ON THINKING BIOLOGICALLY

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IT is worth consideration how far the teaching of biology should govern or modify our attitude towards the great departments of human thought and action,—philosophy, politics, government, education, and social life. Man's physical nature is at all events primary and fundamental. No line of conduct or policy which runs counter to the powers and limitations of that physical nature can ultimately succeed, except at too high a cost. Biological considerations in relation to man, neglected in the past and imperfectly understood in the present, can hardly fail to supply useful lessons and to suggest salutary cautions.

There is little proof of biological knowledge or biological teaching in the most ancient civilizations, such as those of the Nile valley or the plains of Babylonia. The arts of war, of architecture, and of agriculture, were cultivated with success. Irrigation was practised with beneficent results. Mathematics and mechanics made progress. The clear expanse of the nightly sky invited observations which still affect our thinking. But the great problems of the living organism received scant attention. Medicine was interwoven with magic and priestcraft. Disease was attributed to demoniac possession. Incantations and exorcisms usurped the place of rational therapeutics. Botany was largely a question of the collection of herbals. Zoology as a science did not exist.

In biology, as in so many other departments of thought and knowledge, the first impulse came from the Greeks. The Ionian philosophers of the sixth century B.C. were occupied mainly with physical problems, but Heracleitus had glimpses of the great flux of Nature which we now know as Evolution. The all-embracing mind of Aristotle was interested not only in metaphysics, poetry, rhetoric, and ethics, but also in biology, as we see in his treatises *De Anima*, *De Generatione Animalium*, and other writings. His successor, Theophrastus, carried on the work, and made progress especially in botany. The school of Alexandria studied medicine on the lines formulated by the genius of Hippocrates. Galen made some remarkable discoveries in anatomy and physiology, and reduced Greek medicine to a comprehensive and orderly system

which stereotyped the subject for more than a thousand years. The Arabian philosophers concerned themselves with metaphysics, alchemy and its child chemistry, and with medicine, but contributed nothing of importance to the advance of biology. Through the long period of the Middle Ages medicine was paralysed by the ban laid upon dissections of the human body, and by the iron hand of Hippocrates and Galen. Enquiry was limited to what those great teachers had handed down, and the written word supplanted the direct interrogation of Nature. The sixteenth century saw the breaking up of the ice. Sylvius and Vesalius—to neglect some of the less famous forerunners—opened the modern era of biology. In the year 1543 there was published in Basel a folio volume entitled *De Fabrica Humani Corporis* by Andreas Vesalius, and biology had a new birth. Here at length was a man who could use his eyes and his reason, to whom Galen was simply a venerated authority and not an infallible oracle.

Henceforward there was no long pause in the progress of biology, and the names of Harvey, Malpighi, van Helmont, Peyer, Brunner, Boerhaave, Willis, Haller, Mayow, Lavoisier, Bell, Majendie, Bichat, Lamarck, Wallace, Darwin, mark the milestones on the way. Biology had now taken an assured place in the hierarchy of the sciences and was no longer simply a department of medicine. Of all biological discoveries it is a truism to say that the doctrine of Evolution has had the most far-reaching effects both upon thought and upon practice. All great discoveries have had their precursors, men who discerned the dawn but did not live to see the full day of scientific truth, and Darwin was no exception to the rule. The idea of Evolution had floated before the minds of thinkers and philosophers of many schools from the time of Heracleitus, and may even be traced to the speculations of Hinduism. It can be found in the works of Aristotle, and we can detect it through a long succession of thinkers, including Bacon, Descartes, Leibnitz, Hume, Kant, Goethe, Buffon, Hegel, Geoffrey St. Hilaire, Erasmus Darwin, and Lamarck. The case of Goethe is peculiarly interesting, the more so as science was not his primary concern. Lord Haldane thinks that in width of range and variety of interest Goethe's mind was the greatest since Aristotle. His anticipations of Evolution are certainly remarkable. "Who knows whether man himself is not just an effort after a still higher goal?" "All that begins to be seeks for itself room and permanence; hence it forces from its place and shortens the life of something else." With these thoughts floating before the mind of the poet and seer the doctrines of the Struggle for Life and the Survival of the Fittest were not far away.

But all the guesses, previsions and hypotheses of previous thinkers in no way dim the lustre of Darwin's achievement. Other thinkers had visions; he supplied the proof. "Evolution," says Bateson, "is a process of variation and heredity. The older writers, though they had some vague idea that it must be so, did not study variation and heredity. Darwin did, and so begot, not a theory, but a science." "We claim for Darwin," says Alfred Russell Wallace, "that he is the Newton of natural history, and that, just as surely as that the discovery and demonstration by Newton of the law of gravitation established order in place of chaos and laid a sure foundation for all future study of the starry heavens, so surely has Darwin by his discovery of the Law of Natural Selection and his demonstration of the great principle of the preservation of useful variations in the struggle for life, not only thrown a flood of light on the process of development of the whole animal world but also established a firm foundation for all future study of Nature."

Henceforth we are all evolutionists, however we may differ upon details. The static point of view is forever obsolete. For men of the past everything was fixed and final. The earth stood still on its foundations, surrounded by the moving heavenly bodies. Animals and plants had been created perfect in their kind by an almighty fiat. Aristotle had spoken the last word in philosophy. The authority of Galen silenced all enquiry in medicine. The proud motto *semper eadem* might have been inscribed on the portals of science as well as upon the shrines of religion. The modern outlook is a complete reversal of attitude. Becoming, not Being, is the note of the modern world. The everlasting hills themselves are not really everlasting. We can trace their rise, we can anticipate their dissolution. By the exercise of a little imagination we can see them emerge and see them crumble. Before our eyes the Arve and the Arveyron, with their myriad sister streams, are slowly transporting the Alps to the sea. The great inland sea of Africa has become a waterless desert, and may again become a sea. The trees are changing, and the beech is supplanting the oak. The gigantic saurians of the Tertiary epoch have ceased to be. The Cro-Magnons and the Moasterians have given place to other races. Man is not a creature of yesterday. The few thousand years of history are but the ticks of the great clock of time. Society has its roots in the dim mist of unremembered ages. In the abysses of space stars are born and die. Our instincts, habits, works, modes of thought trace their springs not only to primitive man but to the pre-human. Our beliefs are tinged with remnants of man's earliest wondering and fearful outlook upon the great pro-

cesses of Nature. Those beliefs have changed before, they will change again. Nothing is fixed, nothing is final. All is movement, change, variation, development,—not always progress. There will be advance, there may also be recession. Another ice age may come. Progress is not in a straight line, but *en spirale*. The tendency, as the record of the rocks shows, is, however, from the lower to the higher.

This is not the place to discuss the question how far the views of Darwin have been modified by the progress of biological science since his day. How far the conclusions of De Vries, Mendel, Weismann, Bateson and others have modified the Darwinian doctrine, to what extent Natural Selection is the fundamental fact in evolution, whether progress is continuous or saltatory—by infinitesimal increments or by the emergence of new types (mutations)—are questions of great interest, but they do not affect the main thesis. We still argue, and we may long continue to argue, about the *modes* of Evolution, but we no longer argue about the *fact* of Evolution. That stands firm, and we are unable to conceive that it will ever be shaken.

Its philosophical inferences are many and profound. No department of thought has escaped its influence. In history, psychology, geology, archaeology, anthropology, and biology we think henceforth on evolutionary lines. Even religion has not escaped the influence of the evolutionary ferment. Bergson's philosophy is an outstanding proof of the modern standpoint. Kant's reflection was based upon mathematics and the Newtonian physics, that of Bergson is in essence evolutionary. For example, we cannot for ever acquiesce in Kant's dictum that "the subtle investigation of the manner in which the bodily organs are bound up with our thought is for ever in vain." The physiology of the brain, in many particulars still obscure, has made immense strides since Kant. The mechanism of language has been to some extent elucidated, and biology compels us to re-think that old problem. The physician and the pathologist too are familiar with facts which compel this attitude. A small jet of haemorrhage or a clot in the brain may involve a change of mind and character. Under such circumstances the patient may suffer from failure of memory, loss of emotional control, incapacity for consecutive thought. Is it any explanation to say that his "parallelism" is out of order, or that his transmitter has broken down? To the biologist these explanations seem to be merely verbal or symbolical.

Evolution emphasizes the importance of heredity. We are what we are partly by inheritance, partly as the result of environ-

mental influences, using that term in the widest sense to include education and moral and social environment. A failure to take account of heredity has been the rock upon which some philosophies have split. The French encyclopædists—Diderot, d'Alembert, d'Holbach—were men of versatile talent and high capacity. They were out to reconstruct society and to inaugurate a new era for man. But to a large extent they ignored the past, and knew nothing or cared nothing about heredity. They did not recognize that man—physically, morally, and socially—has his roots in the past, and is not an isolated unit but a link in a chain. They did not think biologically, and the results of their labours were to a large extent ephemeral.

It is a question of interest why the various communistic societies which have been tried ended in failure. Plato's *Republic* and More's *Utopia* never had a trial, but it may be safely affirmed that they would have proved unworkable in practice. The modern world has seen similar ideals, inspired by the teachings of Robert Owen, Fourier, and Etienne Cobet, made the basis of practical experiments in social reconstruction. America has been specially fruitful in such experiments—the Shaker community, the Oneida community, the Rappist community, Brook Farm and others. The principles on which these communities were founded had many points in common and many features worthy of admiration. Equality, charity, altruism, justice, the simple life, formed part of their propaganda. But they ended in disappointment and decay. Why did they fail? Was their fatal weakness a wrong theory of Economics or a "fake" view of human nature? Both causes may have been at work, but it is certain that the founders of these communities did not study men and women from the biological point of view. They did not allow for the effects of too close association of individuals, the limitation of choice in marriage, the consequences of breeding, the absence of the stimulation of social contacts and rivalries, the general *ennui* and boredom. They did not think biologically. Man is gregarious. He is not happy in isolation. The primitive hunting and fighting instincts require to be transmuted into other forms of activity; they cannot be wholly ignored.

The biological factor in crime is now generally recognized by experts, but imperfectly realised by the legal profession and the public. Lombroso, no doubt, exaggerated the importance of the criminal type, and there has been a reaction from his views. But it remains certain that many criminals are physically or mentally

abnormal. The low brow, the high-arched palate, the ape hand, the abnormal distribution of hair, the low type of intelligence are relatively common. The proportion of such defects in criminals has been variously estimated. Convicted felons in the Court of General Sessions in New York County showed over ten per cent. of defectives. Other observations put the proportion higher. The question of criminal responsibility which such facts raise is obviously one of great public importance. It is now becoming common to plead mental defect as a defence in criminal cases. When the guilt of the accused admits of little doubt the defence is usually a plea of irresponsibility. Family histories are ransacked; cases of insanity in the stock of the accused are brought to light; peculiarities of behaviour are adduced as suggestive of lack of normal self-control; even psycho-analysis is invoked. How are judges and juries, without technical knowledge, to appraise the value of such evidence? No doubt they have the assistance of expert witnesses, who are too often at variance. If the question is one of a collision or loss of a vessel, the law ordains that maritime assessors, independent authorities, shall sit with the judge, but no similar precaution is thought necessary when the life of a criminal is at stake. The courts are often at a loss to know what value to assign to the facts that the accused had a drunken father, a hysterical mother, a brother, sister, uncle, aunt or cousin in an asylum, or that he suffered in childhood from sleep-walking or St. Vitus's Dance. Such problems should be referred, not to expert witnesses, but to technical advisers of the courts. There is no legal definition of insanity, and it is well known that no definition is possible. The State is apt to assume that a man or a woman is sane or insane, and if the latter, that he or she should be certified and sent to an asylum. This is a crude view of the situation. Borderland cases are common. Responsibility is sometimes a matter of degree. The whole question of the relation of the State to insanity and crime requires reconsideration. There is need for sound biological thinking.

The late war raised many biological problems, and happily they are receiving some attention. The huge loss of human life, the diminished birth rate, the effects of privation and suffering, the increase in tuberculosis and other forms of disease, the food question amongst combatants and non-combatants, have all demanded consideration and enquiry. It is reckoned that the war destroyed seven million lives, a very conjectural figure, which probably does not err on the side of excess. The loss in restricted births must have largely exceeded this total. The effective man power of Europe is believed to have been reduced by at least twenty

per cent. M. March reckons the loss to France of men in the age period of fifteen to sixteen years and the deficit of male births (1914-17) at two millions. Germany is reckoned to have lost 5,600,000 lives by the war, 1,800,000 killed and 3,500,000 due to limitations of births. Her population during the war period declined by over two millions. We have some detailed information regarding France. In the seventy seven unoccupied departments the births in 1913 numbered 604,811 and the deaths 587,445. The corresponding figures for 1917 were 343,310 births and 613,148 deaths. In the devastated areas of France fifty per cent. of the children have been been found to be in some degree tuberculous. Calmette puts the figure higher and believes that seventy per cent are affected by tubercle, or show arrested development, mental or physical or both. In Vienna and other Austrian and German cities the increase in tuberculosis and other conditions dependent on mal-nutrition has been enormous.

During the war the statistics of recruiting in England gave us for the first time a partial physical census, necessarily limited to men of military age. The results were startling. In twelve months (1917-18) 2,425,184 men underwent a medical examination. Grade I (men in perfect physical condition) was found to include only thirty-six per cent. of the total. Grade II (men with slight physical defects) was found to include twenty-two to twenty-three per cent. Grade III (men with serious physical defects) was found to include thirty one to thirty-two per cent., and Grade IV (men practically invalids and unfit for any form of war service) was found to include ten to eleven per cent. It is evident that these figures would require a good deal of sifting before they could be accepted as a fair index of the health conditions of the general population. They do not represent a first draft upon the male population, the war having been in progress for three years. It is fair to assume that an earlier census might have shown more favourable results. Many qualifications would be necessary in defining the value of the official figures, but the general conclusion can hardly be invalidated, viz., that the proportion of perfectly healthy and fit males of military age is much smaller than might reasonably have been expected. The chief causes of disability were found to be:—poor physique and the presence of physical defects; tuberculosis; diseases and degenerations of the cardio-vascular system. It is a remarkable fact that in England and Wales infant mortality continued its downward course during the war, the figure for 1913 being one hundred and eight, and that for 1919 being eighty-nine, per thousand. It would be interesting to

speculate upon the causes of this phenomenon. Most European countries had a very different story to tell.

Food problems bulked largely during the war, and there is a consensus of opinion that they were ably handled by England. There was a shortage of some essential foodstuffs—sugar, butter, potatoes —but little actual want. However irksome the food restrictions may have been in individual cases, there is proof that they had no detrimental effect upon the general population. The general death-rate for 1920—12.4 per 1000—and the infant mortality rate for the same year—80 per 1000 births—were both the lowest on record. Most continental countries fared much worse. In the fighting line there was an ample supply of proteins and saccharines, and the value of the latter as an energy fuel was appreciated. Alcohol was supplied liberally to the French army, more sparingly to the British forces. The value of the calorie as a food unit has been called in question, and we are offered a new unit of energy—the Nem. To summarise all the biological findings emanating from the war would take us too far, but we may at least assume that it has been a potent stimulant in many directions, and that it has led to some fruitful biological thinking. Efficiency in war is the ultimate test—a severe and expensive test—of the nation's manhood, and it is clear that the British race has stood the test well.

Let us now turn to a different field, and enquire how far we are thinking biologically in the great sphere of education. Some matters are self-evident. We must have healthy school buildings, a curriculum which does not make too large demands on physical efficiency, adequate attention to exercise and recreation, medical inspection of schools and scholars. Most civilised countries have more or less fulfilled these conditions, if not always with complete thoroughness and success. We are now agreed that education must fulfil two fundamental conditions: (a) It must be in preparation for life and not merely for a vocation. (b) It must take account of the whole individual—physique, intellect, character. If we appreciate the suggestion of Samuel Butler, we shall avoid the sharp disjunction of body and mind. We shall think of the individual—to use an old simile—as a coin with two faces, not as two coins. We shall think of body in terms of mind, and of mind in terms of body. The psychology of the child and of the youth is now studied with good results, but it must be studied from the physiological standpoint. We must examine the special characteristics of the sense organs of the child, determine the place of observation in education, watch the order of development of the faculties of the brain, enquire into the phenomena

of growth, note the special characteristics of infancy, childhood, and adolescence, take account of the laws of mental fatigue. There are those who are naturally "auditives," learning more readily by the ear, while others are naturally "visuals," learning more readily by the eye. The school time-table must be adjusted so that subjects involving much mental stress shall be taken at times when the brain works most easily, while the lighter subjects are taken at times when the brain is relatively fatigued and, therefore, less receptive. Calisthenics, drill, blackboard demonstration, art lessons must be used as relief from the severer studies. Monotony and fatigue must be avoided. A period for a young child must not exceed half an hour, while forty-five minutes may be assigned to the older scholars. Food must be available at suitable intervals. The classification of scholars must receive due attention, and the mistake must no longer be made of subjecting all scholars of the same age to an identical routine. Denmark has three grades of schools—one for the normal child, another for the child who is slightly below the normal standard, and a third for the definitely abnormal child. Such a system obviously involves great difficulties in the selection of teachers, in the arrangement of the curriculum, and in general administration. Whether the system is worthy of imitation or is too artificial must be decided by the test of experience. It should always be remembered that the child mind represents an earlier stage in the evolutionary process than the mind of the adult. Impulse tends to predominate over reason; emotional control is weak; abstract subjects are not easily grasped; the power of sustained attention is relatively feeble. The child observes readily but reasons slowly. It is interested in flowers, plants and animals; hence nature study may begin early. The love of story is strong, and history may be so taught as to gratify this disposition. There is a love of movement and a bend towards imitation, so dancing and amateur theatricals will be relished and made the medium of cultivating grace of gesture and elegance of speech.

Physiology is beginning to be taught in schools, but only to a limited extent. All knowledge is useful, and it might be thought that no knowledge is more fundamental or more likely to be valuable than a knowledge of one's own body. But this point of view has been only slowly perceived, and is still imperfectly realised. There is still in many quarters a lingering feeling that there is a certain indelicacy in instructing youth regarding the structure and functions of the human body. One wonders what is the evolutionary history of this hesitancy and reluctance to face the facts of life.

Is it a remnant of Manicheism, or the aftermath of the early church's ban upon dissection of the human body? Is it related to the philosophy of clothes? A knowledge of natural structure and function is not only valuable from the point of view of health, but with older scholars might be made the channel of useful philosophical suggestion. The idea that the human body is a perfect organism naturally panders to human vanity, but it has no foundation in fact. Physical structure is determined by the conditions of survival, not by the requirements of an ideal type or a perfect economy. The ear is susceptible only to the impulse of aerial waves of a certain length and frequency. The eye can respond only to transverse waves of a certain length. We have no organ to respond to electrical waves as such. We see nothing distinctly which does not subtend a certain angle upon the retina. In most persons of middle age the eye's adjustment for refraction deteriorates. We have organs that are progressing, some that are decaying, many that are vestigial and useless. Only in the light of Evolution can such facts become intelligible.

Another phase of child life where biological thinking is required is the child's fear of the unknown. Anyone who studies young children must have noticed that fear is not a characteristic of the infant or the child in the first three or four years of life. It comes later and is often pronounced. What is the explanation? It is probably to be found in the tales of fairies, spirits, hobgoblins and demons which silly nurses and maidservants are allowed to instil into their youthful charges.

Turn to another subject which demands biological thinking, viz., racial characteristics, the results of racial admixture, the causes of racial progress and of racial failure and decline. A vast field for enquiry is here open, and only biology can afford many of the most important clues. How far does the Anglo-Saxon race owe its dominant position to a fortunate admixture of racial elements? Are the Latin races progressing or regressing? How far was the decline of Greece and Rome due to biological causes—admixture with inferior stocks, aversion from marriage, malaria, plague? Is Canada going to absorb the Ukrainians, Galicians, Mennonites, and Doukhobors who have settled in her territory in the last two or three decades, or will she keep them permanently in alien enclaves intermarrying only with their own kinsfolk? What is to be the ultimate issue of the negro problem in the United States? Is the so-called "mysterious blight," which seems to afflict some of the coloured races on contact with the white man, really mysterious, and not rather an affair of tuberculosis, venereal disease, and

whiskey? A hundred questions of this kind might easily be propounded. They are not fanciful or theoretical questions. On the contrary, they are urgent and practical questions, and to attempt their solution without the key of biology is to invite certain failure.

The new science of eugenics takes cognizance of many of the foregoing problems. Its essential aim, according to the well known formula of Francis Galton, is "the study of agencies under social control that may impair or improve the racial qualities of future generations either physically or mentally." This is a large programme. Eugenics asks such questions as the following:—What are the conditions of healthy parenthood? What disabilities, physical, mental, or moral, should debar the individual of either sex from becoming a parent? What influences are at work in the world which tend to taint the stream of human life? What are the effects of the three great racial poisons—tuberculosis, venereal disease, alcohol—and how can these effects be prevented, mitigated, or removed? What is the course of the birth-rate and the death-rate, and what practical conclusions can be drawn from the observed facts? What is the influence of heredity upon insanity, feeble-mindedness, and crime? What are the effects of the admixture of races? What is the truth regarding marriages of consanguinity? How far is it practicable to regulate marriage on eugenic principles, and what degree of success is attending the efforts being put forth in certain countries to achieve this end? How far is it true that nations are breeding largely from inferior stocks, and restricting the fertility of the superior classes by excessive taxation and an erroneous economic policy? What is the relative importance of heredity and environmental factors in determining the conditions of human life? In fine, how can we build up a healthier, saner, more efficient race, and make the world a better place to live in for those who will come after us?

These are vast problems, and there are those who hold that our knowledge of heredity and allied questions is still too scanty and insecure to justify effective legislation or social action. But many of the outstanding facts of heredity are patent, at all events to the medical eye. Disease—epilepsy, insanity, feeble-mindedness, dipsomania, hemophilia, hysteria, neurasthenia, deaf-mutism—is plainly in various degrees hereditary. Galton held the doctrine of the inheritance of genius. Perhaps it would be nearer the mark to say that talent, natural capacity, energy and will-power, tend to re-appear in a marked degree in certain stocks. Genius, on the other hand, is a "sport," a "mutation," rare in all stocks and in all ages, and only to a very limited extent transmissible. But the general

facts of heredity are plain enough, and the real question is whether they can be made the basis for effective action. It should surely not be beyond the range of social endeavour to restrain, whether by coercive legislation or by the pressure of educated public opinion, the propagation of the insane, the feeble-minded, the degenerate, to prevent the conveyance of contagious disease in marriage, to arrest the forces which foul the fountain of human life.

Biological thinking is necessary in order to arrive at some definite conclusion regarding the course of the birth-rate and the fluctuations of population. Details cannot be given here, but it is important that the broad facts should be known. Birth-rates are highest in the least progressive countries, such as Russia; lowest in the most progressive countries, such as France. Birth-rates are highest in the slums, lowest in the learned professions. The most inefficient nations and the most inefficient classes are the most prolific. High birth-rates are always associated with high death-rates. The birth-rate in most civilised countries has been falling rapidly in the last half century, the decline amounting to nearly one-half. How far is this due to voluntary restriction, or to economic conditions and the postponement of marriage, or to some more general and more obscure causes? A falling death-rate has almost kept pace with the falling birth-rate, and may be fairly attributed to medical science and a general rise in the level of civilization. What view are we to take regarding the theory that civilization, by preventing famine and disease (it has not yet prevented war), and by preserving the lives of the diseased, the inefficient and the degenerate, is running counter to Natural Selection and lowering the standard of human life? The answer is not easy.

These questions cannot be answered within the limits of one short article. They are important questions. They are practical questions. They are questions not simply for the *savant* and the philosopher, for the study or the laboratory. They are questions for the home, for the council chamber, for the market place, for the press, for the man in the street. Their solution will demand much hard biological thinking.