

- From the SOCIETY.—Transactions of the American Philosophical Society; Vol. XV. Part 2. Proceedings of ditto; Vol. XIV. No. 94.
- From the INSTITUTE.—The Canadian Journal. Vol. XIV. No. 5.
- From the ASSOCIATION.—Transactions of the Devonshire Association. Vol. VII.
- From the EXECUTORS of the late HENRY CHRISTY, Esq.—Reliquiæ Aquitanicæ. Part XVII. November, 1875.
- From the ASSOCIATION.—Journal of the Royal Historical and Archæological Association of Ireland. Vol. III. No. 21.
- From M. VALDEMAR DE MAINOFF.—Ethnographic Map of the Russian Empire; Mongolia and Tangut. By N. Przhewalskago.
- From the AUTHOR.—Address, Department of Anthropology, British Association, Bristol, August 25th, 1875. By Prof. George Rolleston, F.R.S.
- From the EDITOR.—Nature (to date).
- From the SOCIETY.—Proceedings of the Society of Antiquaries of Scotland. Vol. IX. Part 2; Vol. X. Part 1.
- From the AUTHOR.—Naturalist's Rambles in the China Seas. By Dr. C. Collingwood.
- From the INSTITUTE.—The Smithsonian Report. 1875.

The Director read the following Resolution, which had been passed by the Council on that day:—

- “ Proposed by the President, seconded by Mr. Francis Galton, F.R.S., and
 “ unanimously resolved—
 “ ‘ That this Council desire to place on record their esteem for the character,
 “ ‘ and regret at the untimely death, of Commodore Goodenough, whose
 “ ‘ life was sacrificed in the service of his country, and in the promotion
 “ ‘ of anthropological science. They ask leave to offer their sincere and
 “ ‘ respectful condolence to Mrs. Goodenough; and are the more moved
 “ ‘ to do this by the recollection of the services rendered to science by
 “ ‘ her lamented father, Mr. Hamilton.’ ”

The following papers were read by the author :

Short Notes on HEREDITY, &c., in TWINS. By FRANCIS GALTON, F.R.S. [With Woodcut.]

SOME subsidiary results that I obtained in an inquiry into the resemblances between twins, are perhaps worth recording as a separate memoir. My primary results were published in *Fraser's Magazine*, November, 1875, and are reprinted, with revision, among the miscellanies in this volume.

What I am now going to give, concerns the hereditary tendency towards twin-bearing, the largeness of the families in which twins are born, the degree in which they themselves contribute to the population, and the conditions of their sex.

First, in respect to heredity. It was impracticable to judge of this from my returns by any direct method. Twins do not marry so frequently as other people, and I think they are less fertile; hence the parents of twins, who are themselves one of a pair of twins, are relatively few, and the numerical ratio between such parents and the parents of twins generally, would be a fallacious test. Neither could I institute a direct comparison between two groups of children, one of whom were the offspring of fathers or mothers who themselves were of twin birth, and the other were not, because my material was insufficient. I therefore have confined myself to data derived from uncles and aunts.

I find with regard to 94 cases of twins, of whom I have sufficiently full returns, that they had a total of 1,065 uncles and aunts, and that among these there were 27 sets of twins.* In other words, there were twice 27, or 54 persons, who were severally one of a pair of twins among the 1,065 uncles and aunts—say 1 in every 20.

In the population generally the proportion is not nearly so great, but it varies largely under different conditions; and I therefore prefer to compare my returns with those derived from parallel returns supplied by precisely the same classes, which have been drawn up by Mr. C. Ansell, junr., in his most valuable "Statistics of Families of the Upper and Professional Classes of England." It was compiled at the cost and under the direction of the National Life Assurance Society, and leaves nothing to be desired in its completeness, terseness, and adequacy. From these we learn that there is 1 twin birth to about every 100 ordinary births; in other words, there are 2 persons, each severally a twin, among every 101 persons—say 1 in every 50.

Hence the chance of an uncle or aunt of a twin being himself or herself a twin, is as 50 to 20, or $2\frac{1}{2}$ times as great as that of people generally. It may perhaps be thought simpler to state the result in this form:—Among the uncles and aunts of twins, there is an excess per cent. of three individuals of twin birth, due to hereditary causes. The average influence of heredity in fathers and in sons may be taken as fully five times as great as that in uncles and aunts; we should therefore expect, on general grounds, that the former would yield an excess of at least 15 per cent., or an absolute number of $15 + 2 = 17$ per cent. of individuals who were twins; but this, I feel sure, is in excess of the truth. (I have discussed these hereditary ratios, so far as ability was concerned, in my "Hereditary Genius," p. 321.)

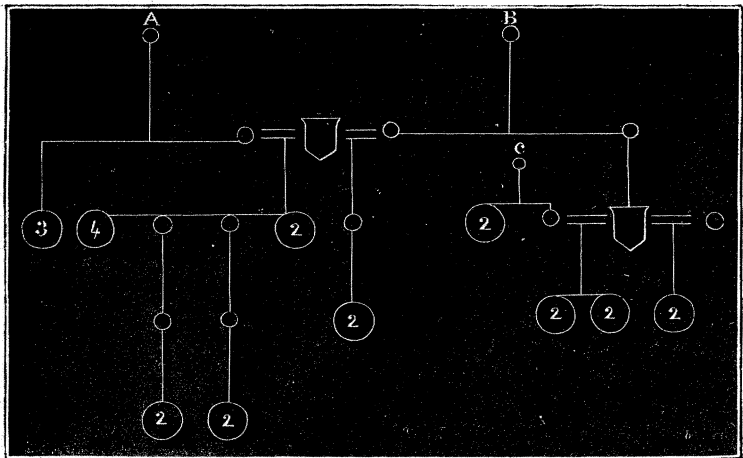
* To save complexity, I include among these, three cases in which the parent was one of the twins.

Next, as regards the relative power of the male and female in transmitting an hereditary tendency to bear twins. I find that the 94 sets of twins above mentioned had—

On the father's side	538 uncles and aunts,
Among whom were	14 sets of twins.
On the mother's side	527 uncles and aunts,
Among whom were	13 sets of twins.

These numbers may be considered identical, in a statistical sense; hence the hereditary tendency is the same in the male and female lines.

The largeness of the families in which twins are born is sufficiently manifest from these returns, which happen to be the only ones I possess that can be adduced in proof of it. We see that 94 sets of twins had, on the father's side, a total of 538 uncles and aunts, which, added to the 94 fathers, makes



632 individuals in 94 families; this is at the rate of $6\frac{3}{4}$ in each of the families of which the father of a twin was a member. Almost the same occurs (the precise figure is $6\frac{1}{2}$) in each family of which the mother of a twin was a member.

I annex a curious instance of the intermarriage of three twin-bearing families, A, B, and C. They all consist of many individuals; but my information is a little imperfect, and even if it were not, it would hardly be necessary to give more details than the number of multiple births and the connecting links between them. I may add that the three families are well known socially, and have each of them distinguished members. The circles in the diagram indicate the cases of

multiple births, and the figures inside the circles show the number of children born on each of these occasions. It will be observed that in three generations there were produced one quadruplet, one triplet, and eight pairs of twins.

A very instructive fact has been related to me concerning a family remarkable for its twins; in which it appears, according to the mother's account, that whenever single children were born to her, they always had six fingers and six toes, but the sets of twins never had. This shows a strong constitutional tendency to multiple propagation.

The vigour of body and mind of those twins who survive infancy, who strongly resemble one another, and who have sent me returns, is certainly not below the average. On the contrary, I find, from the returns that I have received, that nearly one-half of them are decidedly above par; and thence I infer that more than one-half are somewhat above par. It is easy to adduce instances of vigorous twins. One of my own correspondents, a twin, was a senior wrangler; Lords Eldon and Stowell had each a twin sister; and among others who have successfully fought the battles of life may be mentioned Bendigo, the ex-champion pugilist, who was one of a triplet birth.

Notwithstanding Sir J. Simpson's statistical results,* I still think the popular belief to be a true one, that twins contribute less to the population than other people. My returns were not framed to afford a direct answer to the question of their fertility; but I can incidentally gather enough from them to be sure of the fact; also that there is not so strong a tendency among twins to marry, as among other people (however this may be accounted for); and lastly, that the popular belief that both twins, whether of the same or opposite sexes, *never* have children, is erroneous, for I have many instances to the contrary.

There is nothing known in the human race, except as a great rarity, corresponding to the "free-martin" † in cattle; and where known, it has never yet been found, so far as I am aware, in connection with twin births. Neither is this peculiarity of neutral sex found in such domestic animals as dogs or cats, except in the rarest instances; but in the horse, ass, and sheep, and especially in cattle, it is comparatively common.

John Hunter's "Memoir on the Free-Martin" (vol. iv. p. 34,

* *Obstetrical Memories*, i. p. 327.

† Marten seems originally to have meant an animal intended to be killed at Martinmas, which was the period in former years, before the introduction of root-crops, when cattle were slaughtered and salted down for the winter's food of the population. As barren cows were slaughtered preferably to others, the name of marten became especially applied to them. Why the animals about which I have been speaking were called free-martens, it is not altogether clear. Free might mean "naturally admitted to the privilege" of being slaughtered at Martinmas.

edition of 1837) is extremely curious. It appears that when a cow (he says he can only speak of black cattle, but I understand it is a more general fact) brings forth two calves, one of which is a bull calf and the other, to external appearance, a cow calf, the former grows up into a proper bull, but the latter does not commonly grow into a proper cow. The animal is unfit for propagation, and is kept for labour and fattening, like an ox; and it is as well known as a specific form of cattle as is the bull or cow, and is called a "free-martin" by farmers. Close examination and dissection show that the animal is neither a complete female nor male, but combines the anatomical characteristics of both in a very undeveloped and imperfect manner; and those of the male rather predominate over those of the female. This, at least, is the modern view. Hunter's three dissections of free-martins still exist in the Museum of the Royal College of Surgeons, in the teratological division. (See the catalogue of it, pp. 97—101.) Sir J. Simpson subsequently investigated the subject. His principal memoir, alluded to above, is most interesting; and there are several other allusions to free-martins, and to writers upon them, to be found elsewhere in the two volumes of his memoirs.

There is a peculiarity in the sexes of twins; they tend to accord. The word "twin" covers different classes of events—those in which each twin is derived from a separate ovum, and those in which they come from two germinal spots in the same ovum. In the former case they are enveloped, previously to their birth, in separate membranes; and in the latter in the same membrane. Now it appears that twins enveloped in the same membrane are invariably of the same sex, and these, according to the cases of Späeth, who has evidently taken great pains to secure reliable data,* are 24 per cent. of the whole number. (This is, however, greatly in excess of other estimates, which usually give about 6 per cent.) In the remainder they have either one placenta between them, and two membranes, or else they are quite independent, and have separate placentas and membranes. The statistics as to members and sexes under these conditions, vary so astonishingly that I can conclude nothing concerning them. The general upshot is, that about twice as many twins are born of the same sex as of opposite sexes; whereas if there were no influences to produce accord, and on the supposition of an equality of male and female births generally, the numbers ought to be equal.†

* "Studien über Zwillingen." Zeitschrift der Wiener Gesellschaft der Aerzte, 1860. Nos. 15 and 16.

† This is clear, as was pointed out by Mr. C. Ansell, from the following considerations. Supposing absolute independence of sex, the births may be: (1) boy

I have explained in my memoir above alluded to (reprinted in the miscellanies of this volume from *Fraser's Magazine*), that it is only among twins of the same sex, and therefore presumably only among twins derived from the same ovum, that we find an extremely close likeness, or else an extremely marked dissimilarity. On the other hand, in twins of the opposite sex, we find only an ordinary family likeness or dissimilarity. To this I shall recur in my *Memoir on the Theory of Heredity* that is about to be read, and I will now conclude the present one.

A THEORY OF HEREDITY. By FRANCIS GALTON, F.R.S.*

MR. DARWIN stated, in the year 1868, in the preface to his theory of Pangenesis, † that “every one appears to admit that the body consists of a multitude of ‘organic units,’ each of which possesses its own proper attributes, and is to a certain extent independent of all others;” and it may be safely asserted that the general expression of biological opinion since that date has been emphatically the same. We may therefore rest assured that the hypothesis of organic units, and all that such an hypothesis implies, must lie at the foundation of the science of heredity. It remains to determine further particulars; we have to examine how far the details of such theories as are based upon the hypothesis of organic units are correct, and to consider how their deficiencies may be supplied.

The facts for which a complete theory of heredity must account may conveniently be divided into two groups; the one refers to those inborn or congenital peculiarities that were also congenital in one or more ancestors, the other to those that were not congenital in the ancestors, but were acquired for the first time by one or more of them during their lifetime, owing to some change in the conditions of their life.

The first of these two groups is of predominant importance, in respect to the number of well-ascertained facts that it contains, many of which it is possible to explain, in a broad and general way, by more than one theory based on the hypothesis of organic units. The second group includes much of which the evidence is questionable or difficult of verification, and

and boy; (2) boy and girl; (3) girl and boy; (4) girl and girl. All these events would in the supposition be equally likely, and they give two cases of the same, and two of opposite sexes.

*This memoir was in type for publication in the December number of the *Contemporary Review*, at the time when it was read before the Anthropological Institute. I have taken the opportunity afforded by a reprint, to revise it considerably, and to amend it in many particulars.—F. G.

† Darwin: “Variation of Plants and Animals under Domestication,” ii. 370.