

## Some quotations from R.A.Fisher

*Compiled by A.W.F.Edwards*

“Natural selection is a mechanism for generating an exceedingly high degree of improbability”.

Reported by J.S.Huxley in *Evolution in Action*, London: Chatto and Windus, 1953.

...it was Darwin's chief contribution, not only to Biology but to the whole of natural science, to have brought to light a process by which contingencies *a priori* improbable, are given, in the process of time, an increasing probability, until it is their non-occurrence rather than their occurrence which becomes highly improbable.

... Let the reader ... attempt to calculate the prior probability that a hundred generations of his ancestry in the direct male line should each have left at least one son. The odds against such a contingency as it would have appeared to his hundredth ancestor (about the time of King Solomon) would require for their expression forty-four figures of the decimal notation; yet this improbable event has certainly happened.

Retrospect of criticisms of the theory of natural selection. In *Evolution as a Process*, eds. J.S.Huxley, A.C.Hardy and E.B.Ford, London: Allen and Unwin, 1954.

The million, million, million ... to one chance happens once in a million, million, million ... times no matter how surprised we may be that it results in us.

Quoted by K.Mather, *Heredity* **30**, 89–91, 1973.

for the “one chance in a million” will undoubtedly occur, with no less and no more than its appropriate frequency, however surprised we may be that it should occur to *us*.

*The Design of Experiments*, p.13 (6th edition, 1951). Edinburgh: Oliver & Boyd

Natural selection is not evolution.

Opening sentence of *The Genetical Theory of Natural Selection*, Oxford: Clarendon Press, 1930.

What [Hogben and Haldane] do not see is that we ordinarily count as genetic only such part of the genetic effect as may be included in a linear formula and that we make a present to the environmentalists of such variation due to the combined action of genetic and environmental causes as is not expressible in such a formula ... .

18 January 1935, in a letter to J.A. Fraser Roberts. Printed in *Natural Selection, Heredity, and Eugenics*, p.260, ed. J.H.Bennett, Oxford: Clarendon Press, 1983.

... the only evolutionary effect, either in increased fitness or in anything else, that I can recognize as such, is constituted by changes in gene ratio.

18 February 1955, in a letter to O.Kemphorne. Printed in *Natural Selection, Heredity, and Eugenics*, p.229, J.H.Bennett, Oxford: Clarendon Press, 1983.

I believe that no one who is familiar, either with mathematical advances in other fields, or with the range of special biological conditions to be considered, would ever conceive that everything could be summed up in a single mathematical formula, however complex.

The evolutionary modification of genetic phenomena. *Proceedings of the 6th International Congress of Genetics* **1**, 165-72, 1932.

... the best causes tend to attract to their support the worst arguments, which seems to be equally true in the intellectual and in the moral sense.

*Statistical Methods and Scientific Inference*, Edinburgh: Oliver and Boyd, 1956, p.31.

Faith Is Not Credulity.

Subtitle to Science and Christianity, *Friend* **113**, 995–996, 1955.

(in full: 'Christian children should ... be taught that faith does not mean credulity; but is a quality, very like courage, which makes one hold fast to that which is good, ... .')

Fairly large print is a real antidote to stiff reading.

31 May 1929, in a letter to K.Sisam, Oxford University Press. Printed in *Natural Selection, Heredity, and Eugenics*, p.20, ed. J.H.Bennett, Oxford: Clarendon Press, 1983.

After all, it is a common weakness of young authors to put too much into their papers.

*Contributions to Mathematical Statistics*, New York: Wiley, 1950, p.10.308a.

The academic mind, as we know, is sometimes capable of assuming an aggressive attitude. The official mind, on the contrary, is and has to be, expert in the art of self-defence.

Presidential Address to the First Indian Statistical Congress, 1938. *Sankhya* **4**, 14-17.

To consult the statistician after an experiment is finished is often merely to ask him to conduct a *post mortem* examination. He can perhaps say what the experiment died of.

Presidential Address to the First Indian Statistical Congress, 1938. *Sankhya* **4**, 14-17.

In scientific subjects, the natural remedy for dogmatism has been found in research. By temperament and training, the research worker is the antithesis of the pundit. What he is actively and constantly aware of is his ignorance, not his knowledge; the insufficiency of his concepts, of the terms and phrases in which he tries to excogitate his problems: not their final and exhaustive sufficiency. He is, therefore, usually only a good teacher for the few who wish to use their mind as a workshop, rather than a warehouse.\*

Eugenics, academic and practical. *Eugenics Review*, **27**, 95-100, 1935.

\*The original has 'to store it as' inserted before the final words 'a warehouse', but I assume this is a mistake left over from an earlier draft.

Apart from sex linkage, we know almost nothing at present of linkage in man. Yet it is certain that every defect determined by a single factor must be located in one or

other of twenty-three [*sic*] linkage groups. Each defect must therefore be linked in inheritance with numerous other observable traits, and with some of them is probably linked closely. The search for such linkage will certainly be lengthy, and at first, disappointing.

Eugenics, academic and practical. *Eugenics Review*, **27**, 95-100, 1935.

There is, then, in this analysis of variance no indication of any other than innate and heritable factors at work.

(The coining of the phrase 'analysis of variance'.) The causes of human variability. *Eugenics Review* **10**, 213-220, 1918.

The analysis of variance is not a mathematical theorem, but rather a convenient method of arranging the arithmetic.

Discussion to 'Statistics in agricultural research' by J.Wishart, *Journal of the Royal Statistical Society, Supplement*, **1**, 26-61, 1934.

However, perhaps the main point is that you are under no obligation to analyse variance into its parts if it does not come apart easily, and its unwillingness to do so naturally indicates that one's line of approach is not very fruitful.

25 February 1933, in a letter to L.Hogben. Printed in *Natural Selection, Heredity, and Eugenics*, J.H.Bennett, Oxford: Clarendon Press, 1983, p.218.

... the so-called co-efficient of heritability, which I regard as one of those unfortunate short-cuts, which have often emerged in biometry for lack of a more thorough analysis of the data.

*British Agricultural Bulletin* **4**, 217-218, 1951.

In relation to any experiment we may speak of this hypothesis as the "null hypothesis," and it should be noted that the null hypothesis is never proved or established, but is possibly disproved, in the course of experimentation. Every experiment may be said to exist only in order to give the facts a chance of disproving the null hypothesis.

(The coining of the phrase.) *The Design of Experiments*, Edinburgh: Oliver and Boyd, 1935, p.18.

Critical tests of this kind may be called tests of significance, and when such tests are available we may discover whether a second sample is or is not significantly different from the first.

(The coining of the phrase 'test of significance'.) *Statistical Methods for Research Workers*, Edinburgh: Oliver and Boyd, 1925, p.43.

More attention to the History of Science is needed, as much by scientists as by historians, and especially by biologists, and this should mean a deliberate attempt to understand the thoughts of the great masters of the past, to see in what circumstances or intellectual *milieu* their ideas were formed, where they took the wrong turning or stopped short on the right track.

Natural selection from the genetical standpoint. *Australian Journal of Science* **22**, 16-17, 1959.

The statistician cannot excuse himself from the duty of getting his head clear on the principles of scientific inference, but equally no other thinking man can avoid a like obligation.

*The Design of Experiments*, Edinburgh: Oliver and Boyd, 1935, p.2.

I may myself say that I learned it [the theory of inverse probability] at school as an integral part of the subject, and for some years saw no reason to question its validity.

Uncertain inference. *Proceedings of the American Academy of Arts and Sciences* **71**, 245–258, 1936

Dr Jeffreys says that I am entitled to use maximum likelihood as a primitive postulate. In this I believe he is right. A worker with more intuitive insight than I might perhaps have recognized that likelihood must play in inductive reasoning a part analogous to that of probability in deductive problems.

Comment on H. Jeffreys' paper on maximum likelihood, inverse probability and the method of moments. *Annals of Eugenics* **8**, 151, 1938.

We have the duty of formulating, of summarizing, and of communicating our conclusions, in intelligible form, in recognition of the right of *other* free minds to utilize them in making *their own* decisions.

Statistical methods and scientific induction. *Journal of the Royal Statistical Society*, B, **17**, 69-78, 1955.

The Edwards who messed up Cleghorn's data, and is formally thanked for it in his letter to Nature seems not to be my Edwards from Cambridge. It was the thought that it was he that annoyed me, for the estimates published in Nature were manifestly incompetent, and I feared that one of my own pupils was running amok and adding unnecessarily to darkness and confusion. However, I understand he is only one of Hogben's, so all is explained.

27 September 1960, in a letter to R.R.Race. Quoted (with the permission of Professor J.H.Edwards) by A.W.F.Edwards (1998), *The Eugenics Society and the Development of Biometry. Essays in the History of Eugenics*, ed. R.A.Peel; London: Galton Institute, 156–172. (A.W.F.E., a pupil of Fisher's, and J.H.E., an associate of Lancelot Hogben's, are brothers.)

“It looks like a book by Hogben”.

1958, on receiving his copies of the Dover reprint of *The Genetical Theory of Natural Selection*. Quoted by A.W.F.Edwards (1998), *The Eugenics Society and the Development of Biometry. Essays in the History of Eugenics*, ed. R.A.Peel; London: Galton Institute, 156–172.

“That's one in the eye for the General Board”.

1952, on hearing that he was to be knighted. The General Board at Cambridge was the body he held responsible for the failure to establish blood-group and bacterial genetics in Cambridge. Quoted by A.W.F.Edwards (1990), R.A.Fisher, *Twice Professor of Genetics: London and Cambridge, or, “A Fairly Well-Known Geneticist”*. *Biometrics* **46**, 897-904.

“Charming chap the Secretary General. One doesn’t like to put his letters unopened into the wastepaper basket”.

ca. 1954. The Secretary General (at the time H.M.Taylor) was the secretary of the General Board (see preceding quotation). Reported by C.B.Goodhart.

“I am a well-known statistician and a fairly well-known geneticist, but I have never been consulted on any appointment to a University post in statistics or genetics outside my own Department”.

1957. Quoted by A.W.F.Edwards (1990), R.A.Fisher, Twice Professor of Genetics: London and Cambridge, or, “A Fairly Well-Known Geneticist”. *Biometrics* **46**, 897-904.

*Hereditary Genius* [by Francis Galton] stands to-day as one of the great books of the nineteenth century. This is not due to its influence on popular thought, but to its inherent qualities. It was first published in 1869, ten years after the *Origin of Species*, and only separated by two years from the appearance of the first volume of *Das Kapital* by Karl Marx. The latter book is its natural antithesis. Its central aim is the political control of wealth, whereas Galton had his eyes fixed on biological well-being; it dogmatically asserts human equality, while Galton is concerned to measure the important inequalities; it appeals to hatred and vindictive destruction, while Galton, not irrationally for his period, looks forward with confidence to the progressive improvement of existing institutions; above all *Das Kapital* appealed to passion, but *Hereditary Genius* to an almost stoically detached reason. Ideological war had broken out, right in Bloomsbury. It is small wonder that the leftist tradition has never ceased to assail Galton’s work, with an animus that Galton could never begin to understand. Sooner or later, however, the world will have to choose between them.

Review of the reprint of the second edition of *Hereditary Genius*. *Eugenics Review* **43**, 37, 1951.

For the future, so far as we can foresee it, it appears to be unquestionable that the activity of the human race will provide the major factor in the environment of almost every evolving organism. Whether they act consciously or unconsciously human initiative and human choice have become the major channels of creative activity on this planet. Inadequately prepared we unquestionably are for the new responsibilities, which with the rapid extension of human control over the productive resources of the world have been, as it were, suddenly thrust upon us. Yet there have in recent times been some signs of a responsible attitude. We have come to expect kindness in the treatment of the domestic animals. We have come to deplore the irreplaceable loss of the species which ignorance and greed have exterminated. The future of some wild animals has occasioned sufficient anxiety for the provision of Parks and Nature Reserves to be the normal policy of civilised peoples. These are signs that we do not feel that ruthless exploitation is good enough. Our knowledge it is true is still in the highest degree inadequate; yet a beginning has been made with ecological studies, and what has been called population genetics, at least to explore the methods by which more effective knowledge can be obtained.

*Creative Aspects of Natural Law*. Eddington Memorial Lecture, 2 November 1950. Cambridge University Press, 1950.

Fisher believes that human groups differ profoundly “in their innate capacity for intellectual and emotional development” and concludes from this that the “practical international problem is that of learning to share the resources of this planet amicably with persons of materially different nature, and that this problem is being obscured by entirely well intentioned efforts to minimize the real differences that exist”.

*The Race Concept*, UNESCO, Paris, 1952, p.27.

When a large number of individuals are measured in respect of physical dimensions, weight, colour, density, etc., it is possible to describe with some accuracy the population of which our experience may be regarded as a sample. By this means it may be possible to distinguish it from other populations differing in their genetic origin, or in environmental circumstances. Thus local races may be very different as populations, although individuals may overlap in all characters; ... .

R.A.Fisher (1925) *Statistical Methods for Research Workers*, Edinburgh: Oliver and Boyd, 1925, p.37.

So melancholy a neglect of Darwin’s work suggests reflections upon the use of those rare and precious possessions of man – great books. It was, we believe, the custom of the late Professor Freeman to warn his students that mastery of one great book was worth any amount of knowledge of many lesser ones. The tendency of modern scientific teaching is to neglect the great books, to lay far too much stress upon relatively unimportant modern work, and to present masses of detail of doubtful truth and questionable weight in such a way as to obscure principles. Everything depends upon the view the lecturer takes of his responsibilities. Experience in the lecture room suggests that his main concern is, in most cases, to be “up to date”. ... Nothing can really take the place of a first-hand study of the work itself. Many lecturers give the impression that they are using a great work merely as a background against which to display the brilliance of modern research. Eagerness to announce revolutionary discoveries is an unflinching sign of a superficial intelligence, and is surely beneath the dignity of the Professorial Chair.

The specialised research worker is always ready to sneer at the man who prefers the labours of mental abstraction. ...

An age of extreme and unparalleled specialisation, such as that in which we live, needs above all the steadying influence of a firm grasp on principles. Detail itself is arid and tedious; it is moreover largely unintelligible in the absence of explanatory principle. There is too much experiment and too little thought.

Cuénot on preadaptation. A criticism. *Eugenics Review* 7, 46-61, 1915 (with C.S.Stock).

The controversy proved nothing, but that Bateson did not know enough of mathematics, nor Pearson enough of biology.

1946. Draft of entry on Karl Pearson for the *Dictionary of National Biography*, finally published by A.W.F.Edwards (1994) R.A.Fisher on Karl Pearson. *Notes and Records of the Royal Society* 48, 97-106.

My 1918 paper was refereed by Pearson and Punnett, both of whom I later succeeded. ca. 1956. Reported by W.F.Bodmer. (See also Fisher’s letter to C.S.Stock, 18 September 1943, printed in *Natural Selection, Heredity, and Eugenics*, 264–5, J.H.Bennett, Oxford: Clarendon Press, 1983.)

Any opinion put forward by Professor Pearson is worthy of respect; but ...

The goodness of fit of regression formulæ, and the distribution of regression coefficients. *Journal of the Royal Statistical Society* **85**, 597-612, 1922.

G.H.Hardy, the pure mathematician – to whom I owe all that I know of pure mathematics – ... .

The nature of probability. *Centennial Review* **2**, 261–274, 1958.

My revered teacher Prof. Whitehead of Cambridge ... .

Presidential Address to the First Indian Statistical Congress, 1938. *Sankhya* **4**, 14-17.

[Randomization tests]

... it is then obvious at the time that the judgement of significance has been decided not by the evidence of the sample, but by the throw of the coin. It is not obvious how the research worker is to be made to forget this circumstance; and it is certain that he ought not to forget it, if he is concerned to assess the weight only of objective observational facts against the hypothesis in question. A real experimenter, in fact, so far from being willing to introduce an element of chance into the formation of his scientific conclusions, has been steadily exerting himself, in the planning of his experiments, and in their execution, to decrease or to eliminate [by randomization]\* all the causes of fortuitous variation which might obscure the evidence.

*Statistical Methods and Scientific Inference*, Edinburgh: Oliver and Boyd, 1956, p.97; \*3<sup>rd</sup> edition, 1973.

I find this case very confusing, and have not thoroughly checked the result.

A class of enumeration of importance in genetics. *Proceedings of the Royal Society B* **136**, 509–520, 1950.

... the fact is that when I cannot get a grip of a thing in my head I can very seldom make it go on paper.

Fisher to C.G.Darwin, 16 July 1930. *The Genetical Theory of Natural Selection*, Variorum Edition ed. J.H.Bennett, Oxford University Press, 1999, p.304.

I believe sanity and realism can be restored to the teaching of Mathematical Statistics most easily and directly by entrusting such teaching largely to men and women who have had personal experience of research in the Natural Sciences.

Scientific thought and the refinement of human reasoning. *Journal of the Operations Research Society of Japan* **3**, 1–10, 1960.

A ballet dancer gets her ovation on the spot, while she is still warm from her efforts. A wit gets his laugh across the table; but a scientist must expect to wait about five years for *his* laugh. Recognition in science, to the man who has something to give, is, I should guess, more just and more certain than in most occupations, but it does take time. And when it comes it will probably come from abroad.

(Broadcast talk) *Listener* **37**, 662-663, 1947

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Fred Hoyle on Fisher:

Of the books, I would like to recommend especially R.A.Fisher's *A Genetical Theory of Natural Selection (sic)* for its brilliant obscurity. After two or three months of investigation it will be found possible to understand some of Fisher's sentences. I am genuinely sorry for scientists of the younger generation who never knew Fisher personally. So long as you avoided a handful of subjects like inverse probability that would turn Fisher in the briefest possible moment from extreme urbanity into a boiling cauldron of wrath, you got by with little worse than a thick head from the port which he, like the Cambridge mathematician J.E.Littlewood, loved to drink in the evening. And on the credit side you gained a cherished memory of English spoken in a Shakespearean style and delivered in the manner of a Spanish grandee.

*Mathematics of Evolution*. Memphis, Tennessee: Acorn Enterprises LLC, 1999.