

plished, and a good deal is being done to reform criminals so that they do not repeat their offence. But we could still do much to diminish crime in two ways. In the first place, we could cease to punish various forms of abnormal conduct, especially sexual conduct, which are now criminal, and which, though inelegant, do no harm except perhaps to the criminals. The example of such countries as Denmark proves that a relaxation of the law in these matters would not be dangerous. Secondly, we can alter the law so that crime is not the only practicable escape from an intolerable situation. To-day theft is often the only method available for supplying one's children with boots; and murder or suicide the only way of terminating a marriage with an habitual criminal or drunkard.

Britain is ripe to-day for a new attitude to crime based on scientific data and a scientific point of view. The great reforms of a century ago in our criminal law, which abolished capital punishment for minor offences, resulted from the partial adoption of utilitarianism. A similar reform would be only one of the many benefits which would result from the general adoption of a more scientific point of view regarding human conduct.

PM J. B. S. - Halldane
Pelican Books, 2nd ed, 1937
London. IS HISTORY A FRAUD?

EVERY generation must re-write history. New facts become available, and old facts are interpreted anew. In the last century several new standpoints have been adopted, and in particular the attempt has been made to interpret history in terms of economics. But the greatest change has been in the extent of history. A hundred years ago it began about 700 B.C. Before that

time there were various legends. Those of the Bible were in a class apart, and they were treated as Sacred history, and put into a separate compartment from Profane, or ordinary, history. As long as one was compelled to believe in the literal truth of two mutually contradictory accounts of the great Mesopotamian flood, it was no use trying to disentangle the very considerable amount of historical fact embedded in these legends. And the effort of faith involved was relieved by a quite undue scepticism about other legendary events with a historical core, such as the siege of Troy and the story of the Minotaur.

The enlargement of our horizon began with the interpretation of Egyptian hieroglyphics. If Columbus doubled the field of geography by discovering America, Champollion in 1821 doubled the field of history by making possible the translation of documents some of which are over 4000 years old. A generation later Rawlinson decoded the cuneiform script in which the languages of ancient Mesopotamia were inscribed on clay tablets. As a result of this, history now extends more than twice as far into the past as it did a century ago. It is true that the earliest date known with certainty is 2283 B.C. At 11 a.m. on March 8 of that year occurred a total eclipse of the sun, which portended the sack of Ur by the Elamites. This ended the third dynasty of Ur, a city whose history at that time went back to before Noah's flood, which had not completely submerged it, though it laid down 6 feet of mud in its low-lying suburbs. The date of the flood is still doubtful, though probably somewhere between 4000 and 5000 B.C. On the other hand, Woolley is quite confident as to the main sequence of events in southern Mesopotamia as far back as about 3500 B.C., though the dates may well be a century out. Egyptian history appears to begin rather later than this.

Where there are no written or carved records it has been possible to construct a very rough picture of the more important events. Thus we have evidence, from sudden changes in the shapes of the skulls in graves and the objects found with them, of two prehistoric invasions of England. And still further back one discovers, though only in their dimmest outlines, a whole series of different stone ages, each with its characteristic skull-shape and art, until one reaches the half-men of Neanderthal, with great brow-ridges and no chins. They chipped flints in a crude way, and possessed fire, but, though they inhabited Europe for scores of thousands of years, they have not left a single work of art. Only by a perhaps misplaced courtesy do we call them men. It is against this background of barbarism that history stands out.

As history cannot exist in the absence of records, and as archaeology has already reached back to the origin of writing, from pictures, both in Egypt and Mesopotamia, it is unlikely that future research will ever extend our historical knowledge very much further into the past. We shall probably never know the name of any man, city, or nation, before 5000 B.C. Most of historical research in the future will consist in the filling in of gaps. It is therefore possible to-day for the first time to take a bird's eye view of history as a whole.

The picture so obtained proves, I think, that the history taught to-day in our schools and universities is reliable in its details, but as a whole quite misleading. English history is taught as a progress in social organization, broken only by the decay of Roman civilization and its final overthrow by the Angles and Saxons. And the origins of our culture are traced back, on the one hand to the Greeks and Romans, who gradually built up a complete civilization with highly developed litera-

ture, art, and law, from rude beginnings; on the other to the Jews, who evolved most of the religious and ethical ideas which govern us to-day.

The truth is rather different. The curtain rises at Ur and other cities of the land then called Sumer in southern Mesopotamia, about 3500 B.C. and reveals a fully developed civilisation, They built well, using the arch, which only reached Europe 3000 years later. They had cloth, wheeled vehicles, pottery, bronze, copper, silver and gold ware, a small amount of iron, sculpture, music, writing (on clay tablets), seals and a complete social organization. And it is unfortunately quite clear to anyone who visited the British museum in 1928 that their standard of taste in art was superior to our own to-day. They still killed servants to wait on dead princes in Kur-nu-gea (No Return Land), but this practice had been abandoned 500 years later. Though one cannot defend this custom, it is only fair to remember that in this enlightened age more people were killed in four years as a result of the death of the Archduke Franz Ferdinand than were sacrificed in the whole course of Sumerian history. When we get a clearer view of their civilization, about 2500 B.C., we find sanitary conveniences with adequate drains in the houses, better than those of many English cottages to-day. There was a small standing army supported by a feudal system, with conscription in time of emergency for citizens. Slaves existed, but had some legal rights, and could own property. So could women, married or unmarried. There was a definite code of civil and criminal law, with professional judges. 4500 years ago southern Mesopotamia was a great deal more civilized than is half the world to-day. Egypt was also civilized, though probably the average man or woman was worse off than in Mesopotamia. There was also a civilization in the valley of the Indus, of which we know very little,

except that it must have been in contact, or have had a common origin, with that of Mesopotamia.

We do not yet know where civilization started. The Mesopotamians said that their ancestors came from the sea, that is the Persian Gulf. As they represented their gods as standing on mountains, it is conjectured that they came from a hilly country. Their culture cannot have come mainly from Egypt as is sometimes believed, unless some very serious mistakes indeed have been made with regard to dates.

At present the principal clue to the spot where civilization began comes from an entirely unexpected source, namely, plant genetics. Civilization is based, not only on men but on plants and animals. It needs a cultivated plant giving high yields of storable food, an animal to carry loads and pull carts or ploughs, and a plant or animal source of fibres. The principal plants available are the cereals, the soya bean, and the potato, and these are of very unequal value for biochemical reasons. For example, maize, as compared with wheat or oats, is very poor in vitamin B2. Hence populations living mainly on maize get a skin disease called pellagra. This is probably one reason why the maize-civilizations of central America never reached the level of the wheat, barley, and rice civilizations of the old world. The other reason is that America was very poor in domesticable animals. The buffalo is no substitute for the cow, and the llama a very poor one for the horse and sheep.

Hence, if it is possible to determine where cereals and cattle were first domesticated, we shall have gone a long way towards tracing civilization to its source. This task is being undertaken by Vavilov and other Russian scientists. Karl Marx's *Kapital* has largely replaced the Bible in Russia to-day, and one of Marx's doctrines is that if we know how production is organized in a society

we know the most important thing about it, and can even deduce its religious or philosophical system to a large extent. So Russian biologists are studying not only the domesticated animals and plants of to-day, but their ancestors which were the means of production in primitive societies. In the case of wheat the results are fairly clear. There are two distinct groups of wheat, which can only be hybridized with difficulty, and each can be traced to a definite centre. As that centre is approached, more and more different kinds of wheat are found, and these show all kinds of characters, such as purple shoots, which have been lost in the most cultivated varieties, and which are shown by breeding tests to be almost certainly primitive characters. One of these centres is in Abyssinia, the other, from which the more important groups of wheats is derived, in or near south-eastern Afghanistan. The former is taken to be the original home of the agriculture that led up to Egyptian civilization, the latter the source of Indian and Mesopotamian wheats, and of the more important varieties grown in Europe and North America to-day. What is more, a great many other cultivated plants seem to have originated in one or the other of these centres. For example, rye, carrots, turnips, and some types of beans, lentils, flax and cotton, seem to be of Afghan origin. At present the archaeology of these regions is quite untouched, but the results of excavation, especially in the Afghan area, are likely to be of extreme interest. Agriculture, if Vavilov is right, started in mountains, and only later spread to river valleys.

In the same way a knowledge of the origin of the dog would throw an immense amount of light on pre-history. Dogs have been domesticated since neolithic times at least, probably for far longer than cattle, which is doubtless one reason why they fit better into human

society. However, no one has yet any serious idea where they were first domesticated.

But to return to better ascertained facts. Between about 3000 B.C. and A.D. 1400 there was very little improvement in the quality of civilization at its best. Yet it did spread out from its original centres in the valleys of the Nile, Euphrates, and Indus, to cover an ever wider area. This area sometimes contracted, as when our ancestors overran the western Roman Empire, when the Turks destroyed the civilization of Mesopotamia after a continuous run of over 4000 years, or when large areas of Central Asia dried up into deserts. It is probable that an important part in shifting the centres of civilization to more temperate countries was played by the malaria parasite and the hookworm *Ankylostoma*, which causes anaemia. These can only flourish in warm damp countries, and there is a certain amount of evidence that they have been spread about the world during the last 4000 years.

Between 3000 B.C. and A.D. 1400 there were probably only four really important inventions, namely the general use of iron, paved roads, voting, and religious intolerance. Perhaps I should have added coinage and long-distance water supply. Gunpowder had been known for a long time before A.D. 1400 in China, but did not begin to win battles in Europe till the seventeenth century. Some-what before that date, however, it had helped to accelerate the decay of feudalism by diminishing the military value of castles. Knowledge progressed slowly, and we now know that we have greatly over-estimated the originality of Greek mathematics. Babylonian mathematical astronomy was very highly advanced. Kidinnu, their last great astronomer, who lived about 400 B.C., was a great deal more accurate in the numbers which he used in predicting eclipses and the like than any of his successors until about fifty years ago. His knowledge

had, however, been forgotten in the interval, and his calculations were translated just too late to be of any serious value to astronomers. In Assyria the average educated man knew the multiplication table. As King Ashurbanipal put it in his autobiography, 'I recited the complicated multiplications and divisions which are not immediately apparent.' The same level was not reached in England till the late seventeenth century. Pepps was grown up when he learned his multiplication table.

As regards law, the code of King Dungi, who reigned in Ur about 2340 B.C., compares quite favourably with that of King George IV. of England a century ago. King Dungi's subjects kept slaves, though the slaves were allowed private property. They did not, however, hang children for theft. Their wives, unlike those of our great-grandfathers, were allowed private property, and if their husband took a concubine, instead of having no legal remedy at all, like English women up to 1923, they had the right to make their supplanter wash their feet and carry their chair to church, though she had also certain definite rights as against the husband. As the legal code gives a rough reflection of the moral standards of those who framed it, we may suppose that, on the whole, morals have not greatly improved during the course of history.

Christianity and other religions have, of course, on occasion been great weapons in the hands of moral reformers, but they have also been effectively used for the opposite purpose. To take an obvious example, slavery, and what is worse, slave-raiding, still exist in Christian Abyssinia, the latter evil nowhere else. And when Lloyd Garrison opened his anti-slavery campaign in Boston in 1830 he met with such opposition from all religious bodies that he was compelled to start in an infidel hall.

These facts must be weighed against the religious motives which prompted Wilberforce and Clarkson in their campaign against slavery in the British Empire. The balance is equally even in the case of other moral reforms.

Iron of a sort was known from a very early age, but it was only produced on a very large scale and of a useful type in the second millennium B.C. At the siege of Troy, about 1200 B.C., it was still an expensive novelty. It made a somewhat higher material level of civilization possible, but it also made war more efficient and terrible. Paved roads increased the possible size of the state, and voting made various republican forms of government possible, though democracy was extremely rare. The so-called democracies of the ancient world were almost invariably governments by associations of slave-owners. Religious intolerance (which was possibly invented by the Jews, and independently by the Zoroastrian Persians) had important effects in producing uniformity of culture, and was a great means of spreading civilization. The ancient Romans, who were not intolerant, could not conquer the Germans, and did not try to make them substitute Jupiter for Thor. Indeed they thought the two were the same. (I always have to remember this fact before I translate 'Judi' into English, my natural tendency being to equate Jove with Woden.) St. Boniface and other missionaries persuaded many of the Germans to leave Thor for Christ, and incidently to adopt various Roman customs which went along with Christianity, just as modern missionaries diffuse trousers and football along with the gospel. In this way the Germans were ultimately civilized. But religious intolerance, both Christian and Mohammedan, also played a great part in lowering the level of civilization throughout what had been the Roman Empire.

Up till about A.D. 1400, then, civilization spread a great deal, but rose very little. It is only if we confine our attention to such areas as Western Europe, where it arrived very late, that it appears to have improved. In the fifteenth century a new process began. For thousands of years educated people had despised manual labour. This was natural enough when it was largely performed by slaves. But in the late Middle Ages things were different for three reasons. In the first place, the ruling military class were illiterate. Many kings could not sign their names. There was, however, a fair amount of education in other parts of the population. Secondly, thanks to St. Benedict and certain other founders of religious orders, a large number of the clerical class, who were relatively educated, had a first-hand acquaintance with manual labour. Thirdly, the towns were very largely governed by the guilds, in which men who had become skilled workers rose to positions of wealth and power.

Hence the possibilities for experimental investigation on a large scale by educated men arose. The scientists of the past had investigated nature, but almost always by observation and not experiment, and they had never made elaborate apparatus. Plato had believed that the future of humanity lay in the hands of the philosopher who was also a king. He was wrong. The combination required was that of philosopher and craftsman. Modern physics began in Leyden, where the great Simon Stevinus founded statics in 1586 by a study of the principles underlying the lever and the sluice. Incidentally he invented decimals and influenced world history about as much as Napoleon or Washington by devising the system of defence of Holland by sluices. This enabled the Dutch to win the eighty years' war against the Spaniards, who were far better soldiers, and saved the Reformation. And modern industry began

with printing about 1450. This invention was important not only because it cheapened books, but because it was the first example of mechanical mass production applied to articles formerly produced one by one.

Even so the old civilization might perhaps have been saved. The main principles which have guided scientific research ever since were laid down by Galileo, who first used the experimental method not merely as an occasional resort in difficult cases, but as a normal method of investigation. The man who is probably the greatest living experimentalist once said to me that but for Galileo and men like him he would never have thought of using experiment rather than unaided observation and thought to search out the nature of things. If Galileo and a few more like-minded men had been burned alive at an early age we might very possibly still be living under a civilization not greatly different from that of the Middle Ages.

But the progress of science was slow. Galileo died in 1642, and it was not till 161 years later that Symington's steam tug, *Charlotte Dundas*, towed two barges for 19½ miles on the Forth and Clyde Canal. Leuwenhoek invented the first efficient microscope in about 1660, and it was two centuries before Pasteur used it to discover the cause of infectious diseases. It is only in the last hundred years that civilization, after six thousand years, has begun to change all through. But to-day the external conditions of life in civilised communities differ more from those of 1829 than did the conditions of 1829 from those at the time of Noah's flood. And this change, the real world revolution, has only just begun. We have gone an immense way in improving and organizing production and communication; we have nearly abolished water-borne and insect-borne diseases, and that is about all. Science has not yet been applied to most human activities. It can be, and I hope will be, applied to all.

The world is, of course, full of alleged applications of science outside the realms of production and hygiene, but the vast majority of them show no trace of scientific method. Thus there are numberless systems of education which are supposed to be based on scientific child psychology. But they are usually applied to small groups of children, in many cases to the children of unusually intelligent parents, brought up in unusually intelligent homes. If such children later turn out to be more successful than the average, this proves nothing at all. In order to prove the superiority of some new system, for example the Dalton plan, it will be necessary to follow up some thousands of average children educated under it, and some thousands educated on the ordinary system, and to find out which group on the average grow up into better citizens. This has not yet been done, and until it has been done it is ridiculous to talk about scientific method in education. Scientific method combines observation with experiment. Experiment without observation may be an enthralling occupation, but it is not science.

But the application of science to industry and medicine has entirely altered political problems. Until a few years ago every 'civilized' country really consisted of a small number of more or less civilized people among a multitude of uneducated poor who shared to a very slight extent in the benefits of civilization. Any equalization of incomes would merely have reduced the few to the level of the many, and destroyed what little culture existed. Socialism and civilization were obviously incompatible. To-day the national income is large enough to admit of universal education, and it could be more evenly divided than it is at present without endangering science, art, or literature. That particular argument against Socialism is no longer valid. And hygiene has provided another serious argument against our present

economic system. We now live so long that a large portion of the capital in many countries is in the hands of people over sixty years of age, who naturally show less enterprise than younger men and women. A good deal of Socialism arises from irritation at this fact, though anti-Socialists can fairly reply that a Government official at forty commonly shows as little enterprise as an ordinary man at sixty-five.

For this reason history helps us very little in deciding for or against Socialism. The situation of to-day is something entirely new. The old civilization, which had lasted for six thousand years, is in process of replacement by something which will differ from it as completely as it differed from savagery. History, as generally taught in schools, is the story of the political squabbles of the last two thousand years, and is, on the whole, rather a futile story. It becomes valuable when it is studied in detail, because it illustrates the psychology of politicians and that of crowds. Far more light is thrown on the English civil war by the fact that Charles I. was afflicted with severe stammering in his youth than by the quaint legal arguments which he used to justify his ill-considered actions. This is why men and women to-day prefer to read biographies of historical characters rather than histories of the British Constitution. We have our Charles I.'s in politics to-day, and biographical history enables us to understand and pity them. But conventional history may lead us to share their delusion that they are now living in the eighteenth century, as Charles I. apparently supposed that he was living in the Middle Ages.

The interpretation of history has tended to oscillate between two fallacies. The obvious fallacy is to regard it as the story of great men and great movements. But on a long view these very nearly cancel one another out.

The struggle between freedom and authority has gone on all through history, and any unbiased person must recognise that both parties at any moment have had a good deal of right on their side. And few of us can be whole-hearted partisans in any war of more than a hundred years past. In disgust with these great political figures we turn to the idealists who took no direct part in government, but produced novel ideas and points of view. Here, we like to think, are the real leaders of mankind.

We are the music-makers and we are the dreamers of dreams,
Wandering by lone sea-breakers, and sitting by desolate streams,
World-losers and world-forsakers, on whom the pale moon gleams,
But we are the movers and shakers of the world forever, it seems.

We in the ages lying in the buried past of the earth
Built Nineveh with our sighing, and Babel itself with our mirth,
And o'erthrew them with prophesying to the old of the new world's worth,
For each age is a dream that is dying, or one that is coming to birth.

I believe that this is as great a fallacy as the other. The dreamer of dreams can at most replace one set of symbolic ideas by another, the cross by the crescent, or the mother of the gods by the mother of God. After wars and revolutions, crusades and martyrdoms, the new dream is sometimes adopted. The world has been shaken, but there is very little evidence that it has been moved. But if the dreamers and the music-makers have not greatly altered the world by imposing their special dreams on it, the greatest of them have slightly raised the level of human life. We can meet the prospect of

death with greater equanimity because Shakespeare wrote—

Men must endure
Their going hence, even as their coming hither.
Ripeness is all.

We can love more passionately because Marvell told his coy mistress that—

The grave's a fine and private place,
But none, I think, do there embrace.

And we can be better citizens of the universe, better botanists, even better horticulturists, because Jesus said, 'Consider the lilies how they grow; they toil not, they spin not, and yet I say unto you, that Solomon in all his glory was not arrayed like one of these.'

The reason for the relatively small ultimate effect of the dreamer is, I think, fairly clear. He or she is primarily concerned with the human spirit. Even to-day the workings of the spirit of man largely elude our intellectual grasp. In other words, psychology is not a science. Spiritual things must therefore be shown, if at all, in symbols, and these symbols are interpreted in different ways by different men, so that Blake could write—

The vision of Christ which thou dost see
Is my vision's chiefest enemy.
Yours is the healer of mankind,
Mine speaks in parables to the blind.

Thus religion tends inevitably to crystallize into theology, and the letter to choke the spirit.

Ultimately I can see no reason to doubt that psychology will become scientific, with results of incalculable importance. Even to-day the first feeble attempts to introduce scientific method into it are producing a change in human thought and conduct only comparable with those which are generally brought about by a new religion.

Who, then, have been the real world-revolutionaries, the men who have done such deeds that human life after them could never be the same as before? I think that the vast majority of them have been skilled manual workers who thought about their jobs. The very greatest of them are perhaps two men or women whose real names will remain forever unknown, but whom we may call Prometheus and Tiptolemus, the inventors of fire and agriculture. Prometheus, who was a Neanderthal man¹ with great brow ridges and no chin, discovered how to keep a fire going, and how to use it to such advantage that his successors were induced to imitate his practice. Probably some later genius discovered how to kindle a fire by rubbing sticks together, and I like to imagine that it was a woman who first presented her astonished but delighted husband with a cooked meal. Fire was a very ancient invention, made in the early part of the old Stone Age, but apparently seeds were first systematically sown not so very long before the dawn of history. The immediate result was to make possible a fairly dense and settled population in which civilization was able to develop.

All through the historical period great inventions were made which were so clearly useful that they were bound to spread over the earth. Great intellectual discoveries were also made, but they were often forgotten because they led to no practical result. Thus the ancient Egyptian possessed a primitive kind of algebra. The chief algebraical papyrus known to us, which deals with simple equations, is called 'Directions for obtaining knowledge of all dark things.' But this algebra was forgotten and had to be re-invented, because it was not applied to any useful purpose, whereas the Egyptian methods of surveying have developed into those in use

¹ Recent excavations in China suggest that the ape-man *Sinanthropus* possessed fire. Prometheus lived longer ago than I thought.

to-day. To-day science is important because it is applied and it is only the applicable portions of science which are reasonably sure of survival.

Compare the two greatest biologists of last century, Pasteur and Darwin. Pasteur's fundamental ideas are fairly sure of survival, because any nation that disbelieved in them would double its death-rate if it carried that disbelief into practice. But although Darwin's main ideas are accepted by most scientific men, no obvious disasters would follow their rejection.

Both in England and America there are religious bodies which are either anti-Pasteurian or anti-Darwinian. It is perfectly conceivable that during the next century the Roman Catholic Church may gain control of Europe, or the fundamentalists of North America. In either case, Darwinism will be proscribed, and the average man will not be much worse off on that account. But if in the next fifty years Darwin's ideas are applied to produce some great improvements in agriculture, hygiene, or politics, such a proscription will at once become more difficult. A government of consistent Christian Scientists, who refused to take preventive measures of a material kind against the spread of epidemic disease, would be far more dangerous than a government of fundamentalists. Darwin's intellectual achievement may have been as great as Pasteur's, but so far it has only led to a change in fashionable beliefs which may not be permanent, while Pasteur's has affected the whole structure of civilized society, and will probably go on doing so.

If I become Pope, which does not at present seem very probable, I shall at once take all the steps in my power to secure the canonization of Pasteur, who was, of course, a sincere Catholic. And I shall give the official blessing of the Church to some of the theories and practices which he introduced. But I shall point out the

really weak points in Darwin's argument, which most defenders of the faith seem to miss completely, and anathematize them as errors.

It is significant that Pasteur was not only a great thinker but a superb technician, a man of immense manual skill who invented a great deal of the complex technique by which substances can be kept free from microbes, and one kind of microbe can be grown without contamination by others. Bacteriological theory is largely the verbalization of this technique. Pasteur clearly thought a great deal with his hands, Darwin rather little.

Many of the more historically important ideas were not at first put into words. They were technical inventions, which were at first handed down by imitation, and only slowly developed a verbal theory. When they did the theory was generally nonsense, but the practice sound. This was obviously the case, for example, until quite recently, with the extraction of metals from their ores. Certain methods worked, but no one knew why, and those who thought they knew were wrong. As the historical importance of production was not realized until recently, we shall never know who discovered iron-smelting, or, what would be more interesting, how he discovered it.

But there is another reason too. The first-rate technician is generally much more interested in his craft than in his personal fame, or even in his life. In order to obtain the necessary conditions to create a masterpiece or perfect a new process he is perfectly willing to lose himself in a glorious anonymity. The architects of many of the world's greatest buildings, like the great inventors, are often unknown, and generally mere names. The knowledge that this would be so would not have distressed them. Their attitude is summed up in one of the songs sung by airmen during the war.

Take the cylinder out of my kidneys,
The connecting rod out of my brain,
The camshaft from under my backbone,
And assemble the engine again.

The engine remains as their very real memorial. Similarly I am inclined to think that such men have been very largely responsible for so much of steady progress as is traceable behind the ebb and flow of history. The British Empire was made possible by the gradual improvement in navigation during the seventeenth and eighteenth centuries, and was consolidated by the steamship. The United States were united by railroads. The aeroplane is going to create the World State.

The point of view which I am urging is unpopular for two reasons, apart from the inevitable shortness of historical views until recently. In the first place, history is written by people impressed with the importance of their own political and religious views, and inevitably takes on the character of propaganda for them. But a more fundamental cause is as follows. Historians have inevitably thought in terms of words. They have read many books and documents. They have often been great stylists like Gibbon and Macaulay. They have realized the power of words to move multitudes. They have not been manual workers, and have seldom realized that man's hands are as important as and more specifically human than his mouth. Those intellectuals who have also been intelligent with their hands have mostly confined their writing to scientific and technical questions. Perhaps I ought to do so myself. But when I look at history, I see it as man's attempt to solve the practical problem of living. The men who did most to solve it were not those who thought about it, or talked about it, or impressed their contemporaries, but those who silently and efficiently got on with their work.

PREHISTORY IN THE LIGHT OF GENETICS¹

Our knowledge of the human past before the dawn of history will probably always be based in the main on the results of actual excavation of artefacts and skeletons. Nevertheless, a study of current phenomena or those of the more recent past may furnish important evidence. Thus, we cannot neglect the evidence from comparative philology which so impressed our grandparents, or that from the geographical distribution of customs which is brought forward by the diffusionist school to-day. I propose to bring to your notice a new class of evidence, that from genetics. Genetics is the branch of biology which deals with the causation of innate differences between organisms. It includes the study of heredity, but has a wider scope, because it explains not only why children resemble their parents, but why they differ from one another. The key to genetics is the discovery by Mendel that the basis of heredity is atomic, the innate constitution of an organism being determined by genes, of which the number is finite. Moreover, any individual (at least in the higher animals) contains either two, one, or none of each kind of gene.

Now the physical characters on which the anthropologist has so far relied are not simple from the genetical point of view. Thus stature, skull shape, and skin colour are modifiable by the environment, and the difference between the hair form of a Bushman and a European depends on several different genes. Moreover, some characters have a considerable selective value, so that we cannot determine the proportions of pure races which have gone to make a mixed people from its

¹A discourse delivered at the Royal Institution on Friday, February 20, 1931.