BIOMETRY

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The rise of biometry in this 20th century, like that of geometry in the 3rd century before Christ, seems to mark out one of the great ages or critical periods in the advance of the human understanding. From its humble beginnings in meeting the needs and satisfying the practical requirements of the work of land measurement and architecture, *geometry* found its way, by the enchanting clarity of its concepts and processes, into the heart of what the Greek world meant by a liberal education; an education that is fit for *free* men who would think for themselves, and not fit only for slaves and officials whose aims and concepts were dictated from above. It was the liberation of the spirit experienced by the Greek students of geometry which gave the subject to them the exalted status it undoubtedly held, and won the veneration of the entire period. We can, I think, partly understand their feeling, when we realise that here for the first time the human spirit came to handle abstractions, of their nature necessarily timeless and perfect, and to handle them with confidence, because they were well defined. The well defined abstraction seems, in fact, to be the invention of the Greek geometers, and an invention of lasting significance to human thought.

But it was not merely its conceptual clarity which gave to geometry its fascination. With well defined concepts the intellect found itself capable of acting with unprecedented efficiency. Men learnt to reason, deductively, from well defined abstract concepts, to cogent and irrefrageable conclusions. And with its use, with its exercise, in the field of geometry, the *principles* of deductive reasoning came to be understood, or at least, to be codified, so as to give rise to the subject known as *Logic*. It has been a fashion among some modern mathematicians to speak of Mathematics itself, or themselves, as but a branch of logic. This, of course, is but a formalisation, appropriate to a purely deductive habit of mind. The historical fact unquestionably shows logic as a later growth, a formulation of the thought processes, in which the practice of geometry had already made man sufficiently adept, to ensure agreement as to general principles. And the conclusions of geometers themselves, apart from the artistically unified presentation which Euclid gave them, embody the horse-sense of ages of predecessors trying to measure accurately, and using increasingly subtle and indirect means of measurement and of accurate construction. Even in Euclid's treatise it is dis-

*R. A. Fisher, president of the Society, addressed the Inaugural meeting of the British Region in London on April 29. His address was such an adroit summary of the reasons for launching a new scientific Society that we are publishing it in this issue of BIOMETRICS.

cernible that the grand aim towards which the whole edifice of theorems and problems is directed is the practical and exact construction of the five perfect or absolutely regular figures which are possible in three dimensions.

Now, I suppose circumstances might have conspired to give to surveying, or to astronomy, or to any other subject sufficiently rich in observational detail, the honour of compassing the second great stage of intellectual liberation, by making known the principles of that second and scarcely explored mode of logic, which we know as induction; of clarifying the principles of reasoning from the particular to the general, from the observations to the hypotheses, in ways necessarily inaccessible to purely deductive logic, or to any mathematics which can properly be regarded as derivable wholly from deductive logic, of making men free to recognize with certainty the consequence not of axioms or dogmas, but of carefully ascertained facts. But, as it has happened, it has been reserved for Biometry, the active pursuit of biological knowledge by quantitative methods, to take this great step; and the man who in the nineteenth century did more than any other to prepare the way was, I think, undoubtedly Francis Galton.

The peculiarity of Galton's temperamental make-up which led him to play this part was, in my opinion, the insistent need that he felt to think constructively about variable phenomena. Unquestionably he was led to concentrate his attention upon variation, through the central place which variation held in the theory of evolution, which his half-cousin Charles Darwin had put forward, and which influenced Galton profoundly, as appears clearly in his book *Hereditary Genius*, published after the *Origin* by only ten years. To Galton, however, variation of all kinds had an appeal, or a fascination, as much in meteorology for example as in heredity, and this appeal we can appreciate if we consider what an obstacle to coherent thought mere quantitative variation had formerly been. Even now, common phrases and modes of thought express this impotence from which Galton's generation was just emerging, thanks largely to Galton's own efforts. If one were to say: "Nothing definite can be asserted about the political opinions of entomologists, for their opinions vary", even an audience of biometers might admit the statement as rational, although they all know perfectly well, from their own constant experience, that a great variety of definite statements could be made about every variable phenomenon that had been studied. Without this experience, however,—and the bulk of mankind are without this experience,—without the modern concept of frequency distributions, and the habit of thinking coherently in terms of frequency distributions, thought comes to a full stop. The urge, apparent in elementary text

books of statistics, to find "measures of central tendency" as conceptually constant substitutes for the really variable values, embalms one of the earliest efforts to evade the intellectual difficulty. With better apparatus of thought at our disposal, we can now reinterpret the measures as statistical estimates. As such they make sense; but we should remember that they are still introduced and taught at a stage when there is as yet no thought of estimation. Then again, we still have the administrative compromise, such as "A fair wage is one sufficient to maintain in decency a wife and three children", and it is with pained surprise, and with great reluctance, that the administrator learns to admit that such a decision will leave half the real children of the country, belonging to families of four or more, insufficiently provided for, and that at the same time it saddles the wage fund, and therefore the purchaser of goods, with providing for about twenty million non-existent children. In this aspect family allowances constitute an elementary recognition of the unwelcome fact of biological variability.

The primitive function of the biometric movement, characteristics of the present century, is therefore to conserve by constant use, and incidentally to improve and refine, the thought forms, which make possible an understanding of variable phenomena. These phenomena come to our knowledge by observation of the real world, and it is no small part of our task to understand, design and execute the forms of observation, surveys or experiments, which shall be competent to supply the knowledge needed. The observational material requires interpretation and analysis, and no progress is to be expected without constant experience in analysing and interpreting observational data of the most diverse types. Only so, as I have suggested, can a genuine and comprehensible formulation of the processes of inductive reasoning come into existence. As we bear these objects in mind, as we allow ourselves to appreciate their immense practical importance, as we yield to their intellectual fascination, so, it is common experience, we come to think of ourselves less in terms of the special scientific disciplines, less as chemists or entomologists, geneticists or mathematicians, and more in terms of the community of our interests with those doing similar work in other departments. It is to promote interchange of ideas, personal contacts, and mutual appreciation of our diverse problems and methods, that we have felt the need of a new scientific organisation, in which our work may be viewed in a new perspective, not as something extraneous and eccentric, a funny sort of botany, for example, or of palaeontology, or of medicine, but as a tidal movement of our time, which has already begun to refresh and reinforce the means of research in all the biological sciences.