CHAPTER 1

Human Nature and Culture[1]

Wilhelm Dilthey, the German neo-Kantian philosopher, has left us an account of how, on a night in 1894, there came to him an unnervingly ominous dream. He was staying at a castle in Silesia and, after a long and soul-stirring philosophical discussion, had retired to his bedroom, where there hung a copy of Raphael's famous fresco *The School of Athens.* As Dilthey slept, Raphael's painting came alive as philosophers of post-Renaissance times trooped in to join the ancients and the medievals; whereupon, the whole throng began to separate as though into opposing factions. To one side, around Archimedes and Ptolemy, the naturalistic thinkers gathered; on the other, the idealist philosophers around Socrates and Plato, with bands of mediators forming and re-forming in between. Then, as if impelled by some imperious force, all mediation having failed, the groupings began to recede one from the other, and great fissures opened in the ground between them as they were enveloped in hostile alienation.[2] At this awesome sight, Dilthey was overcome with anxiety; he felt, he tells us, as though the unity of his being was being torn asunder.

I have recounted this dread dream of Dilthey's because it prophetically epitomises what was indeed to happen to the sciences of man during the immediately ensuing decades, and points to consequences from which these sciences still suffer — some of them to the very marrow of their methodologies.

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1 Reprinted from *Man and the New Biology* (Canberra. Australian National University Press, 1970).

2 W. Kluback, *Wilhelm Dilthey's Philosophy of History* (New York, Columbia University Press, 1956), pp. 103ff; H.A. Hodges, *The Philosophy of Wilhelm Dilthey* (London, Routledge and Kegan Paul, 1952), pp. 312ff.

Charles Darwin, when he came to the end of his essay of 1859, *The Origin of Species by Means of Natural Selection,* appended the laconic words: 'much light will be thrown on the origin of man and his history'.[3] With this aside — surely among the most pregnant in the brief history of science — was opened up the prospect that at least some members of 'Adam's sovereign clone' might transcend the banalities of their creation myth, and by dint of scientific inquiry, eventually come to a more truthful realisation of the realities of their phylogenetic past and of the springs of their evolving human nature.

In recent years, evolutionary theory has emerged saliently as the unifying paradigm of all the biological sciences, from biochemistry to ecology,[4] and its status has been radically enhanced by the advances of the last two decades in molecular biology, which as Muller put it, rank 'among the most magnificent and thrilling of all scientific revolutions that mankind has achieved thus far'.[5] So, with the discovery of the way in which genetic information can be stored on nucleic acid, the molecular basis of the evolutionary process has been revealed, and it has become apparent that 'the great specificity and subtlety shown by any particular enzyme'[6] are as much the result of natural selection as the clinging behaviour of a new-born langur monkey or the capacity of an infant *Homo sapiens* to learn one of the modes of symbolic communication characteristic of his species.[7] Indeed, no informed biologist can now have grounds for disagreement with Muller's generalisation that 'the criterion for any material's having life is whether or not it has the potentiality … of evolution by Darwinian natural selection'.[8]

Evolutionary theory then, provides a unifying paradigm for all the biological sciences — but it was not always so, and, if we are to grasp the significance of the new biology for the understanding of man and

3 C. Darwin, *The Origin of Species by Means of Natural Selection* (London, John Murray, 1859), p. 488.

4 E. Mayr, *Animal Species and Evolution* (Cambridge. Mass., Harvard University Press, 1963), p. 1.

5 H.J. Muller, 'Means and aims of human genetic betterment', in *The Control of Human Heredity and Evolution*, ed. T.M. Sonneborn (New York, Macmillan. 1965), p. 101.

6 F. Crick, *Of Molecules and Men* (Seattle and London, University of Washington Press, 1966). p. 52.

7 P. Jay, 'Mother–infant relations in langurs', in *Maternal Behaviour in Mammals*, ed. H. Rheingold (New York. John Wiley 1963), p. 286; E.H. Lenneberg, *Biological Foundations of Language* (New York, John Wiley, 1967), p. 28 and pp. 128ff.

8 Muller, 'The gene material as the initiator and the organizing basis of life', in *Heritage from Mendel*, ed. R.A. Brink (Madison, University of Wisconsin Press, 1967), p. 443.

his behaviour, we must — paradoxically — return to the 19th century and relate the symbolism of Dilthey's dream to the vicissitudes of Darwin's theory.

The intellectual commotion that followed the publication of the *Origin of Species* is well enough known.[9] A comparable furore was created by the appearance, in 1871, of *The Descent of Man.*[10] As Tylor noted, during that same year, to many there seemed 'something presumptuous and repulsive' in the view that the history of mankind was 'part and parcel of the history of nature',[11] and so, during the last decades of the 19th century, there arose a number of related ideologies opposed to the notion of a naturalistic and evolutionary science of man. Moreover, not a few of those involved were themselves men of science. For example, it was Rudolf Virchow, celebrated for his contributions to cellular pathology, who at Munich in 1877 vehemently attacked Haeckel's 'monistic view of the origin and nature of man'.[12] Indeed, so deeply felt was Virchow's opposition that he gave voice to fears that 'the theory of descent' might bring to Germany the horrors of the Paris Commune, and then proceeded, on the basis of his own researches in 'the domain of prehistoric anthropology', vigorously to contest the theory that man was phylogenetically 'allied to the rest of the animal world'.[13]

While Virchow was thus combating 'the incubus called Descent',[14] a young man named Franz Boas, who was to become the founder and father of cultural anthropology in America, had already begun his studies in the physical sciences at Kiel. A few years later, in Berlin, the young Dr Boas came profoundly under the influence both of Virchow (with whom he came to share a life-long antipathy to evolutionary biology), and of neo-Kantian idealism, which led him to abandon the mechanistic

9 G. de Beer, *Charles Darwin: Evolution by Natural Selection* (London, Nelson, 1963), chapter 8.
10 F. Darwin (ed.), *The Life and Letters of Charles Darwin* (London, John Murray, 1888), Vol. III, p. 133.
11 E.B. Tylor, *Primitive Culture* (London, John Murray, 1871). p. 2.
12 E. Haeckel, 'Charles Darwin as an anthropologist', in *Darwin and Modern Science,* ed. A.C. Seward (Cambridge, University Press, 1909), p. 145; cf. also *Nature* (1877), 16:491.
13 R. Virchow, 'The liberty of science in the modern state', *Nature* (1877), 17:74 and 112.
14 This was the phrase of Adolf Bastian, friend and collaborator of Rudolf Virchow, who was also an inveterate opponent of evolutionary theory; cf. Haeckel, *Freedom in Science and Teaching* (London, Kegan Paul, 1879), p. 7.

Weltanschauung of the natural sciences.[15] In 1885 he was to take these beliefs with him to America, and, in 1894 — the year of Dilthey's dream — in an address to the American Association for the Advancement of Science,[16] Boas propounded the doctrine of cultural determinism, which as it became adopted by his students was to culminate in the alienation of cultural anthropology from the biological sciences in general, and from evolutionary biology in particular.

And that same year, in Europe, Emile Durkheim (an exact contemporary of Boas) was preparing for publication his treatise *Les règles de la méthode sociologique* which propounded the doctrine that 'social facts' were entirely unrelated to biological facts,[17] and so opened up a methodological chasm between sociology and the biological study of human societies.

So it was, with the doctrines of Boas and Durkheim as the catalysts of fission, that the social sciences began to recede from the biological and natural sciences. Dilthey's dream was being methodically acted out, and the stage was being set for the sterile nature–nurture controversies of the 1920s — of which we are all the intellectual heirs.

The most eminent of Boas's early students was Alfred Kroeber, who likewise evinced a keen antipathy to evolutionary theory, and was apt, at this period, to refer to those 'infected with biological methods of thought'.[18] Characteristically, it was Kroeber, in a series of papers beginning in 1915, who pursued to its methodological extreme the doctrine of cultural determinism he had acquired from Boas, arguing, with emphatic rhetoric, that there was an 'eternal chasm' between the cultural and biological. There was, proclaimed Kroeber (and his language could not have been more sweeping), an 'utter divergence between social and organic forces'; culture was 'an entity in itself', and entirely unconnected with the biological order and evolutionary process.[19] With this doctrine went a series of rudimentary assumptions which soon became fundamental to anthropological

15 C. Kluckhohn and O. Prufer, 'Influences during the formative years', in *The Anthropology of Franz Boas,* ed. W. Goldschmidt (American Anthropological Association, Memoir No. 89, 1959), pp. 9ff; P. Radin, 'The mind of primitive man', *New Republic* (1939), 98:303; G. Stocking, *Race, Culture and Evolution* (New York, Free Press, 1968), p. 138.

16 F. Boas, 'Human faculty as determined by race', *Proceedings, American Association for the Advancement of Science* (1894), 43:218.

17 E. Durkheim, *Les règles de la méthode sociologique* (Paris, 1895).

18 A.L. Kroeber, 'Inheritance by magic', *American Anthropologist* (1916), 18:34.

19 Kroeber, 'Eighteen professions', *American Anthropologist* (1915), 17:283–288; 'The superorganic', ibid. (1917), 19:163–213.

orthodoxy: human nature was (as Margaret Mead was subsequently to put it) 'the rawest, most undifferentiated of raw material';[20] there was, it was held, a 'generic unity' or 'equivalence of hereditary endowment' throughout the entire human species;[21] and from these two assumptions a third was derived, the conclusion that 'every human expression' was completely moulded by 'social conditioning'.[22] Biological variables, by arbitrary pronouncement, had been completely excluded.

These implacable departures in cultural anthropology were paralleled by a militant movement in psychology, begun in about 1913 by John B. Watson, which came to be known as Behaviourism.[23] Initially, Watson was concerned primarily with breaking free from introspectionism, and he wrote bravely of his vision of psychology as 'a purely objective experimental branch of natural science'.[24] In the early 1920s, however, with Watson's resignation from Johns Hopkins University to become (in 1924) an advertising executive,[25] and under the influence of the anti-instinct movement in American social psychology,[26] Behaviourism became transformed into a rhetorical crusade against the recognition of biologically determined variables in human behaviour. Within a few years, Watson was declaiming to the world that there was 'no such thing as any inheritance of capacity, talent, temperament, mental constitution and characteristics', and that 'nurture not nature' was responsible for what a child became in life.[27]

The distinction between nature and nurture is a hoary one; Prospero, it will be recollected, described the abhorred Caliban as 'a devil, a born devil, on whose nature, nurture can never stick'.[28] In the 1870s these terms were brought into scientific discourse by Galton in his pioneer researches

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20 M. Mead, 'Growing up in New Guinea' (1930), in *From the South Seas* (New York, Morrow, 1939), p. 212.

21 Boas, *The Mind of Primitive Man* (New York, Macmillan, 1911), p. 155; L. Spier, 'Franz Boas and some of his views', *Acta Americana* (1943), 1:108.

22 Spier, 'Some central elements in the legacy', in *The Anthropology of Franz Boas*, p. 146.

23 J.C. Burnham, 'On the origins of behaviorism', *Journal of the History of the Behavioral Sciences* (1968), 4:143–151.

24 J.B. Watson, 'Psychology as the behaviorist views it', *Psychological Review* (1913), 20:158.

25 Watson in *A History of Psychology in Autobiography*, ed. C. Murchison (Worcester, Mass. Clark University Press, 1936), Vol. 3, pp. 279ff.

26 G. Adams. 'Human Instincts', *American Mercury* (1928), 14:458.

27 Watson, *Behaviorism* (New York, Norton and Co., 1925), p. 74; 'What is behaviorism?' *Harper's Magazine* (1926), 152:729.

28 W. Shakespeare, *The Tempest*, Act IV, Scene 1.

on the life histories of identical twins.[29] However, at least since the time of Johannsen's fundamental distinction (of 1909) between genotype and phenotype,[30] no informed biologist has opposed heredity to environment as though the one might be wholly dominant over the other. Indeed, as Zirkle has pointed out, 'any attempt to make one more important than the other is as silly as trying to determine which is the more important in deriving a product, the multiplicand or the multiplier'.[31] In other words, on the nature–nurture issue biologists have long taken an interactionist position. As Dobzhansky has recently phrased it: 'The genotype and the environment are equally important, because both are indispensable. There is no organism without genes, and any genotype can only act in some environment.'[32] So, in 1915, while Kroeber was professing that 'heredity cannot be allowed to have acted any part in history',[33] we find the biologist Conklin (in the first edition of his book *Heredity and Environment in the Development of Man*) declaring that 'neither environment nor heredity is all-important … both are necessary to development'.[34]

At this distance in time it is a matter for wonderment that Kroeber, Watson and the other fervent environmentalists of the 1920s should have had the intellectual temerity to take the extreme stance that they did. Their behaviour becomes understandable, however, when it is realised that biology, during the first quarter of this century, was itself in a state of profound confusion.

In 1880, in celebrating the 'coming of age' of *The Origin of Species*, in a lecture at the Royal Institution, T.H. Huxley felt justified in declaring that Evolution had taken its place 'alongside of those accepted truths which must be taken into account by philosophers of all schools'.[35] Within a few years of Darwin's death in 1882, however, the situation had begun to change. First came Weismann's trenchant critique of the doctrine of

29 F. Galton, 'The history of twins as a criterion of the relative powers of nature and nurture', *Journal of the Anthropological Institute* (1875), 5:391–406.
30 W. Johannsen, *Elemente der exakten Erblichkeit* (Jena, Fischer, 1909).
31 C. Zirkle, *Evolution, Marxian Biology and the Social Scene* (Philadelphia, University of Pennsylvania Press, 1959), p. 447.
32 T. Dobzhansky, *Heredity and the Nature of Man* (New York, Harcourt, Brace and World, 1964), p. 55.
33 Kroeber, 'Eighteen professions', *American Anthropologist* (1915), 17:285.
34 E.G. Conklin, *Heredity and Environment in the Development of Man*, rev. ed. (Princeton, University Press, 1930), p. 72. (First edition was in February 1915.)
35 T.H. Huxley, 'The coming of age of the Origin of Species', *Nature* (1880), 22:4.

the inheritance of acquired characters,[36] a doctrine which Darwin himself had incorporated into evolutionary theory in the shape of his sterile Pangenesis hypothesis of 1868.[37] From the 1890s onward, other biologists began to express discontent with the principle of natural selection. With the unearthing, in 1900, of Mendel's results, a vain quarrel began between the mutationists and biometricians,[38] with the mutationists expressing ever-increasing doubts as to the efficacy of natural selection, until, in April 1914, we find Karl Pearson lamenting that the work of Darwin was being 'largely undermined'.[39] Later that same year — in Australia — in his Presidential Address to the British Association,[40] William Bateson conclusively rejected Darwinian theory, and, falling back on preformist notions, advanced the view that all cases of genetic variation might be due to the loss of elements present in an original complex. Bateson's views were widely publicised,[41] and were greeted sympathetically by the leading American geneticist T.H. Morgan, who, at that time, also held a mutationist theory of evolution.[42] Soon after this, Jennings was telling the Washington Academy of Sciences that 'the evolutionists might almost feel that the enemy had crept into their citadel and was blowing it up from within';[43] and, by 1922, in the course of a British Association symposium

36 Weismann's criticism of the doctrine of acquired characters was initiated by his remarks on heredity and the 'continuity of the germ-plasm' at a meeting held on 21 June 1883, when he was tendered the position of Vice-Rector of the University of Freiburg; cf. L. Cuénot, 'The inheritance of acquired characters', *Annual Report, Smithsonian Institution* (for the year ending 30 June 1921) (Washington, Government Printing Office, 1922), p. 336; cf. also A. Weismann, *The Germ-plasm: a Theory of Heredity* (London, Walter Scott, 1893).

37 C. Darwin, *Variation of Animals and Plants under Domestication* (London, John Murray, 1868), Vol. 2, chapter xxvii.

38 R.C. Punnett, 'The early days of genetics', *Heredity* (1950), 4:1–10, G.S. Carter, *A Hundred Years of Evolution* (London, Sidgwick and Jackson), p. 121; Mayr, 'Where are we?', *Cold Spring Harbor Symposia on Quantitative Biology* (1959), 24:1ff.

39 K. Pearson, *The Life, Letters and Labours of Francis Galton* (Cambridge, University Press, 1914), Vol. 1, p. vi: in preface dated Gallon Laboratory, 8 April 1914.

40 As President of the Eighty-Fourth Meeting of the British Association for the Advancement of Science, William Bateson delivered two addresses, the first in Melbourne on 14 August 1914 and the second in Sydney on 20 August 1914; cf. *Report of the Eighty-Fourth Meeting of the British Association for the Advancement of Science, Australia, 1914* (London, John Murray, 1915), pp. 3–38.

41 William Bateson's presidential addresses were also published in *Nature* (93:635–642, 674–681), *Science* (40:287–302, 319–333), and in the *Annual Report (for 1915) of the Smithsonian Institution* (Washington, Government Printing Office, 1916), pp. 359–394.

42 T.H. Morgan, *A Critique of the Theory of Evolution* (Princeton, Princeton University Press, 1916); cf. also E.G. Jeffrey, 'Drosophila and the mutation hypothesis', *Science* (1925), 62:3–5.

43 H.S. Jennings, 'Observed changes in hereditary characters in relation to evolution', *Journal of the Washington Academy of Sciences* (1917), 7:283.

on Darwinism, as part of a chorus of criticism by Willis[44] and other eminent biologists, J.T. Cunningham was giving it as his opinion that natural selection was 'as extinct as the dodo'.[45]

By this time Fisher and Haldane[46] had already begun the mathematical researches, which, with those of Sewall Wright and others,[47] were to reconcile the facts of genetics with the process of natural selection, and to result in the rise of the synthetic theory of evolution — that 'mutated phoenix' (as Julian Huxley has called it)[48] — which now reigns supreme in modern biology. But this new epoch did not effectively begin until about 1930, with the publication of Fisher's classic essay *The Genetical Theory of Natural Selection,* and, during most of the second and third decades of this century, evolutionary biology was beset by discord and confusion.[49]

So it was that during this period, Kroeber, Watson and others were able to promulgate their extreme environmentalist views. Behaviourism, it is instructive to note, was based on 'tacit assumptions' almost identical with those of cultural anthropology, these assumptions being, as the Brelands

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44 J.C. Willis, 'The inadequacy of the theory of natural selection as an explanation of the facts of geographical distribution and evolution', *Report of the Ninetieth Meeting of the British Association for the Advancement of Science*, Hull, 1922 (London, John Murray, 1923), p. 399; cf. also Willis, *Age and Area* (Cambridge, University Press, 1922).

45 Cf. *Nature* (1922), 110:752; J.R. Cunningham was one of the participants in a symposium on 'The Present Position of Darwinism', held jointly by the botanical and zoological sections during the course of the Ninetieth Meeting of the British Association for the Advancement of Science at Hull in September 1922. In his presidential address to Section K (Botany) at the Eighty-Ninth Meeting of the British Association in Edinburgh on 9 September 1921, Professor D.H. Scott, F.R.S., had given it as his opinion that 'for the moment, at all events, the Darwinian period is past' (cf. *Nature* (1921), 108:154); and later that year in Toronto, on 28 December 1921, William Bateson, in an address to the American Association for the Advancement of Science, renewed his criticism of the Darwinian theory of evolution by natural selection (cf. *Science* (1922), 55:55–61). Bateson's views were given great notice in the popular press, (cf. H.F. Osborn, 'William Bateson on Darwinism', *Science* (1922), 53:194–197), and were used by those who in the immediately following years attempted to suppress the teaching of evolutionary theory in certain of the southern and western states of the USA (cf. W. Bateson, 'The revolt against the teaching of evolution in the United States', *Nature* (1923), 112:313–314; including Bateson's statement that it was he who 'all unwittingly dropped the spark which started the fire').

46 R.A. Fisher, 'The correlations between relatives on the supposition of Mendelian inheritance', *Transactions, Royal Society of Edinburgh* (1918), 52:399–433; cf. also J.B.S. Haldane's papers on 'A mathematical theory of natural and artificial selection', which were published in the *Proceedings of the Cambridge Philosophical Society* from 1924 onwards, and which were summarised in Haldane's *The Causes of Evolution* (London, Longmans Green, 1932), pp. 171–215.

47 S. Wright, 'Evolution in Mendelian populations', *Genetics* (1931), 16:97–159; cf. also Wright, *Evolution and the Genetics of Populations*, Vol. 1, *Genetic and biometric foundations* (Chicago and London, University of Chicago Press, 1968); A.H. Sturtevant, *A History of Genetics* (New York, Harper and Row, 1965), chapter 17.

48 Julian Huxley, *Evolution: The Modern Synthesis* (London, George Allen and Unwin, 1942), p. 28.

49 de Beer, *Charles Darwin: Evolution by Natural Selection*, p. 183.

have stated them, that 'the animal comes to the laboratory as a virtual *tabula rasa,* that species differences are insignificant, and that all responses are about equally conditionable to all stimuli'.[50] Here also, it will be observed, phylogenetically given variables are arbitrarily excluded.

Whatever may have been the scientific inadequacies of Behaviourism, its appeal was immense. Watson's book of popular lectures, when it was first published in 1925, was declared in the *New York Herald-Tribune* to be perhaps the 'most important book ever written',[51] and his doctrines soon became the gospel of the late 1920s. By 1927, V.F. Calverton, in the *Modern Quarterly*,[52] was referring to environmentalism as the 'great movement' underlying contemporary thought, and there was talk of 'a new enlightenment'.[53] The analysis of this fascinating epoch in intellectual history I must leave to another occasion. For the present, I only wish to note that the paradigm in terms of which many of the social sciences still operate was largely derived from the doctrines and assumptions of the uncompromising environmentalism of the 1920s and 1930s. Moreover, it is in the murky light of this paradigm that many educated people still think about human nature and culture. What bearing, then, have the advances of the last few decades in the biological sciences had on the doctrines and assumptions of such men as Kroeber and Watson, and on the related paradigm of certain of the social sciences?

Let me begin with an examination of the assumption that in all human populations there is an 'equivalence of hereditary endowment'. This assumption, often also referred to as the principle of the psychic unity of mankind,[54] is akin to the widespread notion that there is a unitary and uniform nature which we all share, and which, one of these days when we have sufficient knowledge, it will be possible to typify. We are here confronted with an example of typological thinking of a kind that is quite incompatible with the findings of modern population genetics. In Ernst Mayr's judgment, 'the replacement of typological thinking by population thinking is perhaps the greatest conceptual revolution that has taken place in biology';[55] without question, it is an innovation in understanding that is fundamental to the new biology.

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50 K. and M. Breland, 'The misbehavior of organisms', in *Readings in Animal Behavior*, ed. T.E. McGill (New York, Holt, Rinehart and Winston, 1965), p. 459.
51 Cf. *Nation*, 13 January 1926.
52 V.F. Calverton, 'The analysis of behavior', *Modern Quarterly* (1927), 4:302.
53 S.D. Schmalhausen, *Why We Misbehave* (New York, Macauley, 1928), p. 17.
54 M. Harris, *The Rise of Anthropological Theory* (London, Routledge and Kegan Paul, 1968), p. 15.
55 Mayr, *Animal Species and Evolution*, p. 5.

With the recognition of the fact that the genetic processes involved in evolution operate in populations, there has, in recent decades, been much research in this field, and one of the notable outcomes has been the demonstration that natural populations of outbreeding diploid species, including man, far from being genetically uniform, are genetically highly heterogeneous.[56] Furthermore, this genetic diversity is seen as adaptive, for in many vertebrate species it is an array of genotypes which enables a Mendelian population both to maintain its hold on any particular ecological niche, and to react adaptively to environmental change. This diverse array of genotypes within an outbreeding population is due to the independent behaviour of chromosome pairs during meiosis. Thus man, with 23 chromosome pairs, produces gametes (or germ cells) with any of the two to the power 23 alternative genomes (or haploid chromosome sets). This, as Hirsch has pointed out, makes 'vanishingly small' the chance that any two children of a given sexual union (with the exception, of course, of monozygotic twins) will be genetically identical, the probability as Hirsch has calculated it) being less than 1 in over 70 trillion.[57] The probability that two unrelated individuals will have the same genotype is effectively nil. In other words, all human beings (with the exception, again, of monozygotes), from the time of their conception, possess a genotype or biological endowment of a *uniquely individual kind.* It follows, as Dobzhansky has phrased it, that 'the nature of man as a species resolves itself into a great multitude of human natures', and that human nature is 'not unitary but multiform'.[58]

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56 J.M. Thoday, 'Selection and genetic heterogeneity', in *Genetic Diversity and Human Behavior*, ed. J.N. Spuhler (Chicago, Aldine Publishing Co., 1967), pp. 89–98.

57 J. Hirsch, 'Behavior genetics and individuality understood', *Science* (1963), 142:1437. It should be noted that the trillion is here the American one (10^{12}). As Professor D.G. Catcheside, F.R.S. (Director, Research School of Biological Sciences, The Australian National University) has kindly pointed out to me, the situation is, in fact, not so simple as '2^{23} alternative genomes', where the assumption is made that each of these is different, which is further dependent on the assumption that the two members of each chromosome pair are different. Professor Catcheside comments: 'While this is probable in man and other outbreeding organisms, it is not necessarily true. However, the diversity is likely to be increased by virtue of any pairs of chromosomes within which there are two or more genetic differences which may be reassorted by crossing over. Thus the possible number of gametes is decreased by a factor of two for every chromosome pair which has no genetic difference between its members and increased by a factor of two for each genetic difference in excess of one in each chromosome pair with two or more differences'.

58 Dobzhansky, *Heredity and the Nature of Man*, p.49: 'Of flies and man', *American Psychologist* (1967), 22:42.

This is not, of course, to deny that there are behavioural mechanisms specific to all members of the human species; what it does mean is that due regard must be paid to individual variability in any comparative study of these mechanisms. Further, there are now sound scientific grounds for the full recognition of individuality in the analysis of social and cultural behaviour; the way in which one individual plays a role (however it be ritualised) will be different from the way the next individual plays it, and this difference, the evidence indicates, will, to a significant degree, be genetically determined.

It also follows from the discoveries of population genetics that a human being, when he issues from his mother's womb, is not, in behavioural terms, a *tabula rasa,* and the 'most undifferentiated of raw material', for, as we have seen, human beings are intrinsically variable before they undergo differentiating experiences.[59] This conclusion, moreover, has been borne out in recent years by researches carried out at the Neonatal Behavioural Laboratory at the Albert Einstein College of Medicine, which have demonstrated 'consistent individual differences in response intensity' in human neonates 'during the first few days of life'.[60]

The notion, so prevalent among psychologists and anthropologists in the 1920s and 1930s, that the human neonate was a mere 'reaction-machine',[61] was accompanied, as might be expected, by a total rejection of evolutionary theory, or 'the mentalistic continuity doctrine', as a prominent psychologist of the time scathingly called it.[62] Thus, the view that man's behavioural repertoire might, in significant ways, be phylogenetically determined was completely rejected, and it was held, as the social psychologist Kantor stated it in 1924, that for the human species, behaviour began and ended with 'the individual's actual interactions with his stimuli conditions'.[63]

This simple-minded, stimulus-response, chain-reflex model of behaviour was essentially a speculative construct owing nothing to the findings of comparative neurophysiology as they then existed, for it was at this

59 Hirsch, 'Behavior genetics and individuality understood', p. 1437.

60 W.H. Bridger and B. Birns, 'Experience and temperament in human neonates', in *Early Experience and Behaviour: The psychobiology of development*, ed. G. Newton and S. Levine (Springfield, Illinois, Charles C. Thomas, 1968), p. 89; cf. also H. Papousek, 'Genetics and child development', in *Genetic Diversity and Human Behavior*, pp. 171–186.

61 Calverton, 'The rise of objective psychology', *Psychological Review* (1924), 31:426.

62 J.R. Kantor, 'An attempt toward a naturalistic description of emotions', *Psychological Review* (1921), 28:131.

63 Kantor, *Principles of Psychology* (New York, Knopf, 1924), p. 172.

very time that the meticulous experimental research of men like Coghill and Lashley[64] was demonstrating conclusively the scientific inadequacy of an empty-organism, peripheralist paradigm. Soon after this, von Holst disproved the chain-reflex hypothesis[65] by demonstrating, for example, that a completely deafferented spinal eel can still swim in a well co-ordinated manner. And this was followed by the brilliantly executed researches of Weiss and many others[66] in which the neuro-muscular connections in various vertebrates were surgically rearranged. In no instance could the animals operated on learn to overcome the anatomical disarrangement. These and other comparable experiments showed, in the words of Lenneberg, 'that motor co-ordination (and certain behaviour patterns dependent upon it) is driven by a rigid, unalterable cycle of neuro-physiological events inherent in a species' central nervous system'.[67] This conclusion that certain of the basic behaviour mechanisms of a species are phylogenetically programmed in the central nervous and related systems was further demonstrated, from the 1950s onwards, by the researches of such notable investigators as von Holst, MacLean, Delgado, Penfield and Heath,[68] in which the brains of a variety of vertebrate species, including man, were explored by the method of direct electrical stimulation by means of implanted micro-electrodes.

64 G.E. Coghill, *Anatomy and the Problem of Behavior* (New York, Macmillan, 1929); K.E. Lashley, 'The relation between cerebral mass, learning and retention', *Journal of Comparative Neurology* (1926), 41:1–58.

65 E. von Holst, 'Uber den Prozess der zentralnervösen Koordination', *Pflügers Arch. ges. Physiol.* (1935), 236:149–159; cf. K. Lorenz, 'Morphology and behavior patterns in closely allied species', in *Group Processes, Transactions of the first Conference*, ed. B. Schaffner (New York, Josiah Macy Jr Foundation, 1955), p. 183: 'I think we can now accept it as a fact that the central nervous system can generate and co-ordinate nervous impulses, without any afferent inflow'.

66 P.A. Weiss, 'Experimental analysis of co-ordination by the disarrangement of central–peripheral relations', *Physiological Mechanisms in Animal Behavior: Symposia of the Society for Experimental Biology* (New York, Academic Press, 1950), 4:92–111; cf. also R.W. Sperry, 'Physiological plasticity and brain circuit theory', in *Biological and Biochemical Bases of Behavior*, ed. H.F Harlow and C.N. Woolsey (Madison, University of Wisconsin Press, 1958), pp. 401–424.

67 Lenneberg, *Biological Foundations of Language*, p. 19.

68 E. von Holst and U. von Saint Paul, 'On the functional organization of drives', *Animal Behaviour* (1963), 11:1–20; P.D. MacLean, 'New findings relevant to the evolution of psychosexual functions of the brain', *Journal of Nervous and Mental Disease* (1962), 135:289–301; J.M.R. Delgado, 'Cerebral heterostimulation in a monkey colony', *Science* (1963), 141:1613; W. Penfield and T. Rasmussen, *The Cerebral Cortex of Man: A clinical study of localization of function* (New York, Macmillan, 1952); R.G. Heath, 'Pleasure response of human subjects to direct stimulation of the brain: Physiologic and psychodynamic considerations', in *The Role of Pleasure in Behavior*, ed. R.G. Heath (New York, Hoeber Medical Division, 1964), pp. 219–243.

Much of this work has been undertaken in close conjunction with research by ethologists — whose discoveries and theories are also very much a part of the new biology. The principal achievement of ethology has been the demonstration of the truth of Darwin's supposition (in his book *The Expression of the Emotions in Man and Animals)* that many behaviour mechanisms are phylogenetic adaptations; in other words, that such behaviour mechanisms have evolved in the same manner as other features of animal populations by process of natural selection, and so are transmitted, from generation to generation, in the genetic code. That this in fact occurs in infra-human animals can now, in the light of the findings of ethology and behaviour genetics, be taken as demonstrated.

Indeed, as the behaviour geneticist Aubrey Manning has described,[69] an animal may possess within its nervous system the equivalent of an encoded 'picture' of the normal environment, and the appropriate responses to make to it. Further, the results of a recent experiment by Sackett[70] indicate that comparable innate recognition mechanisms exist even among species of the zoological order to which we ourselves belong. In Sackett's experiment, solitary young rhesus monkeys, reared in isolation from birth, and deprived of any opportunity of observing their own reflections, were enabled, by pressing levers, to project coloured slides on the walls of their cubicles. These slides depicted a range of objects, including a number of monkeys. Sackett's experimental subjects showed a marked preference for pictures of conspecifics, and especially for those of infant rhesus monkeys. Further, an early preference for pictures of threatening older rhesus monkeys persisted until about 2½ months of age, when fear responses were displayed and such pictures were avoided. In view of the fact that these infant monkeys had not experienced any social communication with conspecifics (or any other animal species), their recognition of an expression of threat becomes strong evidence for the existence in the rhesus monkey of phylogenetically programmed receptor mechanisms which make such reception possible.

In infra-human animals, then, the neonate is no behavioural *tabula rasa.* But this fact will cause no surprise to the evolutionary biologist, who recognises how vital to survival certain behaviour mechanisms are;

69 A. Manning, 'Drosophila and the evolution of behaviour', in *Viewpoints in Biology,* ed. J.D. Carthy and C.L. Duddington (London, Butterworths, 1965), 4:126.

70 G.R. Sackett, 'Monkeys reared in isolation with pictures as visual input: evidence for an innate releasing mechanism', *Science* (1966), 154:1468–1473; cf. also R.L Fantz, 'The origin of form perception', *Scientific American* (1961), 204(5):66–72.

who understands that these behaviour mechanisms have emerged in the course of evolutionary history because they contributed decisively to the reproductive success of the animal populations in which they were found, and who, from his knowledge of molecular biology, is aware that the genetic code is capable of storing and transmitting a quantum of exceedingly intricate information. As Francis Crick has graphically put it, the DNA molecules from just one sperm cell carry sufficient information, if it were written out, to 'fill about five hundred large books, all different — a fair-sized private library'.[71] An embryo's genotype, then, is an evolved compilation of astonishingly intricate instructions, not only for the building of such a marvellously complex structure as the central nervous system, but also for its behavioural operation. Or, to put it in another way, a genotype is the conditioning with which a living organism enters its environment, fitted to utilise it, this conditioning being the cumulative product of genetic adaptation to a succession of ever-changing environments during countless past generations. And these are conclusions which indubitably apply to us all, for one of the facts of which we may all be sure is that all of our lineal ancestors — back to the Miocene and beyond — reached reproductive age.

What then of the human neonate? Like other primate neonates, we find him equipped with a range of fixed action patterns, such as reflexive rooting and sucking, as well as displaying spontaneous cyclic activity, which as Teitelbaum has remarked,[72] is 'instinctive rather than reflexive', being strongly influenced not merely by external stimuli but by internal states as well. Nonetheless, the manifest behavioural repertoire of a newborn human infant is conspicuously limited. It was this superficial impression, perhaps more than anything else, which led Watson to the facile and erroneous conclusion that in the human species heredity counted for 'almost nothing', and led him to describe the human neonate as 'a piece of unformed protoplasm'.[73] What he failed to realise was that the genetic determination of the behaviour of an individual is far from over at birth. And here we come to the notable discoveries, in recent decades, of developmental biology. In the words of Frank Beach, 'the genotype is in continuous operation as far as its effects on behaviour

71 Crick, *Of Molecules and Men*, p. 58.

72 P. Teitelbaum, 'The biology of drive' in *The Neurosciences*, ed. G.C. Quarton, T. Melnechuk and F.O. Schmitt (New York, Rockefeller University Press, 1967), p. 559.

73 J.R. Watson, *Psychological Care of Infant and Child* (London, George Allen and Unwin, 1928), p. 18; Watson et al., 'Is man a machine?' *Forum* (1929), 82:265.

are concerned';[74] and further, it is now known that genes are 'turned on and off' in the course of ontogeny in intimate interaction with the environment, so producing the phenomenon of the critical or sensitive period of behavioural development.

Perhaps the best-known example of this is imprinting in certain species of birds, to which attention was first drawn by Konrad Lorenz in the 1930s.[75] Since then, critical periods for learning have been discovered in a wide range of social animals; among most breeds of dog, for example, as Scott and Fuller report, the optimum period for social bonding is between the sixth and eighth weeks.[76] Similarly, there is now a convincing body of evidence that there is a critical period for primary social bonding in the human species, beginning at a point in maturation reached at about three months or thereabouts, and marked by the onset of a persistent alpha rhythm of three to four waves per second in the electrical activity of the infant's brain.[77] This evidence, moreover, indicates (as does the comparative evidence from primatology)[78] that human kinship behaviour is phylogenetically based — a conclusion with profound implications for social anthropology and allied disciplines. There are also immediately practical implications; for example, J.P. Scott, a distinguished investigator of the process of primary socialisation, counsels those who would acquire a dog to do so, if possible, when it is between six and eight weeks of age; and he has recently advised that the adoption of a human infant should, ideally, occur 'as soon as possible after birth and no later than the first six months of life'.[79]

74 F.A. Beach, 'Ontogeny and living systems', in *Group Processes*, p. 14.

75 K. Lorenz, 'Companionship in bird life' (1935), reprinted in *Instinctive Behavior*, ed, C.H. Schiller (London, Methuen, 1957), pp. 83–128.

76 J.P. Scott and J.L. Fuller, *Genetics and the Social Behavior of the Dog* (Chicago and London, Chicago University Press, 1965), chapter 4.

77 J.P. Scott, 'The process of primary socialization in canine and human infants', *Monograph of the Society for the Research into Child Development* (1963), 28:1–47; D.B. Lindsley in *Brain Function*, ed. C.D. Clernente and D.B. Lindsley (Berkeley and Los Angeles, University of California Press, 1963), 5:73ff.

78 M. Yamada, 'A study of the blood-relationship in the natural society of the Japanese macaque', *Primates* (1963), 4:43–65; A. Tsumori, 'Newly acquired behavior in social interactions of Japanese monkeys', *Social Communication among Primates*, ed. S.A. Altman (Chicago and London, University of Chicago Press, 1967), pp. 207–219; J. van Lawick-Goodall, 'The behaviour of free-living chimpanzees in the Gombe stream reserve', *Animal Behaviour Monographs* (1968), Vol. 1, Part 3, pp. 222ff.

79 Scott, 'The process of primary socialization in the dog', p. 435.

Another instance is the critical period for language acquisition in the human species, the evidence for which has recently been presented by Lenneberg in his book *Biological Foundations of Language.* With the human infant the development of language does not begin until the age of 18 months or thereabouts, at which stage highly complex verbal behaviour is acquired naturally — that is, without formal instruction. We tend to take this extraordinary event, like so many biological phenomena, for granted; but we might well ask why the development of language behaviour does not take place earlier, as at six months when the infant is equally exposed to the verbal behaviour of those around him. The reason, the biological evidence suggests, is because the genetically monitored maturation of the nervous system has not yet reached the requisite sensitive period. When it does, however, the development of verbal behaviour is, as Hockett has expressed it,[80] 'as inevitable as menarche or the appearance of axillary hair, and genetically more stable than either'. In other words, as Lenneberg concludes, 'the processes by which the realized outer structure of a natural language comes about are deeply-rooted species-specific, innate properties of man's biological nature'.[81]

Rousseau in his enchanted dream was convinced that it might be possible to teach apes to converse like men. This, we now know, is 'against the use of nature', for a series of scientific investigations have shown that 'even amid human surroundings' a young chimpanzee 'never prattles and babbles' as a human infant does when beginning to talk,[82] this being for the good reason that the chimpanzee species has not evolved a genotype that permits the development of the brain mechanisms to sustain symbolic verbal behaviour. In such ways, then, whatever be the vaunting whims of men, 'nature her custom holds'.

In discussing the activation of genes during the course of ontogeny I noted that this occurs 'in intimate interaction with the environment'. Let me further emphasise that the recognition of the genetic determinants of behaviour in no wise involves neglect of the environmental determinants. Indeed, one of the major facets of the new biology is the meticulous experimental study of the both profound and subtle ways in which environmental forces influence the development of individual organisms,

80 C.F. Hockett, review of *Biological Foundations of Language* by E.H. Lenneberg, *Scientific American* (1967), 217(5):142.

81 Lenneberg, *Biological Foundations of Language*, p. 394.

82 W.N. Kellog, 'Communication and language in home-raised chimpanzees, *Science* (1968), 162:423–426.

and particularly during the course of early experience. It is this which René Dubos has recently called 'Biological Freudianism',[83] and many examples of such research could be cited, from Thompson's experiments on the influence of prenatal maternal anxiety on emotionality in young rats, to Gottlieb's recent demonstration that duck embryos (that is, still in the egg) are influenced by duck noises occurring in the outside world, and that such stimulation is essential to the development of their species-specific auditory perception.[84]

We are here dealing with behavioural plasticity, which is generally characteristic of the most recently evolved vertebrate class, the mammals, and especially characteristic of the most recently evolved order of that class, the primates; above all, of that primate of primates, *Homo sapiens.* The existence of this behavioural plasticity does not, however, preclude the existence of genetic diversity in populations, or the existence of genetically programmed behaviour mechanisms in individual organisms. Viewed in evolutionary perspective, therefore, learning behaviour is a phylogenetic adaptation, a way of completing the differentiation of the central nervous and related systems 'in greater detail and more adaptively than can be accomplished by gene encoding alone',[85] and it is this evolutionary innovation which has made possible the adaptive radiation which we observe in the diverse cultures of man.

A stage has now been reached, then, in the biological study of behaviour where any rigid and pervasive dichotomy between innate and acquired responses has become otiose. Galambos, in his recent discussion of the brain correlates of learning, has written: 'every sample of behaviour reveals an aspect of the past history of the organism that has been stored within the brain. These memories arise both via genes and through experience'; and he has suggested that 'all of them come into existence, are stored, and receive their expression through fundamentally the same mechanisms'.[86]

83 R.J. Dubos, *So Human an Animal* (New York, Scribner, 1968), p. 77.
84 W.R. Thompson, 'Influence of prenatal maternal anxiety on emotionality in young rats', *Science* (1957), 125:698–699; G. Gottlieb, 'Prenatal behavior in birds', *Quarterly Review of Biology* (1968), 43:148–174.
85 J.L. Fuller and W.R. Thompson, *Behavior Genetics* (New York, John Wiley, 1960), p. 4.
86 R. Galambos, 'Brain correlates of learning', in *The Neurosciences*, p. 641.

Thus, the discoveries of recent decades demand of the student of animal and human behaviour an interactionist paradigm which gives recognition to genetical and environmental feedback and interaction both in the ontogeny of individual organisms and in the phylogeny of breeding populations.

This interactionist paradigm, it will be seen, is markedly at variance with that contrived by Kroeber, Watson and the other intransigent environmentalists of the 1920s and 1930s, and its emergence has been the chief cause of the ferment that has been abroad in the behavioural sciences in recent years, and particularly since the advent of behaviour genetics in the early 1960s. Today, I would doubt it there are any informed behavioural scientists who would wish to take other than an interactionist position, and this must be ranked as one of the principal happenings in the scientific progress set in motion by the new biology.

Further, the interactionist paradigm has given rise to the exciting prospect of a unified science of man and his behaviour. For example, the recent major symposium on 'Biology and Behavior', held at Rockefeller University, had as its aim, according to Carl Pfaffman, the initiation of 'a period from which a unitary science of man will emerge in which his biochemistry, biophysics and biology will be integrated with the understanding of his behaviour'.[87]

As a result of this progress, and the present scientific supremacy of the interactionist paradigm, not a few social scientists and others, trained in yesteryear, now find themselves far out on a conceptual limb not of their own making — and this can no longer be regarded as a salubrious intellectual situation in which to be. In other words, such has been the progression in biological discovery and understanding during recent years that no one who professionally concerns himself with the study of men and their ways can afford any longer to pride himself on his illiteracy in matters biological. Rather, one would hope and expect that before long suitable courses on the evolutionary and biological bases of behaviour will become a recognised part of professional training in all disciplines in any way concerned with human behaviour.

87 C. Pfaffman, *Introduction to Neurophysiology and Emotion* (first of a series on Biology and Behavior, proceedings of a conference held under the auspices of the Russell Sage Foundation and the Rockefeller University), ed. David C. Glass (New York, Rockefeller University Press and Russell Sage Foundation, 1967), p. ix.

In recent years there have also been major changes in our understanding of the probable nature of human evolution. As I noted earlier, the cultural anthropologists of the early decades of this century would have no truck with Darwin's theory of evolution by natural selection. Thus, Kroeber, having asserted that 'nothing, homologous to the rudest culture' existed even among 'the highest animals', went on to advance the theory that culture had not evolved gradually in the course of human phylogenesis, but had originated by a sudden 'leap to another plane'.[88] The subsequent discoveries of prehistoric archaeology and of the ethological study of infra-human primate behaviour have reduced Kroeber's theory to the status of a private fantasy, for it is now known, from the researches of Dr Jane van Lawick-Goodall and others among wild chimpanzees in central Africa,[89] as also from those of Dr Kawai and his associates on the Japanese monkey,[90] that rudimentary cultural behaviour does indeed exist among infra-human primates; furthermore, both the palaeontological and archaeological evidence demonstrates an unbroken evolutionary continuity. Kroeber's theory, therefore, must be rejected, as also, on genetical grounds, must the Lamarckian theory of human domestication advanced by Boas.[91] From a multitude of scientific discoveries, then, it has become plain that evolution by natural selection has gradually created the human species, as it has all other populations of living things — but with certain innovations which seem to have occurred mainly in the evolutionary history of the *Hominidae* — that is of *Homo sapiens,* and the fossil species related to him.

And here I would like to pay tribute to the work of Sherwood Washburn, the distinguished American evolutionary anthropologist, whose researches and interpretations (with those of his many collaborators and colleagues) are leading to the emergence of a new anthropology. Among the most

88 Kroeber, 'The morals of uncivilized people', *American Anthropologist* (1910), 12:437; 'The superorganic', *American Anthropologist* (1917), 19:163–213; cf. p. 208; 'Social evolution is without antecedents in the beginnings of organic evolution … the dawn of the social thus is not a link in any chain, not a step in a path, but a leap to another plane'.

89 Lawick-Goodall, 'The behaviour of free-living chimpanzees in the Gombe stream reserve', pp. 202ff: A. Kortlandt and M. Kooij, Protohominid behaviour in primates', *Symposia of the Zoological Society of London* (1963), 10:61–88; Kortlandt, 'On tool-use among primates', *Current Anthropology* (1966), 7:215–216.

90 M. Kawai, 'Japanese monkeys and the origin of culture', *Animals* (1965), 5:450–455.

91 Boas, 'Human faculty as determined by race', pp. 309ff; *The Mind of Primitive Man*, pp. 75ff; 'The aims of anthropological research', *Science* (1932), 76:607.

important of Washburn's notions is the inference that the gene pools of hominid populations evolved in a feedback relationship with nascent cultural behaviour. Thus, in Washburn's words:

> The success of initial tool using, perhaps only slightly more advanced than that seen in the contemporary chimpanzee, led to selection for the biology that made tool using possible, and the study of the brain of *Homo sapiens* shows that large areas are associated with hand skills. The reason that tool making evolved so slowly was that the brain had to evolve before the skills of *Homo erectus* were anatomically possible. According to this view the explanation of human evolution is to be sought in the feedback relation between successful behaviour and the biology that makes the behaviour possible.[92]

In other words, a cultural innovation is an addition to the previously existing environment with consequent feedback or selective pressure on the breeding population and its gene pool; which means, it will be discerned, that instead of being 'utterly divergent', as Kroeber in his ignorance supposed, cultural behaviour and man's biological nature have, on repeated occasions in the unbroken course of evolution, been in communication at the molecular level, for, as J.B.S. Haldane has succinctly phrased it, 'the principal unit process in evolution is the substitution of one gene for another at the same locus'.[93]

We may say then that the species *Homo sapiens* is pre-eminently the evolutionary product of the new selective pressures that came with the emergence of rudimentary forms of culture — this emergence going back some millions of years, at least into the Pliocene, and possibly, as Leakey has recently suggested,[94] into the Miocene. It follows that, in the study of human evolution, prehistoric archaeology and the comparative analysis of cultural behaviour become as important as genetics, the neurosciences, ethology and ecology; and further, that the relevant concepts and findings of all these and various cognate sciences must be integrated if the aetiology of human evolution is to be fully comprehended.

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92 S.L. Washburn, 'Behavior and the origin of man', *Rockefeller University Review* (1968), January–February, p. 17.

93 Haldane, 'The cost of natural selection', *Journal of Genetics* (1957), 55:511.

94 L.S.B. Leakey, 'Development of aggression as a factor in early human and pre-human evolution', in *Aggression and Defense* (*Brain Function*, Vol. 5) (Berkeley and Los Angeles, University of California Press, 1967), p. 7.

With the advent of cultural behaviour, then, our hominid ancestors entered a new phase of evolutionary development in which behavioural adaptations dependent on the transfer of information from generation to generation by other than wholly genetic mechanisms gradually increased, until, with the emergence of symbolic modes of communication, *Homo sapiens* has become that evolutionary *rara avis* — a predominantly cultural animal. Nonetheless, as modern research indicates, our capacity to increase and transmit learned behaviour is still and always has been and will be ultimately dependent on phylogenetically evolved capacities. It thus becomes apparent that culture is a purely natural phenomenon, and has developed in continuous interaction with phylogenetic processes to become the prime biological adaptation of our species.

It is, moreover, our unique evolutionary history which has made us the 'embodied paradox' that we are; for man, in behavioural terms, is a kind of evolutionary compendium, with mechanisms in the phylogenetically old parts of his brain, such as his reticular formation and limbic system, which he shares with vertebrates as meagre as lizards and as excitable as the chimpanzee; while in his neo-cortex are neuronal circuits which confer on him the capacity to engage in symbolic behaviour and to exercise preferences — so that he becomes like a god, having knowledge of good and evil. This capacity to exercise preferences has gradually emerged in the course of human evolution in close conjunction with the capacity to symbolise, to recall the past and envisage the future, and so has given to man a freedom of action, limited though it be by inexorable natural processes, that far excels that of any other animal organism. And with this freedom — as the brief chronicle of our recorded history shows — human individuals have soared to sublime heights and descended to disastrous depths.

We are here confronted with the phenomenon of human values, for values are a function of the capacity to exercise preferences, and so, ineluctably become a part of the subject matter of evolutionary anthropology, as indeed of any discipline that concerns itself with human behaviour.

In the words of the American biologist Herrick: 'Man's capacity for intelligently directed self-development confers on him the ability to determine the pattern of his culture and so to shape the course of human

evolution in directions of his own choice. This ability, which no other animals have, is man's most distinctive characteristic, and it is, perhaps, the most significant fact known to science.'[95]

The truth embodied in these words has now, I believe, become apparent to very many scientists; moreover, concern with values is intrinsic to what Bronowski has called 'the culture of science'. We can practise science, as Bronowski reminds us, 'only if we value the truth'.[96] By valuing the truth, scientists make radical discoveries about the determinisms of nature, which inevitably extend the range of choices open to men, and so create situations in which concern with values is inescapable. Indeed, I would argue that it is only when he understands something of the determinisms of nature, including, most importantly, the determinisms of his own body and brain, that a man can begin to become truly and humanly free. As René Dubos has so well expressed it: 'Man makes himself through enlightened choices that enhance his humanness'.[97]

What then are the prospects for a science of human values? First, it will be necessary to transcend the doctrine of cultural relativism which denies even the possibility of any broadly based evaluation of human choices, by asserting, as it does, that differing forms of cultural behaviour or shared preference are normal *sui generis,* and so cannot be compared in biogenetic or any other terms.

Fortunately, the biological sciences have something better to offer us. Basic to the science of evolutionary biology is the phenomenon and concept of adaptation. Simpson, Pittendrigh and Tiffany have defined an adaptation as 'any aspect of the organism which promotes its welfare, or the general welfare of the species to which it belongs, in the environment it usually inhabits'.[98] Fundamental to this definition is the notion of welfare, and it is apparent, in the light of much cumulative experience in the biological sciences, that no adequate analysis of the evolutionary process is possible without the concept of adaptive value.

95 C.J. Herrick, cited by Robert B. Livingston in *The Neurosciences*, p. 500.
96 J. Bronowski, *The Identity of Man* (New York, Natural History Press, 1965), p. 100.
97 Dubos, *So Human an Animal*, p. xii.
98 G.G. Simpson, C.S. Pittendrigh and L.H. Tiffany, *Life: an Introduction to Biology* (New York, Harcourt, Brace, 1957), p. 434.

Further, concomitant with this fundamental biological phenomenon of adaptation is the phenomenon of organic diversity, for adaptation and diversity are equally the products of evolution by natural selection. Moreover, this diversity of animals and their behaviour exists both among species and between individuals within the same Mendelian population.

From these natural characteristics of populations of living things, we are able to derive the fundamental principle of *adaptive diversity,* and it is this principle, I would suggest, that must guide any science of human values, for it provides us with the soundest of biological foundations — *the positive evaluation of diversity whenever it is adaptive* — this being the value inherent in evolution by natural selection and so in the life process itself.

The analysis of the diversities of human behaviour in terms of their adaptive value must depend, it is plain, on a unified scientific understanding of the natures and situations of human beings. This scientific understanding, which we have been seeking for so short a time, is still very limited, but it is now progressing faster and more fundamentally than ever before in our extraordinary history as a species, and from this we can take hope.

But let us also hope that those who become involved in the scientific study of values will not neglect the wisdom of their precursors, who, down the ages, have given concern to the nature — ever-changing as it is — of human values.

On a wall of one of Canberra's high schools someone has written: God is dead. Beneath it a juvenile wit has added the words: No, he's not, he's alive, and doing a science course at the Uni. This experience, I have little doubt, would be edifying to many of the gods of which men have so far conceived, but I am constrained to wonder whether some of man's gods, if only in the sense of symbolic projections of species' wisdom about adaptive values, might not have something of importance to tell some of the scientists.

One of the most memorable of William Blake's poems begins:

Tyger! Tyger! burning bright
In the forests of the night.
What immortal hand or eye
Could frame thy fearful symmetry?

And Blake goes on to ask:

Did he who made the Lamb make thee?

We now know that it was the evolutionary process that made the Tyger burning bright, as it made us; but to me as a student of human evolution, one of the most notable of evolutionary phenomena is that the human species, ascended as it is from impulsive, predatory and carnivorous apes, should have produced behavioural innovators, whatever their quirks, such as Hammurabi and Confucius, Akenaton and the Buddha, Jesus (for Blake's Lamb has a capital L) and Francis of Assisi, who, with his awareness of the interdependence of living things, might well be adopted (as an American historian has recently suggested)[99] as the patron saint of ecology.

Such an ethic of concern for the welfare of others, which is comparable to the Buddhist value of needfulness, is gradually becoming part of a scientific and humanistic attitude towards human existence, and a true scientist must, I believe, while not abandoning the mechanistic *Weltanschauung* (which has contributed so markedly to the scientific understanding of biological phenomena), come to adopt such an attitude of informed concern towards the life process in all its aspects, for without such human values, as W.H. Auden has reminded us, 'no secular wall will safely stand'.[100]

What we can rationally hope for, then, is the emergence, within the next few decades, of a unified science of man and his behaviour, grounded on evolutionary biology, and drawing on the universe of relevant scientific knowledge, while remaining cognisant of evolving human values in their adaptive diversity.

When geneticists, neuroscientists, ethologists and ecologists can sit down with archaeologists and historians, psychologists and anthropologists, to work together, using a common scientific and human language, to illumine the evolutionary history and the natures and cultures of men, the day of such a unified science of man will have dawned. That day, I hope and believe, is not far distant.

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99 L. White, 'The historical roots of our ecologic crisis', *Science* (1967), 155:1207.
100 W.H. Auden, 'Vespers' in *Collected Shorter Poems, 1927–1957* (London, Faber and Faber, 1966), p. 335.

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