a little altered. After copiously enumerating the mistakes that have proved fatal in the past, he bids statesmen "not do it again". M. Pasteur did not content himself with advising us to keep out of the way of mad dogs.

"Aristotle," as Mr. Newman tells us, "traces the development of society without reference either to religion or to war" (p. 39); and he naturally had no inkling of the transformations that they were still destined to work. Yet he might have learned something from Plato about the one, from Philip and Alexander about the other, of these tremendous forces. Perhaps, after all, he was more influenced by the Macedonian supremacy than Mr. Newman (p. 478) will admit. If we look on him as a member of the peace-party at Athens, some light may be thrown on his attitude. Since the Greek city-states had been cut off from all hope of military supremacy, he, like Isocrates, would convince them that it is an unjust and unworthy ambition. A new ideal had to be sought, and would readily be supplied by the occupations of his own life. From this point of view we may, without disrespect, compare him to the *décadents* of contemporary France; or (the contrast is sufficiently wide) to those great men who, under the shadow of Persian supremacy, turned Judæa into a Levitical state.

Aristotle's *Politics* is open to the objection very justly brought against *Paradise Lost* that it "proves nothing". Nevertheless, like *Paradise Lost*, it is well worth reading; and Mr. Newman deserves our thanks for making it so much easier to read with profit than before.

ALFRED W. BENN.

Natural Inheritance. By FRANCIS GALTON, F.R.S. London: Macmillan & Co., 1889. Pp. x., 259.

This seems to me a very important contribution to a neglected side of the doctrine of Heredity or Descent. It is an attempt to apply accurate quantitative methods to the various successive steps by which one generation of organised beings follows another. Statistics in abundance have long been available as to the characteristics of each such generation separately, with the result, of course, of showing that, so far as the stable conditions of natural life are concerned, these characteristics are preserved unchanged over long periods of time. But no one, so far as I know, had hitherto thought of tracking the intermediate steps, and of raising and answering the question, with rigorous numerical accuracy, *Why* it is that successive generations thus continue to resemble each other?

As sometimes happens, the first step required towards the explanation of the phenomena was to discover and call attention to a new difficulty, or at any rate to one which had never been sufficiently observed. This difficulty is one which requires a

certain familiarity with the principles of Probability for its appreciation. We may take it as a fact of observation, confirmed by abundant statistics, that the *mean* characteristics of each generation,—say that of stature,—are preserved comparatively unaltered. And the researches of Quetelet, continued and amplified by many official and unofficial followers, have established that the Law of Dispersion about this mean retains practically the same invariable type. With these results most persons have remained satisfied, and have regarded them, so far as mere statistics are concerned, as a tolerably full solution of the inquiry.

But here, as Mr. Galton points out, arises a difficulty. The commonly recognised causes are in great part those which tend to *increase* the dispersion about the mean. If, for instance, any one were asked offhand what was the relation between the average stature of fathers and their sons, he would very likely say that they would probably be about the same, that if we took a large number of men of six feet in height, we should find that whilst some of the sons were taller than the parents, and some were shorter, the average height would be about the same. And it might be thought that this was the very meaning and *rationale* of improvement of races by artificial breeding. But this will not do. If we were to admit such an assumption, it can be readily shown that in each successive generation the dispersion about the mean, whilst retaining the same general character unchanged, would continually increase in amount. In other words, out of every given random batch of the same number of persons, say 1000, taken from successive generations, the extreme heights of the tallest and of the shortest men would be continually becoming more extreme. The state of things, in fact, would be one which is familiar in problems about gambling, in which it has been always recognised that the rich men would tend in the long run to grow richer and the poor to grow poorer, whilst the average income, of course, remained unchanged.

We must, therefore, look about for some counteracting influences which shall tend, so to say, to put some compression upon this tendency to expansion. There are two such, apparently, which act in concert; one of them being a result of pure theory as applied to obvious facts of observation, and the other a very peculiar and interesting result of novel statistics, as discovered and established by Mr. Galton's special exertions.

The first of these rests upon the established fact that people have two parents, combined with the statistical experience that, in selecting a mate, stature is a matter of indifference: in other words, that the marriage-selection is, in respect of this characteristic, a 'chance'-selection.[1] If this be so, we have at once to

[1] Of course this fact had to be based upon statistics laboriously collected for this special purpose; for here, as in most of the investigations described in this volume, no statistics directed towards the precise point in view were discoverable. The popular impression upon this matter

some extent what we are seeking, *viz.*, a constraining influence upon the otherwise too great tendency towards dispersion. For the theory of Probability tells us at once that the degree of dispersion (as measured by the 'Probable Error') of a random selection of pairs of things will be less than that of the single things in the ratio of $1 : \sqrt{2}$.

But although this is a *vera causa*, and one which tells in the right direction, we should find, on accurately "taking out the quantities," that it is not sufficient. And here comes in the most original part of the whole inquiry. We must first, however, premise a word of explanation about one or two technical terms which Mr. Galton has had to introduce. The average female stature is, of course, less (in about the ratio of 1 to 1·08) than that of the male, but in all respects it follows the same general law. We must, therefore, for purposes of comparison, multiply all the former figures by 1·08, and we then get what may be called a set of "transmuted statures" which may be freely combined with those of the opposite sex. And when any two of these are combined in an average we get what he calls a "mid-parent". That is, the mid-parent is a sort of fictitious source of progeny, whose stature is the average of that of the father and of the transmuted stature of the mother. For all purposes of a statistical investigation of the kind in question, we may substitute a scheme or arrangement of "mid-parents" for one composed of averages of the two separately.

Now, the curious statistical fact discovered by Mr. Galton is that there is a strict numerical law of "regression" connecting the height of the mid-parent with that of the offspring. The average departure of the latter from the mean is only two-thirds that of the former. This becomes plainer if we take a concrete instance. Suppose a father of six feet, and a mother of five feet four, in a population where the average male stature was five feet eight, and the average female five feet three: the "mid-parent" here is five feet ten inches and a half [$\frac{1}{2}$ $(64 \times 1{\cdot}08 + 72) = 70{\cdot}5$]. This departs from the mean by two inches and a half. The children (males and transmuted females) will, on an average, only depart from the mean by two-thirds of this, *viz.*, by an inch and two-thirds. That is, the average height of the *sons* of such a couple will be about five feet nine inches and two-thirds, and of the *daughters* five feet four and a half inches.

In speaking, as above, of the "regression" from parent to offspring, it must not be supposed that the same regression is not displayed in the opposite direction, *viz.*, from offspring to their parents, and, indeed, from any individual in the direction of

seems incorrect. Charlotte Brontë, for example, if I remember right, weds the diminutive curate Mr. Sweeting to the stately Dora Sykes, in accordance with a 'mysterious law,' which governs such selections by contrast.

lateral connexion to his kinsmen. Pèrhaps the best way of summing up the facts here is in the form of a paradox, by the juxtaposition of the following three indisputable results of statistical inquiry:—On an average, the sons of tall men, though tall, are shorter than their fathers; the fathers of tall men, though tall, are shorter than their sons; and the height of each successive generation remains the same. In other words, start with any exceptional individual, either up or down the line of descent, or laterally: those in immediate juxtaposition with him will also be found to be exceptional, though less so than he is himself; but after two, or at the very outside three, such steps have been taken, we find the exceptional characteristic will have almost entirely disappeared,[1] and any batch of his relations will not differ from a chance-selection of ordinary mankind in any perceptible degree. This conclusion (as well as the apparent paradox stated above) rests upon the fact that the preponderating mass of mankind are what we call 'average,' *i.e.*, grouped close about their mean. Hence it follows that, in the long run, the really exceptional persons will be found to be the exceptional offspring of ordinary parents, rather than the 'ordinary' offspring of exceptional parents.

It need hardly be pointed out how widely this scientific conception of heredity differs from the popular conception, founded, as the latter is, in some degree upon traditions derived from legal and feudal origin. "The blood of the Howards"—or Buggins—is supposed to flow undiluted from generation to generation, and to display itself by continual emergence of the same characteristics. But those who can bring their minds to recognise that they have mothers as well as fathers, and that each factor contributes about equally, must admit that the general characteristics of their ancestors in the tenth degree (say) will indistinguishably resemble those of the ancestors of anybody else, except, of course, in so far as their ancestors, through intermarriage of cousins, have been kept from doubling in number at every step backward. To this must be added another exception, *viz.*, the tendency to marry into the same rank in society, and thus, in so far as character at all depends upon rank, to curtail the full potentiality of equalisation. But this condition is very apt to be overrated, as anyone would soon find who undertook to work out conscientiously an inverted pedigree which should display the name and position, say, of every one even of his sixteen great-great-grandparents.

[1] Mr. Galton calls attention to a very important distinction here, *viz.*, the distinction between qualities which *blend* and those which do not blend. Numerically speaking, as regards the mere average, it comes to the same thing whether a quality disappears by an imperceptibly faint presence in *all* the descendants (after, say, a single cross) or by being present in a marked degree in an *extremely small percentage* of all the descendants. But the actual concrete results are widely different.

The conclusions thus indicated are very far-reaching in their consequences. Mr. Galton has called attention to a number of them, but we may briefly suggest one or two more. Consider, for instance, the *persistency* of race-characteristics, and the violent, if temporary, shocks which may be borne without introduction of any permanent consequences. Thus the unquestionably small stature of the French nation as compared with the English has been attributed in great part to the devastating effect of the twenty-two years of warfare following on the Revolution. Throughout all that long period there was a continued selection of all that was tall and strong, and rejection of all that was short and weakly. The former was sent out for slaughter and disease; and, if sent home in health, returned after the best years of early manhood were past. The latter remained behind to continue the population. At first sight this seems a most potent disturbing influence, but closer investigation, in the light of the above results, shows that it is liable to be vastly exaggerated. For one thing, the women were unaffected by such selection, and, therefore, as statistics show, the disturbing influence must be exactly halved to begin with. Then, again, long as the war lasted, only one generation was affected, and we now know how potent the influence of the whole ancestry at one remove is shown to be. In fact, it seems certain that if—what has never been approximated to in any time or place—every tall man without exception were selected from a single generation and exterminated on battle-fields, the effect on the next generation would be but very slight indeed, if perceptible at all. For the tall men of one generation are, in preponderating numbers, the offspring here and there of some of the many who were themselves but mediocre. Again, another suggestion: does it not seem to follow that we must not be sanguine, through the effects of processes of heredity, of any hope of serious improvement in the human race? We are sometimes apt to notice what has been effected amongst animals, and to take this as an analogy for what may be effected amongst ourselves. But how has it been effected in the former case? By persistent, unrelenting destruction, or suspension from natural functions, continued through generation after generation, of every individual who fell below the mark. So far as heredity is concerned,—we are not, of course, attending to the general ameliorating influences of sanitary precautions, education, and so forth,—nothing short of this continuity of practice would avail to keep a succession of generations above the position of what may be called normal equilibrium.

A word must be added as regards the evidence adduced by Mr. Galton in support of his results. His conclusions are, of course, meant to be extended by analogy to all characteristics, mental and moral as well as physical, though at present accurate quantitative data are only available in respect of a few of the latter. As he says, his statistics had to be entirely collected by

himself, since nothing available had ever been attempted apparently by any previous investigator. He began by what may seem a very remote analogy, *viz.*, the results, as regards size and weight, of breeding selectively families of *sweet peas*. But the bulk of his human data were the result of offering, some years ago, a series of money prizes for the best "Record of Family Faculties". As these excited considerable interest at the time, we need not here pause to give any further account of them. It need only be said that their scientific aim was to collect data for connecting the peculiarities of the individual, in respect of stature, strength, eye-colour, artistic or literary taste, liability to special disease, and so forth, with the corresponding peculiarities of all his ancestors within the third remove, and of all his collaterals within the same limits. The net results, though not so extensive as could have been wished, seem to have been very carefully and conscientiously compiled, and furnish the basis for a large amount of most interesting and trustworthy inference.

Mr. Galton's well-known ingenuity and fertility of resource in respect of mechanical and diagrammatical illustration deserves passing notice. There is, for instance, a wheel-and-axle machine described, for calculating the probable height of a son and daughter from the observed height of the parents. A couple of weights, hanging by cords from two of the connected wheels, can be set by scale in accordance with the latter data, and a third weight, on its own scale, automatically indicates the desired number in feet and inches for either sex. Another diagram to which attention may be particularly directed, as it is one which really aids in the work of proof, is intended to illustrate the process of "regression," and the successive steps by which we should pass from any selected group,—selected, that is, in respect of any particular characteristic which exists in a marked degree,—to their mediocre ancestors or collaterals at a few degrees' remove. It will be intelligible enough to one familiar with Mr. Galton's "ogive," which he commonly substitutes for the more usual 'exponential' curve employed to represent the dispersion of a group of magnitudes about their mean. Conceive a number of these ogives cut out on stiff cardboard, and place one upon another (all cut the same size), until we have a block of them on a square base, with an ogive surface at the top. Take a precisely similar block and set it near the other, but turn it on its base through an angle of ninety degrees relatively to the former. Then conceive the former cut into a number of thin slips parallel to the direction of the second set of ogives; in other words, at right angles to the actual cards of which it is composed. The latter set of sections will be composed of rectangular slips, whose altitude varies according to the familiar law of deviation as expressed on this scheme. The two blocks will represent diagrammatically the composition and arrangement, in respect of any assigned characteristic, of two generations of the population. When they stood in the same

angular direction they served to display the statistical uniformity of those generations. When standing at right angles they serve to display the process of regression by which a selected group, of any particular standard, will be modified in their posterity or ancestry into a perfectly normal or 'chance' selection. For the same block, according as we look at it, is composed either of rectangular, or of ogival slips: the former represent the selected group of one definite magnitude in respect of their peculiarities; the latter represent the chance-group which will resemble any other chance-group.

As was remarked above, it seemed better to dwell somewhat minutely on one line of inquiry developed in this volume, rather than to attempt to compress into a short space an abstract of the whole. I have therefore dwelt prominently on the characteristic of stature, which lends itself to accurate investigation and numerical verification. But this is only one of the characteristics to which the same argument may, by analogy, be extended, and, indeed, only one of those which Mr. Galton has taken into consideration. For instance, a whole chapter is devoted to the discussion of eye-colour, the extent to which this can be proved to be hereditary, and the process by which the statistical persistence of the distribution of such colours is secured. The investigation here is in some respects different from that which deals with stature, since we are here concerned with a quality which does not "blend". "Parents of different Statures usually transmit a blended heritage to their children, but parents of different Eye-colours usually transmit an alternative heritage" (p. 139). This requires us to appeal to *percentages* of eye-colour as contrasted with measurements of individual stature. Two other chapters are devoted to similar investigations in respect of Artistic Faculty and of Diseases; the statistics of these being, like the preceding, obtained from the returns sent in for competition and described as "Records of Family Faculties". It need not be said that here, as with all Mr. Galton's work, we find a model of the way in which statistics should be employed. These have been acquired, tested and put to use with the most scrupulous care and skill, and the trust yielded to them is just as great as it should be, and no greater.

JOHN VENN.

On Truth: A Systematic Inquiry. By ST. GEORGE MIVART, Ph. D., M.D., F.R.S. Kegan Paul, Trench & Co., London, 1889. Pp. x., 580.

It is difficult for a person not well acquainted with the history or the present condition of Catholic philosophy to appreciate the real significance of a book like Mr. Mivart's *On Truth*. Yet Mr. Mivart writes for the general English public, and he would probably prefer to be regarded from the outside.