phalanges articulating with one metacarpal constitute the majority of cases.

Sometimes the two thumbs are webbed together (GRUBER, *Bull. Ac. Sci. Pét.* xv. p. 480, fig.) sometimes they are separate and *may be*



FIG. 101. Right hand having a thumb double from the metacarpus, shewing the relationship of images between the two thumbs. (After ANNANDALE.)

opposed to each other (FACKENHEIM, *Jen. Zts.*, xxii. p. 358, fig. iv.; ANNANDALE, *Diseases of Fingers and Toes*, Pl. III. fig. 25). This condition is important as an indication that between these double-thumbs there may be a relation of images (Fig. 101).

The duplicity may be and often is very different in degree in the two hands, though it is very commonly present in both.

514. The description given of duplicity in the pollex applies equally to the hallux, though of duplicity in the latter perhaps fewer cases are recorded. Here too the duplicity may be in all degrees of completeness. An example from ANNANDALE (*l. c.*, Pl. III. fig. 32) is shewn in Fig. 102.

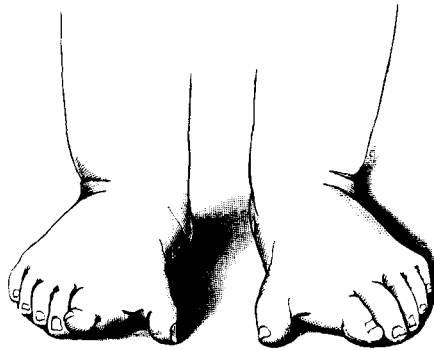


FIG. 102. Feet of infant, No. 514, having thumb-like supernumerary digits arising from the metatarsi of the great toes.

(After ANNANDALE.)

Here a thumb-like extra hallux is borne on the inner side of the metatarsal I. Several such cases are known (cp. No. 517).

515. Among the cases called by authors "double-thumb" are a certain number in which the two thumbs are not equally developed, that on the radial side being more rudimentary. In such a case we are entitled to consider the radial thumb as an extra digit formed in Succession to the normal thumb, and not as a double of it. In speaking of other Meristic Series (especially mammæ and teeth) we have seen that it is not possible accurately to distinguish between cases of duplicity and cases of change in number of the series by formation of another member in the Succession. This is extremely well seen in digits. For firstly several conditions intermediate between the two are recorded by many authors (*e.g.* a case in which the radial thumb had two phalanges "ankylosed" together [or rather not completely segmented from each other]. GRUBER, *l. c.*, p. 480; cases in which the radial thumb had only one phalanx, *ibid.*, p. 482; STRUTHERS, *Edin. New Phil. Jour.*, 1863 (2), p. 87; BOULIAN, *Rec. de Mém. de Méd. milit.*, 1865, Ser. 3, XIII. p. 67, *figs.*); and besides this there are several examples in which one hand bore a clear pair of double-thumbs, while in the other hand there is an extra radial digit in succession to the normal thumb (*e.g.*

FACKENHEIM, *l.c.*, p. 359, fig. iv.). Thus do the two conditions pass into each other, though some cases are clearly cases of duplicity and some are clearly cases of extra digit in Succession¹.

I know no case of unmistakable duplicity in any digit but pollex or hallux; but no doubt a good many cases of extra digit arising from the minimus may be of this nature (*e.g.* ANNANDALE, Pl. III., fig. 28), though it is more likely that the extra digit is in Succession.

In digits other than I or V the only case of possible duplicity known to me as occurring in a limb not exhibiting one of the complex conditions of polydactylism, are those of STRENG (*Vierteljahrschrift f. prakt. Heilk.*, XLIX. 1856, p. 178; original not seen by me; quoted by GRUBER, p. 476), being a case apparently of double medius on one metacarpal; and of DUSSEAU, *Cat. Mus. Vrolik*, No. 518, two terminal phalanges on right medius (together with double thumb; six fingers on left hand and peripheral duplicity of hallux in each foot). Accompanied by numerical Variation in other parts of the digital series such cases of duplicity are known in a few other cases.

(3) *Combinations of the foregoing.*

Limbs not rarely present the forms of polydactylism already named in combination. Such combination may be found in the same limb, or one or more limbs may present one form, while another form may be found in the other limb or limbs. Of these combinations the following three cases will be sufficient illustration.

Case of double hallux on each foot, and rudimentary digit attached by peduncle to the minimus of each hand.

516. A female member of a polydactyle family [particulars given] had an abortive supernumerary finger attached by a peduncle to the little finger of each hand. In the feet the two *great toes* were each partially double. In the left great toe the individual phalanges could be felt and there were two nails. In the great toe of the right foot the adjacent sets of phalanges were inseparably united by their lateral borders, forming one bone, which was correspondingly broadened. There was only one nail which was notched in the middle of its free border. MUIR, J. S., *Glasgow Med. Jour.*, 1884, N. S. xxi. p. 420, Plate.

Case of each extremity with double pollex or hallux and rudimentary digit attached to minimus.

517. Female infant having thumb of each hand double, the two sets of bones lying in the same skin and connective tissue. In the right hand the nails and phalanges of each were quite distinct, but it was not certain whether the metacarpals were separate or not. In the left hand the nails were not completely separate and the phalanges of the two thumbs were less distinctly separate. To the first phalanx of the little finger of each hand was appended a rudimentary bud-like finger, hanging by a peduncle.

The feet resembled the hands. From the inner border of the metatarsal of each great toe there proceeded a well-formed thumb-like toe with two phalanges. This toe was set at right angles to the great toe and could be flexed and to some extent opposed. On the external border of the right foot there was a small extra little toe hanging by a peduncle from the metacarpal V. In the left foot the supernumerary little toe was bound up with the normal little toe for its whole length. HAGENBACH, E., *Jahrb. f. Kinderheilk.*, xiv. 1879, p. 234, figs. [Cp. No. 514.]

¹ Compare with the largely similar series of phenomena seen in the foot of the Dorking fowl (*v. infra*). But in it if the two hallucal digits are not a true pair it is most commonly the *inner* that is the largest, conversely, to the general rule in the extra digits arising from the pollex in Man.

Case of double hallux in combination with extra digits on external side.

518. Man in Middlesex Hospital, 1834, having on the right foot two toes articulating with the first metatarsal, and on the left foot two toes articulating with the first metatarsal, and also two toes articulating with the fifth metatarsal. From the ulnar side of one of his hands two fingers had been removed. In each hand the middle and ring fingers were adherent throughout their length, as also were all the toes, except the minimi. Five brothers and three out of four sisters of this man had six toes on each foot and six fingers on each hand. The other sister had seven toes on one foot and six on the other, and had two extra fingers on each hand. *London Med. Gaz.*, 1834, April, p. 65, *figs.*

(4) *Irregular examples.*

Thus far we have considered cases of polydactylism that can be in some degree brought into order and included in general descriptions. There remain a small number of irregular cases each presenting special features which make general treatment inapplicable. These cases are instances of extremities, mostly feet, having seven, eight or nine digits. The descriptions of these cases are for the most part fragmentary, and as the bones have been examined in only one of them (MORAND) so far as I am aware, the relations of the digits to each other and to the limb are obscure. Speaking generally in these irregular examples there is an appearance of division, possibly of duplication, of several digits. It should be noticed also that in some of them (*e.g.* BLASIUS, No. 520) the digits did not lie evenly in one plane but were in a manner bunched up so as to overlie each other. In such a case it would be interesting to know whether the digits originally grew in one plane and were afterwards shifted during growth, or whether the original Repetition was thus irregular.

As all these cases differ from each other an adequate account of them could only be given at great length, and by reproducing the original descriptions in full, together with such figures as are attainable. For these reasons it would not be profitable to introduce them here, though in a study of the nature of Meristic Repetition it is important to remember that these irregular cases exist. As illustrative of several cases I have appended an account of two complex cases in the foot and of one in the hand, giving references to such others as I am acquainted with.

- 519*. Girl, *æt.* 6, having abnormal toes on the left foot as follows (Fig. 103). The total number of toes on the left foot was nine. From the position and form it appeared that the digits (6—9) representing II, III, IV and V were normal, but upon the radial side of these instead of a single hallux there were five toes. Of these 1 and 2 were imperfectly separated, articulating with the first metatarsal by their first phalanges, which were united to form a common proximal head. Each had a distinct second phalanx and in general form resembled a great toe having a separate nail. The second metacarpal bore firstly a pair of toes, 3 and 4, which were still less separate from each other than 1 and 2, the bifidity being confined to the soft parts. These two toes had one proximal and one distal phalanx in common. The second metatarsal also bore an external digit, 5, which in form rather resembled a normal *third* digit, being considerably shorter than 6 [and presumably containing three phalanges]. The toes 1, 2, 3 and 4 were found after amputation to be devoid of muscles and presented only the terminations of the flexor and extensor tendons

having their normal insertions. The toes 1 and 2 were supplied by the same flexor tendon which bifurcates and passes to be inserted into the ultimate phalanx of each



FIG. 103. Foot of No. 519. (After ATHOL JOHNSON.)

- by a separate slip. The vinculum by which it is attached is common to the two bones. JOHNSON, ATHOL A., *Trans. Path. Soc.*, ix. 1858, p. 427, *fig.*
520. Male infant having supernumerary toes on the left foot. The tarsus and metatarsus were abnormally wide. The hallux appeared externally to be divided into two. This duplicity was most marked in the second phalanx and appeared in a slight infolding of the skin. The nail also shewed traces of duplicity. Next to the hallux were two toes which were bent upwards and inwards. Of these the one overlaid the other. The uppermost was found after excision to have two sets of phalangeal bones enclosed in the same skin; these two articulated with a single metatarsal bone. The lower toe was thought by BLASIUS to represent the digit II. Next to this there was a rudimentary digit with a slightly developed nail. After excision it was found that this toe contained a cartilaginous basis which was partly segmented into two phalanges and articulated with a metatarsal. External to this rudimentary toe were three normal toes, representing as BLASIUS supposes, the digits III, IV and V. External to the putative V was another digit of the same size and shape. BLASIUS, v. *Siebold's Jour. f. Geburtsh.*, xiii. 1834, p. 131, figs. 1 and 2; figures copied in AHLFELD, *Missb. d. Mensch.*, Taf. xx. fig. 11. [This foot appears to contain parts of ten digits.]
521. Child having polydactyle hands as follows. In each hand the fingers were webbed to the tips, each minimus having an extra nail. In the *right* hand the pollex was triplicate, having three sets of phalanges and three nails, the whole being in a common integument. In the *left* hand the pollex was duplicate, having two sets of phalanges webbed together and two nails. Each member thus formed a prehensile paw. In right foot little toe webbed to next toe. Some (not all) of brothers and sisters had similar hands: father and grandfather had similar hands: mother and grandmother normal. HARKER, J., *Lancet*, 1865 (2), p. 389, *fig.*
522. The following are other examples of irregular polydactylism: MORAND, *Mém. Ac. Sci. Paris*, 1770, p. 139, figs. 8 and 9. (The same redescribed from Morand's figure by DELPLANQUE, *Etudes Tératol.*, ii. Douai, 1869, p. 67, Pl. v.; and again by LAVOCAT, *Mém. Ac. Sci. Toulouse*, v. 1873, p. 281, Pl. i., who takes a different view.) GRUBER, *Mém. Ac. Sci. Pét.*, Ser. vii. Tom. ii. No. 2 (fig. copied in *Bull. Ac. Sci. Pét.*, xv. 1871, fig. 6, and by AHLFELD, *Missb. d. Mensch.*, Pl. xx. fig. 20). GRUBER, *Bull. Ac. Sci. Pét.*, xv. 1871, p. 367, figs. 4 and 5. OTTO, *l.c.*, Pl. xxvi. figs. 8—11. FROBIEP, *Neue Notizen*, &c., Weimar, No. 67, 1838, iv. p. 8, figs. 4—8 (very brief account of important case, copied by AHLFELD and others). DU CAUROI, *Jour. des Sçavans*, 1696 (pub. 1697), p. 81 (quoted first by Morand, afterwards wrongly quoted by many writers. DWIGHT, *Mem. Bost. N. H. S.*, iv.

No. x. p. 474, supposes that this is a case of double-hand, palm to palm (as No. 503), but the original probably means that two adjacent thumbs and two adjacent annulæ were united, the digits being all in one plane).

POPHAM, *Dubl. Quart. J. of Med. Sci.*, XLIV. 1867, p. 481.

DUSSEAU, *Cat. Mus. Vrolik*, 1865, p. 457 (very brief, see p. 352).

GRANDÉLÉMENT, *Gaz. des hôp.*, 1861, p. 553.

LISFRANC (see *Schm. Jahrb.*, XII. 1836, p. 263).

RÖRBERG, *Jour. f. Kinderkr.*, xxxv. 1860, p. 426.

MARJOLIN, *Bull. Soc. de Chir.*, 1866, Ser. 2, vi. p. 505, fig. (probably case of double-hand).

ANNANDALE, *Dis. of Fingers and Toes*, 1865, p. 39 (eight metatarsals on a foot possibly associated with change of Symmetry).

Ibid., p. 35, figs. 41 and 49 (pollex with two sets of phalanges but three nails, together with extra digit external to V). Cp. No. 521.

HEYNOLD, *Virch. Arch.*, 1878, LXXII. p. 502, Pl. VII.

MASON, F., *Trans. Path. Soc.*, 1879, xxx. p. 583 (foot having eight metatarsals and nine digits).

MELDE, R., *Anat. Unters. eines Kindes mit beiders. Defekt d. Tibia u. Polydactylie an Händen u. Füßen*, Inaug. Diss., Marburg, 1892 (important).

REDUCTION IN NUMBER OF DIGITS.

Though in reduction of digits the course of Variation is generally irregular and the result often largely amorphous there are still features in the evidence which may be of use to us, and a few selected cases are of some interest. These features will be spoken of under the three following heads, though for a general view of the subject reference must be made to teratological works.

- (1) Reduction in number of phalanges.
- (2) Syndactylism.
- (3) Ectrodactylism.

(1) REDUCTION IN NUMBER OF PHALANGES.

As in certain cases of polydactylism it appeared that increase in the number of phalanges in the thumb could be regarded as a step in the direction of increase in the number of digits, so a reduction may be thought to be a step towards diminution in the number of digits. But though many cases of reduction in number of phalanges are recorded, there is in them nothing which suggests that they may be fitted into a series of gradual reduction comparable with the series of gradual increase already described. It is indeed chiefly as illustrating the possible completeness and perfection of Variation that these phenomena have a direct bearing on the subject of Meristic Variation. The following case is chosen as being especially regular and symmetrical.

*523. Man having only one phalanx in each hallux, and two in each of the other fingers and toes. The hands were almost exactly alike. The thumb had a short metacarpal $\frac{5}{8}$ in. long, and one phalanx ($1\frac{1}{3}$ in.), the joint between them being loose as if composed of soft tissue. By the length of the metacarpal (3 in.) the index is longer than the other digits. The next two metacarpals have only half that length. The metacarpal of V is $1\frac{1}{2}$ in. long, but from its obliquity does not project so far as that of IV. The proximal phalanx of the index measures $1\frac{3}{8}$, medius $1\frac{3}{8}$, annularis 1, minimus $1\frac{1}{2}$. The distal phalanx in index and middle $\frac{1}{2}$, ring and little $\frac{5}{8}$ in. In left hand the distal phalanx of index is proportionally shorter. Except the index all the digits present their usual proportions. The feet are well formed as far as distal ends of metatarsals. The toes are short, pulpy and loosely articulated. Each has two phalanges except the hallux, which has only one. This case was a twin with a normal male. An elder brother and younger sister have the

digits similarly formed, but in the last the feet are also turned in. STRUTHERS, *Edin. New Phil. Jour.*, 1863 (2), p. 100.

As an example of similar and simultaneous Variation in both extremities this is an instructive case.

(2) SYNDACTYLISM.

Under this name have been described those cases in which two or more digits are to a greater or less extent united together. In their bearing on the morphology of Repeated Parts some of these variations are very instructive. It will be found that the important considerations in this evidence may be divided into two parts. Of these the first concerns the *manner* of the variation and the second to the *position* in which it is most commonly found.

The manner of union between digits.

In many cases of union of digits the limb is amorphous; with these we have now no special concern. In simpler examples the digits may be of normal form but some or all of them may be united by a web of integument for a part or the whole of their length. (For records of such cases see FORT, ANNANDALE, &c.).

- *524. But besides these cases of webbing are many in which the union may be of a much more intimate character. Taking the cases together a progressive series may be arranged shewing every condition, beginning from an imperfect webbing together of the proximal phalanges to the state in which two digits are intimately united even in their bones, and perhaps even to the condition in which two digits are represented by a single digit (see No. 529). That the latter condition represents a phase in this series of variations does not seem to be generally recognized by those who have dealt with the subject but it is impossible to exclude it.

The lower conditions of this variation are sufficiently illustrated by Fig. 104, I and II (from ANNANDALE, *Diseases of Fingers and Toes*, figs. 39 and 33), shewing cases of medius and annularis partially combined for the whole of their length. A higher condition is shewn in Fig. 104, III, in which the same digits are united so closely that their external appearance suggests that only four digits are present in the hand. In this specimen (ANNANDALE, *l. c.*, p. 14) there were nevertheless five metacarpals, but the first phalanges of III and IV were united peripherally and bore a second and third phalanx and one nail common to them both. The same author (*l. c. fig.* 44) gives an illustration of such a set of bones from OTTO¹.

The following cases are interesting as occurring in Apes.

- *525. ***Pithecia satanas*** (Monkey): young male having the third and fourth digits of the hand on each side completely connected by a fold of nude skin. The remaining digits of the hands and feet were normal. FORBES, W. A., *P. Z. S.*, 1882, p. 442.
526. ***Macacus cynomologus***: specimen having the fifth finger of the right hand represented by a rudiment only. On dissection the first phalanx of the fifth finger was found to be enclosed with that of the fourth. All the fingers of the abnormal (right) hand were somewhat misshapen and bore several exostoses. [? congenital variation] FRIEDLOWSKY, A., *Verh. zool. bot. Ges. Wien*, 1870, xx. p. 1017, Plate.

¹ I have failed to find the original of this figure in OTTO's works.

Before going further certain points are to be noted. First, the union as shewn in the figures is a union or compounding *as of optical*

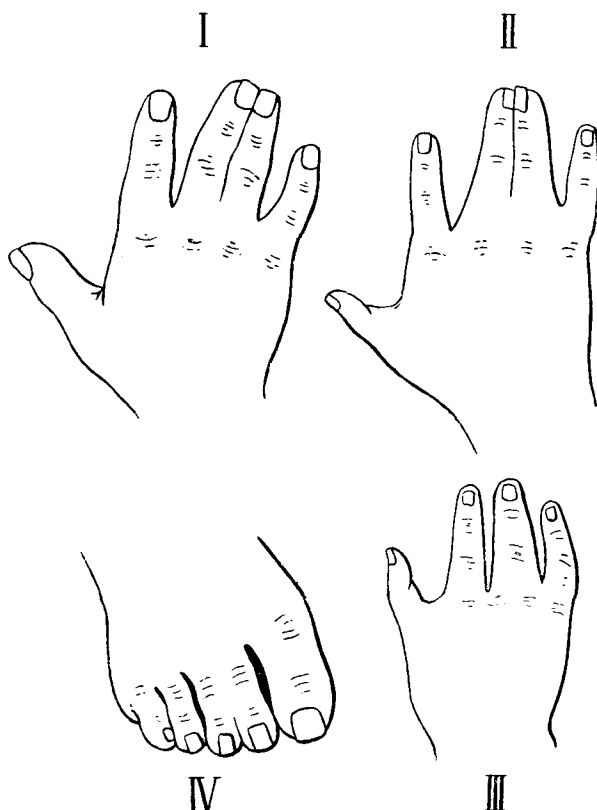


FIG. 104. Cases of syndactyly. I, II and III. A progressive series illustrating degrees in the union of medius and annularis in the hand. IV. Case of union of index and medius of the foot. The union is incomplete peripherally. (After ANNANDALE.)

images in Bilateral Series, and is not like that of parts in Successive Series. Next, the union of the bones is *more complete peripherally and less complete centrally*. The latter is a rule very commonly observed in cases of the union of the bones of digits both in Man and other mammals. This statement is made without prejudice to the other fact that in the least state of syndactyly as manifested by union of the soft parts, it is the most central phalanges which are united. Such a case of partial union between II and III in the foot¹ is shewn in Fig. 104, IV (ANNANDALE, *l. c.*, fig. 34). The rule that in the lowest condition of syndactyly of the bones it is commonly at the periphery that the union is most complete is also difficult to understand in connexion with

¹ Compare several remarkable cases of this variation in one family, LE CLERC, *Mém. soc. Linn. Normandie*, ix. p. xxvi.

the fact that the division of digits in the lowest forms of polydactylism appears also first in the *peripheral* phalanges. These phenomena appear to be in contradiction to each other, and I am not aware that the fact of the appearance of the digits early in the development of the limb throws any light on the difficulty.

The number of digits which may be thus united is not limited to two, and examples of intimate union between three and even four digits are common.

The position of union.

*527. Those who have treated of this subject do not, so far as I am aware, notice the fact that the phenomenon of Syndactylism most frequently affects particular digits. From an examination of the recorded cases it appears that in the hand there is a considerable preponderance of cases of union between the digits III and IV. I regret that I have not material for a good analysis of the evidence on this point, but I may mention meanwhile that in a collection taken at random of some thirty-five cases of hands having only *two* digits united (chiefly those given by FORT and ANNANDALE) over 25 are cases of union of the digits III and IV¹; in only one were the digits I and II united; the digits II and III in ?4 cases; the digits IV and V in ?3 cases.

*528. On the other hand if two digits in the *foot* are united they are nearly always II and III.

If in the hand *three* digits are joined they may be either III, IV and V, or (perhaps less commonly) II, III and IV. In cases of union of all the digits II to V, the digits III and IV are often much more intimately united than the others, and are often recorded as having a common nail, while II and V have separate nails.

This question of the comparative frequency of the different forms of syndactylism would probably repay full investigation, and to the study of the mechanics of Division it would clearly be important. In the meantime may be noted the fact that the evidence suggests the possibility that we have here to do with a case of union of parts which are related to each other as optical images, and that the digits II to V of the hand constitute an imperfect Minor Symmetry within themselves. The fact that the subjects of most frequent union in the foot are the digits II and III, not the digits III and IV as in the hand, may be connected with the fact that the hallux stands to the foot in a different geometrical relation from that which the pollex bears to the hand and that consequently the axes of Symmetry are different in it.

(3) ABSENCE OF DIGITS (ECTRODACTYLISM).

In the conditions already described though the digits are not all clearly divided from each other yet no one whole digit can be supposed to be absent. Even in the specimen shewn in Fig. 104, II, from the presence of separate metacarpals III and IV the identity of the several digits is still easily recognized. These *simplest cases however* by no means exhibit all the phenomena. From a large group of cases the three following are chosen as each illustrating a distinct possibility.

¹ Owing to the ambiguity of some records as to the similarity of the condition in the right and left hands I cannot give exact numbers.

Upon the morphological questions arising out of these facts comment will be made when the whole subject of numerical Variation of digits is discussed.

Representation of digits II and III of the pes by one digit.

- *529. Man having four digits in the right foot as shewn in Fig. 105. The calcaneum, astragalus, navicular, first (internal) cuneiform and cuboid were normal. The navicular had on its peripheral surface three facets as usual. The second and third cuneiforms were completely united to form one bone which bore no traces of its double nature as shewn in the figure ($c^2 + c^3$). The peripheral surfaces of both form one plane. Taking the four digits in order, the minimus has its normal form and tarsal relations. The digit next to it has the normal form and relations of a digit IV.

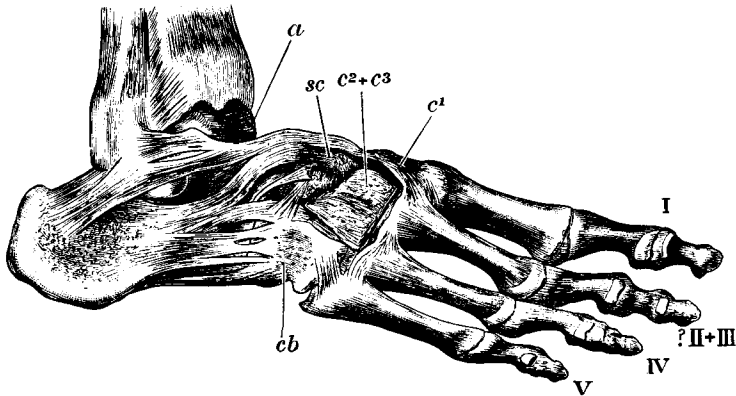


FIG. 105. Bones of the right foot of No. 529. I, hallux. II+III, digit apparently representing index and medius. IV, annularis. V, minimus. *a*, astragalus. *sc*, navicular. *cb*, cuboid. *c*¹, internal cuneiform. *c*²+*c*³, bone apparently representing the middle and external cuneiforms. (After GRUBER.)

Internal to this is a metatarsal of abnormal thickness articulating with the single bone presumably representing the external and middle cuneiforms. This metatarsus presented no trace of duplicity. It bore a digit of three phalanges of more than normal thickness but otherwise normal. The hallux was normal, having two phalanges. Each of the other digits had three phalanges, but the 2nd and 3rd phalanges of the minimus were ankylosed.

Of the muscles, the transversalis pedis, one of the lumbricales, one of the interossei dorsales and one of the interossei plantares were absent. The extensor and flexor longus each had three tendons. [Detailed description of bones and soft parts given.] GRUBER, W., *Virch. Arch. f. path. Anat. u. Phys.*, 1869, XLVII. p. 304, Pl. VIII.

Single digit articulating with the cuboid [probably a case of representation of digits IV and V by one digit].

- *530. Man having four digits on the left foot as follows. The foot is well formed. The digits I, II and III are normal and have normal tarsal relations. The fourth digit has a well-formed metatarsal and three phalanges. The bones are perhaps rather more robust than those of a normal fifth digit, but the metatarsal has the normal tuberosity at the base strongly developed. This metatarsal articulates with a cuboid of somewhat reduced size having only one articular facet on its peripheral surface. The other parts were all normal, and even in the muscular system only a trifling abnormality was found. Parents normal. STEINTHAL, C. F., *Virch. Arch. f. path. Anat. u. Phys.*, 1887, CIX. p. 347.

Reduction of digit IV of pes.

*531. [This case is introduced here for comparison with the last.] A left foot having abnormalities as follows. Calcaneum, astragalus, internal cuneiform normal in size and shape. The second cuneiform is rather broader than usual, but the surface which it presents to the internal cuneiform has all the characters of a middle cuneiform. External to this middle cuneiform is only one large tarsal bone in the distal row. This bone presents no clear sign of duplicity, but from its form and relations it appeared that it represented both the cuboid and the ecto-cuneiform. The hallux and digit II have approximately normal relations. The large cuboid-like bone bears externally a metatarsal agreeing in shape with a metatarsal V; and internal to this the same tarsal bone bears another metatarsal which upon its external side gives off yet another metatarsal of reduced size. Each of the five metatarsals bore a digit, but the digits of the minimus and of the slender IV were webbed together. [Full details given.] BRENNER, A., *Virch. Arch. f. path. Anat. u. Phys.*, 1883, xciv. p. 23, Pl. II.

532. Besides these simpler cases there are very many recorded instances of reduction in number of digits in which the identification of the parts is quite uncertain. From the point of view of the naturalist it is worthy of remark that even in some of the cases departing most widely from the normal form the limb though having only three or perhaps two digits still presents an approach to a symmetry. Examples of this kind are given by GUYOT-DAUBES (*Rev. d'Anthropol.*, 1888, xvii. p. 541, *figs.*) and by FOTHERBY (*Brit. Med. Jour.*, 1886 (1), p. 975 *figs.*) and many more. Fotherby's record is interesting as relating to a family among whose members feet bearing only two opposable claw-like digits of irregular form recurred for five generations. Evidence relating to limbs of this kind is so obscure that it is not possible as yet to make deductions from it, but there seems to be a general agreement among anatomists that when two digits only remain one of them has the characters of a minimus.

Reference must be made also to the fact that in cases of absence of radius the pollex is almost always absent. This seems to be established in very many cases. The only examples of a pollex present in the absence of a radius known to me are that of GRUBER, *Virch. Arch. f. path. Anat. u. Phys.* 1865, xxxii. p. 211, and that of GEISSENDÖRFER, *Zur Casuistik d. congen. Radiusdefectes*, Münch. 1890.

HORSE.

Variation in the number of digits in the Horse¹ has been repeatedly observed from the earliest times. The mode of occurrence of the change is by no means always the same, but on the contrary several distinct forms of Variation may be recognized. On inspection the cases may be divided into two groups.

- A. Cases in which the extra digit (or digits) possesses a distinct metacarpal or metatarsal.
- B. Cases in which the large metacarpal or metatarsal (III) gives articulation to more than one digit.

Besides these I have placed together in a third group (C) two very remarkable cases which cannot be clearly assigned to either of the other groups. These instances are of exceptional interest from the fact that in them is exhibited a condition intermediate between those of the other two groups. We have seen repeatedly that

¹ In the Mule two cases have been recorded, but in the Ass I know no instance of polydactylism. Describing a polydactyle horse seen on a journey in Rio Grande von JHERING (*Kosmos*, 1884, xiv. p. 99) states that he believes polydactyle horses to be much more common in S. America than in Europe, and that most persons who have travelled much in that country have met with cases. Mules between the jackass and mare are bred in great numbers, but he had heard of no case in a mule.

Meristic Variation may take place by division of single members of Series, a phenomenon well seen in the B group; and we have also seen many cases of numerical Variation by addition to the Series associated with a reconstitution, or more strictly a redistribution of differentiation amongst the members of the series thus newly constituted; but here in these rare examples of the C group the nature of the parts is such that it cannot be predicated that the change is accomplished by either of these methods exclusively. From such cases it follows that the two processes are not really separable, but that they merge into each other. (Compare the similar facts seen in regard to teeth p. 269, and mammæ p. 193.)

A. EXTRA DIGITS BORNE BY DISTINCT METACARPAL OR
METATARSAL.

The cases in this group may be subdivided as follows:

- (1) *Two digits, one being formed by the development of the digit II.*
 - a. Only *three* metacarpals or metatarsals (II—IV) as usual. Common form: fore and hind limb.
 - b. *Four* metacarpals (? I—IV). Common form: anatomically described in fore limb only.
 - c. *Five* metacarpals (? I—V). Single case in fore limb.
- (2) *Two digits, one being formed by development of the digit IV.* Rare.
- (3) *Three digits; the digits II and IV both developed.* Rare.
- (4) *Two digits; the digits II and IV both developed, III aborted.* Rare.

It will appear from the evidence that though the same variation is often present in the limbs of both sides this is not always so. The fore and hind limbs also sometimes vary similarly and simultaneously, but in other cases they do not. Different forms of numerical Variation are also sometimes found on the two sides, and not rarely the variation in the fore limb is different from that in the hind limb.

- (1) *Two digits, one formed by development of the digit II.*
 - a. *Three metacarpals or metatarsals only.*

To this division and to the next, (1) *b*, belong the great majority of cases of polydactylism in the Horse. Unfortunately most of the records have been made from living animals and contain no *anatomical description*: in the absence of such particulars it is not possible to know whether a given case belongs to this division or to the next, and it thus is impossible to determine the relative frequency with which the two forms occur.

The following are given as specimen cases.

Fore foot.

*533. Horse of common breed, having a supernumerary digit on the inner side of the right fore foot (Fig. 106).

Humerus and radius: no noticeable variation. *Ulna* a little more developed than usual; lower end slightly broken, having probably reached to lower fourth of radius. The part of the inferior and external tuberosity of the radius which is usually supposed to represent the ulna is larger than in the normal form.

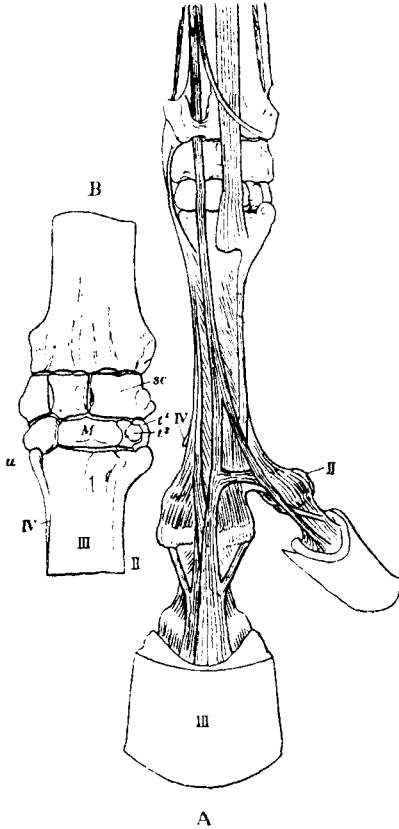


FIG. 106. Right fore foot of Horse, No. 533.

A. The leg seen from in front.

B. The carpal bones enlarged.

M, magnum. *sc*, scaphoid. *u*, unciform. *t*², trapezoid. *t*¹, supernumerary bone not found in normal, representing trapezium. *IV*, the metacarpal representing digit IV. *III* and *II*, metacarpals bearing those digits respectively. (After ARLOING.)

Carpus consisted of eight bones, instead of seven as usual. *Scaphoid* much larger than normal; lunar, cuneiform and pisiform normal. In the lower row the magnum and unciform have normal relations, but in the place of the normally single *trapezoid* are two bones, one anterior (*t*²), the other posterior (*t*¹). These together bear the enlarged inner metacarpal (*II*). The posterior of these bones had a short pyramidal process lying beside the inner metacarpal. This process was partially constricted off and is regarded by

ARLOING as a representative of the metacarpal I, the carpal portion of the bone being the trapezium.

The outer metacarpal (IV) was perhaps slightly larger than usual.

The inner metacarpal (II) was greatly enlarged at its central end, articulating with the two bones t^1 and t^2 , and partly with the magnum. In its central part this metacarpal was fused with the large metacarpal (III) and above is united to it by ligamentous fibres. Below it again separates from the large metacarpal and is enlarged, bearing an additional digit of three phalanges, the lowest bearing a hoof. [This hoof is not curved towards the large hoof as in many specimens described, but is convex on both sides, resembling the hoof of an ass.] The large central metacarpal was flattened on the side adjacent to the enlarged metacarpal II. The muscles, nerves and vessels are fully described (*q.v.*). ARLOING, M. S., *Ann. Sci. Nat., Zool.*, Ser. V. T. VIII. pp. 61—67, *Pl.*

534. Foal having two toes on each fore foot. The father and mother of this foal were both of the "*variété chevaline comtoise.*" The foal in question was the only one which this mare dropped and she died two months afterwards. The foal was in nowise abnormal excepting for the peculiarity of the fore feet. The carpus was normal and the *external* metacarpal was rudimentary as usual and ends in a small knob. The internal metacarpal is thicker than the external one and bears a digit of three phalanges, the terminal phalanx bearing a small hoof. This hoof is curved outwards towards the normal hoof. The ligaments and tendons of the foot did not suffice to keep it stiff, and as the animal walked, it not only touched the ground with the hoof but also with the posterior surface of the phalanges. This led to inflammation of the foot, in consequence of which the foal was killed. CORNEVIN, *Nouveaux cas de didactylie chez le cheval*, Lyons (1882?). [Note that this case differs from the last in the fact that the carpus was normal.]

A similar case in the right fore foot is given by KITT, *Deut. Ztsch. f. Thiermed.*, 1886, xii. *Jahresb.*, 1884—5, p. 57, *fig.*

Hind foot.

Among the many accounts of polydactyle horses I know none which gives an anatomical description of a case of a fully developed digit II in the *hind* foot. The following case, indeed, is the only one known to me in which any facts respecting the condition of the tarsus of a polydactyle horse have been ascertained. In it, as will be seen, the digit II was not fully developed.

535. Horse having the metatarsal II enlarged and bearing a rudimentary digit (Fig. 107 B and C). In the left hind foot the arrangement was as shewn in Figs. B and C. The metatarsal II was enlarged and articulated with "two united cuneiform bones" [presumably one bone with indications of duplicity]. Internal to this digit was a "first cuneiform bone," but the digit I was not developed. The metatarsal II bore peripherally a rudiment of a digit as shewn in the figure. The right hind foot was similar to the left but it is stated that the "three small cuneiform

bones" were separate¹, as shewn in Fig. 107 C. The fore feet of the same animal were in the condition described in (1) *b*. [See No. 537.] MARSH, O. C., *Am. Jour. Sci.*, XLIII. 1892, pp. 340 and 345.

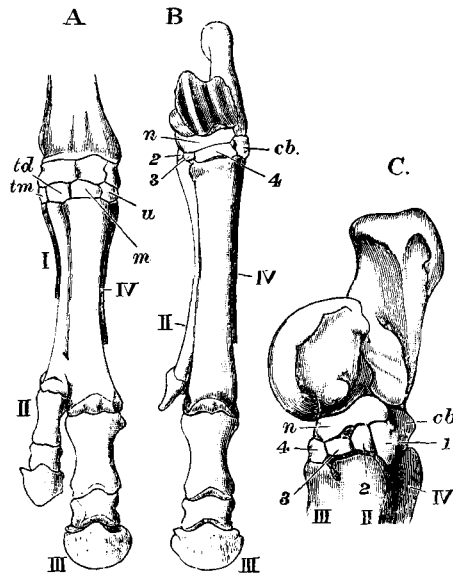


FIG. 107. Limb bones of a polydactyle horse.

A. Left fore foot. No. 537.

B. Left hind foot. No. 535.

C. Tarsus of right hind foot from the inside. No. 535.

n, navicular. *cb*, cuboid. 4, ecto-cuneiform. 1, 2, 3, three bones placed as cuneiforms. *td*, trapezoid. *tm*, trapezium. *u*, unciform. *m*, magnum.

I, II, III, IV, numerals affixed to the metacarpals on the hypothesis that these are their homologies. Cp. Fig. 108, which is lettered on a different hypothesis.

(After MARSH.)

b. Four metacarpals.

This condition is a higher manifestation of the variation seen in the cases just given. In No. 533 the digit II was developed and in addition the trapezium had appeared; in the cases now to be

¹ MARSH introduces this case in support of a contention that these variations are of the nature of Reversion. Upon the same page appears the statement that "in every specimen examined, where the carpal or tarsal series of bones were preserved and open to inspection, the extra digits were supported in the usual manner," *l. c.*, p. 345: this assertion is hardly in agreement with the previously stated fact that the metatarsal II is supported by two cuneiform bones. On p. 349 Marsh comments on the presence of five bones in the distal row of the tarsus, and from the expressions used it is implied that five such bones had been met with in other polydactyle hind feet. A number of alternative explanations are proposed; (1) that the five tarsals correspond "to those of the reptilian foot"; (2) that the first may be a "sesamoid"; (3) that the first may be a remnant of the first metatarsal, for such a rudiment "apparently exists in some fossil horses." With conjectures of this class morphologists are familiar. Into their several merits it is impossible to inquire, but it may be mentioned that the real difficulty is not the presence of the cuneiform marked I, but the fact that the tarsal element of the digit II seems to have been double, and that the digits in reality are not supported in the usual manner.

given the digit II is extensively developed and the trapezium bears a splint bone representing the metacarpal I, like that which in the normal represents the digit II. This is a phenomenon illustrating the principle seen in the case of teeth and other parts in series (see p. 272), namely, increase in the degree of development of the normally last member of a series correlated with the appearance of a new member beyond it.

Nevertheless the same cases have sometimes been described (e.g. *Catal. Mus. Coll. Surg.*) on a different hypothesis. This is illustrated by the lettering of Fig. 108. On this other view the innermost carpal is considered to be the *trapezoid* and its splint-bone is regarded as the original metacarpal II. The second digit, *ac*, and its tarsal bone are supposed to be "accessory" or "intercalated." To these terms it is difficult to attach any definite meaning. The proposal that some digits are to be reckoned in estimating homologies and that others are to be omitted is arbitrary, and, if allowed, would make nomenclature dependent on personal choice. It is, as has been often pointed out in foregoing chapters, simpler to number the parts in order as they occur and to accept the visible phenomena as the safest index of the methods and possibilities of Variation. Nevertheless, to illustrate the point at issue I have introduced two cases of the same Variation, the one, No. 536, lettered on the view advocated by the *Catalogue* of the College of Surgeons, &c., the other, No. 537,

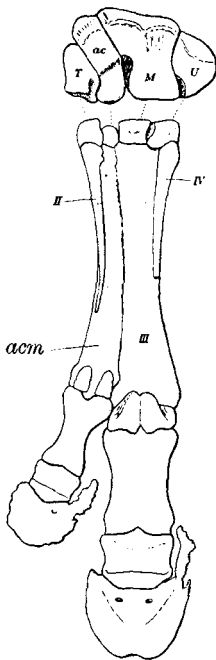


FIG. 108. Right fore foot of Horse No. 536 from behind. The upper surfaces of the carpal bones of the distal row are separately shewn above. Specimen in *Coll. Surg. Mus., Ter. Cat.*, 304.

T, trapezoid. M, magnum. U, unciform. ac, accessory carpal bone. II, III, IV, metacarpals. acm, accessory metacarpal.

This figure is lettered to illustrate the hypothesis adopted in the *Catalogue*, which is alternative to that adopted in Fig. 107, A.

lettered on the other and in the case of polydactyle horses, more usual method.

*536. Horse: right manus with extra digit (Fig. 108). The distal row of the carpus is present. It consists of four bones, the unciform, magnum and two other bones. Of these that lettered *T* on the view of the *Catalogue* must be supposed to be the normal trapezoid, while *ac* is considered to be an intercalated bone, perhaps an additional os magnum. The unciform bears a splint-bone, namely mcp. IV. The magnum bears a fully-formed mcp. and digit III. With the bone *ac* articulates a large and substantial metacarpal with a digit of three phalanges and a hoof, while the bone *T* bears another splint-bone, marked II in the figure on the hypothesis that the digit *ac* is not to be reckoned. *Cat. Mus. Coll. Surg., Terat. Series*, 1872, No. 304. As mentioned above, it would be more consistent with fact to count the bone *ac* as trapezoid with mcp. II and the bone *T* as trapezium with mcp. I.

537. Horse having both fore feet (Fig. 107, A) as in the last case, the hind feet being in the condition described in the last Section, No. 535. MARSH, *Am. Jour. Sci.*, XLIII. 1892, p. 340, *figs.* 3, 6, and 8.

538. Foal having right manus closely resembling the above, the other limbs being unknown. The mcp. I was longer than the normal mcp. II. In this case the metacarpal II was partially united to mcp. III at the central end but was free from it peripherally. WEHENKEL, J. M., *La Polydactylie chez les Solipèdes*, from the *Journal de la soc. r. des sci. méd. et nat. de Bruxelles*, 1872, *fig.* 2.

Probably the feet of a large number of polydactyle horses would be found to be in this condition if examined. MARSH, *l.c.*, mentions three other cases known to him in Yale Museum.

c. Five metacarpals.

*539. Horse having *five* metacarpals and one supernumerary digit in the left manus, and *four* metacarpals with a similar supernumerary digit in the right manus.

In the *left* manus with the trapezoid there articulated a well-developed metacarpal II bearing the extra digit. Internal to this was a trapezium bearing a splint-bone, 6 cm. long, 1.5 wide at proximal end, representing metacarpal I [as in Section (1) *b*] coalescing peripherally with III. On the external side of III the splint-bone IV was present as usual. The case is remarkable from the fact that external to the metacarpal IV there was another rudimentary metacarpal, presumably representing V. This bone was distinctly separated from IV at the central end, but was for the most part united with it. PÜRZ, *Deut. Ztschr. f. Thierm.*, 1889, xv. p. 224, *figs.* [The figures illustrating this paper are carefully drawn. The representation of mcp. I is quite clear, but the condition of the mcp. V cannot be well seen, as the whole foot is represented with its ligaments, &c., which partly conceal the structure. The whole account is very minute and gives confidence in the statements.]

The *right manus* of the same animal came into the possession of the University of Graz and was described independently. In it also the metacarpal II was developed and bore a well-formed digit. There was also a rudimentary metacarpal I beside it, having a length of 5.7 cm., and a breadth of 1.5 cm. at the central end. [The description is brief and makes no mention of a mcp. V: further account promised.] MOJSISOVICS, *Anat. Anz.*, 1889, IV. p. 255.

(2) *Two digits, one being formed by development of the digit IV.*

Cases of this variation are exceedingly rare. No. 540 is the only instance known to me in which a proper account exists. Most writers on the subject make a general statement that such cases exist, but give no references.

*540. Horse, having a supernumerary digit on the *outside* of each fore foot. (Fig. 109.) The animal was from Bagdad. The outer rudimentary metacarpal (IV) was well formed and of nearly even thickness throughout its length. It bore a digit of three phalanges and a well-formed hoof. The hoof was elongated and is described as being shaped like the hoof of a cloven-footed animal. [The description is very imperfect, but two good figures are given, from which it may be gathered that the inner metacarpal (II) was somewhat more developed than in an ordinary horse; and it appears that both the inner and outer metacarpals were separate throughout their course, but whether they could be detached from the large metacarpal or were ankylosed with it is not stated. The carpal bones are not described, but the figure suggests that the unciform was larger than it normally is. It is not stated that the two feet were alike in details. The large hoof (III) is represented as of the normal shape.] WOOD-MASON, J., *Proc. Asiat. Soc. Bengal*, 1871, p. 18, Plate.

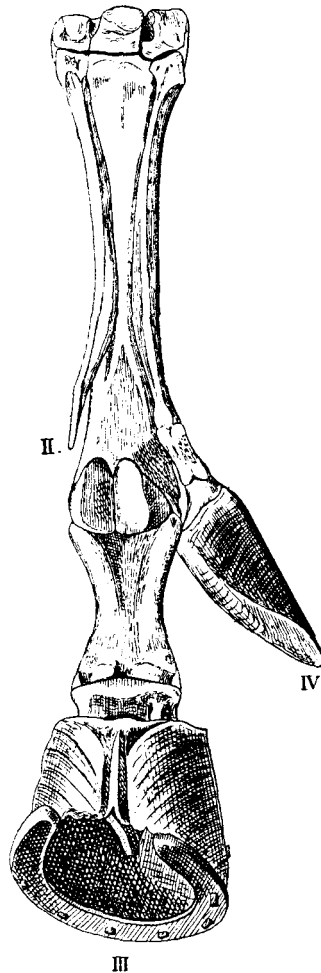


FIG. 109. Right fore foot of Horse, No. 540, the *external metacarpal (IV)* being developed, bearing a digit.

(After WOOD-MASON.)

WEHENKEL, *l. c.*, p. 15, mentions a similar specimen in the Museum of the Veterinary School at Berlin described by GURLT, *Mag. f. gesam. Thierh.*, 1870, p. 297 [not seen, W. B.].

(3) *Three digits* [? *the digits II and IV being both developed*].

Examples of this variation are alluded to by many authors but I know of no anatomical description. The following are all very imperfectly described.

541. Foal (foetus): left manus having three sub-equal digits; right manus two digits and rudiments of a third more developed than usual. Hind feet normal. GEOFFROY ST HILAIRE, *Ann. Sci. Nat.*, xi. 1827, p. 224.

Similar case, BREDIN, *Froriep's Notizen*, xviii. p. 202.

542. Horse from Texas, having extra digit on inside of each manus, and an extra digit both on the outside and on the inside of each *pes* [external view only]. MARSH, *Am. Jour. Sci.*, XLIII. 1892, p. 344, fig. 7.

543. Horse with both splint-bones bearing digits in each foot. FRANCK, *Handb. d. Anat.*, Stuttg., 1883, p. 228.

(4) *Two digits; the digits II and IV both developed, III aborted wholly or in part.*

Mention of these cases must be made in illustration of the possibilities of Meristic Variation, but the parts were in all three instances so misshapen that the animals could not have walked.

544. Foal having two toes on each foot, the developed toes belonging to the metacarpals and metatarsals II and IV, while the normally large III was not developed at all in the fore feet and was in the hind feet represented by a wedge of bone only.

Hind feet. Left. Bones of leg and tarsus said to have been normal. Metatarsal III represented by a wedge of bone fixed between the greatly developed metatarsals II and IV. The wedge-like bone 5 cm. wide at upper end, having usual tarsal relations. Its length about the same as its width. Laterally it is united to the metatarsals II and IV which curved round it till they met, and then curve away from each other again. Each was about 20 cm. long and bears a misshapen digit consisting of a proximal phalanx and a hoof-bearing distal phalanx. A small nodule of bone attached to the proximal phalanx may or may not represent part of a middle phalanx. *Right.* Very similar to left, but the wedge-like III was rather broader—[for details see original].

Fore feet. More misshapen and less symmetrical than hind feet: metacarpal III not developed at all. The metacarpals II and IV curved towards each other and crossed, giving an unnatural appearance to the feet. *Right foot.* Cuneiform and lunar united, and upon the surface of the bone formed by their union there was a groove occupied by two parts of the tendon of the anterior extensor metacarpi passing to mcp. II and IV respectively. Pisiform and scaphoid normal [this is not clear from the figure]. Magnum absent. Unciform and trapezoid abnormal only in respect of their relations, for whereas they should articulate with the magnum they do not do so, for both magnum and mcp. III are not represented. Metacarpal II was 11 cm. long, mcp. IV being 19 cm. long. Each bore a digit with a hoof; the digit IV having a proximal and a distal phalanx connected by a fibrous cord instead of a middle phalanx. The digit II had a rudimentary distal phalanx only. *Left foot* like the right, but with the mcp. and digit II more fully developed. [Muscles fully described. It may perhaps be thought that there is not sufficient proof that the developed digits are actually those normally represented by the splint-bones II and IV, but the condition of the hind feet is practically conclusive that this is the right interpretation.] WEHENKEL, *La Polydactylie chez les Solipèdes*, from *J. de la soc. r. des sci. méd. de Bruxelles*, 1872, Plate.

545. Foal, in which the right anterior leg possessed two metacarpals and digits.

The radius, ulna and proximal series of carpal bones were normal. In the distal series only two bones were present, viz., an inner bone corresponding to the trapezoid, and a magnum. There was no separate bone corresponding to the

unciform, but in its stead, the head of the outer metacarpal was continued upwards to articulate with the cuneiform. Between the heads of the two metacarpals was an irregularly quadrate bone which articulated with the magnum in the place where the large metacarpal (III) should be. This bone however only extended a little way, articulating at its outer end with a notch in the external metacarpal. [This is the author's view, but the figure strongly suggests that this quadrate bone may have been originally in connexion with the external metacarpal and that it may have been separated from it by fracture. If this were so, the large metacarpal would then not be represented by a separate bone at all.] The outer metacarpal distally bore three phalanges of irregular shape, flexed backwards and outwards. The inner metacarpal articulated solely with the trapezoid. Peripherally it bore a callosity which was due to the healing of a fracture. The phalanges of the inner metacarpal were three, but the first was reduced in length, while the second was elongated and bent in a sinuous manner. The ungual phalanx of this toe was cleft. [The author regards this case as analogous to the foregoing one, No. 544, that is to say, as an instance of development of the normally rudimentary lateral metacarpals to the exclusion of the large one (III), and he considers therefore that the large metacarpal (III) is only represented by the quadrate ossification which lay between the two developed metacarpals.] ERCOLANI, G. B., *Mem. della Acc. Sci. d. Istituto di Bologna*, S. 4, T. III. 1881, p. 760, *Tav. I. fig. 11.*

546. Foal in which the feet were all very abnormal. In the two fore feet the metacarpal of the normal toe (III) was very little developed, being however somewhat larger on the left side than it was on the right. It bore no digit. The external metacarpal bone (IV) of each fore foot attained a considerable length and bore a small hoof-bone. In the left fore foot the inner metacarpal was present but reduced; in the right foot it was absent. Right hind foot also had the external metacarpal developed and bearing three small phalanges, but the central metacarpal (III) was fairly developed, bearing however only two phalanges. Left hind foot was amorphous. BOAS, J. E. V., *Deut. Ztschr. f. Thiermedecin*, VII. pp. 271—275. [For full description, measurements and figures see original.]

B. CASES IN WHICH METACARPAL III GIVES ARTICULATION TO MORE THAN ONE DIGIT.

These cases are clear examples of the representation of a single digit by two. It will be seen besides that the two resulting digits may stand to each other in the relation of optical images (see Fig. 110) and do not form a Successive Series, thus following the common method of division of structures possessing the property of Bilateral Symmetry in some degree (cp. p. 77). All cases of this variation known to me occurred in the fore limb.

547. Foal: a right fore foot figured from a specimen in the collection of the Veterinary School of Copenhagen (Fig. 110) has two complete digits articulating with a single normal metacarpal bone. The two digits are symmetrically developed; each consists of three phalanges and bears a hoof. These two hoofs are well formed and curve towards each other like those of Artiodactyles. BOAS, J. E. V., *Deut. Ztschr. f. Thiermedecin*, VII., p. 277, *Taf. XI., fig. 9.*

548. Two fore feet of a foal, each being irregularly and unequally bifid. BOAS, *ibid.*, *figs. 7 and 8.*

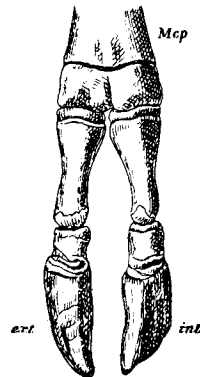


FIG. 110. Right fore foot of Horse No. 547.

Mcp, peripheral end of metacarpal III. ext, external side. int, internal side.

(After BOAS.)

549. Filly, two-year old, which had been born with left fore foot cleft like that of the Ox. Each of the two toes had three phalanges, which were completely separate as far up as the metacarpo-phalangeal joint. The division externally was carried to the same extent as in the Ox. The lower end of the great metacarpal III felt as if bifurcated like that of the Ox, so as to give separate articular support to the two toes. Upper parts normal. The lesser metacarpals, II and IV, felt through skin, seemed to terminate rather lower down in left foot than in right, but this was uncertain. Animal examined alive. No attempt at shoeing had been made, and hoofs having become elongated forwards had had their points sawn off. The whole foot was much larger or more spread than the other. STRUTHERS, J., *Edin. New Phil. Jour.*, 1863, pp. 279 and 280.

*550. Horse: right fore foot having phalanges bifid (Fig. 111). The limb was normal as far as the distal end of the metatarsal, except for some exostoses. The proximal phalanx was short and of great width; in its lower third it divided into two divergent parts, the divergence being more marked on the posterior face than on the anterior. Each of these diverging processes bears a complete second and third phalanx. The third phalanges each bear hoofs, which are convex on the outer sides but fit together on the opposed surfaces, the external hoof being slightly concave on its inner face, while the internal is slightly convex. On the plantar surface, each toe bore a half-frog. The two large sesamoids, normally present in the Horse, are in this specimen united along their inner borders to form a single bone, which was placed behind the upper part of the proximal phalanx. Two small sesamoids lay behind the third phalanx. A good deal of exostosis had taken place in all the phalangeal bones. ARLOING, M. S., *Ann. Sci. Nat.*, Ser. V., Tome VIII. pp. 67—69, Pl.

551. Foal: in right fore foot the large metacarpal divided into two parts, each bearing a separate digit. The proximal row of the carpus consisted of four normal bones, but the distal row was composed of two bones only. The external splint-bone (IV) was of normal proportions, but the internal splint-bone (II) had almost completely disappeared. The large metacarpal (III) divided in its peripheral third into two equal cylindrical branches, each of which bore a digit composed of three phalanges and bearing a crescentic hoof. These two digits were bent across each other in a shapeless way. DELPLANQUE, *Mém. Soc. centr. d'Agric. du Dép. du Nord*, s. 2, ix. Douai, 1866—1867, p. 295, Pl. III. fig. 5.

552. Mule, having two distinct toes on each fore foot. The hoofs were shaped like those of the Ox. They were of unequal length. JOLY, *Comptes Rendus*, 1860, p. 1137. [Perhaps a case belonging to this section.]

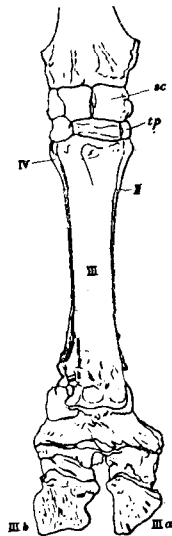


FIG. 111. Right fore foot of Horse No. 550, from in front.

sc, scaphoid. tp, trapezoid. II, III, IV, metacarpals. III a, III b, internal and external sets of phalanges representing the digit III of the normal.

(After ARLOING.)

C. INTERMEDIATE CASES.

We have now seen cases of increase in number of digits occurring by addition to the series, and cases occurring by division of III. It may at first sight seem impossible that there can be any process intermediate between these two. Nevertheless the word sufficiently nearly describes the condition of at least the first of the following cases, and is to some extent applicable to the second also. If the condition shewn in Fig. 112 be compared with those in Figs. 106 and 110 it will be seen that it is really intermediate between them.

553. Horse (young): right manus with internal supernumerary digit. The bones are not in place, but have been attached with wires. The condition is as follows. The distal series of carpus remains and is normal or nearly so. Of the splint-bones, the inner (mcp. II) is thicker than the outer mcp. IV, but it is very little longer. The large metacarpal (III) is almost, but not quite, bilaterally symmetrical about its middle line. In the distal epiphysis the asymmetry is distinct, the internal side of the epiphysis being less developed than the external side. This epiphysis bears a large digit of three phalanges, but instead of being bilaterally symmetrical, like the normal toe of the Horse, each of the joints is flattened on the internal side, the flattening increasing from the first to the third phalanx. The hoof is greatly flattened on its inner face.

Internally to the epiphysis of the digit III there is a separate small bone, representing the distal end of an inner metacarpal. This bone bears a digit with *two* phalanges, and a hoof which is flat on the side turned towards the other hoof, like that of a calf, though it only reaches to the top of the larger hoof. The first phalanx of this digit is imperfectly divided by a suture into two parts. This division is *not* that of the epiphysis from the shaft. This extra digit may be thought to be that of mcp. II, but it is clear that it was in part applied to mcp. III. Note also that mcp. III is modified in correlation with its presence. *Coll. Surg. Mus.*, in *Terat. Cat.*, No. 301.

The foregoing case well illustrates the inadequacy of the view on which an individuality is attributed to members of the digital series. The smaller digit in it is as regards the Sym-

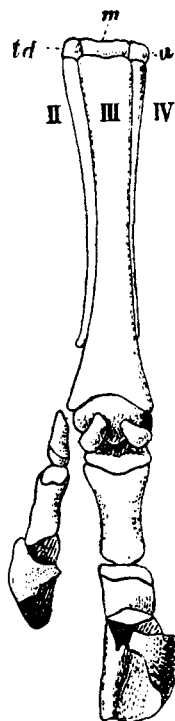


FIG. 112. Right manus of a horse, No. 553, from behind, *m*, magnum. *td*, trapezoid. *u*, unciform. (From a specimen in *Coll. Surg. Mus.*)

metry of the limb complementary to the larger digit. It is a partial substitute for the inner half of the digit III. If the visible Symmetry of the limb is an index of mechanical relations in which the parts stood to each other in the original division of the manus into digits it is possible that there may have been a mechanical equivalence between the two digits.

554. Mule (between jackass and mare): fetus of about nine months having supernumerary digits. Hind limbs normal. Fore limbs normal as far as peripheral ends of metacarpals. Each manus consisted of three digits. *Right.* Metacarpals II and IV normal splint-bones. Metacarpal III normal as far as line of union with its distal epiphysis. The inner part of the sheath of the epiphysis is continued into a rod of fibro-cartilage which supports an extra toe. This rod of cartilage contains a small ossification which represents, as it were, the proximal phalanx of this internal supernumerary toe. Its outer end bears a small second phalanx, and this bears a small distal phalanx which was covered by a hoof. This extra toe, therefore, is internal to the main continuation of the leg, commences from the line of union between the large metacarpal and its epiphysis, and has three phalangeal joints.

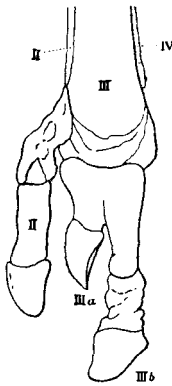


FIG. 113. Left fore foot of Mule No. 554.

IV, the external splint-bone. III, the chief metacarpal. III *a*, III *b*, internal and external rudimentary digits borne by III. II, a supernumerary digit attached to the inner side of III.

(After JOLY and LAVOCAT.)

the proximal phalanx of the large toe is divided longitudinally into two parts, bearing (1) an internal toe having only the unguinal phalanx and hoof; (2) an outer toe which has a second and third (ungual) phalanx.

In the case of both feet, the hoof and unguinal phalanx of the outer toe are turned *inwards*, having an external curved edge and an internal straight edge; but the two inner toes in each case are turned *outwards*, having their outer edges straight and their inner edges curved. JOLY, A. et LAVOCAT, N., *Mém. de l'Ac. des Sci. de Toulouse*, S. 4, Tome III., 1853, p. 364, *Plates*. [Authors regard this case as proof of

The epiphysis of the large metacarpal supports a normal first phalanx with which the second phalanx articulates. This second phalanx is enlarged internally [details obscure] to bear a small extra nodule of cartilage which appears to be of the nature of an extra toe. The second phalanx also bears a large third (ungual) phalanx. This unguinal phalanx together with the minute supernumerary toe borne by the second phalanx are together encased in a common hoof, but the hoof is divided by a groove into two distinct lobes, corresponding with the division between the two digits which it contains. The whole foot, therefore, has one free internal toe and one large toe bearing a small internal one, which are enclosed in a common hoof.

Left fore foot. Fig. 113. The small, lateral metatarsals II and IV, and the large central metatarsal III are normally constructed; but from the inner side of the sheath of the large metatarsal, upon the line of union between the bone and its epiphysis, arises a fibro-cartilaginous rod, which contains an ossification representing the proximal phalanx of a supernumerary toe (lettered II in fig.). This rod of tissue in its proximal portion is represented in the figure as abutting on, but distinct from the end of the inner small, lateral metatarsal. It bears a cartilaginous second phalanx, containing a small ossification, which articulates with a terminal (ungual) phalanx covered by a hoof.

The distal end of the large metatarsal articulates with a large first phalanx, which at its proximal end is of normal width. At about its middle point this phalanx bifurcates into two parts, of which the inner, III *a*, is short and ends a little beyond the point of bifurcation: it bears an unguinal phalanx only, which is encased in a hoof. The outer limb (III *b*) of the bifurcated first phalanx bears an elongated second phalanx of somewhat irregular shape which carries a larger unguinal phalanx covered by a separate hoof. In this foot, therefore, there is an inner toe consisting of three phalanges attached to the inside of the large metatarsal: next,

truth of certain views of the phylogeny of the Horse and employ a system of nomenclature based on these views. This is not retained in the abstract here given.]

ARTIODACTYLA.

In the domesticated animals of this order digital Variation is not rare, being in the case of the Pig especially common. Such variation has been seen in the Roebuck and Fallow Deer, but not in any more truly wild form so far as I am aware. These variations may take the form either of polydactylism or of syndactylism. Of the former a few cases are known in Ox, Sheep, Roebuck Fallow Deer, and many cases in the Pig; syndactylism has been seen only in the Ox and in the Pig. The absence of cases of syndactylism in the Sheep is a curious instance of the caprice with which Variation occurs.

The phenomena of polydactylism in Pecora may conveniently be taken separately from the similar phenomena in Pigs.

POLYDACTYLISM IN PECORA.

At the outset one negative feature in the evidence calls for notice. It is known that in the embryo Sheep rudiments of metacarpals II and V exist¹ which afterwards unite with III and IV. In view of this fact it might be expected by some that there would be found cases of Sheep and perhaps Oxen polydactyle by development of the digits II or V. In the Sheep only one case (No. 555) is known that can be possibly so interpreted; and in the Ox there is no such case unless Nos. 557, 558, and 559 should be held by any to be examples of the development of II, a view attended by many difficulties.

The two following examples are the only ones known to me in which there can be any question of reappearance of a lost digit, but in neither is the evidence at all clear.

- *555. **Sheep.** Some specimens of a small Chilian breed had an extra digit on the hind foot. It was not present in all individuals and was not seen to be inherited; but normal parents were observed to have offspring thus varying. [From the description given I cannot tell whether the extra digit was internal or external. Also, though said to have been on the hind foot, in describing the bones the cannon-bone is twice called *metacarpus*; probably this is a slip for *metatarsus*.] The digit was only attached by skin. It contained a bent bone, of which the upper segment was 20 mm. long, the lower 13 mm. Proximally the

¹ ROSENBERG, *Z. f. w. Z.*, 1873, xxiii. pp. 126—132, *figs.* 14, &c. Sometimes these rudiments remain fairly distinct at the proximal end of the cannon-bone, especially of the fore foot. See NATHUSIUS, *Die Schafzucht*, 1880, pp. 137 and 142, *figs.*

cartilaginous head of this bone rested in a pit on the tendon of the flexor brevis digitorum at the level of the end of first third of the cannon-bone, and peripherally it bore an end-phalanx and claw-like hoof, properly articulating. No splint-bones present. [Other details given: it was suggested that the bent bone represented an extra 'metacarpal' and first and second phalanx.]
 VON NATHUSIUS, H., *Die Schafzucht*, 1880, p. 143.

556. **Capreolus caprea** (Roebuck), 2 yr. old, killed in district of Betzenstein, having a slender fifth digit on the inside of each fore foot. In the left there was a small, conical metacarpal element, bearing a digit with three phalanges. The right extra digit had a longer metacarpal piece with epiphysis, but in it there were only two phalanges. Each bore a hoof of about the size of those of II or V. The hoofs curved outwards. BAUMÜLLER, C., *Abh. naturh. Ges. Nürnberg.*, IX. 1892, p. 53, *Pl.*

Other cases of polydactyle Pecora mostly fall into two groups:

(1) Examples of limbs having three digits borne by a large cannon-bone made up of three metatarsal or metacarpal elements, grouped in *one* system of Symmetry. The axis of Symmetry is then deflected from the normal position, and instead of falling between two digits it approaches more or less to the central line of the middle of the three digits. The degree to which this change of Symmetry takes place corresponds irregularly with the extent to which the innermost digit is developed. This form is known in the Ox only [? Goat].

(2) Limbs in which the series of digits has *two* more or less definite axes of Minor Symmetry. Both of the systems of Symmetry thus formed are in addition arranged about one common axis of Symmetry. The nature of this condition will be discussed later. It occurs in Ox, Sheep, Roebuck and Deer.

(1) *Three digits in one system of Symmetry.*

- *557. **Calf.** Right manus (Fig. 114) having three digits borne by a single cannon-bone. This is an old specimen of unknown history which was kindly sent to me by Mr W. L. Sclater for examination.

Of the carpal bones only the distal row remains, containing a trapezoido-magnum and. unciform not differing visibly from the normal. The cannon-bone spreads at about its middle into three sub-equal parts, each ending in a separate articular head bearing a trochlear ridge. Between these articular surfaces the only point of difference was that in that of the middle digit (*b*), the trochlear ridge was rather nearer to the outer surface of the joint, not dividing it into two halves as usual (see figure). The foramen for entrance of the nutrient vessel was in the channel between the external and middle digits. This channel was very slightly deeper than the corresponding channel between the middle and inner digits. Each articular head bore a digit, well formed,

of approximately similar lengths, having a hoof. The hoofs of the outer and inner digits curved to the middle line of the limb, like the

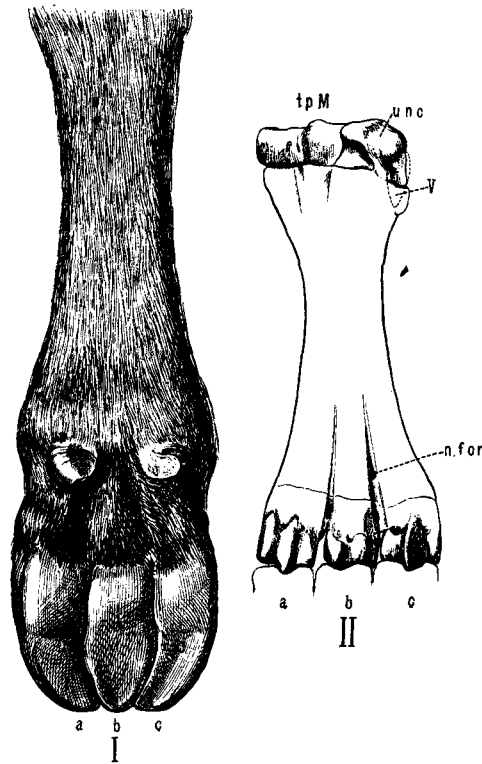


FIG. 114. Right fore foot of a Calf, No. 537.

I. The whole foot seen from behind.

II. The bones from behind.

tpM, trapezoido-magnum. *unc*, unciform. *n. for.*, nutrient foramen. *V*, dotted outline shewing position of supposed rudiment of digit V. Sesamoids not shewn.

normal hoofs of a cloven-footed animal, but the hoof of the central toe was convex on both sides. The two accessory hoofs were in place, one on each side as shewn in the figure. The whole manus was very nearly symmetrical about the middle line of this digit. It was noticeable that the outer and inner hoofs were both rather narrow in proportion to the length of the limb, but the whole width of the foot was rather greater than it should be. The small bone considered to represent the digit V articulates with the unciform as usual, being of normal size. Each of the three digits was supplied with flexor and extensor tendons.

558. **Heifer** having three fully developed toes on each hind limb. The right hind foot described (Fig. 115). The calcaneum, astragalus and cuboido-navicular presented no special abnormality. The cuneiform

series usually consisting of two pieces in the Ox, were here represented by one piece (*c* and *c*³), though externally the bone seemed to be in two pieces. The internal portion (*c*) approximately corresponding in position with the normal ento-cuneiform was imperfectly and irregularly divided by a groove into two parts. The metatarsus or cannon-bone at its proximal end was almost normal, but from about its middle it spread out into three parts as shewn in the figure, each part ending in an articular surface and bearing a digit, but the trochlear ridge for the innermost digit (*ac*) was not quite so large as those for the others. From the skeleton it seems clear that this innermost digit could not have reached the ground.

Of the three hoofs the middle one was the largest, the other two being nearly equal to each other in size. The outermost hoof curved inwards, and the innermost hoof curved outwards. The middle hoof also curved outwards, *but less so than that of a normal digit III, being rather flatter underneath, and having its two edges more nearly symmetrical.* The accessory hoofs ('*ergots*' of French writers) were "in their usual place, on either side of and behind the foot." This specimen was originally described by GOODMAN, NEVILLE, *Jour. Anat. Phys.*, 1868, Ser. 2, i. p. 109. The skeleton of the foot is in the Cambridge University Museum of Pathology.

In answer to my inquiries Mr G. DAINTREE of Chatteris, the owner of this animal, kindly gave me the following information. This cow was bought in 1861 and from her a three-toed strain arose, of which about ten generations were produced. The three-toed condition appeared in both males and females, but no three-toed bull was kept, so that the descent *was wholly through females.* About two in three calves born of this strain had three toes. In one case only were there three toes on the *fore feet.* The third toe was never walked on. The breed was got rid of because it was at last represented only by males, the last being sold in 1887. The beasts were as good as any other cattle of the same class.

559. **Calf.** Left manus having three digits, generally resembling the last case. The external digit is nearly normal. The middle digit is very thick, and is somewhat twisted and flexed. Its ungual phalanx is not specially curved in either direction but it is not truly symmetrical. The innermost digit is thin and short and its ungual phalanx is not much curved. In this specimen there is a decided appearance of division in the distal epiphysis of the metacarpal of the middle digit (? III). *Coll. Surg. Mus., Terat. Series, No. 300.*

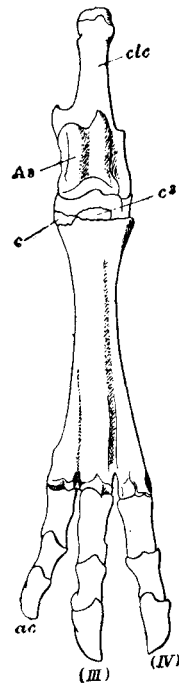


FIG. 115. Right hind foot of heifer, No. 558.

As, astragalus. *clc*, calcaneum. *c*, *c*³, parts of a large united bone representing cuneiforms.

III, IV, *ac*, letters affixed to illustrate the hypothesis that III and IV represent these digits of the normal, and that *ac* is an accessory digit.

The following two cases are perhaps of the same nature as the foregoing.

560. **Goat** having three digits in each manus, described by GÉOFFROY ST HILAIRE, *Hist. des Anom.* i. p. 689. The description states that a supernumerary toe was placed between the two normal toes. The middle toe was one-third of the size of a normal toe, but the lower part of the foot was larger than usual. This case was probably like No. 557; for from the shapes of the lateral hoofs that case also might seem to an observer at first sight to be an example of a toe "intercalated" between two normal toes. But in No. 560 the middle digit was reduced.
561. **Calf** having a small supernumerary toe 'placed between the digits of the right manus.' This toe had a hoof and seemed externally to be perfect, but on dissection it was found to contain no ossification, but was entirely composed of fibrous tissue and fat. ERCOLANI, *Mem. Ac. Bologna*, S. 4, III. p. 772. [Probably case like last, the middle digit being still less developed.]

This case is probably distinct from the others given.

562. **Calf**: right fore foot having three complete metacarpals, each bearing a digit of three phalanges. The two outer were disposed as in the normal, but the innermost metacarpal was quite free from the others and its digit stood off from the others [not grouping into their symmetry as in preceding cases] and having an unguis phalanx [of ? pyramidal shape]. DELPLANQUE, *Études Tératol.*, Douai, 1869, II. p. 33, Pl. II. *figs.* 2 and 3. [It is difficult to determine the relation of this case to the others and I am not sure that I have rightly understood the form of the inner digit; but since this digit seems to be outside the Minor Symmetry of the limb it is almost impossible to suppose that it can really be the digit II reappearing. I incline to think that it is more likely that this digit belongs to a separate Minor Symmetry. Compare the similar phenomena in Figs, No. 570.]

On the foregoing cases some comment may be made. It may be noted that the two first (Nos. 557 and 558) present two stages or conditions of one variation. In No. 557 all three digits reach the ground and the change of Symmetry is completed; in No. 558 the internal digit is not so large in proportion and the plane of Symmetry is not deflected so far.

As to the morphology of the three digits in these cases three views are open on the accepted hypotheses. First, the internal digit (if it be admitted to be *the* supernumerary) may be simply a developed II. The existence of the normal accessory hoofs practically negatives this suggestion, for there can be little doubt that one of them represents II (*v. infra*, No. 579). The condition of the cuneiforms in No. 558 suggests further that an element is introduced into the cuneiform series between the almost normally formed ento-cuneiform and the ecto-cuneiform. But if this new element is the middle cuneiform, then the internal digit (Fig. 115, *ac*) may still be II. But the innermost *ergot* is II in the normal. Or is the inner *ergot* in this case I, and is this once more a case of the development of a normally terminal member, II, and of the addition of I beyond it in correlation, as we saw in the Horse (see p. 364)? That such a correlation may exist is unquestionable, and it is not clear that these cases are not examples of it. But even if this principle be adopted here as a means of bringing these cases into harmony with received conceptions it will presently be seen that it still will not reconcile some other cases, notably those of the presence of supernumerary digits in a Minor Symmetry apart from that of the normal series. Yet if the conception of the digits as

endowed with individuality be not of universal application, we shall not save it even if by ingenuity we may represent the facts of the present case as in conformity with its conditions.

On the other hand it may be suggested that there is a division of some one digit, and undoubtedly in No. 559 there is a suggestion that the innermost digit and the central digit are both formed by division of III. But in the first place this view cannot so easily be extended to Nos. 557 and 558, for in them there is practically no indication that the digits are not all independent and equivalent. The circumstance that the nutrient vessel enters between the external and middle digits may perhaps be taken to shew that they are III and IV; but this vessel, if single, must necessarily enter in one or other of the interspaces and there is no reason for supposing that, were there an actual repetition of a digit, the vessel must also be doubled, though doubtless repetition of vessels commonly enough occurs with repetition of the organs supplied.

Next, the Symmetry of the foot, the development of the middle digit to take a median place, the position of the accessory hoofs, one on either side equidistant from the middle line of the manus, all these are surely indications that this limb was from the first developed and planned as a series of *three* digits, and not as a series of *two* digits of which one afterwards divided. The series has a new number of members, and each member is in correlation with the existence of the new number remodelled.

It is no part of the view here urged to deny that a single digit, like any other single member of a series, may divide into two (or even into three) for this phenomenon is not rare. Probably enough No. 559 is actually a case of such a division of the digit III. But here in digits as in mammæ, teeth, &c., the evidence goes to shew that there is no real distinction between the division of one member to form two, and that more fundamental reconstitution of the series seen in No. 557, for the state of No. 558 is almost halfway between them. In it we almost see the digit III in the act of losing its identity.

(2) *Limbs with digits in two systems of Minor Symmetry* (Double-foot).

In dealing with these there are difficulties. The cases are examples of limbs of Calves or Sheep bearing four or five digits arranged in two groups either of two and two, or of two and three. The members of each group curve towards each other in such a way that each group has a separate axis of Symmetry (Figs. 117 and 118). In several such cases the two groups are related to each other as right and left. Of these facts two different views are possible. For first, a limb of this kind may be a structure like the double-hands seen in Man (pp. 331 to 337), for it is certain that an almost completely symmetrical series of parts is in those cases formed by proliferation of a series normally hemi-symmetrical, however unexpected this phenomenon may be.

On the other hand it might be argued that one of the groups of digits represents the normal, and that the other group is supernumerary.

For, as will be hereafter shewn at length in the case of Insects, supernumerary appendages may grow out from a normal appendage and are then a pair, being formed as a right and a left, composing a separate Secondary Symmetry.

On the first view the digits of each group are in symmetry with each other like those of the normal limb, the two groups also balancing each other like the halves of a double-hand: on the other view one of the groups would be supposed to be made up of a right and a left digit III, or of a right and a left digit IV. The possibility of the second view being true arises of course in the Artiodactyles from the fact that in them the normal digits compose a bilateral Minor Symmetry.

There is nevertheless little doubt that the former account is the right one and that neither group is a Secondary Symmetry; for were either of the groups really in Secondary Symmetry the supposed supernumerary group should contain at least parts of *four* digits. Lastly, some of the cases, as No. 566, are clearly of the nature of double limbs, both groups having a common axis of Symmetry.

A further difficulty arises from the fact that most of these double limbs are old specimens cut off from the trunk. There is therefore no proof that such a limb is not that of a polymelian in Geoffroy St Hilaire's sense. In other words, though it is practically certain that neither of the groups of digits is itself a system of Secondary Symmetry it is quite possible, and in some cases likely that the whole limb is of this nature. In cases of duplicity, especially of posterior duplicity, the two limbs of one or both of the united bodies frequently form a compound structure somewhat resembling one of the double limbs here under consideration. Hence it is not possible to include with confidence great numbers of cases of double limbs described by various writers or preserved in museums, for it is rarely that particulars regarding the rest of the animal are to be had. This difficulty applies to almost all cases known to me and they are therefore given with this caution. This objection of course does not apply to such a case as No. 564.

The following few cases will sufficiently illustrate the different forms of limbs included in this section. They consist of two chief kinds; first, limbs like Nos. 563 and 566, in which both groups contain two digits, and secondly, cases like No. 567, in which one of the groups contains three digits, recalling the state described in the last section (cp. Nos. 558 and 559). Besides these there are some cases of amorphous extra digits not here related.

563. **Cow**, full-grown, right fore foot with four digits arranged in two groups of two, as shewn in fig. 116. The carpus not preserved. No particulars as to the rest of the animal. This specimen is in the Museum of Douai and is described in detail by DELPLANQUE, *Études Tératologiques*, II. Douai, 1869, p. 30, Pl. I. [The possibility that this may be a limb of a pygomelian is not excluded.]
- *564. **Cervus dama** (Fallow Deer). A female having each hind foot double. The division occurs in the upper part of the tarsus, which gradually diverges into two separate tarsi [?metatarsi] and two separate feet. This doe had for several successive years dropped a fawn with the same malformation, though she had been served by several bucks. WARD, EDWIN, *Proc. Zool. Soc.*, 1874, p. 90.
565. Two cases, a **Roebuck** and a **Deer**, mentioned by GEOFFROY ST HILAIRE (*Hist. des Anom.*, I. p. 697) are probably of this nature.

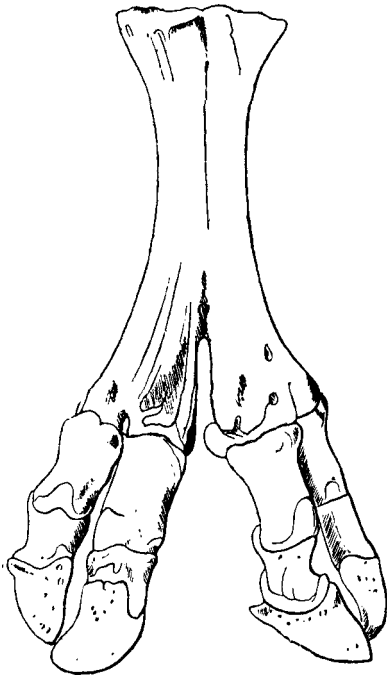


FIG. 116. Specimen stated by Delplanque to have been the right foot of a Cow (see No. 563). (After DELPLANQUE.)

*566. **Sheep**, having four toes, each having three phalanges, on each posterior limb (Fig. 117). In each case the toes were arranged as two pairs, the hoofs of each pair being turned towards each other. Each foot had four united metatarsals, marked off from each other by grooves on the surface of the bone, the division between the metatarsals of each pair of toes being clearly marked at the peripheral ends of the bones. In the case of each foot there were parts of a pair of tarsi arranged in a symmetrical and complementary manner about the middle line of the limb. In each tarsus there was a large bone having the structure of two calcanea, a right and a left, united posteriorly; the upward prolongation, proper to the calcaneum, was present on each side of this bone and projected upwards on each side of the tibia. The astragalus of each foot was similarly a bone double in form, uniting in itself the parts of a right and left astragalus. The left foot had a single flat bone below the astragalus, representing as it were two naviculars fused together; and four bones in a distal row, representing presumably two cuboids, and two cuneiform elements. In the right foot also there was a single bone below the astragalus, and four other bones arranged in a way slightly different from that of the other foot. ERCOLANI, *ibid.*, p. 773, *Tav. II.* figs. 7 and 8.

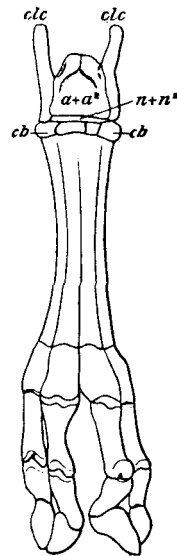


FIG. 117. Bones of left hind foot of a Sheep, No. 566 [*q. v.*] copied from ERCOLANI. *clc, clc*, the two calcanea. *a+a²*, bone representing the two astragali. *n+n²*, the two naviculars. *cb, cb*, the two cuboids.

[A case given by ERCOLANI (*l. c.*, p. 783, Tav. II., figs. 9 and 10) of similar duplicity in a lamb seems to be very possibly a case of double monstrosity. In this animal the hind limbs were altogether absent.]

567. **Calf**, having five digits on one manus. There is nothing to shew positively whether this specimen is a right or a left, and it is even possible that it is part of a polymelian¹. Carpal bones gone. Metacarpals four, disposed in two pairs. One pair bear the digits d^4 and d^5 (Fig. 116), which have a common proximal joint. Their unguinal phalanges curve towards each other, forming a Minor Symmetry like those of a normal Calf. The other two metacarpals bear three digits; two (d^3 and d^2) articulate with one metacarpal having a divided epiphysis. The other metacarpal bears a digit (d^1) of full size curving towards d^2 . The unguinal phalanges of d^2 and d^3 are nearly straight [*cp.* Nos. 558 and 559.] C. S. M., *Terat. Ser.*, No. 299.

568. **Calf**: left hind foot similar case: inner group of two toes curving towards each other and an outer group of three toes of which the middle one was almost bilaterally symmetrical while the hoofs of the other two were each turned towards it. Five metatarsals united but marked out clearly by grooves. Tarsus much as in No. 566. ERCOLANI, *l. c.*, p. 774, Tav. I. fig. 8.

569. **Calf**: left hind foot a somewhat different case, DREW, *Commercium Litterarium*, Nuremberg, 1736, p. 225, Taf. III. fig. 2. [Description meagre, but figure good. Beginning from the inside the five toes turned (1) outwards, (2) outwards, (3) inwards, (4) outwards, (5) inwards, respectively. There were only four metatarsals, (3) and (4) being both borne on one metatarsal.]

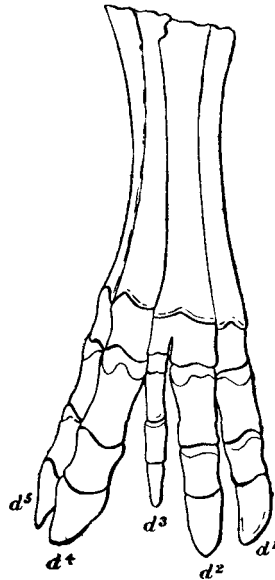


FIG. 118. Manus of a Calf, No. 567. d^1 , d^2 , d^3 , group of three digits [? internal]; d^4 , d^5 , group of two digits [? external].

POLYDACTYLISM IN THE FIG.

Of the great numbers of feet of polydactyle pigs recorded or preserved in museums all I believe are *fore feet*. No case of a polydactyle hind foot is known to me in the pig. All the cases are examples of proliferation upon the internal side of the digital series. With very few exceptions the variation takes one of two forms, consisting either in the presence of a *single digit* internal to the digit II, or in the presence of *two digits*, either separate or partially compounded, in this position. A very few cases depart from these conditions². The condition is very usually the same or nearly the same in both fore feet.

One extra digit, internal to digit II.

570. Such a digit may either have a separate bone for its articulation in one or both rows of the carpus (as ERCOLANI, *l. c.*, Pl. I. fig. 3), or it may articulate with a half-separated extension of the trapezoid (as *Coll. Surg. Mus.*, *Ter. Ser.*, 297 A), or with the metacarpal or other part of digit II (very common), sometimes simply branching from this digit without an articulation. In no case of which good accounts are to be

¹ The *Catalogue* gives no indication on these points.

² For example a l. fore foot in which the metacarpal of II. bears a rudimentary digit on each side of the digit II, three in all. ERCOLANI, *Mem. Ac. Bol.*, 1881, Pl. I, fig. 1.

had does such a digit group itself into the Symmetry of the normal manus; but it stands apart, or is bent or adducted behind the other digits, having a hoof which is irregularly pyramidal, curving in neither direction especially. Such a digit has generally three phalanges, and is of about the size of digit II, though not rarely it is large in size approaching more nearly to III than to II (as *Coll. Surg. Mus., Ter. Ser.*, 297).

Two extra digits internal to digit II.

571. This condition is not less common than the last. The two extra digits are borne either by two separate extra carpal bones (Fig. 119, c^1 , c^2), or by one carpal imperfectly divided (ERCOLANI, *l. c.*, Pl. I., fig. 6); or the metacarpals of the extra digits simply articulate against the carpo-metacarpal joint of II (as in a specimen in my own possession). The extra digits may be double throughout, or the two may be compounded in their proximal parts (ERCOLANI, *l. c.*, Pl. I., fig. 5; also case in Oxford Mus.¹, 1506, *a*, in which the two extra digits were ill-formed and of unequal size, having a common metacarpal). Fig. 119 shews such a pair of extra digits in their most complete form. The central part of the metacarpal of II has either never ossified or has been absorbed. As bearing on the question of the relations of parts in Meristic Repetition the fact of most importance is the circumstance that the digits III and IV retain their normal Symmetry, but the two

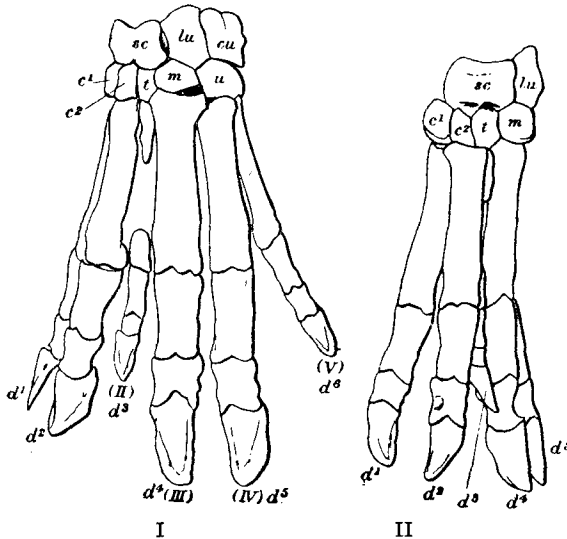


FIG. 119. Left manus of a Pig, No. 571.
 I. View from in front. II. View from inside to shew the convergence of d^1 and d^2 towards each other.
 d^1 , d^2 , two extra digits placed internally. c^1 , c^2 , two extra carpal bones with which they articulate. *sc*, scaphoid. *lu*, lunar. *cu*, cuneiform. *t*, trapezoid. *m*, magnum. *u*, unciform. d^3 — d^6 , the digits II, III, IV, V.

¹ For note of this specimen I am indebted to Mr W. H. Benham.

extra digits form another Minor Symmetry of their own. It is perhaps worth noting that the metacarpal of the digit lettered d^2 in the form of its head is nearly the optical image of that of III (d^4), but this resemblance may be misleading and must not be insisted on. *Coll. Surg. Mus., Ter. Ser.*, 298.

- 572 **Wild Boar.** Two cases, apparently resembling the foregoing are described, from external examination only, in the wild boar by GEOFFROY ST HILAIRE, *Hist. des Anom.*, i. p. 696.

SYNDACTYLISM IN ARTIODACTYLA.

This phenomenon is known in the Ox and is common in the Pig. In all cases the variation consists in a more or less complete union or absence of division between the digits III and IV. Among the many records of digital variation in the Pig no case relates to union between a *lateral* and a chief digit, but it is always the two chief digits III and IV that are united. (Compare the case of Man, p. 358.) In this case there is therefore an absence of a division in the middle plane of a bilateral Minor Symmetry, and the parts that remain united are related to each other as optical images. The phenomenon is thus the exact converse of the variation consisting in a division along a plane of bilateral symmetry which was seen in the Horses Nos. 547 and 550. As was remarked in speaking of similar variations in Man, it is to be noticed that if the union is incomplete, as it commonly is, the *peripheral* parts are the least divided, the division becoming more marked as the proximal parts are approached.

- In the normal Sheep according to ROSENBERG¹ the metacarpals II and V are distinct in the embryonic state, afterwards completely uniting with III and IV. The same is presumably true of the Ox; but whether this be so or not, the digits II and V are in the normal adult not represented by separate bones in the hind foot, and in the fore foot V only is represented by the rudimentary bone articulating with the unciform. Unusual interest therefore attaches to the observations made by BOAS and by KITT of the development of lateral metacarpals and metatarsals (II and V) in Calves having III and IV united. Note also that in two of Kitt's cases there was not only a development of lateral digits but also indications of a *division* occurring in them. Besides this, in the right fore foot of one solid-hoofed Pig (No. 585) there is a slight appearance of duplicity in the unguinal phalanx of the lateral digit V.

On the other hand the reduction of accessory hoofs (*ergots*) in LANDOIS' case, No. 582, seems to be an example of a contrary phenomenon; for the connexion between the developed lateral metacarpals and metatarsals in Kitt's case (No. 579) must be taken as evidence that the accessory hoofs do really represent II and V.

¹ ROSENBERG, A., *Z. f. w. Z.*, 1873, xxiii. pp. 126—132, *figs.* 14, &c.

- *573. **Ox.** Young ox having the two digits of the right fore foot completely united together. At the lower extremity of the large double metacarpal (III and IV) of the normal limb a deep cleft is present, which separates the two articular extremities of the bone. In this specimen this cleft was represented only by a sort of antero-posterior channel, at the bottom of which there was a slight groove, which was all that remained as an indication of the original double nature of the bone. At the back of this metacarpal there were only three sesamoids instead of four, and in the central one there was not the slightest trace of duplicity. This sesamoid was placed opposite to the channel above mentioned. The two first phalanges were entirely united, but the vestiges of this fusion could be seen both before and behind and also in the two articular surfaces by which the bone was in contact with the metacarpal. The same was true of the second phalanges. The third phalanges however were so completely fused and so reduced in size that they had the appearance of a single bone. The two small sesamoids were similarly united. The general appearance of this limb was remarkably like that of the Horse. BARRIER, *Rec. méd. vétér.*, 1884, Ser. 6, Tome 13, p. 490. [No particulars given as to the condition of the other feet of the same animal.]
574. **Ox** having right fore foot with a single large metacarpal and one splint-bone [? V]. The peripheral end of the metacarpal had two articular surfaces closely compressed together, and these two surfaces bore but one digit of three phalanges and one hoof like that of a Foal. The preparation was an old one, and with regard to the accessory hoofs there was no indication that could be relied on. KITT, *Deut. Ztschr. f. Thierm.*, XII. 1886, *Jahresb.*, 1884—5, p. 62, Case No. III.
575. **Calf:** each foot having only one hoof. The phalanges, sesamoids, metacarpals and metatarsals, were all normal and the hoofs alone were united. The cavity of the hoof was divided internally into two chambers, which were more distinct in front than behind. Externally each hoof was slightly bifid in front, but the soles of the feet were without trace of division. MOROT, C., *Bull. de la Soc. de méd. vét.*, 1889, Ser. VII. T. VI. p. 39. Case I.
576. **Calf:** killed at 10 weeks old. The left fore foot alone was abnormal, having only one hoof. Viewed from without, this hoof was like that of a young ass, but it bore a slight median depression, which was about 3 cm. wide and only 1 to 2 mm. deep, which was all that remained to shew its double structure. Internally the cavity of the hoof was single, but a horny ridge was present on the inside in the region of the depression. The two unequal phalanges were peripherally united into a single bone, but were separate centrally, and the two parts were not quite symmetrical [details given]. The other parts were nearly normal. MOROT, C., *l. c.*, Case 2.
- *577. **Ox.** In a newly-born calf the following abnormalities were seen. In the right fore foot there was a small well formed metacarpal bone on the outside of the normal paired metacarpals, and a similar but more rudimentary structure was also present on the inside of the limb. The additional outer metacarpal bore two small phalangeal cartilages, and with them had a length of about 10 cm., but the supernumerary metacarpal on the inner side was more rudimentary and bore no trace of phalangeal structures. The toes

borne by the normal metacarpal of the right fore foot were abnormal, inasmuch as the second and third phalanges were united together. The first pair of phalanges were separate, but their outer ends were modified so as to articulate with the single second phalanx. The distal (third) phalanx bore a groove indicating its double origin, but the second phalanx was without any such groove, and was to all appearance a single structure.

The left fore foot also bore an outer and an inner supernumerary metacarpal, but in this case it was the inner supernumerary metacarpal which attained the greatest size. This inner metacarpal bore two small phalangeal bones, while the outer extra metacarpal was more rudimentary and had no phalanges. The phalanges of the two normal toes were separate in the left foot, but though the bones were of the ordinary formation the two toes were enclosed in a common hoof. BOAS, J. E. V., *Morph. Jahrb.*, 1890, p. 530, *figs.*

BOAS also states that in the museum of the Agricultural School of Copenhagen are several instances of united toes in the fore foot of the Ox, and that in all these specimens the outer metacarpals (II and V) are larger than they are in normal specimens, but are not so much developed as in the case just described. BOAS, *l.c.*

578. A case [sc. Ox (?)] is also mentioned in which the two normal toes of the *hind foot* were united, and the median and distal parts of the metatarsals II and V were developed, though they are absent in the normal form. BOAS, *l.c.*

- *579. **Calf** having the digits of each foot united and bearing a single hoof. The carpus and tarsus were not seen. *Fore foot.* The chief digits, III and IV, were completely united in the fore limbs and bore a single hoof, but, in addition to this variation, the metacarpals of the lateral digits, II and V, were developed and ossified. The length of metacarpal II was 9 cm. and its thickness at the proximal end was 1.5 cm. Metacarpal V had a length of 8 cm. and a maximum thickness of 1.3 cm. at the proximal end. The metacarpal of the united digits, III and IV, measured 13 cm. in length. The metacarpal V was slightly bifid at its distal extremity, and here presented two articular surfaces. With the internal of these there articulated a bone measuring 2 cm. by 0.5 cm., and attached by fibrous tissue to the end of this bone there was a cartilaginous nodule. The external end of metacarpal V bore a rod-like piece of cartilage, 1 cm. in length. This and the cartilaginous nodule of the other part of the digit together formed the basis of one of the accessory hoofs (*ergots*), but the horny covering itself was divided by a deep cleft into two imperfectly separate parts. To the metacarpal of II was loosely articulated a bone 2.5 cm. in length, to which a nodule of cartilage was attached. The end of this digit was covered by an accessory hoof, which was imperfectly double like that of V and contained a second cartilaginous nodule, which was distinct from the first and was not supported by any proximal bone. The union between the digits III and IV was complete, and the re-

sulting structure with its hoof was like that of the Horse. The articulations were perfectly mobile. At the metacarpophalangeal joint there were two sesamoids only. [With this division in the lateral digits on fusion of III and IV compare Pig, No. 585.]

Hind foot. The digits III and IV were united as in the fore feet, but the single hoof was more pointed. The metatarsals II and V were developed. The latter was 12.7 cm. long, and was united to the large metatarsal above, but was free below, and was joined by a ligament to its accessory hoof. That of II began in the middle of the metatarsus, being cartilaginous and of about the thickness of a goose-quill; it was connected with the accessory hoof by a ligament only. KITT, *Deut. Z. f. Thierm.*, XII., 1886, *Jahresb.* 1884-85, p. 59, Case No. I, *fig.*

*580. **Calf.** Three of the feet had each *one* large digit (III and IV) formed much as in the last case. But in the dried preparation it could be seen that in each of these feet there were *four* accessory hoofs, and connected with them several ossicles irregularly placed, representing phalanges 1 and 2 connected by ligaments with lateral metacarpals. The fourth foot [which?] had only *three* accessory hoofs, but the phalanges 1 and 2 of the digits III and IV were partially separated from each other, and there were two distal phalanges, one for each digit; but instead of being side by side, they were placed one behind the other, both being encased in a single hoof. KITT, *l.c.*, p. 61, Case No. II.

581. **Calf.** A right fore foot having the two chief digits (III and IV) represented by one digit with one hoof. The distal end of the common metacarpal had two articular surfaces in close contact which bore a digit in which there were only slight traces of duplicity. The metacarpal of the digit V was represented by two small bones, one beside the upper and one beside the lower end of the large metacarpal. These two ossicles were connected together by a ligament which is prolonged downwards as far as the accessory hoof, and contains two nodules of cartilage. On the median side of the foot there is no rudiment of the metacarpal II, but the accessory hoof contains a nucleus of partly ossified cartilage. KITT, *l.c.*, p. 63, Case IV.

582. **Calf** having a single hoof on each fore foot. In external appearance, the hoof was a single structure, but its anterior portion shewed two projections which suggested that it was really a double structure. The outer accessory hoof was present on the *right foot* in a very much reduced form, but the corresponding structure of the inner side of the foot was entirely absent, and a marked 'turning-point' in the hairs (*Haarwirbel*) indicated the place where it should normally have been developed. In the left foot the accessory hoofs were in the same condition as in the right foot, but the 'turning-point' was not formed at all. There were no skeletal structures corresponding to the accessory hoofs.

The skeleton of left fore foot was prepared. In it the metacarpal was 125 mm. long, having a deep cleft on its anterior face, indicating the line of union of the two metacarpals. The two articular heads, which in a normal animal of the same age are separated from each other by about 5 mm., are in this specimen united by the inner edges of their anterior borders. The proximal phalanges formed a single bone, 32 mm. long. The division between the two bones was visible as a cleft on the anterior surface, in which place the two ossifications were distinctly separated from each other; on the posterior surface the union between the two is continued for half the length. The second phalanges formed a typically single bone, as did also the distal phalanges which bore the hoof. The foramina for the two nutrient arteries of the two toes remained double and entered the single bone, one on each

side. LANDOIS, H., *Verh. d. naturh. Ver. d. preuss. Rheinl.*, Bonn, 1881, S. 4, VIII. p. 127.

Fig. "Solid-hoofed" pigs have been mentioned by many writers from the time of ARISTOTLE. The fact that they have been reported as occurring in many parts of the world makes it likely that the variation has often arisen afresh. The first case (No. 583) is the only instance of *complete* union of III and IV in the pig that is known to me. The variation is most commonly simultaneous in fore and hind feet. As seen, it occurs in many degrees. Several specimens not separately mentioned below are in the Coll. Surg. Mus. and other collections.

583. A fore foot and a hind foot of the same individual, in which the two chief digits were completely united, viz. represented by a single series of bones.

In each case the two chief metacarpals and metatarsals (III and IV) were respectively represented by a single large bone, and with each a single digit of three phalanges articulated. The bones of these digits were straight, and not curved as they are in an ordinary foot in which two toes are present. There was not the slightest trace of duplicity, and the lateral digits were placed symmetrically on either side. The sesamoids were *two* in number

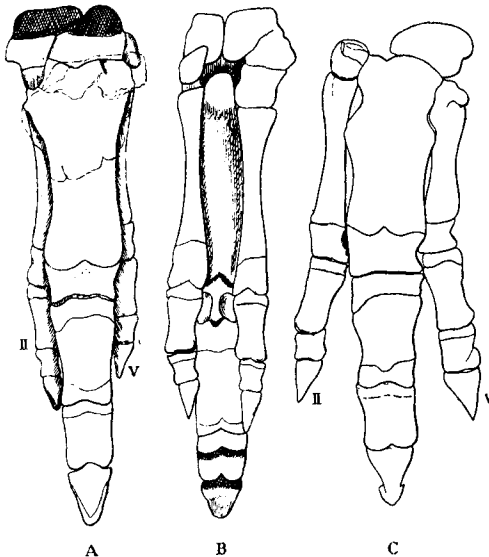


FIG. 120. Bones of feet of solid-hoofed Pig, No. 583, from specimens in the Museum at Alfort, described by BARRIER.

A. Left manus from in front.

B. Left manus from behind.

C. Left pes from in front.

The numbers II and V indicate the digits so numbered in the normal.

instead of four. The carpus and tarsus appear to have also been changed in connexion with this unification of the digits, for in the distal series at least the normal number of bones was not present. [The feet had been cut off across the tarsus and carpus before being received. By kind permission of the authorities at Alfort I examined these specimens and made the sketches in Fig. 118. I could not satisfactorily identify the bones of carpus and tarsus. The proximal parts were covered by a large exostosis.] The extensor of the phalanges ended in three tendons only, and the same was true of the deep and superficial flexors. The central tendon in each case however shewed signs of its double nature. BARRIER, *Rec. méd. vétér.*, 1884, Ser. 6, Tom. XIII. p. 491.

584 A skeleton of a solid-hoofed pig exists in the Museum of the Royal College of Surgeons of Edinburgh which was presented by Sir Neil Menzies of Rannoch, Perthshire. Inquiries instituted by Struthers (1863) elicited the following facts.

“The solid-hoofed pig has been well known and abundant on the estates of Sir Neil Menzies at Rannoch for the last forty years. Most, if not all of them, were black. They were smaller than the ordinary swine, and seem to have had shorter ears. They liked the same food and pasture as the common swine, and showed no antipathy to herd with them. They were more easily fattened, though they did not attain so large a size as the ordinary swine; their flesh was more sweet and tender, but some of the Highlanders had a prejudice against eating the flesh of pigs which did not “divide the hoof,” unaware apparently that the Mosaic prohibition applied to all pigs. A male and female of the solid-hoofed kind was brought to Rannoch forty years ago, by the late Sir Neil Menzies, which was the commencement of the breed there; but I have not been able to learn where they were brought from. Although they did not breed faster than the common kind, they multiplied rapidly, in consequence of being preserved, so that the flock increased to several hundred.

“At first, care was taken to keep them separate, on purpose to make them breed with each other, but after they became numerous they herded promiscuously with the common swine. As might be expected in a promiscuous flock, some of the young pigs had solid and some cloven feet, but I am unable as yet to say whether any definite result was ascertained as to the effect of crossing; whether any experiments were tried as to crossing; or whether after the promiscuous herding, some of the pigs of the same brood presented cloven and some solid hoofs.

“No pig was ever known there with some of its feet solid and some cloven; nor, so far as is known, was there any instance of young born with cloven feet, when both parents were known to be solid-hoofed. The numbers diminished—for what cause is not apparent; so that last year there was only one or two—one of them a boar, which died; and now the solid-hoofed breed appears to be extinct in Rannoch.”

585. “*Fore foot.*—The distal phalanges of the two greater toes are represented by one great ungual phalanx, resembling that of the Horse,

but longer in proportion to its breadth. The middle phalanges are also represented by one bone in the lower two-thirds of their length, presenting separate upper ends for articulation with the proximal phalanges. The proximal phalanges are separate through their entire length. The whole foot above the middle phalanges presents the usual arrangement and proportions in the hog." *Middle Phalanges.* "There is no symphysis or mark indicating a line of coalescence of the two phalanges. The surface across the middle is somewhat irregularly filled up to nearly the level of each lateral part. Each half of the phalanx, as indicated by the notch between the separate upper ends, has the full breadth of the proximal phalanx above it." *Distal Phalanx.* The middle part of this is raised above the lateral parts, and is partially separated from them by a fissure on each side, giving it an appearance as of the union of three bones. The end of the phalanx is notched like that of the horse; it bears no trace of symphysis. "The unguis phalanx of one of the lesser internal toes of the fore foot presents a bifurcation reaching half the length of the phalanx." See Fig. 121.

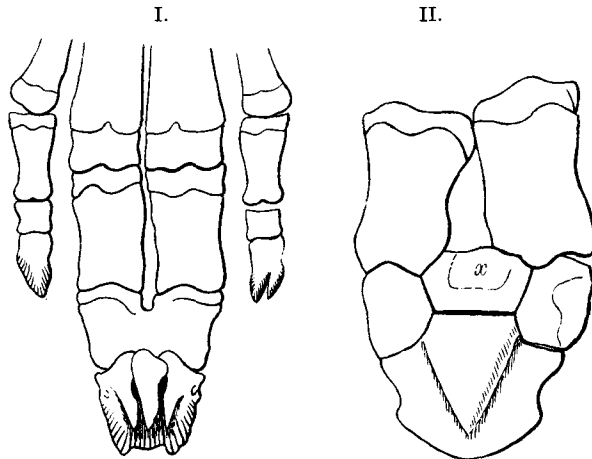


FIG. 121. I. A right fore foot of a solid-hoofed Pig, No. 585, from in front. The unguis phalanx of the digit V is bifid [cp. Nos. 579 and 580].

(After STRUTHERS.)

II. Middle digits of foot of solid-hoofed Pig, No. 587. *x*, an extra ossification wedged in between the phalanges of III and IV. (After ELLIOTT COUES.)

"*Hind foot.* In the hind foot only the *distal* phalanx is single.... There is no trace of double origin to the bone." STRUTHERS, J., *Edinburgh New Phil. Journ.*, 1863, pp. 273-279, *figs.*

586. A pair of solid-hoofed pigs received by Zoological Society of London from Cuba in 1876. The sow gave birth to a litter of six [the solid-hoofed boar being presumably the father]. The six young were three males and three females. The hoofs were solid like those of the parents in two males and one female: in the others the hoofs were cloven as in the normal pig. The feet of one of the solid-hoofed males of this litter were dissected, and it was found that "the proximal and second phalanges are separated as usual, whilst at the extreme distal ends of the unguis phalanges

these bones are completely fused together ; and, further, a third ossicle was developed at their proximal ends, where they are not completely united, between and above them" [cp. No. 587]. "It might have been imagined that the deformity was simply the result of an agglutination along the middle line of the two completely-formed digits ; but such is not the case, the nail-structure being absent in the interval, where it is replaced by bone with a transverse cartilage below it. The nail is continued straight across the middle line of the hoof, as in the horse." GARRON, A. H., *Proc. Zool. Soc.*, 1877, p. 33.

587. Domestic pigs having the two central hoofs compounded into a single solid hoof have been known to occur several times in America. The two other toes remain distinct in these cases. A breed of pigs having this character is said to have been established in Texas, which transmits this peculiarity in a definite way. In this breed the peculiarity is said to have been so firmly established that "no tendency to revert to the original and normal form is observable in these pigs." A cross between a solid-hoofed boar and an ordinary sow is said to produce a litter of which the majority shew the peculiarity of the male parent. "On the sole of the hoof, there is a broad, angular elevation of horny substance, apex forward, and sides running backward and outward to the lateral borders of the hoof, the whole structure being curiously like the frog of the horse's hoof. In fact it is a frog, though broad, flattened, and somewhat horseshoe-shaped, instead of being narrow, deep and acute as in the actual frog of the horse. This arcuate thickening of the corneous substance occupies about the middle third of the whole plantar surface of the foot." The terminal phalanges are united together, and above this single bone is another independent ossification lying between the second phalanges of the two digits, which remain distinct. [Cp. No. 586.] COVES, ELLIOTT, *Bull. U. S. Geol. Geogr. Surv.*, IV. p. 295, *fig.*
588. Case resembling the above reported from Sioux City, Iowa, in which these pigs were bred for some time and were advertised for sale, with the statement that they were also of superior quality. Other cases given from different parts of the United States. In one of these it is stated that one hind foot was thus formed [the others being presumably normal]. AULD, R. C., *Amer. Nat.*, 1889, XXIII. p. 447, *fig.*
589. **Fig.** In all four feet the digits III and IV partially united and covered by one hoof. The metacarpals and first phalanges were separate in each case but the second and third phalanges of the two digits were united together. The common hoofs were not compressed laterally, as in some of the cases seen in the Calf, and the small digits II and V were unmodified. KITT, *Deut. Zt. f. Thiern.*, XII. 1886, *Jahresb.*, 1884-85, p. 64, *Case IV, figs.*

POLYDACTYLISM IN BIRDS¹.

The whole number of cases of Polydactylism recorded in birds generally is small. The phenomena however seen in the Dorking fowl are well worthy of attention and have scarcely been adequately treated. I propose here to give an account of this case, mentioning instances seen in other birds and indicating so far as may be their relation to the facts of the Dorking.

Five-toed fowls have been known from very early times. The character is now most definitely associated with the Dorking, though it is also considered necessary in Houdans for show purposes. It is likely that the latter breed derived the fifth toe from the Dorking. Fifth toes may often be seen to occur in other breeds, but I cannot quote a satisfactory record of their appearance in pure strains.

In the foot of an ordinary four-toed fowl the hallux articulates with the tarso-metatarsus by a separate metatarsal. The hallux in such a foot most often has two phalanges. In its commonest form the five-toed foot departs from this normal in the fact that the hallucal meta-

¹ See also the case of *Rissa*, p. 396.

tarsus bears two digits instead of one. The morphological nature of these digits is obscure. Some have judged that one of them is a "præ-hallux;" COWPER¹ sees in the internal toe the true hallux, and argues that the digit commonly called the hallux is really the index; HOWES and HILL² consider that the normal hallux has split into these two digits. The diversity of these views comes partly from an insufficiency of the area of fact over which the inquiry has been extended, for it will be found that the conditions are very various and shade off imperceptibly in several directions. As in all cases of Meristic Series, the first question relates to the position of these digits in the system of Symmetry of the limb. Are they in a Successive Series with the other digits, or do they balance them? Are they in Succession to each other or do they balance each other as images?

Turning to the facts with these considerations in view it will be seen that no general answer can be given, but that the condition is sometimes of the one kind and sometimes of the other. For there are not merely two conditions, a four-toed and a five-toed, but there is a whole series of conditions and according to the cases chosen so may the question be answered. By examining a few score of fowls' feet many sorts may be seen.

590. (1) The most usual five-toed foot is that figured by COWPER (*l.c.*, p. 249), in which the metatarsal of the hallux bears two digits, an outer one of two phalanges and an inner of three phalanges. For purposes of description let us call the outer the hallux. In this foot then the hallux is the least digit, and the members of the digital series *increase in size on either side of it.*
591. (2) But not rarely is found a state like the last save that the inner digit is borne by the proximal phalanx of the hallux. This is very common. The two digits may then be about equal in size, or more often the hallux is the smaller.
592. (3) Hallux more or less perfectly divided into two digits with a common base, having (a) two, or (b) three phalanges (as in HOWES' case Fig. 5). This state is practically that of the human "double-thumb" (see p. 350), and, just as in that phenomenon, the duplicity may be of various extent, often affecting only the nail and distal phalanx. Between the two parts of such a double digit there is often that relation as of optical images found in human double-thumb, the curvatures of the two parts being equal and opposite. But if both digits are of good size and are separate up to the metatarsal this equality is rarely if ever found, and one of the digits, generally the innermost, is the larger. In this condition therefore there is a Succession from the hallux to the inner digit just as in (1). So the condition of double-hallux, that is to say the representation of one member of a series by two members in bilateral symmetry, shades off imperceptibly into the condition in which a new member is formed in Succession to the terminal member.

It should be noted that this case presents a remarkable difference from that seen in the like cases of variation on the radial side of the hand of Man. In Man the states of true double-thumb are just as in the Fowl; but if there is a difference or Succession between the two parts

¹ *Jour. Anat. Phys.*, xx. p. 593; and xxiii. p. 242.

² *Ibid.*, xxvi. p. 395, *figs.*

it is the *external*¹ which is the greater, being in several cases a three-phalanged digit shaped like an index (see No. 486). Nevertheless in the Fowl it is the *internal* which is the greater.

The conditions in the following cases are not far removed from those named above.

593. **Archibuteo lagopus** (Rough-legged Buzzard): specimen in good condition shot near Mainz, being otherwise normal. The toes of the *left* foot were placed as usual in a bird of prey, but on the outside² of the hind toe was a much smaller accessory toe. This accessory toe was attached to the hind toe almost as far as the base of the claw of the latter. The claw of the accessory toe was half the size of that of the hind toe. In the left leg the muscles of the thigh and shank were less developed than usual. Toes of *right* foot abnormally arranged, being all directed forwards. The three normally anterior toes were on the inside of the series, and the toe which should properly be single and directed posteriorly was double and was directed anteriorly. These abnormally disposed toes were not functional. The right leg was much more developed than the left, and it seemed as if the bird had habitually stood on the right leg. VON REICHENAU, W., *Kosmos*, 1880, vii. p. 318.
594. **Gallinula chloropus** (Moorhen): specimen killed in Norfolk in 1846. "Each of the hind toes possessed a second claw, which in the right foot merely springs from about the middle of the true toe, but in the left is attached to a second toe, which proceeds from the original one, about half-way from its junction with the tarsus." Extra toe and claw in each case attached outside² of the true hind toe. GURNEY, J. H., and FISHER, W. R., *Zoologist*, 1601.
- Guinea-hen** having double hallux; of the two digits the external² was the longer. GEOFFROY ST HILAIRE, *Hist. de Anom.*, i. p. 695.

Division of digits II and III.

595. **Anas querquedula**, L. (Garganey Teal): wild specimen having the left foot abnormally formed. In it there was no toe occupying the place of the hallux, but the digits II and III [using the common nomenclature] were partially bifurcated. In the digit III, the extremity only was divided, but each part bore a separate nail and there was no web between these secondary digits, which were somewhat irregular in form. The digit II divided in about its middle into two nearly similar digits, which were united by a web. The nails of these digits were hypertrophied. ERCOLANI, *Mem. Acc. Bologna*, S. iv. T. III. p. 804, *Tav.* III. fig. 1.
596. (4) From the condition seen in (3) it might be supposed that duplicity of the hallux is the least possible step in the progress of the four-toed form towards the five-toed. It is only one of the least possible steps. For in a few cases upon the base of the digit recognizable as the hallux, and standing in the normal place of the hallux, may be found a minute rudiment of a digit, sometimes with a nail, sometimes without. Between this and the well-formed fifth toe all conditions exist.
- There are thus, as usual in the numerical variations of Meristic Series, *two* least conditions, one being found in duplicity of a single member, the other taking the form of addition of a rudimentary member beyond the last member.
597. Passing now from the simpler conditions of the variation to the more complex, several distinct states may be mentioned. The divergence from the normal may be greater either by the presence of *two* extra digits, or by change in the position of the extra digit or digits.

¹ The only case to the contrary is that mentioned by WINDLE, *Jour. Anat. Phys.*, xxvi. p. 440, in which a three-phalanged digit stood on the radial side of a pollex. This case has not been described. See pp. 326 and 352.

² In reading these records it should be remembered that owing to the backward direction of the hallux the apparent outside is morphologically inside, and probably this is meant in each case.

*Two extra digits are said to be not uncommon in the Dorking but I have myself seen only one case. A foot of this kind is figured by COWPER¹, and in it the appearance is as of an extra digit of three joints (? all phalanges) arising internally and proximally to the hallucal metatarsal, which already bears two small and sub-equal digits. In the case seen by myself there was one large internal digit with three phalanges separately articulating with the tarso-metatarsus, and the hallucal metatarsus bore a digit divided peripherally, bearing two nails related as images. Here therefore there was a *double hallux*, and internal to it a separate digit.*

598. The evidence regarding extra digits in other positions, though small in amount, is of importance as a light on the morphology of these repetitions of digits. We have seen that the ordinary extra digit is, with the hallux, borne on the hallucal metatarsal. In one of HOWES' cases (*l. c.* figs. 2 and 3) this metatarsal instead of simply articulating with the shank of the tarso-metatarsal *was continued up to articulate also with the tibio-tarsus*. From this state the condition in which a separate digit (or digits) articulates with the tibio-tarsus only is not far removed. Of this condition I know no detailed account in the Dorking, though it is referred to by LEWIS WRIGHT², but I have met with the following cases in other birds.
599. **Aquila chrysaetos** (Golden Eagle): having two extra toes borne by right metatarsus [left foot is not described]. The two extra toes attached to upper part of the back of the metatarsus. Each bears a full-sized claw which was curved backwards and upwards. One of the toes bore six scutella on the morphologically upper surface and four on the plantar surface. The other toe, which was more completely united to the metatarsus along its whole length, bore only a single scutellum on the plantar surface. The rest of the foot was normal. JACKEL, A. J., *Zool. Gart.*, xv. 1874, p. 441, *fig.*
600. **Pheasant**: right foot bearing a thin and deformed digit articulating internally with the distal end of tibio-tarsus. Hallux normal. Left not seen. Specimen received from Mr W. B. TEGETMEIER.
601. **Pheasant**: each leg bears a large extra digit of irregular form attached to the middle of anterior surface of tibio-tarsus. The two legs almost exactly alike, but in one the digit is firmly and in the other loosely attached to tibio-tarsus. Specimen kindly sent by Mr TEGETMEIER.
602. **Buteo latissimus** ♂, having extra digit on right leg, the toe was well formed, with two phalanges, bearing perfectly formed claw, loosely attached internally to tibio-tarsus just above articulation with tarso-metatarsus. COALE, H. K., *Auk*. 1887, iv. p. 331, *fig.* [Cp. No. 593.]
603. **Turkey** having two imperfectly separate digits [? images] attached to process of tibio-tarsus. Two cases differing in degree: hallux normal. ERCOLANI, *Mem. Ac. Bologna*, Ser. iv. III. Pl. III. *figs.* 2 and 3.
604. **Pheasant**: somewhat similar case, in which two such digits were similarly placed, but one was large and the other small. *Ibid.*, *fig.* 4.
605. **Larus leucopterus**. For the following case I am indebted to Professor R. RIDGWAY, Curator of the Department of Birds, in the United States National

¹ COWPER, J., *Journ. Anat. Phys.*, xxiii. p. 249.

² "Perhaps the most difficult point in judging Dorkings, however, is to watch against malformations of the feet which have been fraudulently removed; for the abnormal structure of the Dorking foot is very apt to run into still more abnormal forms, which disqualify otherwise fine birds for the show-pen. Birds are not unfrequently produced which possess *three* back toes, or have an extra toe high up the leg; or, in the case of the cock, with supernumerary spurs, which have been known to grow in every possible direction We have on two occasions seen prizes awarded to birds which shewed unquestionable traces of such amputation...." *The Illustrated Book of Poultry*, 1886, p. 331.

Museum. The specimen is No. 76,221 in that collection, marked "Greenland, Sept. 1877; Loc. Kumlien." The accompanying figures were kindly made for me

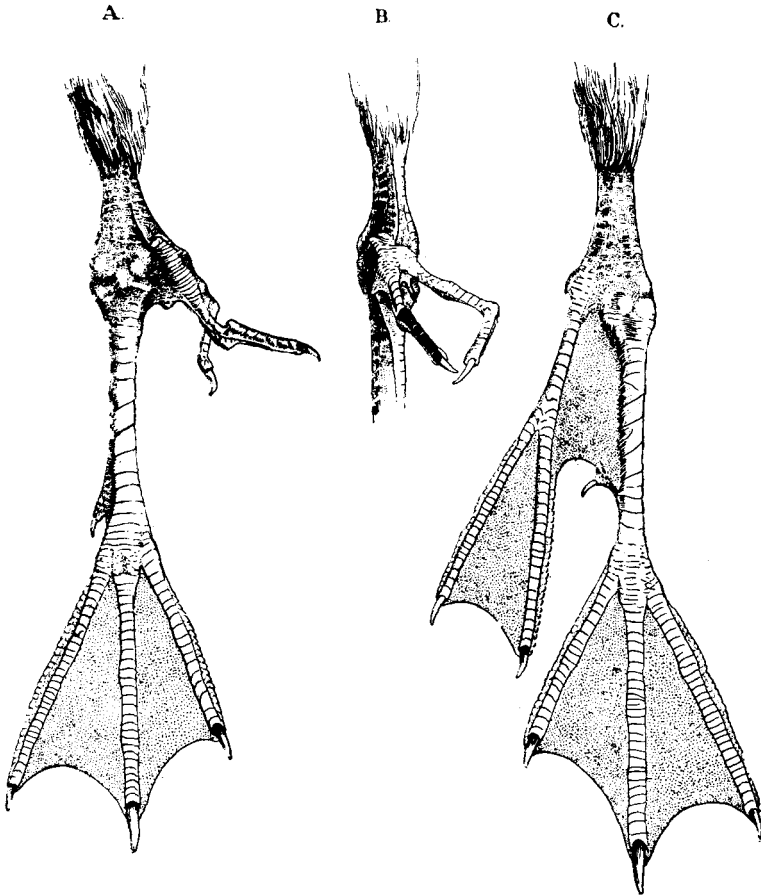


FIG. 122. *Larus leucopterus*, No. 605.

- A. Right foot seen from in front.
- B. The same from the internal side.
- C. Left foot from in front.

From a drawing of specimen in U. S. Nat. Mus., kindly made for me by Prof. RIDGWAY'S direction.

under Professor Ridgway's supervision and sufficiently shew its structure (Fig. 122). [It will be seen that the hallux in A, the right foot, appears on the outside; this I conceive is due to partial rotation to shew the abnormal toes.]

Besides these there are a few amorphous cases of extensive repetition of digits in birds.

These facts shew how fruitless a work it is to try to find a general statement which shall include all the cases. There is an almost unbroken series of conditions starting from *either* duplicity of the hallux, *or* from the presence of an internal rudimentary

digit, up to a condition somewhat resembling that of "double-hand" in Man. If the first digit behind the hallux is the præ-hallux, what are the digits on the tibio-tarsus? If on the other hand the appearance of an extra digit internal to the supposed hallux is to be evidence that this "hallux" is the index, it may equally be argued that if *two* digits come up internal to the "hallux" then the supposed hallux is the medius, and so on indefinitely. Again, though with HOWES and HILL we may accept the cases of double-hallux as evidence that an extra digit may appear by division of the hallux, which is indisputable, we must equally accept the cases Nos. 597 and 598 as evidence that extra digits may grow directly from the tarsus or even from the tibia, though the hallux remain single and unchanged. And between these two there is no line of distinction; they pass into each other. Do not these things suggest that we are looking for an order that does not exist? Is it not as if we should try to name the branches of a tree in their sequences?

Possibly Continuous numerical Variation in Digits: miscellaneous examples.

Under this heading are placed in connexion a few cases of great interest. Whatever may be held as to the relation to the problem of Species of the phenomena hitherto described, it can scarcely be doubted that the following are instances of Variation which at least *may* be of the kind by which new forms are evolved.

Great interest would attach to a determination whether the reduction of the digits in these cases is a continuous or a discontinuous process, but unfortunately these phenomena have been statistically studied by no one, and it is not possible to do more than make bare mention of the fact that such Variation is known to occur. There is no statistical evidence as to whether the individuals in any one locality may not fall into groups, dimorphic or polymorphic in respect of the degree to which the digits are developed (compare the case of the Earwig, Introduction, p. 40). As an inquiry into the Continuity of Variation such an investigation would be exceptionally valuable. In the case, for instance, of *Cistudo* mentioned below, such a statistical inquiry should surely not be hard to make.

- *606. **Chalcides.** This is a genus of Lizards belonging to the family Scincidæ. In several genera of this family the limbs are reduced or absent, differences in this respect being frequent among species of the same genera. (See BOULENGER, *Catalogue of Lizards in Brit. Mus.*, 1887, III. pp. 398, &c.)

Mr BOULENGER kindly shewed me a number of Lizards of the genus *Chalcides* from the shores of the Mediterranean basin which strongly resemble each other in colour and general appearance, but which contained almost a complete series of conditions in respect

of the development of the limbs and digits, ranging from *C. ocellatus* and *C. bedriagæ* with pentadactyle limbs fairly developed, through *C. lineatus* (tridactyle) and *C. tridactylus* to *C. guentheri* in which the limbs are minute conical rudiments. Amongst the species of this series great individual variations occur.

607. **Chalcides mionecton**: normally four digits on each foot. A specimen in Brit. Mus. kindly shewn to me by Mr BOULENGER has on each hind foot *five* digits.
608. **C. sepoides**: Mr BOULENGER tells me that the normal number of digits on each foot is five, but that specimens occur having *four* digits on each foot.
609. **Cistudo**. This genus includes the North American Box-turtles as defined by AGASSIZ (*N. Amer. Testudinata, Contrib. to N. H. of U. S.*, I. p. 444). These animals are widely distributed to the E. of Rocky Mountains. On the hind feet of some of them there are three digits, while others have four. GRAY (*P. Z. S.*, 1849, p. 16) described two Mexican specimens which agreed in having *three* large claws on the hind foot with no appearance of a fourth claw, and even scarcely any rudiment of the fourth toe, which was then believed to be present in the other members of the genus. To this three-toed form he gave the generic name *Onychotria*, but in *Brit. Mus. Cat.*, 1855, he gave up this name as a generic distinction, describing the Mexican form as *Cistudo mexicana*, giving three toes on the hind foot as a definite character.

AGASSIZ in 1857 (*l.c.*) divided *Cistudo* into four species, giving to the Mexican form the name *C. triunguis*, and he states that the western and south-western type is remarkable for having almost universally only three toes on the hind feet. The toe which is missing is the *outer* toe and "it fades away so gradually that the genus *Onychotria* cannot stand." The form found from New England to the Carolinas is called by Agassiz *C. virginica* = *C. carolina*, and he states that he received a *three-toed* specimen from N. Carolina which agreed in all other respects with those from New England.

PUTNAM (*Proc. Boston, N. H. S.*, x. p. 65) stated that the three-toed form found in the South is only a variety of *C. virginica*, and that he had seen two specimens which had three toes on one hind foot and *four* on the other.

610. **Rissa**¹. The common Kittiwake (**R. tridactyla**) as found in

¹ In illustration of the possible bearing of these facts on the problem of Species reference may be made to the fact that among birds there are several examples of species differing from their near allies by reason of the absence of the hallux. Speaking of this feature in *Jacamaralcyon tridactyla*, SCLATER observes: "In the present bird we meet with another example of the same character [viz. a monotypic form], and with one, perhaps, more isolated in its structure than any of those above mentioned, *Jacamaralcyon* being notably different from all other members of the Galbulidæ in the absence of the hallux. At the same time we must be careful not to put too high a value upon this at first sight seemingly important

this country and in N. Atlantic has no hallux, but only a small knob without a nail in its place. No variation in respect of this digit is recorded¹. Birds not distinguishable from the Atlantic Kittiwake occur in the North Pacific, but amongst these Pacific specimens birds are found occasionally as rarities having a hallux "as large as it is in any species of *Larus*" (COUES, p. 646). This feature also exhibits gradations. Specimens are described by COUES and also by SAUNDERS having the hallux including the nail .2 in. long, with a perfect claw. These are given as extreme examples. SAUNDERS remarks that this hallux is small for the size of the bird, stating that another species of similar size, *L. canus*, had a hallux .5 in. long. Of these specimens of *R. tridactyla* from Alaska one had the nail of the hallux developed, though less so than in the extreme case. Saunders states further that the variation is not always equal in extent on both feet of the same individual: he considers that the extreme form is probably rare and local. COUES, E., *Birds of North-West (U. S. Geol. Surv. Terr.)*, 1874, p. 646; and SAUNDERS, HOWARD, *P. Z. S.*, 1878, pp. 162—64.

611. **Rissa brevirostris**: a species from the N. Pacific distinct from *R. tridactyla* shews a similar variation in the development of the hallux, though in a smaller degree. A specimen has no claw on right hind toe and only minute speck on left; another has no hind nail whatever; another has small black nails of unequal size on the two hind toes. SAUNDERS, H., *l. c.*, p. 165.
612. **Erinaceus**. *E. europæus* has a large hallux, while in *E. diadematus* it is only 4 mm. in length, and in *E. albiventris* it is normally absent in adults. An adult female **E. albiventris** had a minute hallux in the left hind foot, represented by a claw and ligamentous structures, the phalanges being absent². In a female a few months old a minute hallux with usual number of phalanges was present on both sides. The presence or absence of a hallux has often been considered a sufficient ground for the formation of a new genus. DOBSON, G. E., *P. Z. S.*, 1884, p. 402.
613. **Elephas**. In both the Indian and African elephant the number of digits represented by bones is five, both in the fore and the hind foot. The number of *hoofs* differs in the two species. The African elephant has normally four on the fore foot and three

character, as the same feature occurs as is well known, not only in certain genera of other allied families (such as Alcedinidæ and Piciidæ), but even in a genus of Oscines (*Cholornis*), in which group the foot-structure is generally of a very uniform character." SCLATER, P. L., *Monograph of the Jacamars and Puff-Birds*, 1879—82, p. 50.

¹ Mr A. H. EVANS has called my attention to a recent paper by CLARKE (*Ibis*, 1892, p. 442) giving an account of a minute rudiment of the hallux in embryos of *R. tridactyla* from Scotland.

² Compare facts as to the loss of the hallux in Mungooses (*Herpestidæ*), THOMAS, O., *P. Z. S.*, 1882, p. 61.

on the hind foot, and I am not aware that variations from this number have been seen.

In the Indian elephant there is variation, and though I cannot give any complete account of the matter the following particulars may be of interest.

According to BUFFON the 'Elephant' has generally five hoofs on both fore and hind feet, but sometimes there are four, or even three¹. He gives a particular case of an Indian elephant with four hoofs on each foot, both fore and hind feet.

TACHARD², to whom Buffon refers, was desired by the French Academy to notice on his journey in Siam, whether elephants had hoofs, and he states that all that he saw had five on each foot. Possibly the four-toed variety does not occur in Siam.

I am indebted to Mr W. T. BLANFORD for the information that the natives of India attach importance to the number of hoofs, and also for the following references. HODGSON³ gives a sketch of elephants with four hoofs on each foot, marked "*Elephas Indicus*, var. *isodactylus* nob., Hab. the Saul forest," together with the following note: "The natives of Nepal distinguish between the breeds with four toes [*sic*] on all the feet and those with five to four toes." SANDERSON⁴ speaking of this says that some elephants have but sixteen hoofs, the usual number being five on each fore foot and four on each hind foot; and that in the native opinion 'a less number than eighteen hoofs in all disqualifies the best animals.' FORSYTH⁵ also alludes to the same fact.

Taken together these accounts seem to shew that five on the fore foot and four on the hind foot is the most usual number, but that both the number on the fore foot may diminish to four and that on the hind foot may increase to five. Several text-books mention the subject but I know no statistics regarding it. In view of the different number characteristic of the African elephant this variation has some interest. In particular it would be of use to know whether the variation exhibits Discontinuity, and also to what extent it is symmetrical.

INHERITANCE OF DIGITAL VARIATION.

614. Recurrence of digital Variation in strains or families is frequent, but though many observations on the subject have been made no guiding principle has been recognized. To the general statement that digital Variation, whether taking the form of polydactylism or other-

¹ BUFFON, *Hist. Nat.*, xxviii. p. 201. The mention of three hoofs must I think refer to the African species, which Buffon does not distinguish from the Indian. In the Cambridge Museum (*Catal.* 699) is an old preparation of the skin of an elephant's foot having three hoofs. This is declared by the Catalogue to be the fore foot of an Indian elephant. Perhaps this is a mistake.

² TACHARD, *Voy. de Siam*, 1687, p. 233.

³ HODGSON, B. H., *Mammals of India*, MS. in Zool. Soc. Library.

⁴ SANDERSON, G. P., *Wild Beasts of India*, p. 83.

⁵ FORSYTH, J., *Highlands of India*, 1872, p. 286.

wise, does very commonly appear in the offspring or kindred of the varying individuals I can add nothing. It should be mentioned that though in families exhibiting digital Variation the forms that the change takes may differ (in some cases widely even among individuals nearly related) yet on the whole the variation, if recurring at all, more often recurs in a like form. This holds good apart from the rarity of the particular form of variation. The facts described by FARGE (*l.c.*, *infra*) are exceptionally interesting in this connexion. In the family described by him *duplicity* of the thumbs occurred in the paternal grandmother, while the father and three children had their thumbs of the *three-phalanged* form as in No. 483. This case strikingly illustrates the well-known principle that Meristic variability may appear in the same strain or family under forms morphologically very dissimilar.

Attention is also called to the circumstance that in the case of the three toes in the ox (No. 558) the descent was wholly through *females*, and the same was almost certainly true in the polydactyle cats (No. 480). In the case of the syndactyle pigs the evidence of maintenance of the variation in the strain is very clear (No. 584). See also No. 564.

As regards digital Variation in Man the following are the best genealogical accounts :

ANDERSON, *Brit. Med. Jour.*, 1886 (1), p. 1107. BILLOT, *Mém. méd. milit.*, 1882, p. 371. BOYD-CAMPBELL, *Brit. Med. Jour.*, 1887, p. 154. FACKENHEIM, *Jen. Zts.*, 1888. FOTHERBY, *Brit. Med. Jour.*, 1886 (1), p. 975. FÜRST (see *Canst. Jahresh.*, 1881, p. 283). HARKER, *Lancet*, 1855(2), p. 389. LUCAS, *Guy's Hosp. Rep.*, xxv., p. 417. MORAND, *Mém. Ac. Sci.*, 1770, p. 140. MUIR, *Glasg. Med. Jour.*, 1884. POTTE, *Jahresh. d. Kinderh.*, xxi., p. 392. POTTON¹ quoted by GRUBER from DE RANSE, *Bull. Soc. d'Anthrop.*, 1863, iv. p. 616. STRUTHERS, *Edin. New Phil. Jour.*, 1863(2), pp. 87 *et seqq.* WOLF, *Berl. klin. Wochens.*, 1887, No. 32. FARGE, *Gaz. hebdoméd. et chir.*, Ser. 2, ii. 1866, p. 61. Case given *Lond. Med. Gaz.*, 1834, p. 65.

Association of digital Variation with other forms of Abnormality.

615. In the great majority of cases of polydactylism the rest of the body is normal, the limb or limbs varying alone. There are however a certain number of examples of polydactylism in association with other abnormalities ; as for instance with phocomely, cyclopia, double uterus, hare-lip, defective dentition, defect of tibia, &c., but there is nothing as yet to indicate any special connexion between these several variations. Diminution in number of digits and syndactylism is on the contrary very often associated with general deformity and with many forms of arrested development. To this no doubt is largely due the fact that cases of ectrodactylism are commonly irregular, whereas polydactylism is generally fairly regular in its manifestations, for numerous cases of diminution in number of digits occur in bodies or in limbs otherwise amorphous.

¹ The notorious case of a village in Isère where the majority of the inhabitants are said to have been polydactyle. Most modern writers on the subject quote this statement but I have never found original authority for the fact. By some it is referred to DEVAY, *Du danger des mariages consanguins*, 1862, p. 95, but I can find no mention of the facts in that work.