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SOME COMMON MISCONCEPTIONS OF EVOLUTION*

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The living world embraces such a variety of form and such a range of structure and mode of life that, to the average man without scientific training, it must always have seemed a great unravelable tangle, inexplicable on any other ground than that of special creation—that some omniscient and omnipotent being made the various forms of life and established them in the world, for his own delectation, if for no other purpose.

But the greater scientific and philosophic minds of the past centuries have been able to discern an order in the midst of this apparent chaos and, from the time of the ancient Greeks, repeated attempts have been made to point out this order and to suggest some more acceptable reason for its existence than to assume that somebody made it all at once and set it up ready to run to the end of time. Naturally, the earlier attempts to convince mankind that there has been a gradual evolution of the present complex order of existence were unsuccessful for want of sufficient knowledge.

It is probable that Aristotle, Lucretius, St. Augustine, Harvey, Buffon, Lamarck, Erasmus Darwin and other great minds of the past apprehended clearly enough the scheme of gradual development of life on the earth, but they lacked sufficient knowledge of the facts to make a convincing argument on a matter apparently so revolutionary. Furthermore, from Augustine on down, they were confronted by a dogmatic theology which effectually blocked the progress of scientific thought for many centuries.

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The scientific men of the past century and a half, especially, have established the following important facts with regard to life on the earth:

1. There has been a gradual development from simpler to more complex forms.
2. There have originated multitudes of new species as well as whole new phyla since the geological record began.
3. Other multitudes of species as well as whole orders have passed out of existence in geological time.
4. These changes have been the result of orderly procedure and not of cataclysmic action.
5. There has been continuity of life and uniformity of biological processes.
6. Untold ages of time have been involved since life first appeared on the earth.

The only satisfactory explanation of these facts is found in organic evolution. All those who have the best right to an opinion on this matter—the scientists who have investigated and carefully weighed all the data, are agreed that there is no other satisfactory method of putting the facts together in logical order. All of the facts and deductions are open to re-examination, but as they have been carefully scrutinized already by large numbers of investigators and from all angles, it is not likely that any different interpretation will be found possible.

Notwithstanding this concensus of opinion among those qualified to judge, there has always been a number of "conscientious objectors" among those untrained in science, on the ground that evolution opposed certain established theological dogmas. A theistic conception of evolution, however, satisfied the more liberal minded of these objectors and there has been a gradual diminution of opposition since the time of Darwin. Recently, however, a well-known, quixotic platform speaker has made a virulent attack on the law of evolution and the weight of his oratory has carried so many people with him, that opposition to evolution has spread like an epidemic through certain portions of this country. If he had chosen, instead, to attack the Copernican theory that the planets revolve around the sun, he would no doubt have convinced many unthinking people and those unfamiliar with the facts. This campaign against a law of nature would be

amusing were it not for the fact that it shows such a deplorable state of ignorance among our supposedly enlightened people, with regard to the progress of science.

It is true that many otherwise highly educated persons do not have a very clear idea of the law of evolution and that many misconceptions are current among them. In the effort to clear up some of these mistaken notions let us consider a few of those which appear to be most commonly held.

It is commonly, but mistakenly, supposed that scientific men are divided in opinion as to the truth of evolution. This idea has arisen from the discussion of certain minor matters, or side issues, such as the mode of origin of species. It may be safely stated that the only questions concerning evolution that are debated by the biological scientists, are those that have to do with the *method* of evolution—the discussion of the means employed by nature in causing the changes that are admitted to have taken place, and the paths along which the advancement occurred. Though there is still much discussion as to just how it has come about, no scientist at the present time has any doubt of the fact of evolution. Furthermore, all will admit that three great interacting factors are to be found in *variation*, however it may be caused; in *selection*, by which inadaptive changes are eliminated and adaptive changes permitted to continue; and in *heredity*, by which any advance, involving the constitution of the organism, may be perpetuated through succeeding generations.

Variations of some sort are necessary, of course, however they may be caused, or there could never be any change and, without change, naturally, no evolution. Moreover, the variations must be of a particular class, for they must be inheritable, and, as far as we know, only those variations are capable of being inherited which involve a change in the germ plasm. The "discontinuous variations" of Bateson and the "mutations of DeVries are the most marked of these germinal variations, but just how small a variation may be and still be inheritable no one has yet discovered. Variation, then, supplies the crude material for evolution.

Natural selection, that much misunderstood and much abused term!—selection is merely another way of stating the fact that variations of all sorts occur and that some of these may benefit an organism, while some others may be harmful to it.

The beneficial variations are of value to the organism in solving its problem of existence and, very naturally, such variations tend to insure that the organism shall live to maturity and through its reproductive period. If a variation is inimical to its possessor, then selection naturally eliminates the organism that possesses such a variation and that is the end of that variation, since, if its possessor does not live, the variation cannot be perpetuated.

Heredity is merely passing on to the next generation any characters which may be a part of the germ plasm of the organism. A species can find no way of continuing a variation that is sufficiently harmful to cause the death of its possessor, or even to pass on for very long a variation that is only mildly disadvantageous. To indicate how important even a slight advantage may be, allow me to quote from Prof. R. C. Punnett; "If a population contains .001% of a new variety, and if that variety has even a 5% selection advantage over the original form, the latter will almost completely disappear in less than a hundred generations." So, heredity becomes an important factor for progress when coupled with variation and selection, in that it gathers up the useful variations and concentrates them in posterity. Or, as Prof. J. A. Thomson puts it, "The true inwardness of heredity is a holding fast of that which is good."

A misconception of heredity lies in the notion that it can accomplish anything more than merely to pass on to future generations what has already become a part of the germ plasm. Just as selection has no evolutionary importance aside from its reaction on variations of different degrees of value in adaptation, so heredity has no place in evolution except as it passes along such characters as have been already selected out as of importance in the life of the organism. Any new variation of the germ plasm, of value, is in this sense selected and, by heredity, becomes a part of the more advanced organism, while any new detrimental variation is swamped by the struggle for existence and is not permitted to be passed along by heredity, because its possessor is eliminated as unfit to meet the conditions of life. It is possible, of course, for a character to be merely useless without being harmful, but such features of an organism must play a very small part in evolution.

Darwin's theory of Natural Selection has been blamed by undiscerning critics as being responsible for the Great War. Unfortunately the term "natural selection," which means nothing more than that one variation may have an advantage over another one under the conditions of nature, has been drawn into bad company by those who have misused it, as, for example, in association with the Neitzschian philosophy of the superman. As a sample, we may quote the following statement from von Bernhardi, "Wherever we look in Nature, we find that war is a fundamental law of evolution. This great verity, which has been recognized in past ages, has been convincingly demonstrated in modern times by Charles Darwin."

Now, Darwin made no such interpretation, and various later biologists have taken exception to this application of his theory to human affairs and especially to war. Thus Thomson wrote, five years before the war, in 1909, in "Darwinism and Human Life": "I find no grounds for interpreting Darwin's 'metaphorical phrase,' the struggle for existence, in any sense that would make it a justification for war between nations." Dr. Chalmers Mitchell also comes to the conclusion (Evolution and the War, 1915) that "They" (modern nations) "differ from the units of zoology and botany in that the individuals composing them are not united by blood-relationship. Even if the struggle for existence were the sole law that had shaped and trimmed the tree of life, it does not necessarily apply to the political communities of men, for these cohere not because of common descent, but because of bonds that are common to the human race."

A former president of this Academy, Prof. Maynard M. Metcalf, stated in his presidential address before the American Society of Zoologists on "Darwinism and Nations," "Human communities, especially, have freed their members from much of the stress of the struggle for existence, by substituting co-operation for rivalry. . . Co-operation may perhaps fairly be said to transcend natural selection as an influence upon the life of highly civilized man. The higher the development of human society, the more dominant becomes the principle of co-operation. Only in the most primitive communities can there be an approach to unrestricted natural selection. Indeed, we know today no such human societies, and it is probable that this stage of social evolution was already passed before man's

ancestors became truly men" (Anatomical Record, Jan., 1918). Thomson again says, "The appeal to human history, which the militarists make confidently, has seemed to many to show that civilization was born out of war. But scientific inquiry does not confirm this conclusion." Havelock Ellis writes (1919) "War probably began late in the history of mankind," and, "War was a result, and not a cause, of social organization." As Thomson points out, "The militarists' appeal to history is not any more convincing than their appeal to biology. The facts are against them in both fields." Finally we should point out, as has been done by various biological writers, that war really is a detriment to both sides, especially between advanced nations, by destroying the best of the younger men, whom the nations at war can by no means afford to lose. Thus war, instead of being contributory to the selecting of the best and the survival of the fittest, too often results in the survival of the unfit on both sides, to the great detriment of the human race.

Thus no one has any cause to shudder at the mere term "natural selection," since, to its gross misapplication as an excuse for war, such as that made use of by ardent militarists, the biologists have as much fault to find as any one. None but the pre-war German philosophers would ever have agreed with von Moltke that "war is a part of God's world order," and the biologist, as much as any one, has a right to feel scandalized by the crass misinterpretation of the selection theory which has been placed upon it.

In a state of nature it is undoubtedly true that "the weaker go to the wall," if by the weaker we mean those that are the least adapted to meet the complex problem of existence, but that does not imply, even in lower animals, that there is usually anything like war between individuals of the same kind. The struggle is confined to the effort of each to maintain itself as an individual, and where competition is keen some have a natural advantage of organization over others and these can better solve the problem of existence while the others fall by the wayside. Of course, the term selection is unfortunate in that in the minds of many persons it is involved with the idea of conscious choice, but no biologist has any difficulty in holding to a proper interpretation of the term.

The notion seems to be prevalent that the proof of evolution hangs on the proof of the method of the origin of species. Now, it happens that the exact cause of the origin of species is still in doubt. This, however, is a comparatively small matter and the law of evolution does not depend upon its solution at all. We have abundant proof that multitudes of species have originated and some of these have been traced through the process of change, even if we do not know what caused the change. Would anyone deny the fact that chickens hatch out of hen's eggs, because the biologist does not pretend to know all the processes involved in the development of the embryo?

It would be extremely interesting to know the causes of the origin of species, but it is not necessary to the fact of evolution. The origin of species in the past is an incontrovertable fact, even if we do not know how they originate. Similarly, organic evolution is an incontrovertable fact, though we may not know all the processes concerned.

In recent years it has often been stated that "Darwinism is discredited" and the average person takes this statement to mean that *evolution is discredited*, for most people cannot seem to get through their heads the fact that *Darwinism* and *evolution are not synonymous*. To what extent Darwinism is discredited, however, depends entirely upon what we mean by the term "Darwinism." Darwin's great contribution was establishing the fact of evolution, than which no greater contribution has ever been made to the fields of science and philosophy.

There is no thought in the minds of scientists of any possibility of controverting evolution, any more than they would deny the Newtonian law of gravitation or the Copernican cosmology. If, however, we merely mean by Darwinism, the same reliance on natural selection of fortuitous variations as the method of origination of new species, which Darwin placed upon it, then we may admit that there are many honest doubters as to the *method* of evolution as stated by Darwin.

However, it is clear that the non-scientific public does not distinguish between the fact of organic evolution and Darwin's explanation of its cause. So, indiscriminating propagandists, opposed to evolution, fix upon the *discussion of Darwin's proposed method* and overlook entirely *the fact which all scientists are agreed upon.*

There are some controversialists again, who misuse, in opposing evolution, the discoveries of Bateson, DeVries, and others, in regard to mutations or larger steps, which throw some doubt on the validity of Darwin's belief in the great importance of minute variations. To accept the mutations of DeVries only means to hasten the process of evolution, since the steps in advance are so much greater than those suggested by Darwin. For, after all, mutations are only germinal, and therefore, hereditary, variations of a more noticeable character, and the acceptance of DeVries' views does not invalidate in the least the importance of the principles of variation, selection and heredity, but only makes possible the progress of evolution at a much more rapid rate than does the Darwinian method. Yet forsooth, because definite mutations are substituted for the minor and fortuitous variations of Darwin, the undiscriminating, ignorant and bigoted proclaim that evolution is overthrown. It would be as truthful to maintain that the Copernican theory of the movement of the planets around the sun is overthrown because a new asteroid is located now and then! Besides it has no bearing on the fact that evolution has taken place.

As to the controversy between those who hold with Darwin and those who agree with DeVries I can see no special difficulty. It may be that they are merely looking at different ends of the same series. Bateson and DeVries at first assumed that mutations must, of necessity, be breaks in the series, of considerable importance. Later investigations, however, have shown that mutations, or hereditary variations, may be much smaller than they were at first supposed to be necessary and, in fact, some of them are much less noticeable than some somatic variations acquired during the life of the individual and not heritable. The difference, which Darwin could not have known, is a qualitative one rather than quantitative, on the basis that to have any evolutionary value, a variation must affect the germ plasm and not merely the body of the individual. On the other hand too great a departure from the normal may have no evolutionary importance because it renders the individual unsuited for life or reproduction and so it is eliminated by natural selection.

It is a common misconception that evolution is a force or power by which things are brought to pass. Even the less dis-

criminating biologists may not be entirely free from this notion, for I recall a little verse which used to be sung at Woods Hole, that Mecca of the biologist, which runs as follows:

"Once I was a Rhizopod, a protoplasmic cell,
I had a little nucleus and oh! I loved it well,
Now I am a man at last, *by evolution's power*,
But oh, my little nucleus! I need thee every hour."

Evolution is merely an explanation of the way things have come to be as they are, together with a statement of the natural laws under which this has taken place. It involves uniformity and continuity in nature and it applies to everything which has undergone change in the course of time.

Some of the confusion in the minds of those untrained in the methods of science is undoubtedly due to the lack of a clear understanding of what is meant by "natural law." A natural law is merely a formula indicating a method of procedure in nature. It is a statement based on the classification of facts and the comparison of their relationships. Civil law, as a man-made rule of conduct implies a restriction and compels conformity, and changes continuously with the varying conditions of human society. Natural laws are merely conclusions drawn from the scientific study of organized series of facts and are immutable except as they are modified by a re-classification and re-statement. A careful reading of the third chapter of Karl Pearson's "Grammar of Science" is recommended to all interested in this matter. "The civil law involves a command and a duty; the scientific law is a description, not a prescription. The civil law is valid only for a *special* community at a *special* time; the scientific law is valid for *all* normal human beings, and is unchangeable so long as their perceptive faculties remain at the same stage of development."

Another misconception of evolution is involved in the idea that it always means an advance of some sort toward higher organization. This idea is contrary to the very method of evolutionary processes. Variations may occur in any direction in any group of organisms, as far as we know, and, theoretically, at least, they are just as likely to be retrogressive as progressive. Secondary simplification is very commonly observed, especially in parasitic organisms.

But what we are especially concerned with in this discussion is progressive evolution in the sense that advances are made in the direction of complexity and the origin of what we are disposed to call higher animals, though we may be guilty of an anthropocentrism in so doing. From the standpoint of the Protozoan we might be considered degenerate, from the fact that our cells have lost their capacity for independent life, and have to live together or not at all. However, it is just this very loss of independence of the individual cell, involving the principle of division of labor and necessitating specialization for the better performance of some process and the co-operation of various parts, that has marked the advance of more complex organisms, whether we may be allowed to call them higher or not.

But variations may occur in all directions and it has often happened that the road to adaptation has lain in the direction of secondary simplification of structure, and selection, in such cases, means the elimination of the more complex, in order to adjust the animal more closely to its environment.

The crayfishes of our American caverns have lost their eyes, but they are highly adapted to a life in total darkness; the sessile ascidians lose nearly all semblance to vertebrate animals, which they clearly possess in the larval stage, by their adaptation to sessile life; the whales and seacows have lost the hind limbs and have taken on a fish-like form in adaptation to aquatic existence. Among parasitic forms we see this carried to the extreme. The tape-worm lacks entirely the intestinal tract, and the parasitic barnacle *Rhizocephala* is so profoundly degenerated that were it not for our knowledge of its development we would not be able to state even its affinities to the Crustacea. These degenerative changes, bringing about the loss of simplification of structures, are just as much the product of evolution as are the modification of a fore limb to a wing in the bird, the highly organized mammalian brain, or the complex social life of bees and ants. As Thomson remarks, "It is plain that evolution may be down as well as up, and that the gates of parasitism and other facile slopes of degenerate life are always open. The tapeworm in its inglorious ease is as much an outcome of evolution as the lark at heaven's gate."

On the other hand, a point on which the man who merely reads about evolution may be at fault, is in thinking that variations are always necessarily fortuitous and occur in a helter-skelter fashion. No doubt many variations are of this nature, but there appear to be others which are directive in their nature from the beginning and which keep on increasing in value with successive generations, the "rectigradations" of H. F. Osborn. The observation of this sort of serial successive variations has led to the suggestion of the principle of *orthogenesis* in evolution, the idea of successive changes along the same line, each going a little farther than its predecessor, so that in a comparatively short time a much greater distance has been compassed than would be possible by mere chance variation in any or all directions. The literature of paleontology is full of such examples, dealing with horns, teeth, limbs, spines, shells and other structures capable of fossilization. The only satisfactory explanation suggested to account for this, seems to be that a small chemical change in the germ plasm may make possible another change of like character and this supply the basis for the next step, and so on. Only on some such basis as this can we explain the evolution of certain structures which make their first appearance in such a small degree that they have no apparent value in selection and yet they keep on varying and advancing along the same line until the structure becomes either adaptive and of value to the organism or inadaptive to a degree sufficient to destroy the species. Such structures may sometimes rise from insignificant, non-selective stages to a condition of much importance to the organism, but, having started to vary in one line the advance may keep on beyond the adaptive condition and finally become a menace to the species. Such conditions of racial senescence are known in numerous examples from the fossil records.

A mistake commonly made by those not engaged in biological work is to think that a great majority of the variations produced must have some value to the organism, since harmful variations are seldom noticed in nature. It is true that beneficial or at least harmless variations are the ones usually noticed, because harmful variations are not perpetuated very long. The biologist with an eye open to these things very often observes them, but they never last long and the more

harmful ones never reach the next generation because they are fatal to the organisms in which they appear. In every species an abundance of such inimical variations may be observed to produce the death of the organism, even before hatching or birth.

The objection has often been raised by the less thoughtful critics of the evolution theory that the principles of selection and adaptation cannot be of much importance after all, since we see many cases where adaptations fail to work and where selection fails to eliminate such variations. A little more insight into the problem would indicate that, after all, any adaptation only needs to work sufficiently to be of benefit to the species *as a whole*, and not necessarily to all individuals. An adaptation is merely an adjustment to a certain condition of life, and if the condition is changed, naturally the adaptation does not exist; that is to say, the particular reason for the existence of a particular structure, process or instinct, does not obtain and therefore the organism is not adapted any longer. Undoubtedly the reason why it is so difficult to keep many wild animals in confinement, or why they often will not reproduce in captivity, is because we cannot supply the conditions for which they are adapted. A single adaptation is not a master key, it will unlock only one particular gate barring the pathway to existence, and if that gate is replaced by another, that key is useless, but it may not be dangerous to carry it.

There are, to be sure, many examples of imperfect adaptation to be found on every hand and the biologist has not failed to take them into account. The case should perhaps be stated something like this: Successful organisms, by which we mean all organisms that continue to exist, are fitted to meet in a satisfactory manner, the ordinary conditions of their natural environment. But the environment is always more or less variable and the adjustment can therefore seldom be perfect. The organism which is *able to pass the adjustment test with a sufficiently high rating* will get along.

Another misconception along this same line arises from the difficulty which man encounters in attempting to look at the results of evolution from an impartial standpoint. He cannot ordinarily escape from the limits of an anthropocentric evaluation of other organisms, and measures all other creatures by

his own foot-rule. Yet aside from his high nervous organization it would seem that man has little to be proud of. Certainly, in many other systems, he is not to be compared in the perfection of his adaptations with multitudes of other animals. Bertrand Russell has facetiously remarked, "Organic life, we are told, has developed gradually from the protozoon to the philosopher, and this development, we are assured is indubitably an advance. Unfortunately it is the philosopher, not the protozoon, who gives us this assurance, and we can have no security that the impartial outsider would agree with the philosopher's self-complacent assumption."

Some one has referred to the results of selection as "the survival of the adapted," and adaptation means merely the ability to meet the conditions of existence in one way or another. All organisms that continue to exist, must therefore be adapted, and the supposedly lower organization of the protozoan may be just as effective as the more complex structure of the mammal. If the only proof of fitness is continued existence, then the Foraminifera, which have had a long and continuous career from the Cambrian period, at least, are far better organisms than were the Dinosaurs, which lasted only through a few millions of years in the Mesozoic and found continued existence impossible. Man, who has been on the earth only a mere half million years or so, has scarcely been given a fair trial to prove his fitness, and the probabilities are that the Foraminifera will continue to flourish long after man has definitely proved his inability to cope with changing conditions. We should, therefore, in justice to our logic, define carefully what we mean by "higher," for higher specialization does not imply higher adaptability.

A mistaken notion of evolution which has caused great concern to the uninitiated is that it is a theory about the origin of man from a monkey. Just why this idea should be so repellent to a large class of people is difficult to see, for after all monkeys are very respectable in comparison with some humans and, furthermore, they are very high in the scale of animal organization. We will all agree that they are incomparably higher than the "dust of the earth," which many persons seem to prefer for their ancestral stock.

But, of course, in thus speaking of the origin of man, no evolutionist has the modern anthropoid ape in mind any more

than he has the modern man. Both are the evolutionary products of a common stock and have taken different directions, different lines of development. Their relationship lies through a common type of remote ancestor. To approach that relationship, one must go back to more primitive Primates, just as to find connecting links between the Primates and Carnivora one must go still farther back to more primitive mammals.

The nature of the "missing link" has exercised the mind of the non-biological world very greatly, because of an erroneous idea of what constitutes a missing link. As far as I am aware this is always popularly applied to the evolution of man and the usual opinion is that there should be found some intermediate form between man and the nearest anthropoid ape, or, because the general public is not informed or discerning in these matters, between man and a monkey. But no biologist would ever expect to find such a connecting link, for none could exist. Man and the apes are contemporaries and so it is impossible that one should descend or ascend from the other. As well might one expect to find the missing link between contemporary horses and tapirs, though both are descended from the same group of primitive ungulate mammals. What we do expect to find and what, in fact, we do find as we go back in time is that we unearth simpler and more primitive types of man until we come to a brain only two-thirds of its present size, a prognathous jaw, less erect posture, etc., and if we carry this far enough we will come to the generalized Primate stock. If we trace out the ancestry of the apes we will run back in a converging series to the same place. The only sort of a connection existing between man and the apes is that of origin from a similar source.

There is also a mistaken notion that evolution fails to account for the origin of the mind of man. But the modern psychologist and the student of animal behavior are agreed that there is no necessity for assuming any break in the continuity of the series of phenomena in the evolution of mind. The origin of mind is indissolubly linked up with the nature of protoplasm, in its automatic movements, tropisms and reactions. If we begin back as far as the protozoa, we may quote the statement of Jennings that even the Amoeba "behaves as if it had a mind of its own." From the indefinite condition of automatism, irritability and conductivity, exhibited by the

lowest animals, we arrive by gradual steps through the better and better organization of a nervous system to a definite brain and the improvement of this organ through various stages in the vertebrates up to man, without a break. Parallel with this we see the development of reflex action, experimental behavior, instinct and learning, to intelligent behavior, inference and rational purpose.

The evolution theory has been before the world in a concrete form for more than sixty years and all scientific men, or those capable of forming a worth-while opinion, have been agreed on it almost without exception ever since the convincing statement of the case by Charles Darwin. Scientific men have generally shown themselves to be capable of forming sane opinions in their own field, but the general public still finds it a difficult matter to accept the word of the scientist, especially when scientific fact seems opposed to some long-standing belief, or common uncritically-judged experience. After nearly 400 years following the announcement of the Copernican theory, a fair share of people still believe the world to be flat, because all they can see of it looks that way. Many more still believe in witch-craft or the influence of evil spirits, and a still larger percentage hold firmly to the moon as a causative agent in the growth of crops, the curing of meat, etc., etc.

After having written the above paragraph the writer came across the following in the "Century Magazine" for February (1922) in an article on "The American Gypsy," by K. Bercovici: "The study of folk-lore * * * has demonstrated that a certain stratum of the population is never reached by the civilization of any given period. There are as many people today who believe in witch-craft and black magic as there were 500 years ago; as many people who go to fortune tellers to have them read the cards, the palms, or tell the future as seen in the bottom of an emptied coffee cup."

In the field of medicine, notwithstanding the advance of science, the general public is as gullible as ever, in the matter of cure-alls, elixirs and nostrums, advertised to heal all "the ills that flesh is heir to." A recent widely distributed advertisement of Dr. Morse's Indian Root Pills states for the benefit of the public that "Malaria is due to a poisonous miasma, which arising from the low swampy lands, becomes assimilated

with the atmosphere," etc., while every scientific man has known for the past 25 years that it can be distributed only through the bite of an *Anopheles* mosquito.

There is scarcely a newspaper that does not occasionally carry an advertisement of an astrologer, a crystal gazer, a clairvoyant, or other similar kind of fakir, while the number of people who still consult the medical almanac for the signs of the zodiac and the changes of the moon is very large, even in the most enlightened countries. The traditional superstitions of the primitive civilization of our forefathers still hold sway in the minds of multitudes in spite of the advancement of the few.

This is easily understood in the uneducated and in that portion of the public whose intelligence rating is much below the average, for such people either have no capacity for much understanding, or no knowledge on which to base anything but an unscientific belief—and when you come to that kind of belief it is as easy to believe one thing as another, especially if you are not particular as to the basis for it. There is a line in an old hymn which runs to the effect that "blind unbelief is sure to err." It would have been equally true had it stated that blind belief is sure to err. It is the blindness in either case that results in the error. "Belief, in the scientific sense of the word," says Huxley, "is a serious matter, and needs strong foundations."

When we come to the educated portion of the public we have some right to expect more discrimination and less general credulity. We have a right to expect that they will refrain from attempts to discredit the work of capable scientists on the basis that it controverts some already established belief. An educated man should at least be able to draw the line between what he knows and what he doesn't know and not attempt to pass judgment on matters outside of his field of training. The educated man without scientific training has no more basis for forming a proper judgment of the Law of Evolution than of the Einstein Theory of Relativity.

I have said that *no scientist doubts the broad fact of evolution* in the organic and inorganic worlds, but it is equally true that in the minds of many of the unscientific, there still remains not only a doubt, but a positive conviction that evolution is merely a vague guess of the scientist and that it is not necessary

to place any reliance on his views. If the question as to the truth of evolution were to be put to a public vote today, I have little doubt that the scientists would be overwhelmingly voted down.

The newspapers still mistake scientific discussions as to the *method* of evolution for doubts as to the *fact* of evolution and often herald this error in glaring headlines, such as "Great Scientist Disputes Darwinian Theory," "Evolution Theory Disproved," etc., etc. This happened no later than last winter following Prof. Bateson's address before the American Association for the Advancement of Science at Toronto. At the close of his address, Bateson said, "Let us then proclaim in precise and unmistakable language that our faith in evolution is unshaken. * * * Our doubts are not as to the reality or truth of evolution, but as to the origin of species, a technical, almost domestic problem. Any day that mystery may be solved." Though the greatest pains were taken to insure that no mistakes should creep into the subject matter presented to the newspapers for publication, the headliner got in his deadly work uncensored, with the result that the next morning's papers carried headlines announcing the unwarranted assertion that this famous British scientist disputed the fact of evolution.

It is quite apparent that the mass of the reading public are unable to distinguish the difference between fact and method in this field of thought. The campaign against evolution just now being waged by a certain notorious speaker is a case in point. When a man who is very evidently unskilled in the handling of scientific data, unfamiliar with the details of the subject, and solely by an appeal to the emotions through his oratorical presentation, can obtain a wide hearing throughout the country and can even influence a state legislature to consider measures for preventing the teaching of evolution, we must admit that the idea has not yet been fully accepted by many so-called educated people.

The editor of "The Congregationalist," (March 16, 1922, p. 326), however, wisely points out that "Addresses such as that which Mr. Bryan delivered in Philadelphia will do very little to affect the course of science, but we think they are calculated to do irreparable harm to religion." And again, "When one realizes the patience, care and courage with which the sincere scientist pursues his quest of truth, there is some-

thing anomalous in the effort to dominate that field by the superficialities of platform oratory."

Professors Henry Fairfield Osborn and Edwin Grant Conklin have also recently replied, through the "New York Times" of March 5, to an article by Mr. Bryan in an earlier number of the same paper. Osborn points out that "evolution takes its place with the gravitation law of Newton." Conklin comments on Bryan's attempt "to establish an inquisition for the trial of science at the bar of theology," and grows facetious over his proposition "to repeal a law of nature by a law of Kentucky."

Mr. Edward M. Kindle, of the Canadian Geological Survey, writes in a recent number of "Science," "A Don Quixote of Mr. Bryan's calibre only appears once or twice in a century and the opportunity to study in cold print the celebrated Nebraskan's proposal to resurrect the 'special creation of species' myth must be appreciated by our scientific brethren who are interested in studying the mysterious ways in which the human mind works when it approaches subjects unfamiliar to it."

It might be added that the English churchmen knew enough to quit fifty years ago when the proof of evolution was demonstrated to them. The modern opponents of the theory have not a single idea at their disposal that was not worn threadbare and proved useless a half century ago, while the facts supporting the theory have accumulated continuously and voluminously. The more enlightened churchmen the world over, long ago accepted evolution as one of the great fundamental truths, leaving only the ignorant and prejudiced among them to butt their heads against the wall of scientific evidence.

Why then, with this mass of evidence which is so clear to the mind trained in the formation of scientific conclusions, has not the general public been more ready to accept these conclusions? Has the public no faith in the findings of the trained scientist? It would seem so, not only in this matter, but in many others. Who is to blame for this condition of affairs? I fear that the scientists themselves are considerably at fault for not making more effort to place their discoveries before the public in such form that they can be "understanded of the people." Scientists have proved to be very poor

propagandists. The facts and discoveries of science are so interesting to them that they go from one research to another without attempting to make clear to others what they have accomplished. If investigators are constitutionally unable to make their meaning clear to the reading public, then we need a group of interpreters who will make it their purpose in life to investigate the investigators and make known the truths of science to the masses of people who may be able to understand, if the facts are written in their language.

Just where does the evolution theory stand today in the minds of scientific men engaged on problems connected with this field of knowledge.

1. That there has been a cosmic evolution, no one familiar with the facts can doubt, though we may still be unsatisfied as to the truth of the nebular hypothesis of Laplace or the aggregation theory of Chamberlain as they concern the formation of the earth.

2. That there has been evolution, in the form of progressive changes of the earth itself, no one capable of forming a proper judgment can doubt, though we may still question the number of aeons it has taken to round the surface of the earth into its present form, and the exact mode of formation of certain rocks and strata may still puzzle us somewhat.

3. That there has been an evolution of organic life on the earth no one familiar with the accumulated data will doubt for a moment. The facts are so patent that one does not even have to possess a very logical mind to be convinced of the truth. The succession of animals and plants from lower to higher forms in past time, as shown by paleontological studies, is as clear and straightforward as any story which research has ever brought to light. This, coupled with the facts of embryology and comparative anatomy, yields a truth which no unprejudiced man can deny. For any one to do so merely proclaims his narrow-mindedness and prejudice and classes him among those of the last degree of blindness who "will not see."

4. That modern man himself is just as patently a product of evolution is clear to anyone familiar with the findings of paleontological anthropology, even if we do not consider the evidence from embryology and comparative anatomy. Our knowledge of fossil man takes us back through several extinct

human species—Neanderthal, Heidelberg, Piltdown, Foxhall and Trinil Man. These extend successively farther and farther back, through the different glacial periods to the later Pliocene, over time variously reckoned in years around 500,000. Through this succession of human species we can trace the gradual development of the cranial capacity to an increase of at least 50%; the retraction of the face from a prognathous to an orthognathous condition, the development of a chin, making possible the free use of the tongue in speech; the completion of the erect posture, and various other features by which man has become physically differentiated from his nearest animal kin. Along with this physical progress we can trace, *pari passu*, the evolution of his civilization.

Granted that we do not yet know all the processes by which these changes in man have come about, the fact that they have come to pass is so evident that only the ignorant, or he who willfully ignores the truth for his own ends, will attempt to dispute the fact. Place what interpretation on it you wish, the fact remains. I hold no quarrel with the man who accepts the fact and interprets it as the method of a supreme being for working out his eternal plan, or, as John Fiske said, "God's way of doing things."

Only we must not let our religious *beliefs* get the better of our common sense appreciation of *facts* in this or any other matter. There is no thing as sacred as truth, in whatever form it comes, and if it interferes even with a long-established belief, then it is time that the basis for that belief is looked into.

We have seen that the evidence of evolution does not rest on guesses or interpretation, but on facts, and not in one field only, but that astronomy, physics, chemistry, geology and all the biological sciences tell the same story in the same way, that of uniformity, continuity and progressive changes.

Gradually, of course, this natural law will receive general acceptance among the reading and thinking public. In the meantime, whenever some misinformed or bigoted egotist displays his ignorance of scientific matters, there are two things which we may do; either we may attack his mis-statements and set the unscientific public in the right through the press, or we may follow the plan adopted by the man who was kicked by a mule, and just "consider the source."