voted by the citizens themselves, local elective boards to spend the money raised by taxation and control the schools, and for the higher grades of instruction permanent endowments administered by incorporated bodies of trustees. This is the American voluntary system, in sharp contrast with the military, despotic organization of public instruction which prevails in Prussia and most other states of Continental Europe. Both systems have peculiar advantages, the crowning advantage of the American method being that it breeds freemen. Our ancestors well understood the principle that, to make a people free and self-reliant, it is necessary to let them take care of themselves, even if they do not take quite as good care of themselves as some superior power might.

And now, finally, let us ask what should make a university at the capital of the United States, established and supported by the General Government, more national than any other American university. It might be larger and richer than any other, and it might not be; but certainly it could not have a monopoly of patriotism or of catholicity, or of literary or scientific enthusiasm. There are an attractive comprehensiveness and a suggestion of public spirit and love of country in the term "national;" but, after all, the adjective only narrows and belittles the noble conception contained in the word "university." Letters, science, art, philosophy, medicine, law, and theology, are larger and more enduring than nations. There is something childish in this uneasy hankering for a big university in America, as there is also in that impatient longing for a distinctive American literature which we so often hear expressed. As American life grows more various and richer in sentiment, passion, thought, and accumulated experience, American literature will become richer and more abounding, and in that better day let us hope that there will be found several universities in America, though by no means one in each State, as free, liberal, rich, national, and glorious, as the warmest advocate of a single crowning university at the national capital could imagine his desired institution to become.

AGASSIZ AND DARWINISM.

By JOHN FISKE,

RECENTLY LECTURER ON PHILOSOPHY AT HARVARD UNIVERSITY.

ONE Friday morning, a few weeks ago, as I was looking over the *Nation*, my eye fell upon an advertisement, inserted by the proprietors of the *New-York Tribune*, announcing the final destruction of Darwinism. What especially riveted my attention was the peculiar style of the announcement: "The Darwinian Theory utterly de-

molished" (or words to that effect) "by AGASSIZ HIMSELF!" Whether from accident or design, the type-setter's choice of Roman capitals was very happy. Upon many readers the effect must have been tremendous; and quite possibly there may be some who, without further investigation, will carry to their dying day the opinion that it is all over with the Darwinian theory, since "Agassiz Himself" has refuted it.

Upon me the effect was such as to make me lay down my paper and ask myself: Can it be that we have, after all, a sort of scientific pope among us? Has it come to this, that the dicta of some one "servant and interpreter of Nature" are to be accepted as final, even against the better judgment of the majority of his compeers? In short, who is Agassiz himself, that he should thus single-handed have demolished the stoutest edifice which observation and deduction have reared since the day when Newton built to such good purpose?

Prof. Agassiz is a naturalist who is justly world-renowned for his achievements. His contributions to geology, to paleontology, and to systematic zoology, have been such as to place him in a very high rank among contemporary naturalists. Not quite in the highest place, I should say; for, apart from all questions of theory, it is probable that Mr. Darwin's gigantic industry, his wonderful thoroughness and accuracy as an observer, and his unrivalled fertility of suggestion, will cause him in the future to be ranked along with Aristotle, Linnæus, and Cuvier; and upon this high level we cannot place Prof. Agassiz. Leaving Mr. Darwin out of the account, we may say that Prof. Agassiz stands in the first rank of contemporary naturalists. But any exceptional supremacy in this first rank can by no means be claimed for him. Both for learning and for sagacity, the names of Gray, Wyman, Huxley, Hooker, Wallace, Lubbock, Lyell, Vogt, Haeckel, and Gegenbaur, are quite as illustrious as the name of Agassiz; and we may note, in passing, that these are the names of men who openly indorse and defend the Darwinian theory.

Possibly, however, there are some who will not be inclined to accept the estimates made in the foregoing paragraph. No doubt there are many people in this country who have long accustomed themselves to regard Prof. Agassiz not simply as one among a dozen or twenty living naturalists of the highest rank, but as occupying a solitary position as the greatest of all living naturalists—as a kind of second Cuvier, for example. There is, to the popular eye, a halo about the name of Agassiz which there is not about the name of Gray; though, if there is any man now living in America, of whom America might justly boast as her chief ornament and pride, so far as science is concerned, that man is unquestionably Prof. Asa Gray. Now, this greater popular fame of Agassiz is due to the fact that he is a European who cast in his lot with us at a time when we were wont to over-

rate foreign importations of whatever sort. As a European, therefore, he outshines such men as Profs. Gray and Wyman, and, as a man whom we know, he outshines other Europeans, like Haeckel and Gegenbaur, whose acquaintance we happen not to have made; just as Rubinstein, whose fame has filled the American newspapers, outshines Bülow (probably his equal as a pianist), who has not yet visited this country. In this way Prof. Agassiz has acquired a reputation in America which is greater than his reputation in Europe, and which is greater than his achievements—admirable as they are—would be able, on trial, to sustain.

And now I come to my first point. Admitting for Prof. Agassiz all the wonderful greatness as a naturalist with which the vague sentiments of the uneducated multitude in this country would accredit him; admitting, in other words, that he is the greatest of naturalists, and not one among a dozen or twenty equals; it must still be asked, why should his rejection of Darwinism be regarded as conclusively fatal to the Darwinian theory? The history of science supplies us with many an instance in which a new and unpopular theory has been vehemently opposed by those whom one would at first suppose most competent to judge of its merits, and has nevertheless gained the victory. Dr. Draper brings a terrible indictment against Bacon for rejecting the Copernican theory, and refusing to profit by the discoveries of Gilbert in magnetism. This should not be allowed to detract from Bacon's real greatness, any more than the rejection of Darwinism should be allowed to detract from the real merit of Agassiz. Great men must be measured by their positive achievements rather than by their negative shortcomings, otherwise they might all have to step down from their pedestals. Leibnitz rejected Newton's law of gravitation; Harvey saw nothing but foolishness in Aselli's discovery of the lacteals; Magendie ridiculed the great work in which the younger Geoffroy Saint-Hilaire began to investigate the conditions of nutrition which determine the birth of monsters; and when Young, Fresnel, and Malus, completed the demonstration of that undulatory theory of light which has made their names immortal, Laplace, nevertheless, the greatest mathematician of the age, persisted until his dying day in heaping contumely upon these eminent men and upon their arguments. Nay, even Cuvier—the teacher whom Prof. Agassiz so justly reveres—did not Cuvier adhere to the last to the grotesque theory of "pre-formation," and reject the true theory of "epigenesis," which C. F. Wolff, even before Baer, had placed upon a scientific basis? Supposing, then, that the Darwinian theory is rejected by Agassiz, this fact is no more decisive against the Darwinian theory than the rejection of Fresnel's theory by Laplace was decisive against Fresnel's theory.

For the facts just cited show that even the wisest and most learned men are not infallible, and that it will not do to have a papacy where scientific questions are concerned. Strange as it may at first seem,

nothing is more certain than that a man's opinion may be eminently fallible, even with reference to matters which might appear to come directly within the range of his own specialty. Many people, I presume, think that, because Prof. Agassiz has made a specialty of the study of extinct and living organisms, because he has devoted a long and industrious life to this study, therefore his opinion with reference to the relations of present life upon the globe to past life ought to be at once conclusive. The fallacy of this inference becomes apparent as soon as we recollect that Profs. Gray, Wyman, Huxley, and Haeckel, who are equally well qualified to have an opinion on such matters, have agreed in forming an opinion diametrically opposite to that of Prof. Agassiz. But the fallacy may be shown independently of any such comparison. Even if all the foundations of certainty seem to be shaking beneath us when we say that an expert is not always the best judge of matters pertaining to his own specialty, we must still say it, for facts will bear us out in saying it. I have known excellent mathematicians and astronomers who had not the first word to say about the Nebular Hypothesis: they had never felt interested in it, had never studied it, and consequently did not understand it, and could hardly state it correctly. After a while one ceases to be surprised at such things. It is quite possible for one to study the structure of echinoderms and fishes during a long life, and yet remain unable to offer a satisfactory opinion upon any subject connected with zoology, for the proper treatment of which there are required some power of generalization and some familiarity with large considerations. Indeed, there are many admirable experts in natural history, as well as in other studies, who never pay the slightest heed to questions involving wide-reaching considerations; and who, with all their amazing minuteness of memory concerning the metamorphoses of insects and the changes which the embryo of a white-fish undergoes from fecundation to maturity, are nevertheless unable to see the evidentiary value of the great general facts of geological succession and geographical distribution, even when it is thrust directly before their eyes. To such persons, "science" means the collecting of polyps, the dissecting of mollusks, the vivisection of frogs, the registration of innumerable facts of detail, without regard to the connected story which all these facts, when put together, have it in their power to tell. And all putting together of facts, with a view to elicit this connected story, they are too apt to brand as unscientific speculation; forgetting that if Newton had merely occupied himself with taking observations and measuring celestial distances, instead of propounding an audacious hypothesis, and then patiently verifying it, the law of gravitation might never have been discovered. Herein lies the explanation of the twice-repeated rejection of Mr. Darwin's name by the French Academy of Sciences. The lamentable decline of science in France since the beginning of the Second Empire has been most conspicuously marked by the tendency of scientific

inquirers to occupy themselves exclusively with matters of detail, to the neglect of wide-reaching generalizations. And the rejection of Mr. Darwin's name was justified upon the ground, not that he had made unscientific generalizations, but that he had been a *mere* (!) generalizer, instead of a collector of facts. The allegation was, indeed, incorrect; since Mr. Darwin is as eminent for his industry in collecting facts as for his boldness in generalizing. But the form of the allegation well illustrates the truth of what I have been seeking to show—that familiarity with the details of a subject does not enable one to deal with it in the grand style, and elicit new truth from old facts, unless one also possesses some faculty for penetrating into the hidden implications of the facts; or, in other words, some faculty for philosophizing.

Now, I am far from saying of Prof. Agassiz that he is a mere collector of echinoderms and dissector of fishes, with no tact whatever in philosophizing. He does not stand in the position of those who think that the end of scientific research is attained when we have carefully ticketed a few thousand specimens of corals and butterflies, in much the same spirit as that in which a school-girl collects and classifies autographs or postage-stamps. Along with his indefatigable industry as a collector and observer, Prof. Agassiz has a decided inclination toward general views. However lamentably deficient we may think him in his ability to discern the hidden implications of facts, there can be no question that his facts are of little importance to him save as items in a philosophic scheme. He knows very well—perhaps almost too well—that the value of facts lies in the conclusions to which they point. And, accordingly, lack of philosophizing is the last shortcoming with which, as a scientific writer, he can be charged. If he errs on a great scientific question, lying within his own range of investigation, it is not because he refrains steadfastly from all general considerations, but because he philosophizes—and philosophizes on unsound principles. It is because his philosophizing is not a natural outgrowth from the facts of Nature which lie at his disposal, but is made up out of sundry traditions of his youth, which, by dint of playing upon the associations of ideas which are grouped around certain combinations of words, have come to usurp the place of observed facts as a basis for forming conclusions. It is not because he abstains from generalizing that Prof. Agassiz is unable to appreciate the arguments by which Mr. Darwin has established his theory, but it is because he long ago brought his mind to acquiesce in various generalizations, of a thoroughly unscientific or non-scientific character, with the further maintenance of which the acceptance of the Darwinian theory is (or seems to Prof. Agassiz to be) incompatible.

The generalizations which have thus preoccupied Prof. Agassiz's mind are purely theological or mythological in their nature. In estimating the probable soundness of his opinion upon any scientific ques-

tion, it must always be remembered that he is, above all things, a devotee of what is called "natural theology." In his discussions concerning the character of the relationships between the various members of the animal kingdom, the foreground of his consciousness is always completely occupied by theological considerations, to such an extent that the evidentiary value of scientific facts cannot always get a footing there, and is, consequently, pushed away into the background. One feels, in reading his writings, that, except when he is narrating facts with the pure joyfulness of a specialist exulting in the exposition of his subject (and, when in this mood, he often narrates facts with which his inferences are wholly incompatible), he never makes a point without some regard to its bearings upon theological propositions which his early training has led him to place paramount to all facts of observation whatever. In virtue of this peculiarity of disposition, Prof. Agassiz has become the welcome ally of those zealous but narrow-minded theologians, in whom the rapid progress of the Darwinian theory has awakened the easily explicable but totally groundless fear that the necessary foundations of true religion, or true Christianity, are imperilled. It is not many years since these very persons regarded Prof. Agassiz with dread and abhorrence, because of his flat contradiction of the Bible in his theory of the multiple origin of the human race. But, now that the doctrine of Evolution has come to be the unclean thing above all others to be dreaded and abhorred, this comparatively slight iniquity of Prof. Agassiz has been condoned or forgotten, and, as the great antagonist of Evolution, he is welcomed as the defender of the true Church against her foes.

This preference of theological over scientific considerations once led Prof. Agassiz (if my memory serves me rightly) to use language very unbecoming in a professed student of Nature. Some seven years ago he delivered a course of lectures at the Cooper Union, and in one of these lectures he observed that he *preferred* the theory which makes man out a fallen angel to the theory which makes him out an improved monkey—a remark which was quite naturally greeted with laughter and applause. But the applause was ill-bestowed, for the remark was one of the most degrading which a scientific lecturer could make. A scientific inquirer has no business to have "preferences." Such things are fit only for silly women of society, or for young children who play with facts, instead of making sober use of them. What matters it whether we are pleased with the notion of a monkey-ancestry or not? The end of scientific research is the discovery of truth, and not the satisfaction of our whims or fancies, or even of what we are pleased to call our finer feelings. The proper reason for refusing to accept any doctrine is, that it is inconsistent with observed facts, or with some other doctrine which has been firmly established on a basis of fact. The refusal to entertain a theory because it seems disagreeable or degrading, is a mark of intellectual cowardice and insincerity. In mat-

ters of scientific inquiry, it is as grave an offence as the letting one's note go to protest is in matters of business. In saying these things, I do not mean to charge Prof. Agassiz with intellectual cowardice and insincerity, for the remark which I criticise so sharply was not worthy of him, it did not comport with his real character as a student of science, and to judge of him by this utterance alone would be to do him injustice.

It was with the hope of finding some more legitimate objections to the Darwinian theory that I procured the *Tribune's* lecture-sheet containing Prof. Agassiz's twelve lectures on the natural foundations of organic affinity, and diligently searched it from beginning to end. I believe I am truthful in saying that a good staggering objection would have been quite welcome to me, just for the sake of the intellectual stimulus implied in dealing with it, for on this subject my mind was so thoroughly made up thirteen years ago, that the discussion of it, as ordinarily conducted, has long since ceased to have any interest for me. I am just as firmly convinced that the human race is descended from lower animal forms, as I am that the earth revolves in an elliptical orbit about the sun. So completely, indeed, is this proposition wrought in with my whole mental structure, that the negation of it seems to me utterly nonsensical and void of meaning, and I doubt if my mind is capable of shaping such a negation into a proposition which I could intelligently state. To have such deeply-rooted convictions shaken once in a while is, I believe, a very useful and wholesome experiment in mental hygiene. That rigidity of mind which prevents the thorough revising of our opinions is sure, sooner or later, to come upon all of us; but we ought to dread it, as we dread the stagnation of old age or death. For some such reasons as these, I am sure that I should have been glad to find, in the course of Prof. Agassiz's lectures, at least one powerful argument against the interpretation of organic affinities which Mr. Darwin has done so much to establish. I should have been still more glad to find some alternative interpretation proposed which could deserve to be entertained as scientific in character. I am sure no task could be more delightful, or more quickening to one's energies, than that of comparing two alternative theories upon this subject, upon which, thus far, only one has ever been propounded which possesses the marks of a scientific hypothesis. But no such pleasure or profit is in store for any one who studies these twelve lectures of Prof. Agassiz. In all these lectures, there is not a single allusion to Mr. Darwin's name, save once in a citation from another author; there is not the remotest allusion to any of the arguments by which Mr. Darwin has contributed most largely to the establishment of the development theory; nay, there is not a single sentence from which one could learn that Mr. Darwin's books had ever been written, or that the theories which they expound had ever taken shape in the mind of any thinking man. I do not doubt that Prof. Agassiz has, at

some time read, or looked over, the "Origin of Species;" but there is not a word in these lectures which might not have been written by one who had never heard of that book, or of the arguments which made the publication of it the beginning of a new epoch in the history of science.

Not only is it that Prof. Agassiz does not attack the Darwinian theory in these lectures; it is also that, until the ninth lecture, he does not allude to the doctrine of Evolution in any way. His first eight lectures consist mostly in an account of the development of the embryo in various animals; and in this we have a pure description of facts with which no one certainly will feel like quarrelling, so far as theories are concerned. He goes to work, very much as Max Müller does, in lecturing about the science of language, when he gives you a maximum of interesting etymologies and a minimum of real philosophizing which goes to the bottom of things. But Prof. Agassiz is not so interesting or so stimulating in his discourse as Max Müller. He does not lead us into pleasant fields of illustration, where we would fain tarry longer, forgetting the main purpose of the discussion in our delight at the unessential matters which occupy our attention. On the contrary, it seems to me that Prof. Agassiz's explanation of the development of eggs is rather tedious and dry, and by no means richly fraught with novel suggestions. The exposition is a commonplace one, such as is good for students in the Museum of Comparative Zoology, who are beginning to study embryology, but there are no features which make it especially interesting or instructive to any one who has already served an apprenticeship in these matters.

In his ninth lecture, Prof. Agassiz begins to make some allusion to the development theory—not to the development theory as it now stands since the publication of the "Origin of Species," but to the development theory as it stood in the days when Prof. Agassiz was a young student, when Cuvier and the elder Geoffroy Saint-Hilaire waged fierce warfare in the French Academy, and when the aged Goethe, sanest and wisest of men, foresaw in the issue of that battle the speedy triumph of the development theory. Beyond this point, I will venture to say, Prof. Agassiz has never travelled. The doctrine of Evolution is still, to him, what it was in those early days; and all the discoveries and reasonings of Mr. Darwin have passed by him unheeded and unnoticed. He arrived too early at that rigidity of mind which prevents us from properly comprehending new theories, and which we should all of us dread.

What, now, is the doctrine which Prof. Agassiz begins to attack, in his ninth lecture, and what is the doctrine which he would propose as a substitute? The doctrine which he attacks is simply this—that all organic beings have come into existence through some natural process of causation; and the doctrine which he defends is just this—that all organic beings, as classed in species, have come into existence at

the outset by means of some act of which our ordinary notions of cause and effect can give no account whatever. For every one of the individuals of which a species is made up, he will admit the adequacy of the ordinary process of generation; but for the species as a whole, this process seems to him inadequate, and he flies at once to that refuge of inconsequent and timid minds—*miracle!*

This is really just what Prof. Agassiz's theory of the origin of specific forms amounts to, and this is the reason why, in spite of grave heresy on minor points, he is now regarded by the evangelical Church as one of its chief champions. Instead of the natural process of generation—which is the only process by which we have ever known organic beings to be produced—he would fain set up some unknown mysterious process, the nature of which he is careful not to define, but for which he endeavors to persuade us that we have a fair equivalent in sonorous phrases concerning "creative will," "free action of an intelligent mind," and so on. In thus postponing considerations of pure science to considerations of "natural theology," I have no doubt Prof. Agassiz is actuated by a praiseworthy desire to do something for the glory of that Power of which the phenomenal universe is the perpetual but ever-changing manifestation. But how futile is such an attempt as this! How contrary to common-sense it is to say that a species is produced, *not* by the action of blind natural forces, *but* by an intelligent will! For, although this most prominent of all facts seems to be oftenest overlooked by theologians and others whom it most especially concerns, we are all the time, day by day and year by year, in each and every event of our lives, having experience of the workings of that Divine Power which, whether we attribute to it "intelligent will" or not, is unquestionably the one active agent in all the dynamic phenomena of Nature. Little as we know of the intrinsic nature of this Omnipresent Power, which, in our poor human talk, we call God, we do at least know, by daily and hourly experience, what is the character of its working. The whole experience of our lives teaches us that this Power works after a method which, in our scholastic expression, we call the method of cause and effect, or the method of natural law. Traditions of a barbarous and uncultivated age, in which mere grotesque associations of thoughts were mistaken for facts, have told us that this Power has, at various times in the past, worked in a different way—causing effects to appear without cognizable antecedents, even as Aladdin's palace rose in all its wondrous magnificence, without sound of carpenter's hammer or mason's chisel, in a single night. But about such modes of divine action we know nothing whatever from experience; and the awakening of literary criticism, in modern times, has taught us to distrust all such accounts of divine action which conflict with the lessons we learn from what is ever going on round about us. So far as we know aught concerning the works of God, which are being performed in us, through us, and around us, during

every moment of that conscious intelligence which enables us to bear witness to them, we know they are works from which the essential relation of a given effect to its adequate cause is never absent. And for this reason, if we view the matter in pure accordance with experience, we are led to maintain that the antagonism or contrariety which seems to exist in Prof. Agassiz's mind between the action of God and the action of natural forces is nothing but a figment of that ancestral imagination from which the lessons which shaped Prof. Agassiz's ways of thinking were derived. So far as experience can tell us any thing, it tells us that divine action *is* the action of natural forces; for, if we refuse to accept this conclusion, what have we to do but retreat to the confession that we have no experience of divine action whatever, and that the works of God have been made manifest only to those who lived in that unknown time when Aladdin's palaces were built, and when species were created, in a single night, without the intervention of any natural process?

Trusting, then, in this universal teaching of experience, let us for a moment face fairly the problem which the existence of men upon the earth presents to us. Here is actually existing a group of organisms, which we call the human race. Either it has existed eternally, or some combination of circumstances has determined its coming into existence. The first alternative is maintained by no one, and our astronomical knowledge of the past career of our planet is sufficient decisively to exclude it. There is no doubt that at some time in the past the human race did not exist, and that its gradual or sudden coming into existence was determined by some combination of circumstances. Now, when Prof. Agassiz asks us to see, in this origination of mankind, the working of a Divine Power, we acquiesce in all reverence. But when he asks us to see in this origination of mankind the working of a Divine Power, *instead of* the working of natural causes, we do not acquiesce, because, so far as experience has taught us any thing, it has taught us that Divine Power never works except by the way of natural causation. Experience tells us that God causes Aladdin's palaces to come into existence gradually, through the coöperation of countless minute antecedents. And it tells us, most emphatically, that such structures do not come into existence without an adequate array of antecedents, no matter what the Arabian Nights may tell us to the contrary.

Now, when Prof. Agassiz asks us to believe that species have come into existence by means of a special creative fiat, and not through the operation of what are called natural causes, we reply that his request is mere inanity and nonsense. We have no reason to suppose that any creature like a man, or any other vertebrate, or articulate, or mollusk, ever came into existence by any other process than the familar process of physical generation. To ask us to believe in any other process is to ask us to abandon the experience which we have

for the chimeras which we had best not seek to acquire. But Prof. Agassiz does not even suggest any other process for our acceptance. He simply retreats upon his empty phrases, "creative will," the "free workings of an intelligent mind," and so on. Now, in his second course of lectures, I hope he will proceed to tell us, not necessarily how "creative will" actually operated in bringing forth a new species, but how it *may* conceivably have operated, save through the process of physical generation, which we know. In his "Essay on Classification," I remember a passage in which he rightly rejects the notion that any species has arisen from a single pair of parents, and propounds the formula: "Pines have originated in forests, heaths in heather, grasses in prairies, bees in hives, herrings in shoals, buffaloes in herds, men in nations." Now, when Prof. Agassiz asserts that men originated in nations, by some other process than that of physical generation, what does he mean? Does he mean that men dropped down from the sky? Does he mean that the untold millions of organic particles which make up a man all rushed together from the four quarters of the compass, and proceeded, spontaneously or by virtue of some divine sorcery, to aggregate themselves into the infinitely complex organs and tissues of the human body, with all their wondrous and well-defined aptitudes? It is time that this question should be faced, by Prof. Agassiz and those who agree with him, without further shirking. Instead of grandiloquent phrases about the "free action of an intelligent mind," let us have something like a candid suggestion of some process, other than that of physical generation, by which a creature like man can even be imagined to have come into existence. When the time comes for answering this question, we shall find that even Prof. Agassiz is utterly dumb and helpless. The sonorous phrase "special creation," in which he has so long taken refuge, is nothing but a synthesis of vocal sounds which covers and, to some minds, conceals a thoroughly idiotic absence of sense or significance. To say that "Abracadabra is not a genial corkscrew," is to make a statement quite as full of meaning as the statement that species have originated by "special creation."

The purely theological (or theologico-metaphysical and at all events unscientific) character of Prof. Agassiz's objections to the development theory is sufficiently shown by the fact that, in the foregoing paragraphs, I have considered whatever of any account there is in his lectures which can be regarded as an objection. *Arguments* against the development theory such objections cannot be called: they are, at their very best, nothing but *expressions of fear and dislike.* The only remark which I have been able to find, worthy of being dignified as an argument, is the following: "We see that fishes are lowest, that reptiles are higher, that birds have a superior organization to both, and that mammals, with man at their head, are highest. The phases of development which a quadruped undergoes, in his embryonic

growth, recall this gradation. He has a fish-like, a reptile-like stage before he shows unmistakable mammal-like features. We do not on this account suppose a quadruped grows out of a fish in our time, for this simple reason, that we live among quadrupeds and fishes, and we know that no such thing takes place. But resemblances of the same kind, separated by geological ages, allow play for the imagination, and for inference unchecked by observation."

I do not believe that Prof. Agassiz's worst enemy—if he ever had an enemy—could have been so hard-hearted as to wish for him the direful catastrophe into which this wonderful piece of argument has plunged him irretrievably. For the question must at once suggest itself to every reader at all familiar with the subject, If Prof. Agassiz supposes that the development theory, as held nowadays, implies that a quadruped was ever the direct issue of a fish, of what possible value can his opinion be as regards the development theory in any way?

If I may speak frankly, as I have indeed been doing from the outset, I will say that, as regards the Darwinian theory, Prof. Agassiz seems to me to be hopelessly behind the age. I have never yet come across the first indication that he knows what the Darwinian theory is. Against the development theory, as it was taught him by the discussions of forty years ago, he is fond of uttering, I will not say arguments, but expressions of dislike. With the modern development theory, with the circumstances of variation, heredity, and natural selection, he never, in any of his writings, betrays the slightest acquaintance. Against a mere man of straw of his own devising, he industriously hurls anathemas of a quasi-theological character. But any thing like a scientific examination of the character and limits of the agency of natural selection in modifying the appearance and structure of a species, any thing like such an examination as is to be found in the interesting work of Mr. St. George Mivart, he has never yet brought forth.

Now, when Prof. Agassiz fairly comes to an issue, if he ever does, and undertakes to refute the Darwinian theory, these are some of the questions which he will have to answer: 1. If all organisms are not associated through the bonds of common descent, why is it that the facts of classification are just such as they would have been had they been due to such a common descent? 2. Why does a mammal always begin to develop as if it were going to become a fish, and then, changing its tactics, proceed as if it were going to become a reptile or bird, and only after great delay and circumlocution take the direct road toward mammality? In answer to this, we do not care to be told that a mammal never was the son of a fish, because we know that already; nor do we care to hear any more about the "free manifestations of an intelligent mind," because we have had quite enough of metaphysical phrases which do not contain a description of some actual or imaginable process. We want to know how this state of things can be sci-

entifically interpreted save on the hypothesis of a common ultimate origin for mammals, birds, reptiles, and fishes. 3. What is the meaning of such facts as the homologies which exist between corresponding parts of organisms constructed on the same type? Why does the black salamander retain fully-developed gills which he never uses, and what is the significance of rudimentary and aborted organs in general? Again I say, we do not want to hear about "uniformity of design" and "reminiscences of a plan," and so on, but we wish to know how this state of things was physically brought about, save by community of descent. 4. Why is it that the facts of geological succession and geographical distribution so clearly indicate community of descent, unless there has actually been community of descent? Why have marsupials in Australia followed after other marsupials, and edentata in South America followed after other edentata, with such remarkable regularity, unless the bond which unites present with past ages be the well-known, the only known, and the only imaginable bond of physical generation? Why are the fauna and flora of each geologic epoch in general intermediate in character between the flora and fauna of the epochs immediately preceding and succeeding? And, 5. What are we to do with the great fact of *extinction* if we reject Mr. Darwin's explanations? When a race is extinguished, is it because of a universal deluge, or because of the "free manifestations of an intelligent mind?" For surely Prof. Agassiz will not attribute such a solemn result to such ignoble causes as insufficiency of food or any other of the thousand causes, "blindly mechanical," which conspire to make a species succumb in the struggle for life.

And here the phrase, "struggle for life," reminds me of yet another difficult task which Prof. Agassiz will have before him when he comes to undertake the refutation of Darwinism in earnest. He will have to explain away the enormous multitude of facts which show that there is a struggle for life in which the fittest survive; or he will at any rate have to show in what imaginable way an organic type can remain constant in all its features through countless ages under the influence of such circumstances, unless by taking into the account the Darwinian interpretation of persistent types offered by Prof. Huxley.

But I will desist from further enumeration of the difficulties which surround this task which Prof. Agassiz has not undertaken, and is not likely ever to undertake. For the direct grappling with that complicated array of theorems which the genius of such men as Darwin and Spencer and their companions has established on a firm basis of observation and deduction, Prof. Agassiz seems in these lectures hardly better qualified than a child is qualified for improving the methods of the integral calculus. These questions have begun to occupy earnest thinkers since the period when his mind acquired that rigidity which prevents the revising of one's opinions. The marvellous flexibility of thought with which Sir Charles Lyell so gracefully abandoned his an-

tiquated position, Prof. Agassiz is never likely to show. This is largely because Lyell has always been a thinker of purely scientific habit, while Agassiz has long been accustomed to making profoundly dark metaphysical phrases do the work which properly belongs to observation and deduction. But, however we may best account for these idiosyncrasies, it remains most probable among those facts which are still future, that Prof. Agassiz will never advance any more crushing refutation of the Darwinian theory than the simple expression of his personal dislike for "mechanical agencies," and his belief in the "free manifestations of an intelligent mind." Were he only to be left to himself, such expressions of personal preference could not mar the pleasure with which we often read his exposition of purely scientific truths. But when he is brought before the public as the destroyer of a theory, the elements of which he has never yet given any sign of having mastered, he is placed in a false position, which would be ludicrous could he be supposed to have sought it, and which is, at all events, unworthy of his eminent fame.

THE PRIMARY CONCEPTS OF MODERN PHYSICAL SCIENCE.

ERRATUM.

Page 710, line 32, for "impenetrability," read "compenetrability."

"Natural science," says Du Bois-Reymond,[1] "is a reduction of the changes in the material world to motions of atoms caused by central forces independent of time, or a resolution of the phenomena of Nature into atomic mechanics. . . . The resolution of all changes in the material world into motions of atoms caused by their constant central forces would be the completion of natural science."

Obviously, the proposition thus enounced assigns to physical sci-

[1] "Ueber die Grenzen des Naturerkennens. Ein Vortrag in der zweiten öffentlichen Sitzung der 45. Versammlung deutscher Naturforscher und Aerzte zu Leipzig am 14. August 1872, gehalten von Emil Du Bois-Reymond." Leipzig, Veit & Comp., 1872.