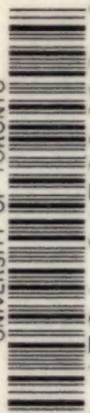


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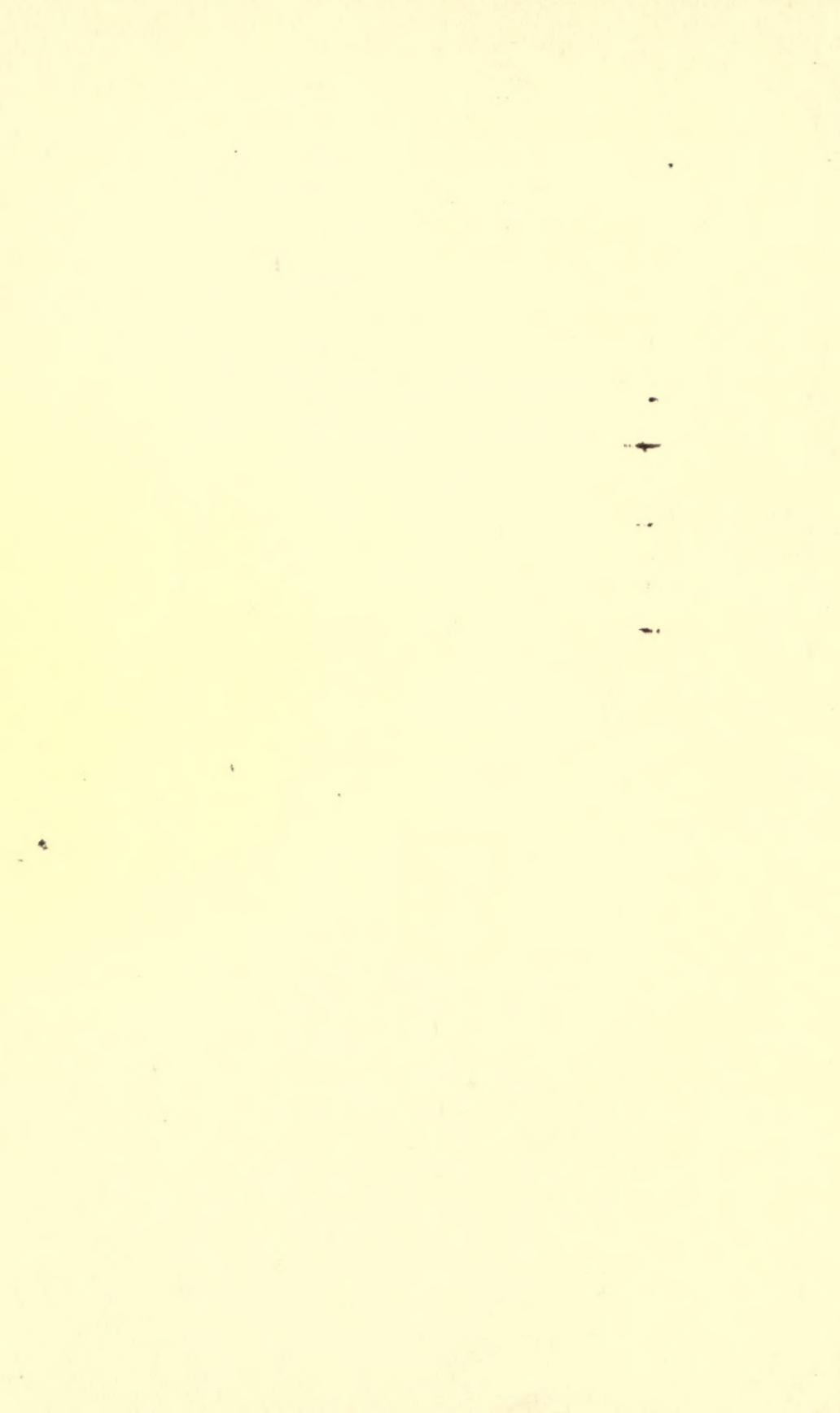


THE COLVER LECTURES
IN BROWN UNIVERSITY

1921

HUMAN LIFE AS THE BIOLOGIST
SEES IT

BY
VERNON KELLOGG



BROWN UNIVERSITY. THE COLVER LECTURES, 1921

HUMAN LIFE

AS THE BIOLOGIST SEES IT

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178689.

15. 3. 23.

NEW YORK
HENRY HOLT AND COMPANY

1922

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CONTENTS

PART I

	PAGE
INTRODUCTORY.....	3
1. HUMAN ORIGIN AND RELATIONSHIPS....	8
2. THE BIOLOGIST AND PRESENT MAN.....	37

PART II

1. THE BIOLOGIST AND WAR.....	49
2. HEREDITY AND HUMAN PROBLEMS.....	64
3. THE BIOLOGIST AND THE REPUBLIC....	90

PART III

1. THE BIOLOGIST AND EVERYDAY LIFE... 96	}
2. THE BIOLOGIST AND DEATH..... 106	
3. THE BIOLOGIST AND SOUL..... 118	
4. THE BIOLOGIST AND THE FUTURE..... 132	

HUMAN LIFE
AS THE BIOLOGIST SEES IT

HUMAN LIFE AS THE BIOLOGIST SEES IT

I

INTRODUCTORY

WHILE engaged in the work of Mr. Hoover's relief organizations I saw a good deal at very close range of the behavior of men at war. I saw a constant struggle in the case of some of these men in positions of authority between two elements in their make-up; a brute element inherent in them as a biologically inherited vestige of prehistoric days, and a strictly human element more recently acquired and transmitted to them by education and social inheritance. Sometimes one element dictated their behavior, sometimes the other. Sometimes, unfortunately, the element of education reinforced the element of brute inheritance. The exist-

HUMAN LIFE

ence and influence of these two usually conflicting parts of human make-up were made especially clear and sharp because of the unwonted and continuous stress of the whole situation. It was an unusual opportunity for the biologist-student of human life to observe the relative strength of these two factors which play their parts in the determination of the behavior and fate of us all. Are we, in our present evolutionary stage, more animal than human or more human than animal? And why? And can any attempt at scientific analysis of present human make-up give us knowledge that will enable us to live more rationally, more successfully, more happily?

As detached and cool-blooded as he can possibly be in his contemplation of the make-up and the capacities and behavior of human beings, the biologist is nevertheless often overcome by those same feelings of awe and reverence in the face of the "wonders of human life," which overcome other less cool-blooded persons.

AS THE BIOLOGIST SEES IT

In his laboratory and study he may assure himself that he is dealing only with an unusually complex, highly-endowed, and, in every way, remarkable animal, and reassure himself, in the face of the difficulties of the biological analysis of this animal, by remembering how he has been able to reveal, and, in some measure, explain the make-up and capacities of other at first baffling animals. But in his home with his family, and in his social intercourse with his friends and acquaintances, he sometimes loses the confidence of his laboratory hours. My wife and little girl are confusingly different from that impersonal thing, man as a laboratory subject, which I persist in hoping to analyze into pieces and properties capable of scientific explanation, or at least description. There is something, or many things, in all the human beings I know personally, and something in myself, which make them and me very different from the samples of the species that I study in the laboratory.

HUMAN LIFE

And yet as biologist I persist in this study, and I follow closely and hopefully the similar studies of other biologists, using this term to mean, in this instance, men variously called morphologists, physiologists, psychologists, sociologists, economists, political scientists, and historians, some of whom may object to being called biologists but most of whom are glad to be so called. And in my talks to you, at the courteous invitation of the authorities of Brown University, and as the incumbent for this year of the lectureship endowed by one of Brown's loyal and generous alumni, I shall try to tell you quite simply and frankly something of the biologist's attitude toward human life as a problem he feels bound to study, and of what he thinks he has found out and what he knows he has not found out in the course of his study as so far prosecuted.

I started studying human life as a biologist by studying first plants, then birds, and, finally, and for a long time, insects. This might be called my under-

AS THE BIOLOGIST SEES IT

graduate course in human life. I began my graduate course first with a baby,—my own—for special subject, and then as she grew older I turned to something easier, just men and women with whom I had less personal relations and knew only as representatives of the animal species, man. I found that I could not advisedly let my serious biological studies be interfered with by such incidental but, some way, very confusing, things as sympathy and love and pride and hope.

HUMAN LIFE

HUMAN ORIGIN AND RELATIONSHIPS

THE biologist pays much attention to origins; often too much. Two things can have a common or related origin and yet acquire differences in the course of their development which make, for all practical purposes, two very different things out of them. Quantitative differences may come to be so great that they have all the practical effect of qualitative differences. Or qualitative differences, very small, indeed, when measured by the chemist or physicist and described in the terminology of their sciences, may have very large effects in the practical relation of the substances or things exhibiting them. The sugar-loving man who eats a little of a certain substance which the chemist assures him is made up of the same numbers of atoms of the same three kinds of chemical elements of which

AS THE BIOLOGIST SEES IT

sugar is composed, although these atoms are arranged within the molecules in a way slightly differing from their arrangement in sugar, may find himself poisoned instead of strengthened. Or, the man who accepts the statement of the zoölogical morphologist that the nervous system of a certain animal differs primarily from that of another in that there is not quite so much of it, but that it is, as far as it goes, of essentially the same kind, and who therefore expects to find his first animal exhibiting the same kind of sense, only not quite so much of it, as his second, will be much surprised when he becomes really acquainted with the sense differences of his two animals.

Nevertheless the biologist has good grounds for paying much attention to commonness of origin and similarities of structural make-up in his attempts to read the riddle of life, even human life. Things that have come from the same thing, or that have a fundamental likeness of structure, are bound to have some

HUMAN LIFE

commonness of capacity and behavior. And so the biologist in his approach to man as a subject of scientific scrutiny is deeply interested in the possible unraveling of the tangled and broken skein of his biological history. Whence and how has he come into being? And into being in the particular form and condition which now characterize him? Can human characteristics be found in less complex stage of development and organization elsewhere in the world of life? And if the human body shows no radical qualitative differences from other animal bodies what will be the significance of this to the biologist in his attempt to study and appraise human life?

As to human origin the biologist finds no tangible evidence to support any other explanation than the now familiar and widely-accepted one of evolution from pre-existing lower animal kinds. For this explanation he does find what is, to him, practically convincing evidence. It is of no very great interest, certainly of no

AS THE BIOLOGIST SEES IT

very great importance to most of us, if we once accept this evolutionary explanation of origin, whether man is traced backward to this or that particular kind of anthropoid ape, or other less anthropoid ancestor. However, when we watch a chimpanzee for some time we come to have a hope that he is not the particular anthropoid whom the biologist would ask us to recognize with any filial admiration or affection. The feeling is even more marked when the orang-utan or the gorilla is the object of our curiosity. It is true, though, that if we watch a chimpanzee long enough a rather unsettling feeling is likely to grow on us that there is something uncannily familiar about him. He seems to be a caricature of some people we know; he behaves curiously like some children, other people's children, that we recall.

I had an experience with a chimpanzee once in Berlin, which sticks always in my memory. I was giving at the time, as a student of zoölogy, some special attention

HUMAN LIFE

to anthropoids, and used to go out almost daily to the Zoölogical Gardens where I had become acquainted with the keeper of the apes. He had a favorite chimpanzee which he used to keep with him a great deal in his own room or office, and I got into the habit of dropping in frequently for an afternoon chat with the friendly pair. The keeper was a rather stolid sort of person who seemed to me to possess a marked paucity of human feeling and expression. On the other hand the chimpanzee seemed possessed of a wide range of human-like interests and feelings and was fascinatingly varied and interesting in his expression of them. The conviction even grew on me that he was almost the more human of the two.

He rarely paid me the compliment of showing any special recognition of me or interest in me. I seemed to lack any special traits of attractiveness for him. But when one day, with the permission of the keeper, I brought an American family with me who had with them a coal

AS THE BIOLOGIST SEES IT

black, extremely African negress as nursemaid, the chimpanzee was so animatedly friendly to this dear old mammy from the very first moment of her entrance that she soon fled, screaming with horror and fright. I shall never forget the strong impression made on me of the chimpanzee's immediate apparent recognition of Matilda as an old acquaintance; she was the kind of human being he knew about and was interested in. Yet as he had been brought to the Gardens as a baby and had had really no personal acquaintance with negroes, if he really knew Matilda or had some sense of relationship with her, it must have been a case of biological memory.

However, the biologist does not claim that we are directly descended from the chimpanzee or any other particular anthropoid or particular lower kind of monkey that we know, either living or extinct. Some biologists favor an origin from a generalized Lemurine type, others from a *Tarsius* type, and others venture

HUMAN LIFE

to claim a breaking away from the quadrumanous group much higher up in its series, seeing in the anthropoids and man the latest and highest two diverging branches in the tall genealogical tree of human ancestry. That anthropoid and human structure are too fundamentally and minutely similar to be coincidence or anything else than true homology, and hence indisputable evidence of a commonness of origin, the biologist simply accepts as a biological fact without regard to his feelings of friendliness or unfriendliness for chimpanzees and their immediate relatives.

This structural evidence of ancestral relationship between the anthropoids and man is, of course, added to by several other well-known kinds of likenesses, physiological, psychological, and even ecological. The similarity of the chemical character of the blood of the two groups as evidenced by the identity of its reactions in the face of certain stimulation, the so-called precipitin reactions, these

AS THE BIOLOGIST SEES IT

reactions differing from those of the blood of other higher mammals, is a notable modern addition to the biological evidence for anthropoid and human relationships. For the same identities or close similarities in blood character occur in the case of other kinds of animals well known to be closely related, as the wolf and dog, or the horse and ass, and do not occur when the blood of two less closely related animals is tested.

A less important and less well-known added bit of evidence is one that came under my own observation a few years ago during the course of some study of certain highly specialized external insect parasites of man and some other mammals. In this study it became apparent that the kinds of these parasites characteristic of and limited to men and apes are more closely related to each other than they are to parasitic kinds characteristic of the other quadrumana or of any other mammals. That is, the parasites of the apes are even less closely related to those

HUMAN LIFE

of the other monkeys than they are to those of man. This points to a probable commonness of origin of the now slightly differentiated parasites of men and apes from some parasite ancestor which may have helped make life uncomfortable for certain common ancestors of the anthropoids and early men.

The biologist finds another evidence of man's place in nature as simply one among the various groups of mammals, in the conditions of the physical variation among different human races, or species, as they would likely be called by any entirely disinterested student of human kind. If an expedition of scientific gentlemen from the Academy of Sciences of Mars, say, should some day find its way to our planet, they would doubtless report to their colleagues, on their return, the discovery of a considerable number of earth-inhabiting different species of man, and might issue a classificatory monograph on them not unlike one of our own monographs on the various species of

AS THE BIOLOGIST SEES IT

bears. Our attempts at classifying the bears, you know, are attended by a good deal of discussion as to whether some of the different kinds are just different races or varieties of one species or whether they truly represent different species. As a matter of fact, I suppose this doesn't much worry the bears; it only worries the scientists.

There is also some suggestive evidence about man's position in Nature to be derived from the facts of the geographical distribution of his different races. The suggestiveness comes from the interesting resemblance of the status of this distribution to that obtaining generally among the higher vertebrates. Dr. J. C. Merriam, the distinguished paleontologist and student of the history of the human species, has especially stressed this fact and its significance. Just as the distribution of the members of a group of mammals or birds indicates in fairly clear outlines a classification of these members such as would be made on a basis of their

HUMAN LIFE

comparative structure, so the different subdivisions of human kind show a similar parallel in their distribution and structural similarities or dissimilarities.

Now the essential point of all that has just been said concerning man's striking structural similarity to certain higher animals and concerning his likenesses to them in other ways, physiological, variational and distributional, is that in these similarities the biologist finds convincing proof of man's origin from, and definite relation to other forms of life. And this must be ever in our minds in all our subsequent discussion. But before pointing out any of the probable special significances to the biologist student of human life of the undoubted evolutionary derivation of man from lower, non-human forms of life, let us glance briefly at another aspect of the consideration of human origin, namely, the pre-history of man as an animal of unmistakable human estate, but of much more primitive human culture than he is at present,

AS THE BIOLOGIST SEES IT

a history that the discoveries and investigations of the last score of years have done more to reveal than had all study previous to the beginning of this century.

The search for relics of man, both of his body and his handiwork or culture, may be, and has, in fact, been, pursued in two slightly different special ways. The historian may trace man back to the days of earliest history as recorded by preserved books and scripts. Then the archæologist and ethnologist may carry the story, ever more broken and incomplete, back by study of his scattered carved hieroglyphs and monuments and implements. Such studies take us back to days of the earliest civilizations of China and Egypt and Asia Minor and Crete.

Here the archæologist hands over the search to the anthropologist and paleontologist, whom he finds have been working from the other end, that is, from earlier periods up to later ones instead of from later ones back to earlier ones, and have been working rather as students of biol-

HUMAN LIFE

ogy and geology than students of humanistics. Man for them is an animal whose evolutionary history is to be traced, as that of other animals is traced, by finding and studying his fossils or the preserved products of his handiwork, or those of his forebears, in their relation to successive geologic formations, hence to time. It is to the paleontologist and historical anthropologist, therefore, that we look for facts concerning the very earliest days of man's existence. How far back in geologic time, how long ago as estimated in years and centuries, does man seem to have lived on this earth? Where did he live? Does he first appear as scattered over all the land surface of the globe, as he now is, or was he originally limited to a certain part or parts of it? What sort of man was he in those first man days? What of his body? What of his habits, his culture, his relation as individual to others of his kind? Oh, there are many crowding questions we wish to put to the student of prehistoric

AS THE BIOLOGIST SEES IT

man, too many to enumerate. And we really hang breathless on his answers.

But before we listen to any of the answers let us note that the anthropologist in his attempts to satisfy his and our curiosity about primitive man has a second string to his bow in addition to that provided him primarily by the paleontologist. He recognizes in his study of the man-group, just as the general biologist does in his study of any group of animals or plants, that the present existing members of his group are not all of equal evolutionary advancement or chronology. There are always some of a type less advanced or specialized, and some of types more advanced. The less advanced are usually presumed to be older in their evolutionary origin than the more advanced, so that although they all live now side by side and at the same time, some may be looked on as in a form or stage of greater primitiveness or antiquity as compared with others. This is indeed quite true of the various living

HUMAN LIFE

kinds or races of man. The native Australians, the Veddahs of Ceylon, the Ainos of Japan, the Bushmen of Central Africa and several other scattered similar small groups do represent in their physical structure, mental capacity and general culture more primitive stages in human evolution than those represented by the larger Caucasian, Mongolian, Negro and Polynesian groups that comprise the great majority of living men.

In comparing the physical and mental character and the culture of these living primitive types with the character and culture of various extinct types of men, as indicated by their recovered bones and articles of handiwork, the anthropologist finds such similarities that he can refer with some confidence to these living primitive types as paralleling in many characteristics some of the more recent types of prehistoric man. He has not yet found alive that missing link between man and the anthropoids which some anthropologists have fondly im-

AS THE BIOLOGIST SEES IT

aged may still be living in unexplored regions of Africa or Asia and to find which expeditions have been occasionally sent out, only so far to return empty-handed. Nor does he find any living types which can possibly be construed to parallel in their condition, or actually to be persisting remnants of, the most ancient or most primitive types of real men. But he gets nearer to understanding the life of man in those days when types of men now extinct were the highest types, by looking at human life as exhibited by the lowest types now living.

What, then, are some of the specific facts which have been determined by paleontologists and anthropologists concerning prehistoric man? To try to tell the whole story is far beyond my intention. We have neither time nor, indeed, need for it for the purposes of this discussion. But the outstanding parts of it can be told in few words, and these parts are extremely pertinent to any general

HUMAN LIFE

consideration of human history; to any special consideration of human life from the view-point of the biologist they are truly essential.

I must recall to your minds that geologists divide the eight hundred million years, more or less, of earth time into a series of successive ages characterized by differing kinds of rocks and by different floras and faunas, all, with the exception of the flora and fauna of the present age, now extinct. It is with only a few of the more recent of these ages that we need now concern ourselves in our search for the geologic evidence of man's origin. Of course, recent is a comparative term. It means, in the mouth of the geologist, something within anywhere from the last few hundred thousand to the last few million years.

In the rocks of these more recent ages, beginning with an age called Lower Oligocene, and running on up through Upper Oligocene, Lower, Mid and Upper Miocene and Pliocene, have been found

AS THE BIOLOGIST SEES IT

the fossil remains of numerous now extinct anthropoid apes. These have been found not only in Asia and Africa, to which continents the few living anthropoids are now restricted, but also in Europe which so far has been the source of all but two of the most ancient human relics. I speak of these fossils as representing numerous anthropoids; but numerous is also a comparative term; I mean by it, simply, considerably more kinds of anthropoids than now exist; and some of these seem to be of a higher specialization than any living anthropoids. But the rocks of none of these ages have revealed any fossils of indubitable human creatures. The one case which may possibly constitute an exception to this statement is that of the famous Pithecanthropus, a creature of which a few bones, to be specific, a skull cap, a femur and two molar teeth, probably belonging to a single individual, were found nearly thirty years ago in Java by Dubois. These relics were found in a situation which if

HUMAN LIFE

it does not allow the fossils to be ascribed definitively to the Pliocene Age, in its very latest days to be sure, at least proves this relic to be an antiquity as old as the very beginning of the Pleistocene or Glacial Age. This is the age immediately succeeding the Pliocene and is the most recent of the geologic series, unless the period since the last great continental glaciers existed is given a special name, such as Recent (with a capital letter) or Present, to distinguish it from that period which included the several glacial and interglacial times now recognized as comprised in the so-called Glacial Age.

Pithecanthropus has been variously hailed with joy as the long-sought missing link or looked on with scorn as an individual degenerate human reversion, or looked on, with less emotion but more judgment, as a creature of very great interest and importance in the study of man's origin whether it be called highest of apes or lowest of men or whether it be excluded from the direct line of human

AS THE BIOLOGIST SEES IT

genealogy and called an offshoot from this direct line, but one arising just before the line had culminated in undoubted human kind. In a famous discussion, held around the actual fossils brought by their discoverer to the Zoölogical Congress at Leyden in 1895, and participated in by an extraordinary gathering of the most eminent anthropologists of the world, five of these experts maintained that *Pithecanthropus* was an ape, seven that it was a man, and seven others that it was a transition form between man and the anthropoids. The discussion was one, you see, primarily of precise classification; there was practical agreement that this creature of uppermost Pliocene or lowest Pleistocene time was so much like an ape and at the same time so much like a man that it proved, if proof were still needed, that as far as structure, at least, is concerned the anthropoids and man differ only quantitatively and not qualitatively.

Now *Pithecanthropus* lived at least from five hundred thousand to one million

HUMAN LIFE

years ago; so that, if he really represents man in lowest human terms, we have had a human history on this earth of which the period since the earliest historically known civilizations of Egypt and Crete is a very small fraction. But that is not necessarily to disparage the possibility of a great deal of important human history occurring during that small fraction of time. The biologist is not so foolish as to suggest that extent of time alone is a measure of the importance of epochs in human history. For most of us that last one hundred-thousandth of the period of man's existence has a hundred thousand times more interest than all the rest. But the biologist believes that paying a little attention to prehistoric man may make the greater attention we pay to historic man more fruitful of a sounder understanding of human character, capacity and possibility.

We seem rather to have taken for granted that *Pithecanthropus* was the first man or obviously near-man type.

AS THE BIOLOGIST SEES IT

If this is to be our starting point we ask the paleontologist if he has found a more or less continuous series of human fossils running forward from Pithecanthropus, both as to time and evolutionary development, up to now. His answer inclines to be, Yes. But, in truth, he has found comparatively few actual fossils or relics of human bodies and very considerable gaps exist in the series both as to gradations in structure and time periods represented. In fact, only one of his undoubted human relics goes back in geologic time to a period approaching that represented by Pithecanthropus.

This oldest one is known as the "Heidelberg jaw"—because it was found in the Elsenz Valley not far from Heidelberg—and is a lower jaw bone with almost all of the teeth in place. Comparing it with the present human jaw it is notable for its unusual size, lack of protruding chin, and great strength and thickness combined with unusual width of the region for the attachment of the muscles used in masti-

HUMAN LIFE

cation. The teeth are large but not out of proportion to the size of the jaw. The jaw bone itself is more simian than human, but the teeth are more human than simian. Particularly notable in this respect are the canines which are not large and long, as simian and many other mammal canines are, but small and not extending above the level of the other teeth. However, in their size, heavy roots, and wide pulp cavities, all the teeth present characters which distinguish them readily from human teeth of today.

In addition to these very earliest actual remains of the bodies of man or man-ape, there have been found, in various localities in Portugal, France, Belgium, and England, and perhaps elsewhere, a considerable number of flaked flints in positions which undeniably refer them to a geologic time ranging back through Pleistocene into Pliocene and probably into an even earlier age. These flaked flints, which in higher or more complex

AS THE BIOLOGIST SEES IT

stages of flaking are commonly known in connection with all of prehistoric man's later Pleistocene life, and even with present human life as exhibited by the more primitive living peoples, are, in their earliest forms—known as eoliths—the subject of much discussion. It has been shown that a certain simple flaking of flint stones can occur by natural physical means without the aid of living creatures. But many of these Pliocene or very early Pleistocene eoliths show such a kind of flaking, affording cutting edges and grips for firm holding in the hand, fitting them to be very simple weapons or tools, that many competent anthropologists insist that they must have been produced by living creatures of sufficient wit and dexterity to make tools out of the material at hand most available for this purpose. Indeed, we can well imagine the first human beings picking up naturally partly flaked flints and then moving on to better tools or weapons by intelligently and deliberately further flaking

HUMAN LIFE

them or flaking other flints found still in the form of heavy rounded pebbles of various sizes.

The great importance of these eoliths to the student of early man is that if they are really man-made they help substantiate the evidence of Pithecanthropus and the Heidelberg jaw as to man's probable origin in Pliocene time, or even earlier. If man did arise in Pliocene time then his antiquity is carried back by many hundred thousand years behind that later Pleistocene period in which we can be certain of his existence on the basis of undoubted human fossils.

This Pleistocene or Glacial Age of which our present time may be reckoned the latest part, was a period of several hundred thousand years characterized by a succession of great continental glaciers sweeping down from the north, probably three on this continent and four in Europe, with separating interglacial times of considerably higher average temperature and hence climatic amelioration.

AS THE BIOLOGIST SEES IT

In the times of the glaciers, animals of the colder regions—as the mammoth, aurochs and the like—occurred all over Europe even to its present southern boundaries, while in the warmer interglacial times animals characteristic of lower latitudes, even considerably lower than those of present southern Europe, replaced them. It is to this interesting age of alternating cold and warm periods that all the known actual older human fossils so far found in Europe, with the exception of the probably older Heidelberg jaw, already mentioned, are assigned.

We have not time even to catalogue these relics of Pleistocene man, let alone refer to them in any detail. All that we can do, and indeed all that for our present purpose we need to do, is to say that skulls and teeth and arm and leg bones and other skeletal parts, sometimes very fragmentary, sometimes gratifyingly intact, together with simple stone and bone weapons and tools and primitive carvings and drawings on cavern walls,

HUMAN LIFE

amounting in all to a very informing quantity of indubitable human remains, have been discovered and exhaustively studied, with the result of revealing the certain existence of man in Europe all through Pleistocene Time, or at least from the first interglacial period of the Pleistocene Age up to that comparatively modern time when the archæologist and later the historian takes up the story of human kind.

The careful study of all these Pleistocene relics of early man's body has enabled anthropologists to distinguish certain successive types of prehistoric man differing in some measure structurally and evolutionally, so that an older type, like Neanderthal man, distinctly shows stronger simian characters such as smaller brain case and more projecting orbital ridges, less chin and more jaw, more curving thigh bones and more opposed great toe, than a later type like Cro-Magnon man. And the exhaustive study of the collected thousands of speci-

AS THE BIOLOGIST SEES IT

mens of early man's handiwork have enabled anthropologists to distinguish a series of successive human cultural stages distinguished by marked differences in the amount of variety and degree of elaboration of the weapons and tools and ornaments made and used by prehistoric man during Paleolithic, Neolithic and the early metal ages. It is indeed remarkable how far the students of prehistoric man have been able to go in picturing, with a high degree of presumptive correctness, the major features in prehistoric human life. They even know what other animals he knew, both from actual remains of these animals found in company with his own bones and from the crude carvings and drawings on cave walls made of these animals by prehistoric man himself. There are certain long limestone caverns in southern France whose walls are veritable picture galleries of Cro-Magnon prehistoric art. The students of prehistoric man know also that many things that were a part of human life as we first

HUMAN LIFE

know it historically formed no part of human life in Pleistocene time. Among the many thousand recovered specimens of prehistoric man's handiwork, there is a singular paucity of variety—a few kinds are repeated over and over again with superficial changes—which is a fact that reveals the limited resources and variety of occupations of this early human life.

But we must not follow this inviting lead. Our aim in this discussion was simply to point out those more important facts in the biologist's knowledge which bear on the problem of man's emergence from the gray mists of prehistoric time and the welter of strange animal life that characterized those early days. And this we have done.

AS THE BIOLOGIST SEES IT

THE BIOLOGIST AND PRESENT MAN

Now all this consideration of man's origin prepares, even compels, the biological student of present-day human life to recognize many characteristics of this life as vestigial, that is, as carried over from pre-human life and from prehistoric human life. It compels him also to face the fact, that if the human body and its capacities are recognized as derived by the more or less understood processes of organic evolution from other lower animal bodies and endowments, with no introduction of supernatural means to give human life qualitatively different capacities—supernatural ones, they might be called—then he must not only expect to find human life influenced by inherited carry-overs from man's animal ancestors but he must expect to find the human body and its behavior and its fate subject in greater or less degree to the influence

HUMAN LIFE

of all those general conditions and so-called laws of biology such as those of heredity, variation, selection, mutation, growth, the influence of environment, etc., which apply to all living things, to all substance and capacities of substance organized as living matter.

But he must be prepared to go even farther. The biochemists and physicists have made much progress recently in showing that many of the long-accepted familiar distinctions between living and non-living matter must be given up and that living matter is fundamentally only a much more complex association or state of the same substances that compose other matter and that therefore it is largely controlled in its behavior just as other matter is controlled, namely, by physical and chemical conditions and stimuli. The Royal Society Christmas lectures given in 1916-1917 before London popular audiences by Dr. Arthur Keith, the famous English anatomist, physiologist, and anthropologist, have

AS THE BIOLOGIST SEES IT

recently been published in book form under the title "The Engines of the Human Body," and if you are interested in knowing the essential likenesses between your body and a motorcycle read this book. It at least reveals how the modern biologist can plausibly describe the body and its functions in the terminology of mechanics and chemistry. So that the biological student of human life must be prepared to take constantly into account the results of the investigations and the significance of the claims of the upholders of the physico-chemical, or mechanistic, conception of life.

Facing all this you can see how necessary it is for the biological student of human life to have, if he is not to be carried off his feet at once into the camp of the cynical and hopeless complete mechanists, a wife and child at home to return to from his laboratory. If I myself am not yet convinced that all of humanism is to be dumped together with all the rest of Nature into the common

HUMAN LIFE

pot of chemicalism it is chiefly owing to my wife and child.

Not that I cannot recognize in them the presence of bodies composed of engines, and of living tissues and organs composed of substances, mostly very complex, but at bottom made up of the same chemical elements which make up the less complex substances of non-living matter. Nor that I cannot perceive in them the results of the influences of the biological laws that I find also in the various lower forms of life.

But I find *more* in them, so much more indeed, that although my scientific training and knowledge urge me to look on this more as only quantitatively more, my common sense and general experience, let alone my recognition of the limitations of scientific knowledge, compel me to see in them the manifestations of natural possibilities so far removed from or in advance of those manifestations as revealed in non-living matter or in the whole range of the rest of the world

AS THE BIOLOGIST SEES IT

of life, that, for all practical purposes, these two human beings, and hence all others, must be looked on as possessed of at least some qualities and capacities essentially different from those found anywhere else in Nature.

But this is not at all to say that I must recognize anything supernatural in these qualities. They may simply be such different and such extraordinary natural qualities that all the study of the most widely versed and wisest student of all the rest of Nature will not enable him to understand these special human qualities and capacities on the basis of this study alone. The scientist can be bigot just as well as the theologian, politician, or anybody else. And that scientist who would pretend to say that because he has studied Nature all his life and has familiarized himself with what has been learned about Nature by all the other naturalists, he can dogmatically declare what are the limitations of natural possibility, is simply a bigot. Just as are those

HUMAN LIFE

theologians or philosophers who without having studied Nature at all pretend to be able to say the same thing. However extraordinary the special qualities that I cannot but see in the human being, and can never see in other kinds of living beings, I am still not necessarily driven to look on man as something out of or beyond Nature. In fact I see so much in him that is familiar elsewhere in Nature that I would have quite as much difficulty in explaining why this is so, if he is supernatural, as I now have in trying to explain all of him in terms of the Nature which is revealed in studying physics, chemistry, and the natural history of plants and the lower animals.

Altogether, then, in approaching the study of human life from the standpoint of the biologist who is not a bigot, but who is after all a biologist and not theologian or metaphysician, we must take fairly into account all that the study of the rest of Nature allows us to make use of in understanding certain aspects of

AS THE BIOLOGIST SEES IT

human life, and yet must guard ourselves against the assumption that because we understand the life of starfishes pretty well we are sufficiently equipped with knowledge to be confident of explaining human life in terms of magnified starfish life. Even if I can declare with almost perfect certainty what will be the color of the eyes of the children of two blue-eyed parents, and with much confidence what kind of mental equipment the children of two congenitally feeble-minded parents will have, because I am familiar with a biological law discovered by a naturalist who studied heredity in garden peas, and because I have noted that this law applies equally well to certain silkworm characters and, finally, to various human traits, I am in no position to say whether your children will believe in God or not, be Republicans or Democrats or Bolshevists, write poetry, or rob banks, or live in settlement houses. I may be able to make a fair prognosis of the degree of resistance to tuberculosis which

HUMAN LIFE

your children will exhibit during their life but I can make no least guess as to their probability of dying in a future war with Germany. I feel pretty certain about what will happen to the human body after death but whether that is the whole significance of death in relation to a human being, I, not being a scientific bigot, am not at all certain. I am not a spiritist but if I claimed to be able to say that there are and can be no spirits, I should be claiming to know the whole order of Nature. And that no naturalist, nor anyone else, does know.

All that the naturalist can claim is that he knows a part of the order of Nature, and if some part of human life comes within that known part of the order of Nature then he insists that anyone seriously considering human life must take cognizance of this knowledge of his. Men who in discussing the possibility of a league of nations doing away with war, argue against such possibility on the assumed premises that fighting is

AS THE BIOLOGIST SEES IT

inherent in human nature and that human nature does not change, are not taking into account the biologist's certain knowledge that human nature does change. The educator or prison reformer who claims that you can do anything with any man by education and environment does not take into account the biologist's knowledge of the unescapable influence on human fate of inherited traits. He knows that it is perfectly true that you cannot put a thousand dollar education into a fifty dollar boy. But well meaning people keep trying to do this all the time.

We have, then, to face, in our further consideration of human life from the point of view of the biologist, two rather sharply contrasted things. One thing is that the biologist does have a certain positive knowledge of some conditions or factors that do help to determine the course of human life. The other thing is that the course of human life is partly determined by a set of conditions which are, so far at least, quite outside the

HUMAN LIFE

special knowledge of the biologist. He can guess about them and wonder about them just as other people do, but he has no right to claim that he knows about them. If some biologists do make this claim it is probably because they are carried away by the interesting sensation of knowing anything at all about what has been so long called "the mystery of life." A famous biologist of the mechanistic-conception-of-life school once said to me, as he saw me find my way to a certain corner seat in a restaurant with bench seats along the walls, that the reason why I tried to find a corner seat was because I was positively thigmotropic, that is, that I was irresistibly impelled, as a sand flea is, to get my body into as much contact as possible with solid surroundings. The fact is that I had made, several days before, an appointment with a friend to meet him in that corner.

The human being has such power of dislocating his reactions to stimuli both as regards time and space that his behavior

AS THE BIOLOGIST SEES IT

cannot be prophesied by any naturalist with ever so complete knowledge of the reflexes and tropisms exhibited by very simple animals. That is, the inevitable and immediate responses of *Paramecium* or houseflies or just hatched spiderlings to physical and chemical stimuli, which responses, in sum, compose their behavior, may have their vestiges in man and do have certain parallels, as in the behavior of the internal organs and certain external reflexes. But for the most part man turns towards or away from light, or finds a seat in a corner or out away from the room walls, because he is influenced by factors very different from simple physical and chemical ones, factors which may be of a week ago or a mile away. It is these non-mechanistic factors or conditions in human life, and their results, that constitute that part of human life, which is peculiarly the human part, that the biologist must hesitate to be dogmatic about. Yet this part must ever have a seizing interest for him—that is, if he

HUMAN LIFE

is himself human and not made over by too much association with *Paramoecium* to be more like his Protozoan pet than like the rest of his own species.

In our continuing consideration of human life, therefore, as the biologist sees it, we shall not hesitate to touch upon any of the phenomena and problems presented by this life whether they be clearly within the province which the biologist can pretty confidently claim as his, or in that other province which less clearly belongs to him but which he may believe he has at least as much right as anyone else to venture into. He can at least peer about in this other province to see if any stray sheep of his own are to be found in it. Certainly in many of the broad problems of human life arising in connection with such subjects as education, militarism, eugenics, delinquency, and others usually regarded as chiefly belonging to the province of humanistics, he can readily perceive biological aspects. That may be his excuse for approaching them.

AS THE BIOLOGIST SEES IT

II

THE BIOLOGIST AND WAR •

IN our preceding discussion we had a fleeting glance at the evidence which convinces the biologist that man is to be regarded as an evolutionary derivation from older and lower forms of life; and hence that in attempting to understand human life he must ever have an eye open to the influences on it of the persisting vestiges of earlier kinds of life which are certainly in it. Also, if man is to be regarded as in and a part of Nature and not out of or beyond it, we must be ready to recognize the part, however large or small, played in determining his fate by those biological factors or laws which play so dominant a part in the determination of the character and fate of the lower animals.

But man by virtue of his social development and educational inheritance has

HUMAN LIFE

gone so far above the lower animals in his evolutionary progress, has become so sublimated a kind of animal, reveals such mysterious special powers and attributes, that we must be very careful not to imagine that we can understand his life on the sole basis of ever so exhaustive a knowledge of the life of the lower animals. But the mysteries in his make-up need not lead us to mysticism in our attempts at their explanation. We would much better be agnostic than mystic. At least that is the position which the biologist student of human life must take if he is to stand consistently in line with his scientific training and experience.

We may assume, then, that we have adopted, in our present quest for knowledge and understanding of human life, a certain attitude, scientific, but open-minded and not bigoted, and gained a certain general orientation. With this clearing of the atmosphere we are ready to move forward in our quest. Too often we make our start in studying human life

AS THE BIOLOGIST SEES IT

by throwing out a smoke-cloud in front of us. What we need rather is as much clearance of the atmosphere as possible. I do believe science, rational science, not bigoted science, gives us that.

How apparently baffled we stand at present before the great problem of war. How confusing and contradictory are the statements vehemently made by the protagonists of differing beliefs concerning it. There is no consensus of men regarding it, not even regarding its desirability or undesirability, let alone concerning its inevitability or the possibility of doing away with it.

I had during 1915 and 1916 a peculiar opportunity of hearing set forth as ably, probably, as the argument can be presented, the reasons which lead some men to believe that war is not only inevitable through all human existence but desirable. Part of this argument came to me with special interest because it was based on grounds of biology and biological law. It came from certain officers of the

HUMAN LIFE

German General Staff living at German Great Headquarters in Occupied France.

For several months, as chief representative of Mr. Hoover's relief organization in Occupied France I had to live, by the convention of agreement between us and the German government, at this Headquarters, where all my activities could be under the keen eyes of the German General Staff. Out of this came my special opportunity of hearing this argument from important sources, for in such forced close association we necessarily came to a status of more or less frank exchange of opinions.

One of the Staff officers was in civil life a professional biologist of much repute, a professor of zoölogy in one of the larger German universities whom I had known years before in student days in Leipzig. Other officers of higher military rank but less academic training expressed in more brutal terms the same argument, but the professor-officer's speeches were the more plausible as he understood

AS THE BIOLOGIST SEES IT

better the language and the theories of biological evolution and was the better able to anticipate and guard against the reasoning that might be used by other biologists to refute him. We had many warm debates.

I tried during the war to tell the American people, as far, at least, as it might be reached through the *Atlantic Monthly*, something of the nature of the German arguments from biology why there must always be war, why there ought to be war, and even why Germany should win in the war then being waged. For I believed that Americans should know something of this feeling and attitude of the German people or of a large, and certainly very influential, part of them. I do not wish to repeat here, too much of what I have presented in the *Atlantic* articles. But we need, for the purposes of our present discussion, to recall the essential features of this claim, for this argument from biology for the inevitableness and even the desirability

HUMAN LIFE

of war has been used, and is used today, by others than Germans.

The argument to which I have referred is based on the assumption that natural selection is the all-powerful factor, almost the sole really important factor in organic evolution. And that as man as an animal species is subject to the control of the same major evolutionary factors as control the other animal kinds, his evolutionary progress or fate is to be decided on the basis of a rigid, relentless, natural selection. It is the argument from a post-Darwinian point of view that goes much beyond Darwin's own conceptions.

Natural selection itself, as you know, is the outcome of a bitter and persistent struggle for existence, in which struggle the fittest or fitter survive while the less fit become either much modified or extinguished. This struggle has three chief phases.

1. An inter-species struggle, or the lethal competition among different animal

AS THE BIOLOGIST SEES IT

kinds for food, space, and opportunity to increase;

2. An intra-species struggle, or lethal competition among the individuals of a single species, resultant on the overproduction due to natural multiplication by geometric progression; and

3. The constant struggle of individuals and species against the rigors of climate, the danger of storm, flood, drought, cold, and heat.

Now any animal kind and its individuals may be continually exposed to all of these phases of the struggle for existence, or, on the other hand, any one or more of these phases may be largely ameliorated or even abolished for a given species and its individuals. This amelioration may come about through a happy accident of time or place, or because of the adoption by the species of a habit or mode of life that continually protects it from a certain phase of the struggle.

For example, the voluntary or involuntary migration of representatives of a

HUMAN LIFE

species hard pressed to exist in its native habitat, may release it from the too severe rigors of a destructive climate, or take it beyond the habitat of its most dangerous enemies, or give it the needed space and food for the support of a numerous progeny. Thus, such a single phenomenon as migration might ameliorate any one or more of the several phases of the struggle for existence.

Again, the adoption by two widely distinct and perhaps originally antagonistic species of a commensal or symbiotic life, based on the mutual-aid principle—thousands of such cases are familiar to naturalists—would ameliorate or abolish the inter-specific struggle between these two species. Even more effective in the modification of the influence due to a bitter struggle for existence, is the adoption by a species of a social or communistic mode of existence so far as its own individuals are concerned. This, of course, would largely ameliorate for that species

AS THE BIOLOGIST SEES IT

the intra-specific phase of its struggle for life.

As a matter of fact, this reliance by animal kinds for success in the world upon a more or less extreme adoption of the mutual-aid principle, as contrasted with the mutual-fight principle, is much more widely spread among the lower animals than familiarly recognized, while in the case of man, it has been, in connection with high brain development and the acquirement of the power of speaking and writing, the greatest single factor in the achievement of his proud biological position as king of living creatures.

Altruism—or mutual aid, as the biologists prefer to call it, to escape the implication of assuming too much consciousness in it—is just as truly a fundamental biologic factor of evolution as is the cruel, strictly self-regarding, exterminating kind of struggle for existence with which the Neo-Darwinists try to fill our eyes and ears to the exclusion of the recognition of all other factors.

HUMAN LIFE

This mutual aid, as a biologic or natural factor, has influenced materially, as I have said, the mode of life, the biologic success and the character of the evolution of many kinds of lower animals. In their case it was not—we presume—consciously chosen or consciously developed. In the case of man, however, where also mutual aid has been a fundamental factor in determining the mode of life and the success and character of the evolution of the species, and where in the beginning also it may have been entirely unconsciously taken on, we face an important new thing in relation to it; that is its conscious development. Indeed, it is the high development of mutual aid plus a high degree of brain power plus the existence of something we call spirit or soul in man, all of these interacting on each other to the advantage of the further development of each, that really distinguishes man from other animals and makes him human. This conscious development of mutual aid, or altruism, by man demands some

AS THE BIOLOGIST SEES IT

further consideration in connection with our present consideration of the problem of war as the biologist faces it.

An essential thing to keep in mind in this connection is that man differs markedly from other animal kinds in having two kinds of inheritance often confused because of the use of the common term, inheritance, for both kinds. He has a biological inheritance—this is real heredity, inherent in him and responsible for much of his physical and mental condition, and for that instinctive behavior, partly indispensable for the actual maintenance of his life and health, as in the obvious cases of the suckling of babes and the winking of the eyelids and the less noticed actions of his internal organs, but partly no longer indispensable, in his present stage of evolution, as in the cases of various brute performances, once necessary to his self-preservation. He has also a social inheritance, not a part of his heredity, but playing a very important and conspicuous rôle in his life, especially

HUMAN LIFE

in his less material, his higher life as we are accustomed to call it, in other words the part of his life that especially characterizes and makes especially worth while being human. Man is not born with this social inheritance in him as his biological inheritance is in him, but with it all about him, ready for him and certain to be, in some measure, imposed on him. He is born into it rather than with it in him.

This social inheritance consists of tradition, of recorded history, of precept and example, in a word, of education. It is possible because of mutual aid and speech, writing and printing. Other animals, especially a few of the higher ones, may also enjoy a certain social inheritance, but man's social inheritance is so incomparably greater and more important in determining the character of his life, that he is in this respect practically qualitatively different from all other animals.

Now with all this in his eyes the biologist interested in the problem of the

AS THE BIOLOGIST SEES IT

inevitability of war and the desirability of it sees the situation as reducible to rather simple terms. If man prefers to be ruled in his relation to fighting and war by his biological inheritance with its vestigial carry-overs from prehuman and prehistoric human days, and does not care to oppose to it his power of conscious development and magnification of his social inheritance to the end of making it victor over his brute heredity—something that he has successfully done in relation to many other things—then war will persist. If he decides, as the Germans seemed to, that the best way to develop the highest type of man and human culture is to depend solely on the natural selection based on a ruthless physical life-or-death determining struggle for existence, with a survival and dominance of the physically strongest, then war is desirable.

But if he recognizes that he must take into account in his study of human development another evolution factor, not

HUMAN LIFE

less natural, and of proved effectiveness, which is based on the mutual aid principle instead of the mutual murder principle, and one which can be backed by all the force of social inheritance to counteract certain opposing influences of biological inheritance, then war need be to him neither inevitable nor desirable.

The protagonists of inevitable war declare that human nature does not change. The biologist declares that human nature does change both by virtue of the influences of strictly biological factors and especially, more rapidly, by virtue of the influences of social inheritance. Human nature to-day, which is certainly not the same as human nature in early Glacial Time, is quite as much the resultant of the work of social inheritance factors as it is of factors of biological inheritance. Human nature, not just the part that is inherited, but the whole of it, including the part that is acquired by each generation, not only changes but can be made

AS THE BIOLOGIST SEES IT

to change in definite direction by education, and it can be made to change with reasonable rapidity, a rapidity that seems very rapid indeed to the biologist accustomed to see change mostly depend on slowly modified heredity.

HUMAN LIFE

HEREDITY AND HUMAN PROBLEMS

THIS all too slight discussion—and all of our discussion can be only suggestive, not exhaustive—of biological and social inheritance in connection with the war problem, brings us naturally to a consideration of certain other problems of human life in connection with which this distinction between biological and social inheritance, and their conflict and relative importance, are of special interest.

It has been so much the fashion lately to emphasize the importance of a consideration of purely biological conditions and laws in the discussions of human problems—a wise fashion, undoubtedly—that some too hasty and thoughtless readers and hearers of such discussions may have gained the impression that the only biology to consider in this connection was the biology which one learns from a

AS THE BIOLOGIST SEES IT

study of the behavior and evolution of kinds of life lower than human-kind. Some biologists have helped spread this impression.

But they do wrong to do this. They are misled by their desire for simplist or monist explanations. It is a great economy of thought, a good example of the Occam's Razor principle, to push toward a monist explanation of natural phenomena. The German war philosophy, if it was an honest philosophy and with many Germans it was honest, was a monist philosophy. If natural selection can and does explain the evolution of plant and animal life and if man is only a form, rather unusually complex, of animal life, then his evolution, too, is to depend on this ruthless all-powerful natural selection.

Well, even granting both premises—and the first one cannot be granted—the conclusion is wrong: man has more in his life than is in the life of sea-urchins, birds, or apes. And this more does

HUMAN LIFE

not necessarily mean something more than or different from biology—although many of you probably believe that it does. The biology of man is much more than and different from the biology of other animals because of the social inheritance element in it—if for no other reason.

The biologists who help lead us to the fascinating but, I think, false belief that human biology is to be all understood some time on the basis of lower animal biology alone, that all that is in man is in lower animals although in much simpler terms, have let their zeal and enthusiasm make them overlook the revelations that their wives and children, their friends and their own selves make to them every day. The trouble is they leave their philosophic consideration of human life to their laboratory hours. They give up being philosophers when they get home and become just human beings, taking things as they come and thinking about them in different terms.

AS THE BIOLOGIST SEES IT

They think about them in terms of money and trouble and pleasure, and love and hate, and personal hopes and chagrins, which are peculiarly human terms. That is why I repeated so many times in my first lecture, and repeat now again, that we biologists *must* take into account in all our looking at human life the things that we see at home as well as the things we see in the laboratory. If we do not we overlook the greatest things in the greatest problems of human life, the things that really make human life human.

But let us turn now to one or two more of those problems which especially involve in their consideration this matter, introduced by our reference to the war problem, of the two kinds of inheritance and the relations between them.

The problem that I have especially in mind at this moment introduces conspicuously the subject of human heredity. Is a man what he is because he is born so or because he becomes so by education, using education in the broad sense of

HUMAN LIFE

including all environment? Of course this is the old, old problem of nature and nurture, already threshed out, one might imagine, to its last possible degree. But if that were true for yesterday it is not true for today, for the reason that we are daily, almost, finding out new things about heredity. Since the beginning of this century we have learned more that seems to be fact about heredity, plant and animal heredity in general and human heredity in particular, than had been learned in all previous time.

In the 1860's an Augustinian monk named Gregor Mendel, living in a cloister in Brunn in Moravian Austria and possessed not only of a divine humility and devotion but of the divine spark of scientific curiosity, or as we call it in scientific circles, research, carried on an extensive lot of experiments in the cloister garden in the way of hybridizing various races of garden peas; he was a Moravian Burbank. He read an account of his observations and conclusions before the

AS THE BIOLOGIST SEES IT

local natural history of Brunn and they were published as two brief papers in the obscure proceedings of this obscure society of local naturalists. And there they lay apparently unnoticed for thirty years. Odd how an epoch-making thing can be put into the world, and lie unnoticed for a third of a century!

In 1900 three eminent European botanists, one in Austria, one in Germany and one in Holland, working separately on heredity problems, each independently and all almost simultaneously, discovered and made known Mendel's work. Today Mendelian inheritance, Mendelism and Mendel are words of almost as much significance to naturalists as Darwinian selection, Darwinism and Darwin.

With the work and theories of Mendel and the three botanists, Tschermak, Correns and De Vries, as stimulus and basis, there has been an energetic pushing on of heredity studies, with a rapid gaining of many facts and much understanding until now we are able con-

HUMAN LIFE

fidently to make statements about the heredity mechanism and behavior really startling in their preciseness and practical importance. We can make enough prophecies about the outcome of many cases of mating to give us sufficient basis to warrant us in modifying our social inheritance in directions to increase advantages or decrease disadvantages derived from biological inheritance.

Before Mendel and the post-Mendelians, about the only so-called law of heredity that had been formulated was Galton's generalization to the effect that an individual receives one-half of his inheritance from his two parents, one-fourth from his four grandparents, one-eighth from his eight great grandparents, one-sixteenth from his sixteen great, great grandparents and so on by decreasing fractions back to the beginning of ancestors, the total of these fractions equalling 1, or the total biological inheritance of the individual. Very interesting, but not very specific as to just what

AS THE BIOLOGIST SEES IT

particular traits, physical and mental—and Galton was almost the first to include mental traits in heredity on the same basis as physical traits—interesting, I say, but not very specific as to just what particular traits one is going to get in the respective $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, etc., from the respective parents, grandparents, great grand-parents, et al. And that is really what we burn to know.

I remember a red-headed boy among my early companions whose parents were brown-haired, and this boy used to wonder why he was red-headed. By constant reminders we never let him cease wondering. Finally his parents discovered that back in the ancestral line there had existed another shock of flame. And parents and red-haired son were satisfied to say that he was a “throw-back” to great grandfather William; red hair was a part of the one-eighth of his inheritance that the boy got from his great grand-parents.

Mendelism makes no such broad gen-

HUMAN LIFE

eralizations as Galton's but it makes much more precise ones. It does not treat of halves or quarters or eighths of one's whole inheritance but of the inheritance of specific characters, as hair-form, eye-color, susceptibility or resistance to particular disease, and feeble-mindedness. I am talking of human traits and human heredity now. Among plants it treats of leaf shape, flower pattern, height of stem, and other characters. Among silkworms it treats of larval coloration and pattern, color of cocoon, number of generations a year, and others. And so on. I might make a long list of specific traits, structural and physiological, in a long list of plant and animal species, and a rather impressive list for the human species, about the inheritance of which quite specific and precise things can be affirmed as a result of the intensive study of heredity that has been done in the last twenty years.

All of these things are interesting and some are both interesting and useful.

AS THE BIOLOGIST SEES IT

You can see the utility to the breeder of silkworms if I am able to say to him that if he will cross a silkworm moth of a certain race which spins yellow silk with one from a certain white-silk spinning race—and it makes no difference whether the male or the female be either of the white or the yellow silk race; there is no factor of sex-potency in the outcome—he will get a progeny of silkworms all of which spin yellow cocoons, but that if for a second generation he mates two of these yellow-spinners together he will get a brood of which three-fourths will spin yellow cocoons and one-fourth white cocoons, while if for a third generation he mates two of these white spinners together he will get a brood all of which will spin white, and only white cocoons, while if he mates all of the yellow spinners inside their group he will get from one-third of these matings broods which spin nothing but yellow cocoons but from two-thirds of them broods which spin both yellow and white cocoons in the precise propor-

HUMAN LIFE

tion of three-fourths spinning yellow and one-fourth spinning white—I say if I can tell a silk grower these things as facts which he can rely on—and I can actually do this as a result of my own experiments and observations—he will find them not only interesting but useful. Think what such knowledge of heredity means to the plant and animal breeder. And then think of what similar knowledge concerning the inheritance of human traits may mean in human life.

The example I have given of the heredity behavior of a certain silkworm characteristic is a case of typical Mendelian inheritance. The inheritance of blue or brown eyes in men follows the same course; so does six and five-fingeredness; so does a certain form of color blindness paired with color visualness; so does Huntington's chorea paired with freedom from this fatal infirmity; so does, although in less perfect form, feeble-mindedness paired with full-mindedness. Mendelian inheritance is the order or behavior of the

AS THE BIOLOGIST SEES IT

heredity of specific unit characters. Not all traits are inherited according to the Mendelian order, but many are. This order can be found out if it exists and then predicted.

It must be found out by experiment (in lower animals and plants) or observation (in human beings) for each specific trait in each species of plant and animal and for man. The order cannot be predicted for another species on the basis of knowledge in one species; nor for man on a basis of knowledge in lower animals. The inheritance of each trait is independent of the inheritance of any other trait, with the exception of occasional yoked or grouped traits which behave as a single unit. It is unit inheritance where single characteristics are the units, not fractional inheritance where all the traits or the whole individual is the unit. It will take a long time to work out the order of heredity for all the Mendelizing traits, physical and mental, which the human species possesses, but it can be

HUMAN LIFE

done; and then we can bring to bear the power of our social inheritance to make human life rapidly better by encouraging the good and discouraging the bad in biological inheritance.

But we do not have to wait until we know the order of inheritance for all our traits before we can begin to use wisely this new knowledge of heredity that began with the revelations of the Augustinian monk Mendel about the inheritance of stem length and pod shape and seed coat of garden peas. We can begin on a basis of the knowledge of the heredity behavior of a single trait. Let me give you an example.

For a long time the characters considered in studies of heredity were exclusively physical ones. Just as in the beginning days of anatomical study man's body was considered too sacred to be submitted to dissection, so in the beginning days of heredity study man's mental traits were considered too sacred for scientific analysis. It was Galton, as I

AS THE BIOLOGIST SEES IT

have already said, who first, in any conspicuous way, included mentality along with physical characters, as subject of studies in biological inheritance. Indeed he gave more attention to the inheritance of mental capacity than to that of physical traits. His first important book on inheritance is called "Hereditary Genius." It is interesting to note, in passing, that Galton's studies and their publication were made *after* Mendel had done his work, but *before* Mendel's work had been discovered and made known to the world.

Ever since Galton, students of human heredity have paid attention to the inheritance of mental traits and general mental capacity. It is a fascinating thing to trace the descent of genius or great talent through the succeeding generations of a family. The Bach family contributed fifty notable musicians to the world in five generations. The death of the astronomer K. H. Struve a few months ago called attention to the fact that his

HUMAN LIFE

father and grandfather, Otto and F. G. W. Struve, respectively, were also eminent astronomers, all three having been gold medalists of the Royal Astronomical Society. Three sons of Charles Darwin have shown mental capacity above the average.

But if unusual mental capacity is heritable so also is unusual mental incapacity, and because marked incapacity becomes a social danger or, at least, burden, much special study has been given it in recent years. The matter interests not only students of heredity, but sociologists, educators, and criminologists. For mental incapacity or insufficiency revealed in children as marked backwardness and feeble-mindedness persists in adults as feeble-mindedness and imbecility, and poses a series of grave problems concerning the social relations of these unfortunates.

One of the most interesting practical outcomes of this intensive study of mental sub-normalcy has been the development

AS THE BIOLOGIST SEES IT

of ingenious intelligence tests, with point scales, by which a definite rating for intelligence can be determined for any individual. These tests were first devised for children but modifications of them have been used for adults. An extensive use of these tests, with highly successful results, was made during the war for rating American soldiers and officers. Indeed the success of this method of testing and expressing intelligence has been one of the most brilliant and useful modern contributions of psychology to practical life.

An interesting and useful feature in connection with the tests is the expression of their results in terms of mental age which may be contrasted at once with the actual age of the individuals tested, so that the degree of mental retardation or advancement is made manifest in readily understandable terms. Thus a child of 12 years of age may be found to have a mental age of but 8 years, meaning that the intelligence of this 12 year old child

HUMAN LIFE

is only on a par with the intelligence of an average normal child of eight. In addition, as the mental age indicates only the general level to which the intelligence of the individual has developed at the time the tests are applied, a measure of the actual rate of mental development of the subject, called the "intelligence quotient," is used. This intelligence quotient is the percentage ratio between the mental and chronological age of the subject. Repeated tests of the same children at intervals of one to four years have indicated that the intelligence quotient of a given child remains practically constant between the ages of ten and sixteen years. By reason of its relative stability, therefore, the intelligence quotient becomes a reliable and useful index of intelligence. Once determined, it is possible to predict by it, within reasonable limits, the probable level to which a given individual's intelligence will develop. From a rather wide experience of these specific ratings

AS THE BIOLOGIST SEES IT

of mental age and intelligence quotient, certain general categories of mental capacity or incapacity have been established and are now commonly used by psychologists. At bottom is the category feeble-minded, then, in ascending order, borderline, dull-normal, average-normal and superior.

Much special study has been given feeble-mindedness by students of heredity in the last decade and it has been fairly satisfactorily proved that this mental condition is not only an inherited condition, but that it may be looked on as a unit human trait following the general Mendelian order as regards its mode of inheritance. If this is really so—and it is hardly any longer open to doubt—it has obviously a most important significance in connection with the whole problem of education. It must make us face squarely the situation that there are limits to the educability of certain individuals and that we should somewhere call a halt on the vain efforts we are

HUMAN LIFE

making to put the same kind and amount of education into all kinds of pupils.

This fact of the heritability of feeble-mindedness has also an important significance in connection with a particular social problem, that of juvenile delinquency, for it has been proved beyond much doubt by the studies of Goddard, Davenport, Kuhlmann, Williams and others that feeble-mindedness and delinquency are all too often closely linked in terms of cause and effect. Dr. Williams has recently published the detailed results of an exhaustive study made by him of 470 delinquent boys (ages 6 to 22 years) in California. His monograph is the record of an admirable piece of investigation conducted in an unprejudiced and rigorously scientific manner, with care to consider all the details and possible influence of environment as well as of heredity on the subjects of his study. Its results can be expressed in few words, and they are results which are confirmed

AS THE BIOLOGIST SEES IT

by a large amount of similar investigation, especially those of Goddard.

Williams finds that about one-third of his juvenile delinquents are feeble-minded and that nearly one-half are border line or dull-normal in mental rating, while only about one-fifth are average-normal or superior. If the percentage of the various mental rating classes in two groups of California boys of similar ages are compared, one group being Williams' 470 delinquents and the other a group of one thousand boys taken at random from all classes of the population, we note the following suggestive facts: Superior rating, delinquent group, 3%, miscellaneous group, 20%; average-normal rating, delinquent group, 19%, miscellaneous, 60%; dull-normal rating, delinquent, 21%, miscellaneous, 10%; border-line rating, delinquent, 27%, miscellaneous, 8%; feeble-minded, delinquent, 30%, miscellaneous, 2%. The association of feeble-mindedness with juvenile delinquency is positive.

HUMAN LIFE

But not all delinquency is due to feeble-mindedness. In Williams' group of delinquent boys, 19% are rated as of average normal intelligence and 3% of superior intelligence. Altogether, in Dr. Williams' judgment, about one-third of California juvenile delinquency, which is a first step toward confirmed adult criminality, is due to hereditary mental deficiency, another third to other undesirable inherited traits and the final third to unfortunate environmental conditions. There are, then, two kinds of causes of juvenile delinquency, and two kinds of remedies are required to combat these causes; one a remedy of better environment, the other a remedy of being better born. Which is a natural introduction to a few words on the general subject of eugenics.

Poor word eugenics, and such a good word, too. But the comic papers and comic stage and the sadly comic capers of the all too serious cranks and all too unwise and too extreme would-be friends have made this good word almost im-

AS THE BIOLOGIST SEES IT

possible; much more, they have seriously hurt the repute of the really good idea it stands for. To be well born is certainly an excellent thing to achieve; anyone contemplating being born would like to arrange it. Racial well-being is certainly an advantageous thing for a race; any people would like to possess it. Well, eugenics means these things, not surgical sterilization of men or women, state controlled breeding of children, abolishment of love, or any or all of these or the other special exaggerations or ugly fancies which have been made synonyms of eugenics by humorists, scoffers, or cranks.

Eugenics bases its claim as a subject for reasonable and sympathetic consideration on two grounds: first, the acknowledged power or influence of heredity for good or ill in helping to determine human fate; and, second, the acknowledged power which we have in education for encouraging good and discouraging bad human heredity. The great recent increase in extent and precision of our

HUMAN LIFE

knowledge of heredity adds materially to the possibility of making eugenics a subject entirely worth serious and active consideration. The more we know of the mechanism, the order and the results of biological inheritance, the more we can develop and make use of a social inheritance which shall help to make individuals and peoples better born.

Guyer in his excellent little book, entitled "Being Well-Born," gives a striking example of what bad and good inheritance can mean by giving the facts in the case of two lines of descent; one, which we may call Line A, came from a normal father mated to a feeble-minded mother and the other, Line B, from the *same* normal father mated to a normal mother. In five generations of Line A, 480 direct descendants included 143 known to be feeble-minded, 291 of unknown or doubtful mentality, 36 illegitimate, 33 sexually immoral, 24 confirmed alcoholics, 3 epileptics, 3 criminals, 8 keepers of disreputable houses, 82 dead as infants,

AS THE BIOLOGIST SEES IT

and only 46 known to be of normal mentality and character. In five generations of Line B, 496 descendants were all, with but one exception, which was a case of religious mania, of normal mentality. But two were alcoholics and none was epileptic or criminal. Only 15 children died in infancy. Practically all the members of this line were good representative citizens including judges, lawyers, doctors, educators, business men, etc.

The notorious Jukes, Kallikak, Nam, Piney, and Zero families, the Tribe of Ishmael, the Hill Folk, and the descendants of Margaret, Mother of Criminals, which have been studied by various students of heredity, show conclusively what bad heredity can do for individuals and society. It is estimated that the Jukes family alone, with its 300 professional paupers, 440 physical wrecks from debauchery, 50 prostitutes, 60 habitual thieves, 7 murderers, and 130 other convicts out of a total of 1200 identified descendants, has cost the state of

HUMAN LIFE

New York over a million dollars for the care of its criminal, defective and immoral members. We may deem it fortunate for us, and for them, that 300 of its known progeny died in infancy.

To be a eugenicist does not necessarily mean to be a crank. It means to be a person interested in such tangible revelations as I have just referred to of the wholesale misery and social injury possible from bad heredity, and willing to approve and actively support whatever can be done wisely by education and legal provision to prevent repetition of this sort of thing. It means to be a person willing to use common sense, scientific knowledge, and prevision for the good of his own family, society, and the race. Karl Pearson has pointed out that one-half of England's new generation is being produced by the most hereditarily unfortunate one-fourth of England's population. Bad heredity is outstripping good heredity in England. No amount of after education or good environment can

AS THE BIOLOGIST SEES IT

make good this fundamental bad start in life. A growing national recognition of this alarming situation is perhaps the reason that eugencics has been less laughed at in England than elsewhere.

HUMAN LIFE

THE BIOLOGIST AND THE PUBLIC

Now these matters of war and juvenile delinquency and racial well-being which I have referred to are all important problems in human life and to all of them the biologist can admittedly make some enlightening contribution. They are but three examples of the many problems of human life with obvious and fundamental biological aspects. But how little has the world, although intensely interested in these problems and anxiously trying to solve them, taken any advantage of the special knowledge offered by the biologist in connection with them. And this in spite of the fact that it has been in recent years quite the fashion to invite the biologist to talk about such problems and even to listen to him with a tolerant interest. But why the fashion of listening to his advice and at the same time the fashion of not acting on it? Well, it is not

AS THE BIOLOGIST SEES IT

all the fault of the public: it is partly the fault of the biologist.

In the first place, the biologist too usually finds much difficulty in making himself understood by the public. He seems unable to escape from the use of a terminology that is included only in the larger dictionaries—and these dictionaries are at home while the public is in the lecture hall. Hence the people who listen to him go away confused and incapable of doing what the biologist thinks he has suggested to them to do. There are hundreds of interesting and pertinent facts of biology that are today waiting intelligible telling in order to be made use of!

In the second place the biologist apparently has difficulty in estimating the varying degrees of practicalness of his knowledge. His facts and his recommendations run all the gamut from tangible practicability to most academic impracticability. Take the very examples I have used this evening! If the biologist has nothing more to contribute to the

HUMAN LIFE

discussion of the tremendously important and pressing problem of war than the assurance that human evolution will carry us beyond war in another geologic epoch or two, he may be listened to with tolerant interest but he will start nothing to help put an end to war. Of course I think that he really has more to offer. I have even tried to indicate what it is that he can suggest, namely, to fight the false notion that human evolution must be left to natural selection, and that war produces natural selection—as a matter of fact war produces artificial selection more than natural selection and a bad or reversed artificial selection at that. He can also encourage the right notion that biological inheritance, especially where already vestigial, can be largely offset by social inheritance.

In fact, it is social evolution, not biological evolution, that we must chiefly look to for future human progress. Most anthropologists agree that the major difference between present man and prim-

AS THE BIOLOGIST SEES IT

itive man—not man of the Ice Age but primitive man of late prehistoric and historic times—lies in the possession by present man of methods and technic based on scientific knowledge not possessed by primitive man. And modern man has gained over primitive man with ever increased acceleration. His movement of advance has been like that of a snowball rolling faster as it gets bigger. Many biologists believe that man is already so specialized an end product of his evolutionary line, that as regards physical change and actual mental capacity he has reached the standing-still stage. Certainly man today as individual is not to be regarded as superior to man of early historic times, of the times of Greek greatness or probably even of the times of early Egypt and Asia-Minor.

In connection with the matter of juvenile delinquency and racial well-being the biologist's contribution of facts and suggestions are of tangible practicability. The biologist says that the

HUMAN LIFE

normal man who married the feeble-minded woman and started a line of descendants of whom four out of five were socially incompetent and hence burdens and dangers to society, and then married a normal woman and started another line of descendants all socially competent, should have been prevented from making the first mating. Don't call this eugenics; call it an application of scientific knowledge and common sense. Think of it as just as important and just as possible as the enforced isolation of a victim of infectious disease, or of homicidal mania.

But not all the problems of human life in the discussion of which the biologist ventures to take part exhibit so clearly as the examples thus far referred to, their biological aspects. The approach of the biologist to these other problems, even his right to approach them, becomes more debatable—but for that very reason, perhaps, more interesting. Can the biologist with his methods of analysis and his knowledge of other kinds of life

AS THE BIOLOGIST SEES IT

than human life, make any, even least, contribution to that which most of us demand first from existence, namely, personal happiness? Can he show us wiser ways of living? He can unquestionably show us safer ways; he can help guide us in our constant great gamble of betting our lives on what we know. And presumably that alone is quite worth our calling on him to give us the benefit of his special knowledge, and his reasoned recommendations. But merely being safer amid danger, merely continuing to live and living longer, is not what many, very many of us, are chiefly concerned with. We want continuing to live to mean something continually larger. We yearn for encouragement of our hopes, for inspiration to struggle on to achieve what we can hardly define but clearly feel intent on. Has the biologist anything helpful to suggest about this? Or will listening to him mean more pessimism, hopelessness, fatalism? If so perhaps we would prefer to be blindly hopeful, ignorantly happy.

HUMAN LIFE

III

THE BIOLOGIST AND EVERYDAY LIFE

IN our preceding discussions we became acquainted with certain facts which contribute in some degree to help solve the problem of human origin and the place in Nature of humankind. And we noted certain other facts which help to reveal the kind and extent of the influence on human behavior of some of those biological factors whose influence on the life of other animals is so obvious to the student of general biology.

In recognizing these facts we have at the same time recognized the necessity of taking account, in any candid study of human life, of the special significance of these facts, which is, simply, that the human species, however different it may seem or actually be from other forms of life, is not so different as to be something

AS THE BIOLOGIST SEES IT

outside of Nature, unrelated to other kinds of creatures, and hence to be studied quite apart from other forms of life. Indeed, in face of the many facts that have been revealed concerning man's relation to other extinct and living creatures and concerning the degree of control exercised over his body and behavior by natural law, it is most puzzling to me to note to what an extent there still exists, among many persons of sufficient education to have had these facts brought to their attention, a disregard of the necessary significance of these facts. I can understand, although I do not share, a certain feeling of repugnance to accepting the situation forced on us by scientific fact and logical induction. I can sympathize with, although not accept, the position of those who persist in wishing and trying to look on themselves and humankind in general as of a different clay endowed with a different breath and existing in a different sphere from the rest of life. I can feel the egocentric

HUMAN LIFE

urge that leads to this position perhaps as strongly as those who take it, but I cannot surrender to it as easily. Scientific observation and cool reason prevent.

How can one accept eagerly and gratefully that knowledge about our bodily make-up and functioning which the biologist gives us, and, on the basis of it, proceed to modify our behavior so as to protect ourselves from accident and disease, and help ourselves in the attempt to adapt ourselves to the actual conditions of the world we live in, and yet reject other no less well demonstrated facts of the same general category brought to us by the same biologist, but the acceptance of which involves a recognition on our part of our true place in Nature.

I am inclined to find an explanation for this popular inconsistency in two or three different causes. \ For one thing some biologists have gone ahead of the actual facts with their justifiable significance and have presented the world with hypotheses instead of demonstrations and

AS THE BIOLOGIST SEES IT

have insisted on an acceptance of unjustifiable significance. I have already called attention to the too bold assumptions of the extreme disciples of the mechanistic school of life. For another thing one can never get away from letting one's own observations, with all their limitations both as to scope and accuracy, play a too large part in determining one's judgments about any matter however technical, and however demanding, for correct understanding, of a certain special training and equipment on the part of the observer. This is one of the reasons why the professors of political economy and sociology have such a hard row to hoe. Everyone is his own economist and sociologist, because the subjects are perforce under everyone's observation, although this observation may really be very limited and usually *is* of a most untrained and unmethodical kind. Professors of astronomy on the other hand are accepted unhesitatingly as authorities; so few of us have telescopes.

HUMAN LIFE

Now the biologists' have a position between these extremes. When they talk about microbes and Dinosaurs their statements are accepted at face value. But when they talk about human beings, which the biologist can study quite as carefully as he can other kinds of beings, there are reservations. When the biologists' talk about human beings is limited to statements about lungs and liver, skeleton and ductless glands, it is not questioned. But when their talk is about the behavior of human beings, about their psychology, their heredity, their responses to environment and education, and their position in Nature, then their talk is tested by the miscellaneous personal observations and prejudices and desires and hopes and beliefs of each individual, and it is accepted or not as it confirms or contradicts each one's notions derived from these things. We all, or most of us, think we know human beings as well as the biologist does. Most assuredly the biologist does not know all

AS THE BIOLOGIST SEES IT

that is to be known about human beings, and about that which he does not know we must certainly be permitted to accept our own guess as likely to be as good as his. But we are too likely to think our own guess even better than his.

This attitude comes largely, I think, from a feeling, after hearing the biologist talk about human life, that his consideration of this life is too academic, too technical, too detached from most of those things that make up our immediate interests and fill our present moments. As important as war may be, and juvenile delinquency and eugenics and the relations of social inheritance to biological inheritance, and as interesting as may be the problems of human origin and the relation of the human species to other animal kinds, all of which are samples, as I have indicated in our earlier discussions, of the things the biologist-student of human life especially talks about, these are not the matters of human life that occupy most of the atten-

HUMAN LIFE

tion of most human beings most of the days. The matters that do so occupy our principal attention are our work and recreation, our clothes and food, our household affairs, our health and our looks, our income, expenditures and savings, the growing up of our children and the growing old of ourselves, our family and social relations, our personal contacts with people and our opinions of them. We think and talk about books and music and pictures, about railways and bridges and motor cars, about scenery and climate and hotels, about politics and diplomacy and governments. And all the time we give a fascinated attention to the particular human beings connected with these things, especially the ones we personally know or see. We note and discuss their particular idiosyncrasies, their likenesses and differences; we compare them with each other and with ourselves. We are concerned, constantly and immensely, with individuals.

It is right here, I believe, that we have a

AS THE BIOLOGIST SEES IT

clue to the explanation of the gulf between the biologist-student of human life and the everyday observer of human life. One deals primarily with the species; the other with individuals. One gives his attention to humankind, the other to particular human creatures. If we knew other kinds of animals as individuals—and we do occasionally, as when we have a particular horse or dog or cat or canary for companion, or scrape literary acquaintance with Lobo the Wolf, or Brer Rabbit, or as when the farmer or his daughter goes out morning and evening with the milking stool, or the pigeon or chicken fancier feeds his pets; I have even come to know individual bees in my glass-sided observation hives—if we knew other animals as individuals, I say, we should have another point of view regarding them. As it is we mostly do not know other animals as individuals; we know them as the biologist does, as species. But as species they do not interest many of us very much; although

HUMAN LIFE

it is exactly as such that they do interest the biologist. And it is primarily as species that the biologist is interested in humankind—that is, when he observes humankind as biologist and not as just one of the rest of us. When one knows animals only as species the interest therefore is chiefly biological; when one knows animals as individuals they possess a new and special interest. It is this special interest that absorbs most of our attention to human kind, which we do know primarily and particularly as individuals. That is what really holds apart, I think, the biologist and the rest of us when the study of man is in question. That is why the biologist's information to us about man seems academic and not pertinent: it leaves us cold. And why the daily newspaper's information about men fascinates and thrills us. And yet—and yet—the biologist's information, as far as he can confidently go with it, is of huge importance to us as individuals. Taken into account and acted on, it can

AS THE BIOLOGIST SEES IT

make wiser, less wasteful, more capable, happier, individuals of us. It can help put us into better physical and mental harmony with the world we simply have to live in. It is not that it merely makes life safer and longer, but saner and larger. And it need not rob us of the hopes and beliefs that many of us cherish. It may do nothing to encourage them, but it cannot, certainly at present, make us give them up. And I do not think it ever will.

HUMAN LIFE

THE BIOLOGIST AND DEATH

I HAVE had during the very writing of this paper the distressing experience of being brought, suddenly and dramatically, to face that problem of human life, that to most of us is the greatest of all its problems, I mean the problem of death. One evening, on a train from Chicago to Washington, returning with a companion from a week's association with hundreds of other scientific men, I spent the hours between dinner and bedtime discussing with my companion the possibilities of science in helping us to understand Nature and Life. He was a man who had given thirty years, with all the advantage of great ability and highly-perfected training, to scientific study. He was withal a most attractive and lovable personality. We parted at the evening's end with smiles of friendship and mutual encouragement to push on

AS THE BIOLOGIST SEES IT

with the task that we had in common. In the morning I found him dead in his berth.

What does the biologist have to tell us of death? Well, first, true to his professional interest, he tells us of the facts and the significance of the death of species. He points to the hosts of extinct kinds of animals, dead species, revealed by the fossils in the rocks. He shows us how this death of successive species reveals and is itself a part of organic evolution, the greatest fact, and its revelation the greatest glory, in biological science. Death of species is at once the revelation and the proof of the struggle for existence with the consequent survival of the fit. Dead species have been the stepping stones to new species; their history is the history of organic evolution. Species are unfit, or become unfit, for various reasons; among them, the reason of overspecialization. This is rather surprising, for all organic evolution is a movement from generalization toward specializa-

HUMAN LIFE

tion, and yet in the very acquirement of this specialization are sown the seeds of species death. What organisms gain in specialization they lose in plasticity. They become so adapted that they lose adaptability. Progress in one direction involves, as someone has said, the closing of the gates in countless other directions; progression thus means a succession of lost opportunities. The Irish stag specializing in antlers was brought by too large antlers to species death. The great Dinosaurs, lords of their epoch, extinguished themselves by too much muchness. There are even analogies of these biologic happenings in human history. And there are even biologists who see the triumphantly super-specialized species, man, in actual danger of species death from too much specialization.

But one of the major lines of human specialization is what might be called a specialization in the direction of safety from over-specialization; it is a specialization in general adaptability, not in par-

AS THE BIOLOGIST SEES IT

ticular adaptation. Man has become able to follow varying natural conditions. I have recently read a fascinating paper on "Forests and Human Progress." In it the author, Dr. Zon, gives a seizing picture of human civilization, first in a stage of being dominated by forests, then in the stage of successful struggle with forests, and finally in the present stage of domination of forests. Somewhat similar stories could be told of man and oceans, man and mountains, man and deserts, man and climate. Man's narrow biologic specialization—think of the narrow limits of temperature, oxygen, food and other conditions in relation to his mere maintenance of life—is offset by his wide social inheritance and his educability. This gives him power to withstand and dominate antagonistic Nature: even power to add the forces of Nature to his own forces. He fights against natural selection; he substitutes a purposeful artificial selection for it. His possession of consciousness, reason and

HUMAN LIFE

volition, by which he makes effective a scientific method or technic of successful struggle with nature, seems to insure him against species death, at any rate in any geologically near future. Cataclysmic world change would wipe him out easily, so specific is his biological adaptation to present conditions; but slow change, and that seems the geologic rule, finds him well protected, so developed is his power of conscious adaptability and his partial control of the conditions of life. "What a plastic little creature man is!" said Emerson. "So shifty, so adaptive! His body a chest of tools and he making himself comfortable in every climate, in every condition!"

But it is not human species death but human individual death that most of us look on as the problem of death. It is here, as always, in *individuals*, including our individual selves, not in *species*, that most of us are principally interested. And when we ask the biologist about what he can tell us of death we are not

AS THE BIOLOGIST SEES IT

asking him about species death but individual death; the death of our relatives and friends, the death of my companion just as he had reached his greatest usefulness for science, for humanity, his greatest power for achievement and, because of it, his greatest joy in living and our greatest loss in his passing. What has the biologist to say about this kind of death?

Truly, very little. He can explain or describe death, as it affects the body, in more precise terms than we commonly use; he can describe the particular, irreversible physical and chemical changes that characterize or are physical death in the exact terminology of science and indicate the immediate specific causes that set up these changes, but this is very far from satisfying us. To explain to us that the human body is a machine which differs from other machines with which it may be compared in that when once stopped it cannot be set going again, is not in the least to solve for most of us the

HUMAN LIFE

great problem. Is death really just what it seems and what the biologist describes it to be, or is it what so many would like it to be, hope it is, and even firmly believe it is? Can the human individual have an ethereal spirit existence apart from, or after, his bodily machine existence? Is man immortal? That is what we insist on asking the biologist who assumes a knowledge beyond that of most of us concerning human life.

The biologist, unless he be a scientific bigot, confesses at once the limitations of his knowledge. He does not claim that his description of individual death necessarily tells the whole story. But he claims that it tells it as far as the kind of evidence which he can accept as telling him things he can rely on now permits. His attention has been called to a great and heterogeneous array of alleged evidence or proof of spirit existence. We confront him by the great intellectual difficulty that most of us have in accepting what seems the awful waste of Nature and of

AS THE BIOLOGIST SEES IT

man himself in having lifted humankind, both as species and individual, to such a peak of evolutionary development, if death ends it all. Just because a single part in the complex material machine, or association of engines, that was my friend's body, suddenly breaks down, is that the end of his story? One evening all that nature and man had done for him were available for our good and his happiness. The next morning, because a trivial mechanical disharmony prevailed during the night over what had been for fifty years mechanical harmony, he is nothing more to us or himself. This seems preposterous, incredible. Must we accept it, biologist?

Sadly he answers, I can give you no comfort. That same waste of Nature's efforts—if it really is waste—is apparent all through the realm of life. This fish produces a million eggs when only a few will successfully develop into new individuals. How many thousand to one are the odds against the successful achieve-

HUMAN LIFE

ment of the extraordinarily complicated life history of one of those internal parasitic worms which demand successive entrance into the bodies of two or more hosts to complete its development? This unconscious waste of Nature is no less preposterous, incredible to me, he says, than that every now and then, consciously flying in the face of what seems to be all self-interest, all enjoyment of life, all reason, millions of men swarm out of their homes, to use all their energy, all their native cunning, all their hard-won scientific knowledge, to kill each other, to bring intense suffering to their wives and children, to destroy their accumulated material possessions, to burn the created glories of their artist geniuses, to work, in a word, all the waste and misery that are the inevitable accompaniments of war. Is this less incredible, he asks, than that nature should tolerate the extinguishing after a period of functioning of the complex of elaborately built up machines which is the human body?

AS THE BIOLOGIST SEES IT

And he adds that the same extinguishing comes to every other animal machine, to all other living bodies. Do you ask for something to continue after death of the pet dog, the favorite riding horse, the bird you shoot as game, or the insect you crush under your feet? I find no proof, scientific proof, he says, that death is not the end of these creatures. And you do not ask me to believe otherwise because of some desire or belief on your part that death is not their end. Well, no more do I find any proof of the kind I am familiar with and content to accept, that death is not the end of man. I do not say that death is the end; that I have scientific proof that it really is the end, but I have no proof, yet, that it is not the end. The strong desire and hope and that next conscious state, belief, which you suggest to me as proof to you that death does not end all, are not the kind of proof on the basis of which I ask you to accept what I do really feel able to tell you as facts about human life, facts many of

HUMAN LIFE

which you are inclined to accept on my word.

Nor have I been able to find proof, the kind of proof that proves things to me, of immortality by attending spiritist seances or in reading the volumes of the Society for Psychical Research or the many other books that recite the experiences of alleged participators in or observers of things of after death. I should, indeed, truly be appalled by death, the biologist says, and it would have a terror for me greater than it has even as a possible complete extinguisher of my personality, if it meant that it was the beginning for me of a perpetual personal spirit existence in which my thoughts and conversations were to be of the kind exemplified by those recorded in the Psychical Research and spiritist books. I do not wish to spend a spirit existence responding to calls from earth to describe the quality of the cigars that I am permitted to enjoy in my eternal life beyond.

But in the same breath the biologist says,

AS THE BIOLOGIST SEES IT

if he is not a bigoted biologist, that he has no right to say and will not say that there cannot be a human spirit life, nor a human immortality, despite the fact that he has seen no spirits and that the only immortality he has been able to discover among living creatures is that of those one-celled animals and plants which, barring accident, reach in a few hours or days after birth a maturity, not followed by natural death, but by a division of the whole body into two parts each of which is an independent new individual, requiring but another few hours or days to grow and develop and reach maturity, and to divide, in turn, into two more continuing individuals. Even this immortality seems to require for its full realization certain occasional special stimulating physical or chemical conditions, for after a few hundred succeeding generations of this self-perpetuation the series tends to run out. Natural death tends to appear. So that perhaps after all this, at first sight, tangible, observable material immortality is only delusion.

THE BIOLOGIST AND SOUL

BUT, I say again, the biologist who is not a bigot cannot authoritatively and hence will not try to affirm that there cannot be human immortality. He simply remains agnostic. He does not know.

Then there is the cognate matter of soul in the living body. The biologist sometimes has a difficult time trying to understand what other people understand by soul. If sweetness of disposition or amiability of character is a symptom of soul, as he is told by some, then he finds soul in many animals. I had two tarantulas once in my laboratory, one of which was a morose, ugly-tempered brute who, whenever I approached him with playful finger, became angry and, rearing on his hinder two pairs of legs and unfolding his great poison fangs, made ready to lunge and strike whenever his malicious intelligence assured him that he could reach

and wound me. But the other tarantula, of the same kind and found in the same field, would let me fondle him and would walk in friendly fashion up my bare arm without ever a thought of hurting me. He was a sweetly dispositioned tarantula.

You see I have used terms in describing the behavior and character of these spiders that we generally reserve for accounts of human behavior and character. And if you say that I should not attribute character or disposition to them but should limit myself to describing their manner of behavior, because we do not know that their behavior was controlled by their disposition—chemical or physical stimuli may have controlled it—then I reply that I can quite as easily and much more confidently describe the similarly contrasting behavior of two human individuals in terms that we usually limit ourselves to in describing animal behavior. The difference is, we have had so much experience with human individuals, that is, have made so many ob-

HUMAN LIFE

servations and so many experiments on them, that in our search for the springs of this behavior we have become accustomed to feel justified in saying that such and such behavior indicates such and such kind of disposition, a large or small possession of kindness, or as some might interpret it, soul. If we knew tarantulas better we might be able to use the same generalization and discriminate among them as fairly.

Mother love reveals the human soul, says one; but mother love is a commonplace among the higher animals and some of the less high. Love and sacrifice of self for family and community prove soul: well, the worker bee works till it falls dead on the threshold of the hive with honey sac or pollen baskets filled with food which it is bringing home to feed the babies and queen and drones of the hive. Faith in an all-wise and all-kind God proves the soul in us. The primitive Africans have no less faith although their God is made of wood or

AS THE BIOLOGIST SEES IT

mud. John Muir's dog, Stickeen, seems to have had no less faith in his master at whose insistence he leaped the dangerous glacier crevasse that seemed too wide. Had Stickeen a soul? The young robins that make their first flutterings from the nest perhaps have faith in the parent birds' assurances. Are they soulful?

But other people mean other things by soul: they mean the creative imagination, the capacity for a self-expression of the wonderful things in them. Man's mind is so wonderful, as evidenced by his discoveries, his inventions, his poetry and music and painting, that you say there simply must be more than brain-cells and nerve fibrils as basis for them; there must be soul in him. But a simple physical injury or disharmony in these material body tissues means a prompt end to all these wonders. A boy companion of mine was called, because of what he could do in music, a genius. He fell one day from a gate post and struck his head against a stone. In

HUMAN LIFE

a few weeks he was as strong a boy as he had been before but he was no longer a genius. There was no longer any soul in his music. Was it his soul that struck against the stone? In that great gray building, the hospital called Salpetriere, in Paris, there are a thousand human beings whose brains and nervous systems do not work in orderly fashion; they are not hopelessly insane: they are temporarily, some perhaps permanently, mentally unbalanced, hysterical. For the time being they show little sign of soul; but when they are cured they will have soul again. Soul seems to mean, or at least to require, continuing mental balance.

The brain is a wonderful instrument in some human beings: in others, whole communities or tribes of others, it now enables its possessors to count no more than five. Human reason does wonders: so does the instinct of the social wasps and the fungus-farming ants. The Brooklyn Bridge is a triumph of engineering: so is the orb-web of the garden spider. I do

AS THE BIOLOGIST SEES IT

not mean that there is no difference between the brain of man, on which seems to depend a part at least of his soul, and the cephalic ganglion of the ant. But may not this difference be one of mass and histologic differentiation and organizations, rather than of fundamental kind or quality, that is, may it not be quantitative rather than qualitative? For all practical purposes, as I said in the first paragraphs of my first paper, this difference may be such as to make two very different sorts of creatures out of men and ants but is one to be assumed to be fundamentally foreign to the other? So fundamentally foreign that one means soul and immortality and the other only carnality and clay? Perhaps it is: I do not know.

Much that means soul and human attributes assumed to be peculiarly and fundamentally derived from some source other than one common to other forms of life, has been plausibly shown by biologists and sociologists to be a highly

HUMAN LIFE

developed derivative of more animal-like attributes. Love may be a beautiful outgrowth from the animal necessities of reproduction and protection; charity from the requirements of an advantageous development and exercise of altruism in the case of an animal species which has adopted the mutual aid principle in evolution rather than the mutual fight principle; hope and belief may be the by-products of a brain development that has outrun biological utility even as the Irish stag's antlers outran advantage in size. But I need not dwell on these iconoclastic ingenuities of the cynical materialist. They are familiar to you and have already been accepted or rejected by you; by some of you on a basis of reason, by others on a basis of emotion.

Emotion itself is a great problem. There are fundamental emotions or conscious states such as fear and hunger and sex interest which are plainly closely related to the brute part of our life, and other less fundamental or derived emo-

AS THE BIOLOGIST SEES IT

tions, such as desire, hope and confidence leading to belief, and doubt and depression, leading to despondency, which are apparently a product of our more intellectual life. But that is to say that they differ from the fundamental emotions common to other animals as well as ourselves only because of our more elaborate and superior nervous development. These derived emotions are among the particularly distinguishing attributes of human life as compared with animal life and play a great part in all of our everyday living. We see more of them, are impressed more by them and think more about them, under ordinary circumstances, than we do of the more fundamental emotions, but how quickly and powerfully the fundamental emotions dominate us under circumstances which strip off for the moment our veneer of social inheritance and so-called peculiarly human qualities. The war revealed this vividly, although it also revealed how some individuals had arrived at a stage

HUMAN LIFE

in human evolution which enabled them to dominate their brute-inheritance in a most wonderful and encouraging way.

An authorized lecturer representing a certain organization with many adherents stated in an address in Washington the other evening that the world is a mental phenomenon and hence that all the things we know in it are controllable by mind, or indeed are simply manifestations of mind. That rather seems to put in the hands of each person possessing mentality the power to do things to or with this old world and the conditions of life on it much as he wills to do them.

I must confess that the biologist sees the world differently. He finds it composed of a lot of things, and sees going on, in and about it, a lot of things which are hard to reduce to mental phenomena and hard to make amenable to his desires and control. He realizes, of course, that without the sense organs and brain no one would have much awareness of the world; that, indeed, one might think it

AS THE BIOLOGIST SEES IT

non-existent. Color is color to us and sound sound only after a mental perception. But the different ether waves which are perceived by us as color and the atmospheric waves as sound might perfectly imaginably go on coursing through the ether and atmosphere although no human or animal sense-organs and brains perceived them. In fact the physicist is quite sure they would. If a photographic plate got in the way of the light waves and a phonographic plate in the way of the sound waves the existence of these waves would be mechanically registered.

In Stanford University a number of years ago I used to walk down an avenue lined with trees—I believe they were trees—to the beautiful quadrangle of buildings, with a companion, now a distinguished professor of philosophy in an important Eastern university, who proved during our walk each morning by what was to me a verbally irrefutable logical argument that there were no trees

HUMAN LIFE

along our way and no quadrangle before us. However, when after successfully avoiding the tree-trunks, we reached the quadrangle we entered it quite naturally and unsurprised, and went on under its arcades to take up our duties in our respective class rooms in it. We, or rather the professor of philosophy, had simply had a pleasant after-breakfast exercise in mental gymnastics. We had done our other gymnastics before breakfast.

The biologist is willing to bet his life that much of the world really exists in a material sense. If the philosopher and I were standing on a railway track with a locomotive engine tearing towards us at fifty miles an hour he might prove to me, if there was time, by his interesting play of words and logic, that nothing was there and hence nothing was going to happen if our non-existent bodies continued to stand still on the non-existent railway. But I would win my bet that something very distressing would

AS THE BIOLOGIST SEES IT

happen unless we stepped off the track, and that pretty quickly.

The biologist is a homely and practical-minded person who is little given to over-refined logic and debate but much given to observation and experiment. He believes that his eyes and ears and brain help him to the saving and enjoyment of life by enabling him to know and adapt his behavior to the world he lives in. The man who makes the world all mental may have reached a higher kind of *Weltanschauung* than the biologist, but the biologist, as far as I know him, is not going yet, for the sake of ascending to this higher plane, to give up remembering what happened to the man who doesn't step off the track, nor will he give up keeping his leg muscles in trim for a quick jump. His low and materialistic *Weltanschauung* is perhaps sufficiently indicated by his using as argument his readiness to bet his life and his enjoyment of life on what he thinks he knows about the reality of matter and energy.

HUMAN LIFE

But he knows, if he is a wise and honest biologist, what I have so often repeated, namely, that he doesn't know it all. When the future or destiny of the human individual are the subject of inquiry the biologist has little more to say than I have already indicated. He remembers his laboratory and tells what he has observed in it. Then he remembers his wife and child and himself, and his heart, not the heart of his laboratory experiments, fills with such thrilling emotions and his brain conjures up such pictures of possibilities for himself and his family and for all humankind that he wonders if he is really the same being that observes things in a laboratory or museum. His laboratory tells him what a precarious and fragile thing life is, how material and condition-ruled and circumscribed a living creature is. But his wife and child and his own consciousness tell him how much more, how immeasurably more, there is in life than he learns in his laboratory. It is this extra-laboratory

AS THE BIOLOGIST SEES IT

observation and realization of the possibilities and actualities of human life that make it, even to the biologist, the vivid, many-colored, suggestive, thrilling thing it is, the thing so full of occasionally realized great moments and of glimpses of infinitely great possibilities that sometimes it seems all mystery, all something more than of this world, and hence all something quite hopeless to study by the methods of his science, or even quite hopeless profitably even to wonder about. Why not take it and make the most of it?

And then comes the insistent question: Ah, *how* make the most of it? And he becomes again the patient struggling student of biology, that is the laws or conditions of life.

HUMAN LIFE

THE BIOLOGIST AND THE FUTURE

THE chief goal of science is not merely to describe the phenomena of matter and life; it is to determine by long and close observation and ingenious and repeated experiment the order or regularity of Nature, and hence to arrive at the position of being able to say what will happen under given conditions, in other words, to prophesy. The goal of the biologist—however unattainable or most limitedly attainable arrival at it may now seem to be—is to be able to speak with confidence of the future behavior or fate of living things; of living things as individuals and as groups and kinds. The biologist really aims at being able sometimes to speak confidently about the future and destiny of humankind. It is well to hitch one's wagon to the stars. A Kansas poet once exclaimed: "I'll wear Aldebaran as a bosom-pin."

AS THE BIOLOGIST SEES IT

If the biologist finds himself now, as we have already pointed out that he does, quite unable to say much worth listening to about the future of human beings after death, he is at least ready to venture some suggestions about the future of the human species in its material relations to the world and world conditions it lives in, and about the possibilities or probabilities of its further development or evolution.

This evolution is a fundamental element in life. Primarily it simply means change, but history, geologic and biologic history, has shown that this change has been progressive, it is change forward and upward. What causes it we do not know, despite our glimpse of some of its factors; what it really is we do not know, despite our sight of its results. "Some call it Evolution, and others call it God," sings William Carruth. But it is real. Human life today is what it is because of it; human life will be tomorrow what it will be, because of it. Is the biologist in position to hazard prophecy as

HUMAN LIFE

to the future course of human evolution?

As Conklin has pointed out, progressive evolution of special lines of animals and plants has limits fixed by its very nature. Evolutionary progress of animal bodies means specialization of the structure and functions of these bodies. Specialization, as we have indicated earlier in this discussion, means closer adaptation to a certain set of conditions of life but also means surrender of general adaptability. If an animal has given up legs for the sake of having flippers or wings or hands, it has acquired a more specific use of its limbs at the expense of a more general use of them. Now man has gone a long, long way in the progressive evolution of his body and its functions. But it is apparently true, as Conklin has said, that for ten thousand years there has been no notable progress in this evolution. If evolution is carrying man forward—and we do not doubt it—it is doing it in a different way. This way seems to be the

AS THE BIOLOGIST SEES IT

way of social evolution, based on man's social inheritance and the biologic factor of mutual aid. If so, we have not to look forward to future man as a physically different man—unless indeed he gives up a little more of that original physical equipment which enabled him to live successfully in Glacial Time as “animal among animals”—but we have to see man of the future as the possessor of an ever more elaborate and higher development of social inheritance, and more and more capable, by virtue of this social inheritance, of an inhibition of the vestigial brute carry-overs in his biological inheritance. That means, in ultimate analysis, that future man can be consciously determined by man today, that human evolution has been turned over to humankind itself to direct.

What an opportunity, but at the same time what a responsibility! Poor starfishes and clams, poor ants and bees, and all the other little animal brothers to man whose fate and future are all in the laps

HUMAN LIFE

of the gods of Nature. How they must envy—if they can envy—that fortunate big brother man who can make his future life what he will, who is his own chief factor in his own evolution. Some communism-mad men sometimes hold up before us the perfect, machine-turned, communal life of ants and bees as a model for humankind to copy. Do they realize what an ant or a bee is born to? An individual life entirely scheduled; a personal knowledge as large at birth as it ever will be; a personal fate that can all be told by the first seeress applied to, and a species fate all in the hands of a coldly impersonal and pitiless Nature. I sometimes feel sorry for the bees. If they have sunshine and flowers they have also the dark and crowded hive. And within and without, their every hour is scheduled, their every activity predetermined. I have even felt so exercised about the bees that I have written a little book about them in which I have imagined a bee heroine called Nuova—who is a new

AS THE BIOLOGIST SEES IT

bee born into the hive who revolts against the monotony and fatalism and hopelessness of usual bee life. Like other books with heroines it has a happy ending, but it wouldn't if it were a scientific text-book.

Compared with the bees and all the other animal kinds whose fate as species depends on external circumstances and inexorable natural law and whose evolutionary progress is dependent on occasional fortuitous germinal variations producing small somatic changes of selective advantage, what an opportunity man has to determine, within limits, the course and even the rapidity of his own evolution. But also what a responsibility!

Here is where the biologist becomes the preacher and exhorter. Here is where biology and the appeal to reason, where technical knowledge and common sense, where science and religion join. The soundest of science leads us to the conclusion that man, by virtue of the possession of a social inheritance, as con-

HUMAN LIFE

trasted with the biological inheritance which is all the inheritance that other animal species have, a social inheritance which gives him the present realities and the future possibilities of a social evolution in addition to his more personal evolution, has in his own hands a great instrument for determining the fate of himself as species; the future of mankind. This, of course, is what the preacher and the poet have always said about man, though on a basis of other conceptions as to how man has been given this power. But whatever the foundations for the agreement between scientist and preacher in their common conclusion, the interesting and important thing is that they do agree and hence that they can reinforce each other in appealing to man consciously to direct his efforts, with all his advantage of scientific knowledge and all his strength of belief, to the production of a higher, a socially and morally higher, future man type.

Thus these discussions of "human life

AS THE BIOLOGIST SEES IT

as a biologist sees it" seem to have a proper moral, even as tested by so suspicious a critic of biology as religion. After all, the biologist does not see human life, in its larger and higher aspects, so differently from the everyday observer or the poet and preacher. He sees wonderful possibilities in it, which man himself can help to make realized. Now if only the everyday observer, poet, and preacher would see human life in regard to those aspects on which the biologist is able to throw some special light, more as the biologist sees it, everything would be all right. The biologist is quite convinced on the basis of a kind of knowledge which, on the whole, has proved itself to all the world as a reliable kind of knowledge, and one that stands the test of time and liveableness, that man can learn much about himself from biological study, and rely much on what he learns in this way to help make his life safer and saner, and himself more capable of achievement, and hence happier. Bi-

HUMAN LIFE

ology is not a science for its own sake alone. It is a science eminently useful and practical to man and at the same time it is a science highly inspiring to him. For if it be depressing, as it may be to some, though it is not to me, that it teaches him that man's life is close brother to all the rest of life, yet it is inspiring in that the same time it reveals how wonderfully much has been done by Nature in making man, and how now man has been let into partnership with Nature for making better man. We are not a foreign matter or being imposed on Nature but Nature's own proudest product. And the power we have for further and higher development is not our own unaided power but that of our own and Nature's in combination. It is a combination that should have almost limitless possibilities.

E.P.B. 17.9.30.

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