

Elasmobranchs, more particularly to the Chimæroids on the one hand, and to such an ancient Selachian type as *Chlamydoselache* on the other; but, at the same time, the Ganoids probably arose from the common ancestral stock not very far off. Though retaining many primitive characters, the Dipnoi, and more especially *Protopterus* and *Lepidosiren*, are in some respects highly specialized, the specialization being largely due to a change of habit.

"Method of Indexing Finger Marks." By Francis Galton, F.R.S.

Sufficient proof was adduced by me in a memoir read November 27, 1890, before the Royal Society (Phil. Trans., B, 1891), of the extraordinary persistence of the papillary ridges on the inner surface of the hands throughout life. It was shown that the impression in ink upon paper of each finger tip, contained on the average from twenty-five to thirty distinct points of reference, every one of which, with the rarest exception, appeared to be absolutely persistent. Consequently that it was possible to affirm with practical certainty whether or no any two submitted impressions were made by the fingers of the same person.

In the present memoir I shall explain the way in which finger prints may be indexed and referred to after the fashion of a dictionary, and on the same general principle as that devised by A. Bertillon with respect to anthropometric measures, whose ingenious method is now in regular use on a very large scale in the criminal administration of France and elsewhere. I desire to show how vastly the practical efficiency of any such method as that of A. Bertillon admits of being increased by taking finger prints into account in the way to be described.

It must not, however, be supposed that the use of indexing finger marks is limited to the above purpose, the power of doing so being equally needed for racial and hereditary inquiries. I do not dwell upon these applications now, simply because I am engaged in making them, and the results are not yet ready to be published. I ought, however, to mention that a great increase of experience has fully confirmed my earlier views, that finger marks are singularly appropriate subjects of anthropometric study owing to many distinct reasons. The impressions are easily to be made by anyone who has the proper appliances at hand. They are as durable as any other printed matter, and they occupy very little space. The patterns are usually sharp and clear, and their *minutæ* are independent of age and growth. They are necessarily trustworthy, and no reluctance is shown in permitting them to be taken, which can be founded either upon personal vanity or upon an unwillingness to communicate undesirable family peculiarities.

Without caring to dwell on many of my earlier failures to index the finger prints in a satisfactory way, my description shall be confined to that which has proved to be a success. It is based on a small variety of conspicuous differences of pattern in each of many digits, and not upon the numerous minute peculiarities of a single digit. My conclusions are principally based on a study of the impressions of all 10 digits of 289 different persons, but the tables given in the memoir refer only to the first 100 on my list. These are sufficiently numerous to serve as a fair sample of what we might always expect to find, while they are not too cumbersome to print and to discuss in full detail.

Though I have spoken and shall speak only of impressions, it is not really necessary in forming an index to make any impression at all. All the entries that appear in it may be derived directly from the fingers themselves.

I rely, for the purpose of indexing, on the three elementary divisions of primaries, whorls, and loops. They are severally expressed by the numerals 1 and 2, 3 and 4, 5 and 6. The reason of this double numeration is that most of the patterns have a definite axis. Those that are formed by ridges which proceed from only one side of the finger, lie in a sloping direction across its axis, the slope being directed according to the side from which the supply of ridges proceeds. All normal slopes, or those that are (roughly) parallel to a line drawn from the tip of the forefinger to the base of the little finger, as well as all the patterns that have no definite axis, are expressed by the odd numerals, 1, 3, or 5. All abnormal slopes are expressed by the even numerals, 2, 4, or 6. It cannot be too strongly insisted that the words right and left are ambiguous, and must not be used here.

The forefingers are the most variable of all the digits in respect to their patterns, their slopes being almost as frequently

abnormal as not; the third fingers rank next; the little finger ranks last, as its pattern is a loop in nine cases out of ten. I therefore found it convenient not to index the fingers in their natural order, but so that the sequence of the numerals which express the patterns on the digits should be divided into two groups of three numerals, and two groups of two numerals, as 355, 455, 55, 35. The first group 355 referring to the first, second, and third fingers of the left hand; the second group 455 to the first, second, and third fingers of the right hand; the third group 55 to the thumb and fourth finger of the left hand; the fourth group 35 to the thumb and fourth finger of the right hand. The index is arranged in the numerical sequence of these sets of numbers.

Before translating the patterns into numerals, I find it an excellent plan to draw symbolic pictures of the several patterns in the order in which they appear in the impression, or in the fingers themselves, as the case may be, confining myself to a limited number of symbols [a list of those which have thus far sufficed is given in the memoir; 5 of them are symmetrical symbols, and 9 are tailed and duplicated for the reasons given above, one of each pair being inclined to the right, and the other to the left. The total number of these hieroglyphs is consequently 23]. A little violence has of course to be used now and then, in fitting some unusual pattern to one of these symbols. But we are familiar with such processes in ordinary spelling, where the same letter does duty for different sounds, as *a* in the words *as*, *ask*, *ale*, and *all*. The merits of this process are many. It facilitates a leisurely revision of first determinations; it affords an adequate record of the character of each pattern; it prevents mistakes between normal and abnormal slopes; it prevents confusion when changing the sequence of the entries from the order of the impressions to that used in the index; and, lastly, it affords considerable help to a yet further subdivision of the patterns.

In making a large and complete index, the symbols would, of course, be cast as movable types, and be printed with the letter-press.

It appears from the 100 cases that are printed in the memoir that there were 83 different varieties of index numbers when all 10 digits are used. Consequently the average number of references required to pick out a single well-defined case from among these 100 would be equal to 100 divided by 83—that is, to about 1.2. I do not expect from my own reiterated experiences that there would be much trouble due to transitional cases, after a standard collection of doubtful forms had been collected and numbered, so as to insure that different persons should follow a common standard. I find much uniformity in my own judgment.

Owing to the large effect of correlation, an index based on all the 10 digits is not much superior in efficiency to one that is based on six—namely, upon the first three fingers of both hands. In the 100 different sets there are, as already said, 83 varieties of pattern in the one case, and there are 65 in the other, which roughly accords with the relative efficiency of 5 to 4. It is, therefore, a fair question whether it is worth while to impress all the 10 digits. The chief advantage of doing so is to add to the volume of evidence, and to supply data which mutilation, or bad scars, or obliteration due to some exceptional cause might render of value. The three fingers of both hands are more than twice as useful for an index as those of one hand only; again, the three fingers of one hand are nearly twice as useful as two only. I may mention that for my present inquiries into racial and hereditary patterns I am, for various reasons, dealing only with the first three fingers of the right hand, and slightly rolling the forefinger, so as to obtain a full impression of its pattern on the side of the thumb.

When searching through a large number of prints that bear the same index number, in order to find a duplicate of a particular specimen, it is a very expeditious method to fix on some one well-marked characteristic of a minute kind, such as an island, or inclosure, or a couple of adjacent bifurcations, that may present itself in any one of the fingers, and in making the search to use a lens or lenses of low power, fixed at the end of an arm, and to confine the attention solely to looking for that one characteristic. The cards on which the finger marks have been made, may then be passed successively under the lens with great rapidity.

[It is proposed to exhibit specimens illustrative of this and of the previous memoir, together with appliances for taking impressions from the fingers, at the approaching *soirée* of the Royal Society.]