SCIENCE

FRIDAY, JUNE 19, 1914

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PROSPECT OF HUMAN PROGRESS[1]

MY principal purpose this evening is to invite you to look forward to the time to come and to enquire as to the prospect of human progress which is thus opened to view. But it will be necessary to give a great part of our attention to the past in order to build, as it were, a lookout from which we can obtain a vision of the future.

We shall not be so rash as to attempt a prediction of events or even of discoveries; but we shall try to determine the sort of progress which the indications of the present and the teachings of the past lead one naturally to expect. This will certainly be a safe procedure, provided that we can find common elements of fundamental importance in the basic characteristics of each period; for it can hardly be supposed that the future will suddenly depart from the principles of progress which have been impressed upon the race throughout its long period of evolution up to the present.

It will be necessary for us to pass in rapid review the great stages of development by which man has changed from a beast-like savage to a cultured civilian. We shall find that these stages have been marked off by a few leading inventions, each of them giving a fundamental new element to the period of progress following its appearance. In this review we shall be guided primarily by the researches and conclusions of ethnologists.

It is probably impossible to conceive of man existing as man and not having the elements at least of language for intercourse with his fellows. Therefore, by com-

[1] An address delivered to the Graduate Club of Indiana University on the evening of May 7, 1914.

mon consent, it has been supposed that primitive man was in the possession of spoken language, developed to such a degree as to enable him to communicate effectively with his associates.

A moment's reflection will be sufficient to bring to mind the immense importance of language to any animal fortunate enough to have found, by chance or otherwise, a means for its development. He has for the first time, in the words of his language, a sort of concrete receptacle for his thoughts. Prior to the acquisition of this tool for thinking, his thought had been, as it were, a fluid stream from which he could take up and hold permanently only that which would adhere to a sieve dipped into the stream. He could not give his thought objective existence as standing out before him. He could only feel its passage as it was driven through his mind by one impulse after another from his material environment. But with language at his disposal the case becomes different. Between the language and his thought there is a mutual reaction; and by means of the former the latter is deposited so that it may become the subject of objective study. The immense impetus which this would give to the development of the intellect must be apparent to every one.

There is another and greater element of development in the invention of language, namely, that which is associated with the power of intelligent intercourse. By its means our primitive man has become able to live in part outside of himself and in the thought of others. Thus he can project into himself the experiences of many other persons. This gives a new richness and a new meaning to his life. He is no longer confined to the range of his own experience as his means of development. All his contemporaries, so far as he knows them, can be made to contribute to his progress and be themselves gainers in the act. And even more than this is true: the experience of one generation can be passed down by tradition to the next. Thus the cumulative effect of the progress of one generation after another first became available to our primitive ancestors. It gave a great impetus to progress.

Indeed, it is true, I believe, that man has not yet taken another step of advancement of as great importance to him as this first one; and consequently I have dwelt on it at some length. It is also to be contrasted, as you will see, with the greater part of his later progress. For, it is essentially intellectual in its character, whereas much of the other depends for its value on the increased control which it gives man over his material environment.

The next stage of development was brought in, it is supposed, by the discovery of the uses of fire. The knowledge of fire is so widely distributed that it is a question whether any authentic instance is on record of a tribe altogether ignorant of it. By means of its use man became able to leave the tropical parts of the world and to go into the more invigorating temperate climates. He also had an enlarged and more nutritious food supply, owing to the increased value of many meats and vegetables on being cooked.

The next prime invention appears to have been that of the bow and arrow. Its chief contribution to progress is also in the increased and improved food supply which it made available. A tribe using the bow and arrow could have meats at all times. Such a diet probably contributed to increase the physical vigor and the courage of the savage possessed of it for the first time. The primitive tribes of Australia and Polynesia had not advanced to this stage when they were discovered a few generations ago.

It appears to be the general opinion that each of the three stages brought in by the three discoveries and inventions named endured for a long period of time, perhaps for something like one hundred thousand years or longer. In all of these stages our ancestors were yet in the savage state. The advance to the higher state of barbarism was brought about by the marvelous discovery of a means of making pottery. Man learned to fashion moist clay into a useful shape and burn it into hardness so that it would endure use. The vessels so constructed afforded him a means of boiling his meats and vegetables so that many of them became highly palatable, whereas they were almost or quite inedible when merely roasted before a fire.

Man, having advanced thus far, was still in a very unsatisfactory state when viewed from our present organization of communities with fixed abodes. He was necessarily nomadic. If he settled down to live permanently at a given place, then the animals, upon which he depended so largely for food would soon disappear from that vicinity both because he destroyed them and because he excited fear in them. But after a time he found means for overcoming this difficulty. Doubtless it had proved profitable, to both the men and the dogs, for the two to hunt together. Thus the dog came to be domesticated. When the idea that captive animals could be of service was clearly conceived, it was an easy step to the domestication of the sheep, the ox, the camel, the horse. Thus man came to have a meat and milk supply readily procurable at all seasons; in addition, he had in the horse and the dog valuable assistants in the chase. As his animals required pasture he came naturally to recognize the value of an increased yield from the soil. Thus, from being a herdsman, he gradually developed into a husbandman. Then he came to have fixed abodes, and the idea of nationality began to take definite shape.

At this stage of development man had no very effective tools. Wood and bone and chipped flints were the materials out of which were made such as he had. Presently some one made the master discovery of the art of smelting iron. From this time forward man was equipped with tools worthy his hand and his brain.

This invention brought in the last of the three periods of barbarism. Each probably extended over many thousands of years. During these periods man had leisure for the development of his artistic sense; and the way in which he used this leisure is indicated by the remains of his art which have endured to the present day—such as the wonderful paintings found in numerous caves in Europe.

The age of civilization, properly so called, was now brought in by an invention comparable to that in connection with which man emerged as man from his previous savage state. That early advancement, you will recall, was associated with the development of spoken language. The new age of civilization was brought in by the acquisition of written language.

From this time forward progress has been much more rapid than previously. The first stage of civilization extended over the period from the invention of writing to the close of the so-called middle ages, when a new stage was brought in by the invention almost simultaneously of gunpowder, the mariner's compass, paper and the printing press. Coupled with this was the scientific discovery and the demonstration by Copernicus that the sun and not the earth is the center of our planetary system.

These inventions and discoveries brought about simultaneously three fundamental revolutions in human thought and human

relations. By means of gunpowder the peasant became a match for the bravest knight, so that the latter could no longer trample over the former in safety. The castle of the lord no more could serve as a certain stronghold against danger. Gunpowder became a mighty leveling influence and began to prepare the way for equal rights to all men. Through the use of paper and the printing press books were soon widely distributed among a large class of people whereas before they had been the luxury of a few rich nobles. The advances in astronomy turned men's minds upside down, as it were, and set them to feeling that all conceptions of the world and of man were in need of fresh examination and possibly fundamental revision. Add to this the power of the mariner's compass, which enabled men to sail in safety across unknown seas, so that the whole wide world was about to come under their dominion. You can not fail to see that all these things, thrown as they were at once into experience, would undoubtedly produce a profound stir and commotion in the human mind. Such was the state of experience and such were the means of development in the middle stage of the higher civilization.

A period characterized by so much activity would naturally be one of rapid change. You would therefore expect it not to last long. Such indeed was the case. Only about four hundred years had elapsed when, towards the close of the eighteenth century, James Watt gave to the world the perfected steam engine. A new tool of power was thus in the hands of the men of that and future generations. It increased the working speed manyfold and thus brought in a period characterized by greater leisure for the cultivation of those elements of civilization not directly connected with obtaining a food supply. Man then entered upon the present stage of civilization, the highest to which he has yet attained.

We have now passed in rapid review the elements of the material basis for the progress of mankind. We have necessarily considered only the greatest outstanding facts. Now I should like to ask each of you to take these facts and to build them into a lookout from which to view for a few minutes the prospect of human progress. Or, if you prefer a different figure, will you consider these as constituting a mirror in time by means of which you can see in the past and the present the image of the future, just as by means of a mirror in space you see an extended image in one position while its object is in another?

In the first place, let us ask in what way these inventions and discoveries may be looked upon as the cause of progress. A cause may operate in two very different ways. If a ball is fired from a rifle the explosion of the powder *impels* it into motion and drives it forth. There are other causes in operation; but this is the fundamental impelling one. On the other hand, if the same ball is held at some height and the support is removed, it will also be set in motion. Undoubtedly the taking away of the support is one of the causes of this motion. It is not, however, the impelling cause; it is one acting by release.

If, now, we consider the means of progress we have mentioned, we can find no power in them through which they could have been the impelling causes of human progress. They undoubtedly operated by way of releasing the activity of man. We must assume, then, that there was a power of development inherent in human nature and that these inventions and discoveries merely released that power into activity. That appears to be the teaching of the whole of human progress. It is illustrated

also in the development of the individual. It is clear that the environment is not creating the growing intellect; but it is serving as a means of release to set free its activity and is thus making possible its attainment of power. The fire which lighted the savage's camp in the woods also kindled the intellect of the man who operated with it. It gave him new things to consider. Ultimately it put new tools into his hands and finally it has led his descendants into their most remarkable inventions.

These considerations make it clear that we shall have a fundamental understanding of progress only when we take into account the intellectual and moral and spiritual forces which are released or developed from age to age. These things are elusive; it is hard to get a grasp of them. They have in them the fluidity of life and they slip through our fingers so that we can hardly hold them. And yet they have doubtless had a profound influence of their kind, especially upon the relation of man to man. Consider, for example, this one command, "Thou shalt love thy neighbor as thyself." T. H. Green remarks that this has not varied in form during the whole of human development but that there has been a profound change in the answer to the question, Who is my neighbor? As our conception of duty and one's responsibility to his fellow has widened, we have given a broader and broader answer to this question, so that now every member of the human race is to be considered as our neighbor. Indeed, we have gone further than that and have come to include within the pale of our brothers even the most remote tribes of men. Obviously, this conception, moral or religious in character, must exercise a profound influence on the civilization of the future. Likewise other matters of this sort must have their important places; and we will give a just reflection of progress only when we take them into account.

In this connection I must call your attention more precisely to the interplay of material and intellectual forces. We have spoken of the former as releasing the latter. To stop here would be to give a very partial view of the situation. As soon as the intellect has come into play material things will be put into juxtaposition which are not found so in a state of nature. Thus the mind is able to release material forces which had not been in evidence before. These in their turn stimulate the intellect to a greater activity and thus increase its powers. Then we have new juxtapositions of natural things brought about through the deeper insight of the mind into the relations of phenomena. The connections which are thus put in evidence become more and more profound until at length we find man able to control the elusive electricity and by its means to transmit great powers of nature into his homes and his shops, subdued and taught to do his labor for him at his bidding. There seems to be no limit to the progress which may be engendered by this interaction between material and intellectual forces.

Of a similar character, but still more profound in its effect, is the quickening due to the intercourse of man with man. It was this, as we have seen, which characterized the first period of human development. One can not doubt that it has played a fundamental rôle throughout the whole range of progress.

It has been observed many times that a new vigor of character is produced by the intermingling of different races or nationalities of peoples at corresponding stages of development. The new is stronger than either of the elements which go into it.

There is a mutual stimulation which carries them into greater power than either could have attained alone. It is like the production of certain alloys where the mixed metal is much more useful than either of its constituents. The combination possesses properties which do not seem to be in either of the elements combined. It is this intermingling which gives to the character of colonial peoples that remarkable virility which it is often observed to possess. It is this which throws back from the colonies such an influx of power into the mother country. We shall get a picture of how all this is so if we consider the human race to have had at first certain potentialities of development and each group to have lost or to have weakened certain of these while developing others to a considerable or to a vast extent. What we get, then, by the intermingling of these different peoples is the reuniting of these various potentialities, in their developed and strengthened form, so that we come to have in a single individual a combination of elements of power which could be brought to him only by the junction of divergent streams of progress.

Looking at the matter thus we see strong grounds for optimism as to the prospect of further development. Never before in the history of the world has there been so much amalgamation of peoples as at the present time; and consequently there has never before been such an opportunity for reuniting the potentialities which have developed along divergent lines. There is greater facility of travel; means of communication have increased to a remarkable extent; and nations and peoples begin to exhibit a spirit of cosmopolitanism, so that the feeling of world citizenship is coming to play an effective part in the affairs of commerce and government. There is growing up also a demand for a universal language to facilitate intercourse; but what this will result in one can not at present predict with confidence.

World-wide intermingling of peoples carries with it, no doubt, its characteristic attendant dangers. The various local civilizations which were developed in earlier times, such, for instance, as those of Greece and Rome, ceased to flourish when their central populations became stagnant through the lack of accretions from without. It appears that one line of development can not continue indefinitely unless the potentialities which the people lose in their progress are supplied to them again by another people who have retained what the former had lost. Therefore, if the whole world should become a single community with a single life, we should have only one line of development in progress and hence should naturally suffer in the end a resulting stagnation.

This, however, is probably a danger which should not be anticipated. Though the whole world may be brought very close together by the present tendencies of civilization, it can hardly be supposed that it would grow into a single people with a single life. Such a thing has hardly yet taken place in England after a thousand years of close association on the part of peoples which were descended from a common stock not far removed. Furthermore, if any one should feel that there is ultimate cause for alarm in this matter, the problem could yet be safely left to the future for solution. We may be confident that it will be dealt with in a wise manner when it arises. So many new influences are now coming into play and so many lines of progress are converging into a great central stream that it would be hazardous to undertake a suggestion as to how this problem could be dealt with. It is a question for the future and the future must answer it.

Will you allow me, now, to turn abruptly

to an examination of these chief elements of progress from a different point of view, one which more precisely characterizes the outlook of the man of science? It is this latter point of view, I believe, which is most suggestive of the prospect of progress lying out before us.

If we look at those general elements which have characterized the principal stages of development—those, namely, of savagery, barbarism and civilization proper—we shall find that they are marked off by certain leading conquests, as follows:

During the period of savagery man was winning his way to a partial conquest of the world in the large. At its beginning he was confined to a relatively small portion of the earth's surface, namely, to the more tropical parts. This was true for two reasons: he had not yet discovered means to protect himself against the more rigorous climates; he also required to remain in a region where a food supply was available throughout the year. During the period, however, he acquired the control of fire and invented the bow and arrow. He thus became able to take care of himself throughout a much wider portion of the earth's surface, thanks to his increased control over material things.

In the next period, that of barbarism, he began to bring under his control the animal, vegetable and mineral kingdoms. The animals were taught to do his work and were kept also for a food supply. He learned to cook vegetables so as to render them much more palatable. Furthermore, he acquired the use of iron. In all this, you will observe, he was still dealing with things in the large.

During the next period, that of civilization proper, there was the first adumbration of a control of things in the small; but it was only an adumbration. It is the energy of molecules which gives to the steam engine its power; but this engine deals with them in the mass and not in the small. So has it been in the control of electricity attained during previous generations; men have not dealt with it in the small.

Thus, throughout all progress until the time of the last generation, it has been true that the conquests of men have been over things in the large.

There is strong reason to believe that we are now entering upon a new stage of progress brought on by the mastery of things in the small. I shall indicate briefly some of those over which we are now gaining such control.

We are no longer content to study electricity in the large; we have chased it down to the electron and probably even to the sub-electron. We are thus in a position to get a fresh insight into its phenomena. We have studied the various rays, visible and invisible, which are produced by the discharge of electric particles; and by means of them we have learned to photograph the bony framework and even the soft organs of the living human body. Here we have begun a conquest which we hope to carry on to many fundamental results.

Ordinary matter also is yielding up to us a more profound secret than we have ever before brought to light. This began with the study of emanations from radium and has been continued with a number of other substances. Furthermore, we have been able to strike off from atoms of various kinds the electron itself and have thus disclosed the intimate kinship of elements which previously had been considered entirely distinct. Here again we have just begun a conquest which we hope to carry on to many fundamental results.

Our men of science have also entered into the living organism and have begun to

study the basis of life itself. Witness the frequent investigation of living cells and even the elements, such as chromosomes, of which these are composed. Here the researches of Mendel and his followers come into play, revealing to us a new means through which we may hope ultimately to control even the character of those yet unborn. Here also we have just begun a conquest which we hope to carry on to many fundamental results.

There is one other mastery over things in the small to which I wish to call your attention, one having in it a great power for the development of strong and vigorous human beings, ready for the further advances of the future. I refer to our new and increasing knowledge of disease-producing germs. Here also we have just begun a conquest which we hope to carry on to many fundamental results.

Thus there has been opened to us in a short space of time a varied and undreamed-of world in the small over which we are now to gain the mastery. Our analysis of previous progress shows that we have here something vitally new. It should therefore lead to important development. Our confidence in this is great, since a little reflection on the matter brings out the fact that we now have converging into one main stream many of the elements which have characterized previous progress.

The actual development which we thus anticipate will be realized only if science indeed makes the conquests which seem to lie out before us. Why, then, may we feel sure of such advance? Time will allow only a brief answer. A slight examination of the past will put in evidence the fact that the fundamental discoveries of the earlier ages came about mostly by chance. Men were not seeking systematically to know the secrets of nature. They learned a few things in a haphazard way. They had not found out how to make a systematic and all-embracing search through fields either old or new. Fresh discoveries continue to be made right up to the present and with greater speed than ever before. New sorts of questions are asking for an answer. This indicates that the undiscovered regions yet to be found are vast in extent. To-day an increased number of persons are seeking the new. They have learned better methods of research and are able to go about their problem in a more systematic way. Undoubtedly there is still in human character the potentiality of great power to be released through the excitation of new discoveries. Therefore one can not fail to have the best of confidence that there is a long and important line of advancement now to be followed out.

Thus we have at hand every means of progress. The prospect is a pleasing one. He who works at this builds something into all subsequent human development. This is a labor worthy the mettle of the noblest intellect. The science of to-day is lighting the way of progress; and every real contribution to its results will make brighter the illumination of the future. I congratulate you that you have entered upon this labor. May the flower of science blossom at your touch and the vine of knowledge bear luscious fruit under your hand and the pure wine of its vintage flow forth to swell the stream of progress.

R. D. Carmichael

Definiteness of Appointment and Tenure[1]

The college professor is rapidly being forced to occupy a new and important position in our public affairs and is receiving more of the

[1] Delivered before the College Section of the Association of American Agricultural Colleges and Experiment Stations, Washington, D. C., November 13, 1913.