

THE OCCURRENCE OF AN ADDITIONAL PHALANX
 IN THE HUMAN POLLEX. By BERTRAM C. A. WINDLE,
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 College, Birmingham.* (Plate II.)

SOME time ago the man whose hands are figured in the accompanying illustrations¹ was sent to me for inspection. His description of his condition was that he had "five fingers and a thumb on one hand, and five fingers and no thumb on the other." On examining him I found the following condition of affairs. Left hand—the thumb bore on the radial side of its metacarpal bone a supernumerary digit, provided with a well-formed nail, and consisting of two phalanges, provided with movable articulations with one another and with the metacarpal bone. The thumb itself was nearly as long as the index finger, the appearance of which it simulated, and was provided with a metacarpal bone and with three phalanges, movable articulations existing between each of the members. The digit in question, though simulating the appearance of the other members of the series, was yet functionally a thumb. Right hand—the normal number of digits was present, but the radial digit or thumb, like that on the other hand, had a metacarpal bone and three phalanges, the articulations between the members being movable. In its relation of position to the other members of the series, this digit was unmistakably a thumb, and so far as could be seen it possessed the usual

	Metacarpal.	1st phal.	2nd phal.	3rd phal.
Left hand—				
Radial pollex,	...	3·0	2·5	...
Ulnar pollex,	4·5	5·0	2·5	2·3
Index, . . .	6·0	5·0	2·5	3·0
Right hand—				
Pollex, . . .	5·0	4·5	1·8	3·0
Index, . . .	6·0	5·0	3·0	3·0

¹ I ought to mention that these drawings were made for me by my late pupil, Mr W. M. Sadler, whose early death I much regret.

Fig. 1.

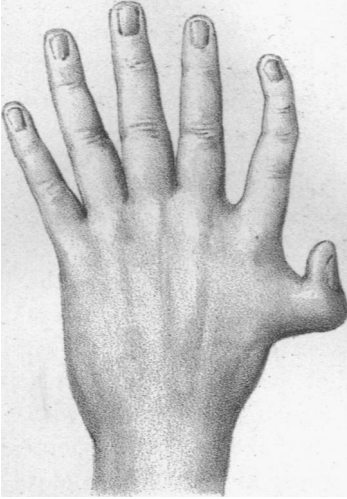


Fig. 2.

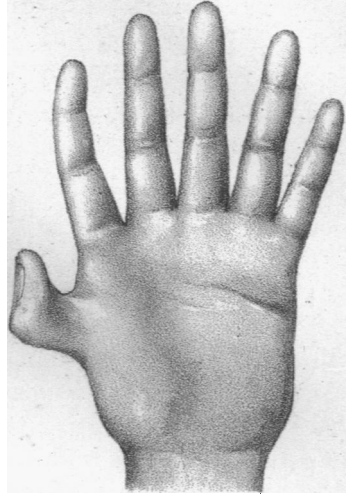
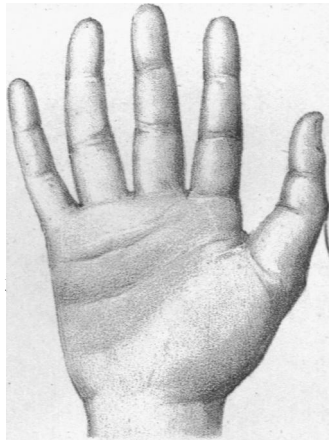


Fig. 3.



Fig. 4.



muscles of that digit. It was not so long in proportion as the corresponding digit of the other hand. The preceding table gives the measurements.¹

The unusual nature of this case having much interested me, I made a careful search through teratological literature for others of a similar nature. As the condition is a rare one, I think it may be useful briefly to give the details of the cases which I have been able to discover, more especially as I shall have to allude to them in discussing the points for consideration to which they give rise.

Case 1 (Struthers, *Edin. New Phil. Jour.*, 1863, p. 83. Also mentioned in *References to Papers on Anatomy*, by Professor Struthers, pub. 1889, sec. 22).—A.S., has six digits on each hand and on each foot. One of the thumbs presents three phalanges on each hand. The two thumbs are supported on one unbifurcated metacarpal bone. The thumb next the forefinger is clearly felt to have three phalanges, while the lesser thumb has two phalanges. It is the same on both hands. The greater thumb is $2\frac{3}{4}$ inches in length on the left hand, and $2\frac{1}{2}$ on the right; the lesser thumb is 2 inches in length on both hands. The circumference of the greater thumbs on the left and right sides, respectively, is $2\frac{1}{2}$ and $2\frac{1}{4}$, that of the lesser thumbs being 2 inches. The two thumbs are webbed at their base. In each hand, it is the thumb next the forefinger which is used. There is some evidence of heredity in the condition.

Case 2 (same references).—J.J., aged 21, has the thumb on both hands of unusual length and form. Each possessed an additional joint, giving three phalanges besides the metacarpal bone, the additional bone being placed in the position of a middle phalanx. The metacarpal bone is $2\frac{1}{4}$ inches in length, and appears to be quite normal. The first phalanx is $1\frac{3}{4}$ inch in length, and is, therefore, longer than usual. The additional bone, occupying the position of a middle phalanx, is broader on the inner, or radial, side than on the side next the index finger, having a triangular or wedge-shaped figure, which gives the distal phalanx an inclination towards the index. It measures along the radial side $\frac{5}{8}$ inch, along the ulnar side $\frac{1}{4}$ inch, and $\frac{1}{2}$ inch along the middle. The position of the base of this wedge-shaped additional bone is shown by a double protuberance on the radial side. Between these a depression may be felt corresponding to the short shaft between the articular ends. The distal phalanx is an inch in length. The measurements were made exactly from the joints, avoiding the error of including the knuckles twice. When the thumb is straightened, its point passes a sixth of an inch beyond the joint between the proximal and middle phalanges of the index finger.

¹ These measurements may not be absolutely correct as they were made from casts of the hands, but they are at least relatively accurate.

The thumb of the right hand scarcely advances so far as that joint. The unusual length of the thumbs in this case is gained by the proportionately greater length of the proximal phalanx and by the presence of the additional bone, while the distal phalanx is a little shorter than usual. At the joint on the proximal side of the additional phalanx there is the usual extent of flexion and extension. Between it and the distal phalanx passive motion is free and readily felt in both thumbs, although it cannot be carried so far as to cause an angle or additional knuckle. Some motion in the lateral direction can also be made at this joint. The utility of the thumb is not impaired. The fingers are longer than usual (their lengths, from the metacarpo-phalangeal articulation, are—forefinger, $3\frac{7}{8}$; middle, $4\frac{3}{8}$; ring, $4\frac{1}{4}$; little, $3\frac{1}{2}$ inches. The whole hand is 8 inches in length, present the usual proportionate length, and have three phalanges each. A maternal aunt had the same kind of thumb on the right hand, being the only instance of the occurrence of the peculiarity in any relative of the family.

Case 3 (Rüdinger, *Beiträge zur Anatomie des Gehörorgans, der venösen Blutbahnen der Schädelhöhle, so wie der überzähligen Finger*, München, 1876, s. 25. Quoted by C. Hennig, *Mitth. aus der Heilanstalt*, "I. Von der Überzahl der Finger und Zehen und von Dreigliedrigen Daumen," Leipzig, 1880, s. 2).—The subject, an adult male, had the first digit on each hand doubled, and each of these digits was provided with three phalanges. Work was performed with the digit lying next to the index finger, and this was more stoutly built than the radial thumb. The three phalanges of these four digits showed no resemblance to the normal members of a thumb. The radial metacarpal of the thumb was somewhat stronger than the ulnar, and drawn from the dorsal towards the palmar surface resembled the metacarpal bone of a thumb; otherwise, both the metacarpals of these thumb-digits showed all the characteristics of the metacarpal bones of the fingers. In the right hand of this man there were three supernumerary carpal bones, articulating with others of the series; two of these lay in the first row, distal and dorsal to the scaphoid and between it and the lunare; the third, which lay between the trapezium and trapezoid, was only visible on the dorsal surface. The left carpus possessed two supernumerary bones, one between the scaphoid and lunare, and the other between the trapezium and trapezoid.

Case 4 (same references).—The seven-year old daughter of the man whose case has just been described. There was the same malformation on both hands; but in addition there was in the left hand a seventh finger. This was a stump-like appendage situated on one of the thumb digits, with two members possessing only the power of passive motion and furnished with a well-formed nail.

Case 5 (Otto, *Sexcentorum Monstrorum Descriptio Anatomica*, No. 256).—The case was that of a man, aged 24. In both hands the annularis, medius, and index were fused, the last being represented by

a small stump, which was more distinct on the left than on the right hand. In spite of the appearances there was really a superfluity of digits, each hand possessing six, or rudiments of six. Each hand had two trapezia. In the right hand the radial pollex possessed three phalanges, and a metacarpal which articulated with the radial and smaller trapezium and with the ulnar pollex. The ulnar pollex had a metacarpal which articulated with both trapezia, the index, and the radial pollex. It also possessed one long phalanx. The second phalanx of the radial pollex was very markedly smaller than any of the other members. The index had a metacarpal bone and one phalanx. The left hand possessed a radial pollex consisting only of a metacarpal bone which articulated in a similar manner to the corresponding bone of the other hand. The ulnar pollex had a metacarpal with the same articulations as on the right, and three phalanges, the second being the smallest, though the difference was not so marked as on the left. The index had a metacarpal and one phalanx. With regard to the musculature, in both hands both pollices received a slip from the flexor longus pollicis, and neither had any tendon from either of the flexors of the digits. The right hand had the abductor, flexor brevis, opponens, and part of the adductor attached to the radial pollex, the remainder and greater part of the last-mentioned muscle going to the ulnar pollex. Extensores primi internodii and ossis metacarpi pollicis were attached to the radial, and secundi internodii to the ulnar, pollex. Extensores carpi radiales longior and brevior were attached to the index and medius respectively. In the left hand the abductor and opponens were attached to the radial pollex, the adductor solely to the ulnar. Extensores ossis metacarpi and secundi internodii pollicis were attached to the radial pollex, and extensor primi internodii to the ulnar. Extensores carpi radiales longior and brevior were attached as in the other hand.

Case 6 (Gegenbaur, *Morph. Jahrb.*, Bd. xiv. s. 394).—The subject possessed four normal fingers and two abnormal. The latter belonged to the radial side of the hand, and were united to one another throughout their length (syndactylous), so that both together acted as a functional thumb. The ulnar was larger than the other ("præpollex"), and lay on its dorsal surface, so that looked at from the palmar surface only one was visible. The præpollex was, compared with the other digits, a very slender finger. Both abnormal digits possessed metacarpals of greater length than those of the other fingers. The præpollex possessed two phalanges, and its metacarpal articulated promixo-laterally with the metacarpal of the pollex. Its proximal uncartilage-clad extremity lay opposite the trapezium, but did not articulate with it. The stronger pollex possessed a metacarpal and three phalanges, was opposable to the other four digits, but amphiarthrotically united to the carpus, not having a saddle-joint. The remaining four fingers showed slight peculiarities, the medius alone articulating with the os magnum. A centrale was present.

Case 7 (Wenzel Gruber, *Virchow's Archiv*, Bd. lxxxvi. s. 495).—There was a supernumerary pollex on each hand, those on the right both possessing two phalanges. The radial pollex of the left hand had three phalanges, the last possessing a spur-like process on its radial side, which the writer states was apparently a second phalanx fused to it. I shall refer further to the articulations and musculature of this case.

Case 8 (Wenzel Gruber, *Bull. de l'Acad. Imp. des sc. de Petersbourg*, Tome xvi. Col. 359-368).—I have only been able to give the brief reference made to this case in the paper in *Virchow's Archiv*, Bd. xcvi. s. 186). The subject was living. The left hand possessed six metacarpals with seven (*sic*) fingers, one three-phalanged pollex and five three-phalanged digits.

Case 9 (Annandale, *Malformations of the Fingers and the Toes*, p. 29).—The subject was a girl, aged 13, otherwise well formed. The hand was perfectly developed in every way, except that the thumb resembled a long forefinger, having three phalanges. "Since then," he says, "I have met with other similar cases."

Case 10 (Farge, *Gaz. hebdom. de méd. et de chir.*, 1886, No. 4, p. 61. Quoted by Fackenheim, *Jenaischen Zeitsch. f. Naturwiss.*, Bd. xxii. N.F. xv. s. 356).—A family of the name of Cady evidenced hereditary polydactyly. The paternal grandmother possessed four thumbs. The father had instead of thumbs, fingers with three phalanges. He had six children as follows :—(1) A boy with normal hands ; (2) a boy with a supernumerary thumb on the left hand ; (3, 4, 5) two boys and a girl, who, like the father, had no thumbs, but instead of these three-phalanged fingers ; (6) a boy possessing five metacarpals with three phalanges belonging to each, and, besides, a rudimentary 6th digit forming a projection under the skin, and representing a radial pollex.

In addition to these cases, I should mention that Burt Wilder¹ states that "Dubois describes a case (*Arch. de Méd.*, April 1826) which is referred to by Fort (*Difformités des Doigts*, p. 58, 1869), and in the cabinet of the Boston Society for Medical Improvement is a plaster cast of another case which came under the observation of Dr B. E. Cotting, and was described by Dr J. B. S. Jackson (*Catalogue of Museum of Med. Imp. Soc.*)."² I regret that I have been unable to refer to any of the references just mentioned.²

¹ "Intermembral Homologies," *Proc. Bost. Soc. Nat. Hist.*, xiv. 154. I have to thank Professor Howes for drawing my attention to this paper, as well as for other kind assistance.

² Since this paper was in type, I learn that Dr Shepherd exhibited at the Montreal Medico-Chirurgical Society (April 2, 1891) the left manus of a pig with six digits and a well-developed trapezium. The pollex possessed three phalanges.—(Note in *Medical Press*, Sept. 9, 1891.)

It may now be well briefly to sum up the salient features of the cases which I have detailed, and this will be most conveniently done in a tabular form.

Table of Cases of Three-Phalanged Pollices.

Case.	Hand.	No.	With Spny.	Rad.	Uln.	With-out.	Notes.
Author's.	both.	2	1	...	1	1	
I.	both.	2	2	...	2	...	Hereditary.
II.	both.	2	...	...	...	2	Hereditary.
III.	2 on each.	4	2	both.		...	Herd., a rudy.
IV.	2 on each.	4	2	both.		...	7th rad. digit.
V.	both.	2	2	1	1	...	
VI.	1 (?which)	1	1	...	...	...
VII.	left.	1	1	1	1	...	Supy. plx. right.
VIII.	left.	1	1	?	?	...	
IX.	...	1	...	...	...	1	
X.	both.	2	...	...	...	2	
X., a.	both.	2	...	...	...	2	
X., b.	both.	2	...	...	...	2	Hereditary.
X., c.	both.	2	...	...	...	2	
X., d.	both.	2	2	...	2	...	
		30	14	2	7	12	

It will be observed from the above table that the three-phalanged pollex may exist (1) alone and representing the normal pollex, or (2) with a supernumerary pollex. In the latter case both pollex and supernumerary or præpollex may possess three phalanges (Cases 3 and 4), or the three-phalanged digit may be the ulnar of the two, or more rarely, the radial. It will also be noted that, as in polydactylism, the influence of heredity is met with in several of the cases.

I propose now to consider several points of interest which are raised by the consideration of this subject:—

I. Nature of these three-phalanged digits.

At the outset, we are met with the question as to whether these three-phalanged digits should be considered as of the nature of thumbs or not. In the case quoted from Rüdinger, that author states it as his opinion, that the condition in question is not one of reduplication of the thumbs, but of increase in number of the ordinary digits. This distinction appears to me to be more metaphysical than real; and, moreover, I do not think that it is in any way borne out by the facts.

One of his cases is, undoubtedly, somewhat difficult of explanation; I allude to the second, in which rudiments of seven fingers were present. I have not been able to see the original account, and can only, therefore, venture to suggest that possibly the rudimentary digit may have been the præ-pollex; the second, the pollex; the third, the index, and so on to the ulnar side of the hand, where the last finger would be a postminimus. In this case we should have had to do with an instance of a heptadactylous manus of the type suggested by Bardeleben, which will be again referred to in a subsequent section of this paper. In any case, however, this instance is an isolated one. Of the remainder, it will be noticed that in twelve cases, the three-phalanged digit replaced the normal pollex and functioned as a thumb, being in the instances, where any note is made of the fact, opposable to the other digit. To call such a digit an instance of a double index with (presumably) absent pollex, is, to my mind, a misuse of terms, unless, indeed, we are to confine the term pollex to a two-phalanged digit, a limitation for which I can see no justification. In a second group the three-phalanged digit is radial, and the normal thumb has two phalanges. If this last be not a pollex, it will be necessary to adopt the double hypothesis that the index is doubled and that one of the two has lost a phalanx. This leaves the group where the three-phalanged digit is ulnar to a supernumerary having two or less phalanges, a group, the members of which, might with more reason be claimed as instances of doubled index. But a consideration of the musculature in cases of double pollex will, I think, establish the fact that these digits are much more of the nature of pollices than of that of the other digits. The additional phalanx is, of course, only an incident in a supernumerary pollex, and we may, therefore, consider the musculature of double thumbs whether three-phalanged or not. As the facts are of importance, I here give Gruber's tables, which I have amplified by adding the conditions in two cases published by him in a subsequent paper to that in which the table was given, as well as the case dissected by Otto.

TABLE I.

Case.	Cases with a Double Metacarpal			
	To Radial Poll.	To Ulnar Poll.	To both Poll.	Anomalies.
3. ¹	E. oss. metacarp. E. primi intern. Abductor. Opponens.	E. secundi intern.	Flexor longus.	Abd. divided into abd. and fl. prop. poll; rad. fl. br. only an ulnar belly. Double interpoll.
4.	Abductor.	E. oss. metacarp. EE. pr. et sec. intern. Opponens. Flexor brevis. Adductor.	Flexor longus.	Abd. br. as above divided into two.
9.	E. oss. metacarp. E. primi intern.	Adductor.	Flexor longus. Ext. longus.	Abd. separated in two below. Two-bellied opponens. Two-layered add. and interpollis.
Otto. Rt.	Abductor. Flexor brevis. Opponens. Adduct. (part). EE. pr. et sec. intern.	Adductor (part). E. sec. intern.	Flexor longus.	
Otto. Lt.	Abductor. Opponens. E. oss. metacarp. E. sec. intern.	Adductor. E. primi intern.	Flexor longus.	

TABLE II.

Case.	Cases with a Single Metacarpal			
	To Radial Poll.	To Ulnar Poll.	To both Poll.	Anomalies.
1.	E. primi intern. Opponens.	E. sec. intern. Adductor.	Flexor longus. Abductor. Flexor brevis. (E. oss. metacarp.)	Interpollis.
2.	E. primi intern. Abductor. Opponens.	Adductor.	Flexor longus. E. sec. intern.	Slips from uln. belly of fl. br. and add. to rad. poll.
5.	... ..	EE. oss. metacarp et sec. intern. Opponens. Flexor brevis. Adductor.	Flexor longus. E. primi intern. Abductor.	

¹ The numbers are those of Gruber's cases.

TABLE II.—*continued.*

Case.	Cases with a Double Metacarpal			
	To Radial Poll.	To Ulnar Poll.	To both Poll.	Anomalies.
7.	E. primi intern. Abductor.	E. sec. intern.	Flexor longus. Opponens. Flexor brevis. (E. oss. meta- carpi.)	Abd. div. below two-bellied oppo- nens. Double interpoll.
8. ¹	Abductor.	E. sec. intern. Int. pr. volar. Adductor. Flexor brevis.	Flexor longus. E. primi intern.	Interpoll.
9.	Abductor. E. primi intern. Opponens. Adductor.	... .. E. sec. intern.	Flexor longus.	

Wenzel Gruber sums up the account of the musculature of his cases by saying "the arrangement of the flexor longus is constant or almost so in all the cases, and so is that of the abductor and adductor. The arrangement of the extensor secundi internodii frequently (six-ninths to seven-ninths of the cases) is the same. In more than half the cases the interpollicaris is present, and that in either a single or double condition. Exceptionally in hands with a supernumerary pollex, a supernumerary extensor pollicis et indicis, and also the interosseus primus volaris, may exist." The nature of the musculature of these cases of double pollex is, I think, an exceedingly strong argument for the explanation of their value in the series of digits which has been suggested above. The following points should be specially noted:—(1) The short muscles normally belonging to the pollex are fairly evenly divided between the two pollices. The interpollicaris passing between the two appears to be a dismemberment of the adductor, and additional weight is lent to this by the fact that in Case 6 where the adductor is dilaminated, so also is the interpollicaris. (2) The extensors are also divided between the two pollices. (3) The tendon of the flexor longus always divides into two portions, one for either pollex. (4) Neither pollex receives in any case a tendon from either of the flexors of the digits or from the extensor communis digitorum. (5) In the case where they are mentioned the carpal extensors

¹ Cases 8 and 9 are from *Virchow's Archiv*, Bd. xcvi. s. 186.

are not connected with the ulnar pollex, but pass to the next two fingers in the series. The facts, then, seem to point to the conclusion that these supernumerary digits are both really of the nature of thumbs, or perhaps it would be more accurate to say that they are the first and second digits of a hexadactylous manus. In any case there appears to be no reason for supposing that the ulnar of the two is a reduplication of the index finger.

II. *The absent member of the normal thumb.*

In a paper from which quotation has already been made, Burt Wilder discusses the question as to what constitutes a digit or dactyl, and points out that whilst "among the mammalia, the vast majority of those digits and dactyls about which no question can arise, consist of three phalanges, are visible to the eye as subdivisions of the distal extremity of the member, and perform some obvious function in the economy of the animal; the ordinary mammalian digit or dactyl being thus functional, visible, and trimerous, there are many exceptions to this definition." Arguing, however, from the trimerous nature of the great majority of digits, most writers on anatomy seem to be agreed that the typical pollex would possess a metacarpal and three phalanges. The three-phalanged pollex might, therefore, be viewed as a return to the typical condition. On the other hand, as Professor Howes has been good enough to point out to me, it is very questionable whether such a condition can in any just sense be called reversional, since, as he says, "if the appearance of a third phalanx be really reversional, it is strange that the palæozoic Stegocephali should not possess more than two." In fact, the Cetacea are the only members of the mammalia possessing in some instances more than two phalanges in the pollex (*Catodon*, *Physeter simus*, *Globiocephalus*). Waiving the question of atavism, it is legitimate to enquire into the nature of the morphology of the members of the normal pollex, in connection with those supplied with three phalanges. Differing views have been put forward on this question by writers on anatomy. Humphry,¹ after giving several reasons in favour of the view that the proximal member corresponds with a phalanx, says—

¹ *Human Skeleton*, p. 395.

“It is evident, in short, that the first bone is neither truly a metacarpal bone nor a phalanx, but is intermediate between the two. Taking all things into consideration, it is perhaps most correct, as it is certainly most convenient for description, to continue to call it a metacarpal bone, and to consider that the second phalanx, with its flexor perforatus tendon, is the digital segment which is missing in the thumb.”

And in a note he says—

“This view derives confirmation from comparative anatomy.”

Sappey¹ says—

“On peut le considérer, avec MM. Joly et Lavocat, comme composé d'un métacarpien rudimentaire et de la première phalange du pouce. Le métacarpien et la phalange ont chacun pour origine un point osseux distinct. Mais ces deux points, au lieu de rester indépendants, se soudent l'un à l'autre. Le point d'ossification supérieur, ou le métacarpien proprement dit, représente à peine le sixième de l'os; le point d'ossification inférieur, ou la première phalange du pouce, en forme la presque totalité. Ainsi constitué, il appartient beaucoup plus aux phalanges qu'aux métacarpiens, et devait offrir surtout les caractères qui distinguent les premières; ce sont ces caractères qu'on retrouve en effet sur son corps et son extrémité inférieure.”

Henle² considers that the controversy has been settled by the observations of Uffelmann, to which I shall allude more particularly later on, and says—

“Der Mittelhandknochen des Daumens weder ein eigentlicher Mittelhandknochen noch eine Phalange, sondern ein Repräsentant beider ist.”

Maclise³ says—

“I have reason to believe that the bone which we term the metacarpal bone of the thumb in one animal is the true homologue of the first phalanx of the finger (in his figure), and for this reason, viz., that the metacarpal bone of the human thumb is constituted of two ossicles, which have become consolidated. If we class the hindmost ossicle with the other metacarpal bones, the foremost ossicle will represent the first phalanx of the other fingers, and this will give three phalanges to the thumb, as to the other fingers. It is worthy of notice, that the so-called metacarpal bone of the thumb corresponds as to the nucleary deposit with the first phalanx of the finger.”

Struthers, discussing this question in connection with the cases of three-phalanged thumbs already quoted, says⁴—

¹ *Traité d'Anatomie*, i. p. 391.

² *Hdb. der Anat. des Menschen*, pt. i. s. 261.

³ *Todd's Cyclop. Anat. and Phys.*, art. “Skeleton,” p. 663.

⁴ *Op. cit.*, p. 111.

“The facts in comparative osteogeny show, that the position of the epiphysis is decisive in establishing the view that the bone which is wanting in the human thumb and great toe, and in the internal digit of other five-toed mammals, is the metacarpal and metatarsal, although custom and convenience lead us to apply these terms to the bone which homologically is the proximal phalanx.”

Turning now to the cases of three-phalanged pollices, the chief noteworthy point in the present connection is that in those instances where the condition is sufficiently described, the smallest of the members is the middle or second phalanx, this being so markedly the case in one of Struthers' subjects, that he speaks of “the additional bone occupying the position of a middle phalanx.” Now, as in normal digits, the middle phalanx is considerably larger than the distal, it would from this appear that this smaller second phalanx was the intruder, and thus that it, as Humphry suggests, is the missing member in the human pollex. The question is, however, one which can only be satisfactorily settled from embryological considerations, and it may, therefore, be well to review it in the light of recent observations as to the nature and origin of the phalanges and of certain structures connected with the articulations.

Boulenger¹ having published a paper in which he confirmed former statements as to the existence of a supernumerary phalanx between the ultimate and what is normally the penultimate one in the Polypedatinæ, Professor Howes and Mr Davies were led to investigate the morphology and genesis of supernumerary phalanges.² In this paper they have shown that a structure, such as the fibrous pad of the common frog, may be looked upon as the homologue of the skeletal supernumerary phalanx of the higher Ranidæ and Hylidæ. From the examination of various amphibians, they conclude that

“the phalanges and syndesmoses are, together with their investing sheath, differentiations of a continuous and common blastema; and that the syndesmoses, while intimately related to the sheath, are formed, not as ingrowths of the same but as differentiations of that mass from which the phalanges are derived, and that they differ from these, initially, only in degree of elongation.”

These facts show that the supernumerary phalanx, the normal phalanges, and the syndesmoses are all on a developmental

¹ *Proc. Zool. Soc.*, 1888, p. 204.

² *Ibid.*, p. 495.

equality. The last named must then be looked upon as structures which, despite secondary changes, would be liable to take on more or less completely the condition of a phalanx. Indications of this are not wanting; for Leydig, in describing the supernumerary phalanx (his "Zwischengelenkknorpel") in *Hyla Arborea*, asserts—

"Er fehlt selbst bei Reptilien nicht, wo ich denselben früher übersehen hatte; gegenwärtig kenne ich ihn bei *Lacerta* (*L. muralis* und *Platydictylus mauritanicus*."

And in the conclusions at the termination of their paper they state—

"1. That the supernumerary phalanx of the Anura is a true phalanx, and, at the same time, structurally identical with the interphalangeal syndesmosis of these and the other Amphibia, all transitions between the two being represented in adults of the living forms. 2. That the syndesmoses and phalanges are differentiations of a common blastema. 3. That the facts of development herein recorded indicate a possible intercalary origin, from inter-articular syndesmoses for supernumerary phalanges in general."

In a paper on the development of the joints in birds and mammals, Hepburn,¹ though not dealing with the question of supernumerary phalanges, has also shown that the bone-matrices and the articular disc possess a tissue continuity, and are derivatives of a common blastema, of which the articular disc is at first the undifferentiated form; and, further, that the articular disc may develop into a plate of cartilage and form a synchondrosis, or may differentiate into fibrous tissue and form a syndesmosis or synarthrosis, or, finally, may partly cleave and form a joint-cavity. Again, he has shown that the proximal and distal segments of the articular disc develop into the articular cartilages of the joint, and probably form part, if not all, of the epiphyseal ends of the bones, that the circumference of the articular disc develops into the capsule of the joint, and that inter-articular fibro-cartilages and ligaments are derived from the articular disc as the result of the modifications of the joint-cavity. From the researches of these authors it follows that various structures in the digits are of the same morphological value as the bony segments, and that in them we may find a clue to the origin of the additional phalanx occasionally met

¹ *Jour. of Anat. and Phys.*, vol. xxiii. p. 507.

with in the pollex. But in addition to what has just been stated, there is evidence to show that segments of the digit which are present in the fœtus may abort and be non-existent in the adult. Thus Wiedersheim states,¹ that though the third finger in all existing carinates has only one phalanx as compared with four in archæopteryx; in embryos of the duck, a cartilaginous rudiment of a second phalanx is present in the third finger of the manus. Amongst the mammalia Kukenthal has shown that in *Globiocephalus melas*,² and in *Beluga leucas*,³ there is a reduction in the number of phalanges in passing from the fœtal to the adult condition. Taking these last-mentioned facts in connection with the observations of Howes and Hepburn, it would seem probable that some structure exists in the pollex which is capable by further and independent development of giving rise to an additional segment. It now remains to enquire whether any trace of such a structure is to be met with in the development of the thumb. It has already been mentioned that Sappey considered the proximal segment of the pollex as consisting of a metacarpal, the proximal epiphysis and a phalanx, the diaphysis, the two being fused to form one bone in the adult. In this description, however, he took no account of the distal epiphysis. Thomson,⁴ states that

“from the circumstance that in all favourable instances which have come under my notice at ages between seven and fifteen years, traces of the separation of the distal epiphysis have been found in both the first metacarpal and metatarsal bones, I am inclined to look upon the disposition at least to the formation of such epiphyses as general; while in a certain number of instances, the proportion of which I cannot at present determine, the separation by cartilage of a bony epiphysis is at one time complete.”

A more complete account of the behaviour of this end of the bone is given by Uffelmann,⁵ who has shown—

“Dass in einem gewissen, mehrere Jahre dauernden Stadium der Entwicklung der Anschein eines besonderen Knochenkerns in

¹ *Comp. Anat. of Vertebrates*, Eng. ed., p. 107.

² *Anat. Anzeiger*, 1888, s. 638.

³ *Ibid.*, 912.

⁴ *Jour. of Anat. and Phys.*, vol. iii. p. 131.

⁵ *Der Mittelhandknochen des Daumens*, Göttingen, 1863. Quoted by Henle, *loc. cit.*

Capitulum besteht, ohne dass ein solcher jemals in Wirklichkeit vorhanden wäre. Beim Neugeborenen ist die untere Chondroepiphysis etwas weniger hoch als die obere, umgekehrt wie bei den übrigen Mittelhandknochen. Im dritten Lebensjahre zeigt sich der Knochenkern in der oberen Chondroepiphyse und im sechszehnten Jahre, früher als irgend eine andere Epiphyse der Handknochen, verwächst er mit der Diaphyse. Am unteren Ende des Daumen-Mittelhandknochens wächst, zwischen dem Ende des ersten und dem dritten Lebensjahre, von der Endfläche der Diaphyse ein stummelähnlicher Fortsatz in die Chondroepiphyse hinein, der radialwärts am weitesten von der Oberfläche des Knorpels entfernt bleibt, dieselbe aber auch ulnarwärts nicht erreicht. Im achten Jahre ragt die Diaphyse mittelst dieses Fortsatzes bis in die Nähe der Articulationsfläche; an der radialen Seite bleibt zwischen dem Fortsatz und dem entsprechenden Theil der Endfläche der Diaphyse eine dünne lage Knorpel lange Zeit von der Articulation ausgeschlossen, die noch in zwölften Jahre 0.75 mm. mächtig ist. Sagittale Schnitte, welche etwas radialwärts von der Mitte des Knochens angelegt sind, gewähren also um diese Zeit das Bild einer selbständigen Epiphyse, während weiter ulnarwärts die Knochensubstanz des Mittelstücks und des Köpfchens kontinuierlich zusammenhängen. Vom zwölften Jahre an ossificirt die Zwischenknorpelscheibe langsam von der Tiefe gegen die Oberfläche; vor vollendete Ossification macerirte Knochen zeigen eine mehr oder weniger tiefe Furche zwischen Köpfchen und Körper an der radialen Seite, die als eine unvollständig verwachsene Epiphysengrenze gedeutet worden sein mag."

It seems possible that in this distal epiphysis we may have a structure capable of taking an independent development, and thus of giving rise to a supernumerary phalanx, which in this case would be the first. This hypothesis can only be put forward in a tentative manner, and, indeed, the whole question requires the further examination of suitable material, not always easy to obtain, for its complete elucidation. It may reasonably be objected that such a hypothesis leaves the question of the proximal epiphysis of the metacarpal unsettled, but it should not be forgotten that Thomson has described the occasional presence of indications of a similar epiphysis in the metacarpal bone of the index finger.

III. *Relation to the præpollex question.*

I do not intend entering at any length into this question, because I hope to do so in a paper upon which I am now engaged, and in which I propose to deal fully with the subject of polydactylism, but there are a few points which it may be

convenient to allude to now in connection with the present subject. Professor Bardeleben has brought forward much evidence to show that the typical manus and pes are heptadactylous, and that rudiments of the first (præpollex) and the seventh (postminimus) digits exist in a wide range of animals; and this view, whilst disputed by some, has received the support of other writers. I think that his theory receives a certain amount of support from the condition with which I have been dealing. It is certainly suggestive that the presence of Bardeleben's præpollex in the human manus should be accompanied by an assumption of the trimerous digital condition by the next member, viz., the normal pollex. There remain in this case the other two conditions, in which the three-phalanged pollex is met with, to be explained. With regard to those cases where the trimerous pollex replaces the normal thumb, they, I think, need not be considered in this connection, since no element of polydactylism enters into the question. But the other and rarer cases where the trimerous digit is radially placed, and is separated from the index by a dimerous pollex, are more difficult to explain. Perhaps a solution of the difficulty may be found in comparing the condition with the well-known cases where a normally trimerous digit in the centre of the series is dimerous, a state of affairs which may extend to more than one finger.

I venture to offer the following conclusions:—

- (1) That the three-phalanged pollex, when existing in a pentadactylous manus, is not an example of duplication of ordinary digit, but is a true thumb.
- (2) That the musculature shows that where there is an additional digit on the radial side, it and the digit next to the index, both partake of the nature of thumbs, and may be looked upon as the first and second digits of a hexadactylous, or, perhaps, as in Rüdinger's case, of a heptadactylous manus.
- (3) That the missing segment of the normal thumb is the proximal phalanx, and that it is represented by the distal epiphysis of the metacarpal bone.

- (4) That the combination of a supernumerary pollex with a trimerous digit separating it from the index lends a certain amount of support to Bardeleben's view as to the nature of the typical manus.

EXPLANATION OF PLATE II.

- Fig. 1. Left hand—dorsal aspect.
Fig. 2. " " —palmar "
Fig. 3. Right " —dorsal "
Fig. 4. " " —palmar "