Were nothing fearing, and God's peace was in the air,
And none was prophesying harm—
The vast disaster fell:
Where stood the temple when the sun went down,
Was vacant desert when it rose again!

Ah, yes! 'Tis ages since it chanced!

So long ago it was,
That from the memory of the hamlet-folk the Light has passed—
They scarce believing, now, that once it was,
Or if believing, yet not missing it,
And reconciled to have it gone.

Not so the priests! Oh, not so
The stricken ones that served it day and night,
Adoring it, abiding in the healing of its peace:
They stand, yet, where erst they stood
Speechless in that dim morning long ago;
And still they gaze, as then they gazed,
And murmur, "It will come again;
It knows our pain—it knows—it knows—
Ah, surely it will come again."

S. L. C.

LAKE LUCERNE, *August* 18, 1897.

## THE CENTURY'S PROGRESS IN BIOLOGY.

BY HENRY SMITH WILLIAMS, M.D.

### I.

IT was in 1790 that Goethe published the work that laid the foundations of his scientific reputation—the work on the *Metamorphoses of Plants*, in which he advanced the novel doctrine that all parts of the flower are modified or metamorphosed leaves. This was followed presently by an extension of the doctrine of metamorphosis to the animal kingdom, in the doctrine which Goethe and Oken advanced independently, that the vertebrate skull is essentially a modified and developed vertebra. These were conceptions worthy of a poet; impossible, indeed, for any mind that had not the poetic faculty of correlation. But in this case the poet's vision was prophetic of a future view of the most prosaic science. The doctrine of metamorphosis of parts soon came to be regarded as a fundamental feature in the science of living things.

But the doctrine had implications that few of its early advocates realized. If all the parts of a flower—sepal, petal, stamen, pistil, with their countless deviations of contour and color—are but modifications of the leaf, such modification implies a marvellous differentiation and development. To assert that a stamen is a metamorphosed leaf means, if it means anything, that in the long sweep of time the leaf has by slow or sudden gradations changed its character through successive generations until the offspring, so to speak, of a true leaf has become a stamen. But if such a metamorphosis as this is possible—if the seemingly wide gap between leaf and stamen may be spanned by the modification of a line of organisms—where does the possibility of modification of organic type find its bounds? Why may not the modification of parts go on along devious lines until the remote descendants of an organism are utterly unlike that organism? Why may we not thus account for the development of various species of beings all sprung from one parent stock? That too is a poet's dream; but is it only a dream? Goethe thought not. Out of his studies of metamorphosis of parts there grew in his mind the belief that the multitudinous species of plants and animals about us have been evolved from fewer and

fewer earlier parent types, like twigs of a giant tree drawing their nurture from the same primal root. It was a bold and revolutionary thought; and the world regarded it as but the vagary of a poet.

Just at the time when this thought was taking form in Goethe's brain, the same idea was germinating in the mind of another philosopher, an Englishman of international fame, Dr. Erasmus Darwin, who, while he lived, enjoyed the widest popularity as a poet, the rhymed couplets of his "Botanic Garden" being quoted everywhere with admiration. And posterity, repudiating the verse which makes the body of the book, yet grants permanent value to the book itself, because, forsooth, its copious explanatory footnotes furnish an outline of the status of almost every department of science of the time.

But even though he lacked the highest art of the versifier, Darwin had, beyond peradventure, the imagination of a poet coupled with profound scientific knowledge; and it was his poetic insight, correlating organisms seemingly diverse in structure, and imbuing the lowliest flower with a vital personality, which led him to suspect that there are no lines of demarcation in nature. "Can it be," he queries, "that one form of organism has developed from another; that different species are really but modified descendants of one parent stock?" The alluring thought nestled in his mind and was nurtured there, and grew into a fixed belief, which was given fuller expression in his *Zoönomia*, and in the posthumous *Temple of Nature*. But there was little proof of its validity forthcoming that could satisfy any one but a poet, and when Erasmus Darwin died, in 1802, the idea of transmutation of species was still but an unsubstantiated dream.

It was a dream, however, which was not confined to Goethe and Darwin. Even earlier the idea had come more or less vaguely to another great dreamer—and worker—of Germany, Immanuel Kant, and to several great Frenchmen, including de Maillet, Maupertuis, Robinet, and the famous naturalist Buffon—a man who had the imagination of a poet, though his message was couched in most artistic prose. Not long after the middle of the eighteenth century Buffon had put forward the idea of transmutation of species, and he reiterated it from time to time from then on till his death in 1788. But the time was not yet ripe for the idea of transmutation of species to burst its bonds.

And yet this idea, in a modified or undeveloped form, had taken strange hold upon the generation that was upon the scene at the close of the eighteenth century. Vast numbers of hitherto unknown species of animals had been recently discovered in previously unexplored regions of the globe, and the wise men were sorely puzzled to account for the disposal of all of these at the time of the Deluge. It simplified matters greatly to suppose that many existing species had been developed since the episode of the Ark by modification of the original pairs. The remoter bearings of such a theory were overlooked for the time, and the idea that American animals and birds, for example, were modified descendants of Old World forms —the jaguar of the leopard, the puma of the lion, and so on—became a current belief with that class of humanity who accept almost any statement as true, that harmonizes with their prejudices, without realizing its implications.

Thus it is recorded with *éclat* that the discovery of the close proximity of America at the northwest with Asia removes all difficulties as to the origin of the Occidental faunas and floras, since Oriental species might easily have found their way to America on the ice, and have been modified as we find them by "the well-known influence of climate." And the persons who gave expression to this idea never dreamed of its real significance. In truth, here was the doctrine of evolution in a nutshell, and, because its ultimate bearings were not clear, it seemed the most natural of doctrines. But most of the persons who advanced it would have turned from it aghast could they have realized its import.

II.

There was one man, however, who was moved to give the doctrine full explication. This was the friend and disciple of Buffon, Jean Baptiste de Lamarck. Possessed of the spirit of poet and philosopher, this great Frenchman had also the widest range of technical knowledge, covering the entire field of animate nature. The first half of his long life was devoted chiefly to botany, in which he attained high distinction. Then, just at the beginning of our century, he turned to zoölogy, in particular to the lower forms of animal life. Study-

ing these lowly organisms, existing and fossil, he was more and more impressed with the gradations of form everywhere to be seen; the linking of diverse families through intermediate ones; and in particular with the predominance of low types of life in the earlier geological strata. Called upon constantly to classify the various forms of life in the course of his systematic writings, he found it more and more difficult to draw sharp lines of demarcation, and at last the suspicion long harbored grew into a settled conviction that there is really no such thing as a species of organism in nature; that "species" is a figment of the human imagination, whereas in nature there are only individuals.

That certain sets of individuals are more like one another than like other sets is of course patent, but this only means, said Lamarck, that these similar groups have had comparatively recent common ancestors, while dissimilar sets of beings are more remotely related in consanguinity. But trace back the lines of descent far enough, and all will culminate in one original stock. All forms of life whatsoever are modified descendants of an original organism. From lowest to highest, then, there is but one race, one species, just as all the multitudinous branches and twigs from one root are but one tree. For purposes of convenience of description, we may divide organisms into orders, families, genera, species, just as we divide a tree into root, trunk, branches, twigs, leaves; but in the one case, as in the other, the division is arbitrary and artificial.

In *Philosophie Zoologique* (1809), Lamarck first explicitly formulated his ideas as to the transmutation of species, though he had outlined them as early as 1801. In this memorable publication not only did he state his belief more explicitly and in fuller detail than the idea had been expressed by any predecessor, but he took another long forward step, carrying him far beyond all his forerunners except Darwin, in that he made an attempt to explain the way in which the transmutation of species had been brought about. The changes have been wrought, he said, through the unceasing efforts of each organism to meet the needs imposed upon it by its environment. Constant striving means the constant use of certain organs, and such use leads to the development of those organs. Thus a bird running by the sea-shore is constantly tempted to wade deeper and deeper in pursuit of food; its incessant efforts tend to develop its legs, in accordance with the observed principle that the use of any organ tends to strengthen and develop it. But such slightly increased development of the legs is transmitted to the offspring of the bird, which in turn develops its already improved legs by its individual efforts, and transmits the improved tendency. Generation after generation this is repeated, until the sum of the infinitesimal variations, all in the same direction, results in the production of the long-legged wading-bird. In a similar way, through individual effort and transmitted tendency, all the diversified organs of all creatures have been developed—the fin of the fish, the wing of the bird, the hand of man; nay, more, the fish itself, the bird, the man, even. Collectively the organs make up the entire organism; and what is true of the individual organs must be true also of their *ensemble*, the living being.

Whatever might be thought of Lamarck's explanation of the cause of transmutation—which really was that already suggested by Erasmus Darwin—the idea of the evolution for which he contended was but the logical extension of the conception that American animals are the modified and degenerated descendants of European animals. But people as a rule are little prone to follow ideas to their logical conclusions, and in this case the conclusions were so utterly opposed to the proximal bearings of the idea that the whole thinking world repudiated them with acclaim. The very persons who had most eagerly accepted the idea of transmutation of European species into American species, and similar limited variations through changed environment, because of the relief thus given the otherwise overcrowded Ark, were now foremost in denouncing such an extension of the doctrine of transmutation as Lamarck proposed.

And for that matter, the leaders of the scientific world were equally antagonistic to the Lamarckian hypothesis. Cuvier in particular, once the pupil of Lamarck, but now his colleague, and in authority more than his peer, stood out against the transmutation doctrine with all his force. He argued for the absolute fixity of spe-

cies, bringing to bear the resources of a mind which, as a mere repository of facts, perhaps never was excelled. As a final and tangible proof of his position, he brought forward the bodies of ibises that had been embalmed by the ancient Egyptians, and showed by comparison that these do not differ in the slightest particular from the ibises that visit the Nile to-day. Lamarck replied that this proved nothing, except that the ibis had become perfectly adapted to its Egyptian surroundings in an early day, historically speaking, and that the climatic and other conditions of the Nile Valley had not since then changed. His theory, he alleged, provided for the stability of species under fixed conditions quite as well as for transmutation under varying conditions.

ERASMUS DARWIN.

But, needless to say, the popular verdict lay with Cuvier; talent won for the time against genius, and Lamarck was looked upon as an impious visionary. His faith never wavered, however. He believed that he had gained a true insight into the processes of animate nature, and he reiterated his hypotheses over and over, particularly in the introduction to his *Histoire naturelle des Animaux sans Vertèbres*, in 1815, and in his *Système des Connaissances positives de l'Homme*, in 1820. He lived on till 1829, respected as a naturalist, but almost unrecognized as a prophet.

III.

While the names of Darwin and Goethe, and in particular that of Lamarck, must always stand out in high relief in this generation as the exponents of the idea of transmutation of species, there are a few others which must not be altogether overlooked in this connection. Of these the most conspicuous is that of Gottfried Reinhold Treviranus, a German naturalist physician, professor of mathematics in the lyceum at Bremen.

It was an interesting coincidence that Treviranus should have published the first volume of his *Biologie, oder Philosophie der lebenden Natur*, in which his views on the transmutation of species were expounded, in 1802, the same twelvemonth in which Lamarck's first exposition of the same doctrine appeared in his *Recherches sur l'Organisation des Corps Vivants*. It is singular, too, that Lamarck, in his *Hydrogéologie* of the same date, should independently have suggested "biology" as an appropriate word to express the general science of living things. It is significant of the tendency of thought of the time that the need of such a unifying word should have presented itself simultaneously to independent thinkers in different countries.

That same memorable year, Lorenz Oken, another philosophical naturalist, professor in the University of Zurich, published the preliminary outlines of his *Philosophie der Natur*, which, as developed through later publications, outlined a theory of spontaneous generation and of evolution of species. Thus it appears that this idea was germinating in the minds of several of the ablest men of the time during the first decade of our century. But the singular result of their various explications was to give sudden check to that undercurrent of thought

JEAN BAPTISTE DE LAMARCK.

which for some time had been setting toward this conception. Then for a generation Cuvier was almost absolutely dominant, and his verdict was generally considered final.

There was, indeed, one naturalist of authority in France who had the hardihood to stand out against Cuvier and his school, and who was in a position to gain a hearing, though by no means to divide the following. This was Étienne Geoffroy Saint-Hilaire, the famous author of the *Philosophie Anatomique*, and for many years the colleague of Lamarck at the Jardin des Plantes. Like Goethe, Geoffroy was pre-eminently an anatomist, and, like the great German, he had early been impressed with the resemblances between the analogous organs of different classes of beings. He conceived the idea that an absolute unity of type prevails throughout organic nature as regards each set of organs. Out of this idea grew his gradually formed belief that similarity of structure might imply identity of origin—that, in short, one species of animal might have developed from another.

Geoffroy's grasp of this idea of transmutation was by no means so complete as that of Lamarck, and he seems never to have fully determined in his own mind just what might be the limits of such development of species. Certainly he nowhere includes all organic creatures in one line of descent, as Lamarck had done; nevertheless he held tenaciously to the truth as he saw it, in open opposition to Cuvier, with whom he held a memorable debate at the Academy of Sciences in 1830—the debate which so aroused the interest and enthusiasm of Goethe, but which, in the opinion of nearly every one else, resulted in crushing defeat for Geoffroy, and brilliant, seemingly final, victory for the advocate of special creation and the fixity of species.

With that all ardent controversy over the subject seemed to end, and for just a quarter of a century to come there was published but a single argument for transmutation of species which attracted any general attention whatever. This oasis in a desert generation was a little book called *Vestiges of the Natural History of Creation*, which appeared anonymously in England in 1844, and which passed through numerous editions, and was the subject of no end of abusive and derisive comment. The authorship of this book remained for forty years a secret, but it is now conceded to have been the work of Robert Chambers, the well-known English author and publisher. The book itself is remarkable as being an avowed and unequivocal exposition of a general doctrine of evolution, its view being as radical and comprehensive as that of Lamarck himself. But it was a résumé of earlier efforts rather than a new departure, to say nothing of its technical shortcomings, and while it aroused bitter animadversions, and cannot have been without effect in creating an undercurrent of thought in

opposition to the main trend of opinion of the time, it can hardly be said to have done more than that. Indeed, some critics have denied it even this merit. After its publication, as before, the conception of transmutation of species remained in the popular estimation, both lay and scientific, an almost forgotten "heresy."

It is true that here and there a scientist of greater or less repute—as Von Buch, Meckel, and Von Baer in Germany, Bory Saint Vincent in France, Wells, Grant, and Matthew in England, and Leidy in America—had expressed more or less tentative dissent from the doctrine of special creation and immutability of species, but their unaggressive suggestions, usually put forward in obscure publications, and incidentally, were utterly overlooked and ignored. Special creation held the day, apparently unchallenged and unopposed.

IV.

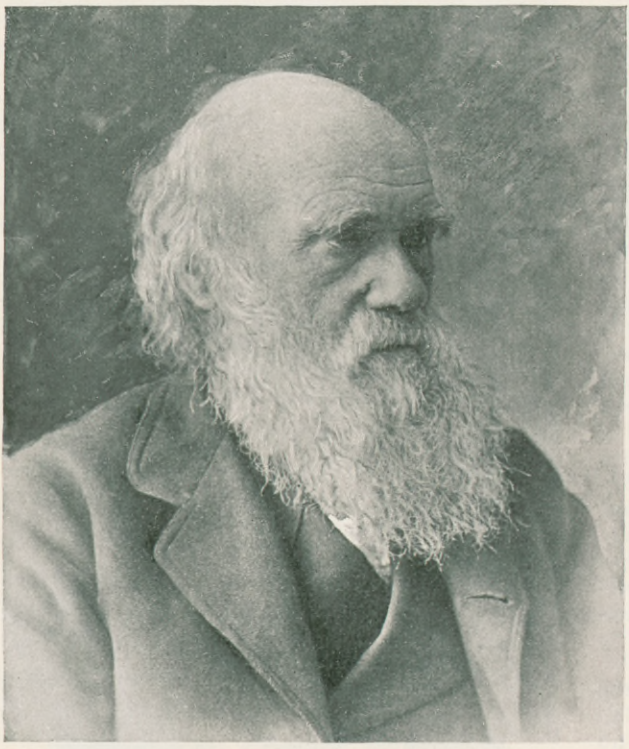
But even at this time the fancied security of the special-creation hypothesis was by no means real. Though it seemed so invincible, its real position was that of an apparently impregnable fortress beneath which, all unbeknown to the garrison, a powder-mine has been dug and lies ready for explosion. For already there existed, in the secluded workroom of an English naturalist, a manuscript volume and a portfolio of notes which might have sufficed, if given publicity, to shatter the entire structure of the special-creation hypothesis. The naturalist who by dint of long and patient effort had constructed this powder-mine of facts was Charles Robert Darwin, grandson of the author of *Zoönomia*.

As long ago as July 1, 1837, young Darwin, then twenty-eight years of age, had opened a private journal, in which he purposed to record all facts that came to him which seemed to have any bearing on the moot point of the doctrine of transmutation of species. Four or five years earlier, during the course of that famous trip around the world with Admiral Fitzroy, as naturalist to the *Beagle*, Darwin had made the personal observations which first tended to shake his belief in the fixity of species. In South America, in the Pampean formation, he had discovered "great fossil animals covered with armor like that on the existing armadillos," and had been struck with this similarity of type between ancient and existing faunas of the same region. He was also greatly impressed by

ÉTIENNE GEOFFROY SAINT-HILAIRE.

the manner in which closely related species of animals were observed to replace one another as he proceeded southward over the continent; and "by the South American character of most of the productions of the Galapagos Archipelago, and more especially by the manner in which they differ slightly on each island of the group, none of the islands appearing to be very ancient in a geological sense."

At first the full force of these observations did not strike him; for, under sway of Lyell's geological conceptions, he tentatively explained the relative absence



CHARLES ROBERT DARWIN.
From a photograph by Elliott and Fry, London.

of life on one of the Galapagos Islands by suggesting that perhaps no species had been created since that island arose. But gradually it dawned upon him that such facts as he had observed "could only be explained on the supposition that species gradually become modified." From then on, as he afterward asserted, the subject haunted him; hence the journal of 1837.

It will thus be seen that the idea of the variability of species came to Charles Darwin as an inference from personal observations in the field, not as a thought borrowed from books. He had, of course, read the works of his grandfather much earlier in life, but the arguments of the *Zoönomia* and *Temple of Nature* had not served in the least to weaken his acceptance of the current belief in fixity of species. Nor had he been more impressed with the doctrine of Lamarck, so closely similar to that of his grandfather. Indeed, even after his South American experience had aroused him to a new point of view he was still unable to see anything of value in these earlier attempts at an explanation of the variation of species. In opening his journal, therefore, he had no preconceived notion of upholding the views of these or any other makers of hypotheses, nor at the time had he formulated any hypothesis of his own. His mind was open and receptive; he was eager only for facts which might lead him to an understanding of a problem which seemed utterly obscure. It was something to feel sure that species have varied; but how have such variations been brought about?

It was not long before Darwin found a clew which he thought might lead to the answer he sought. In casting about for facts he had soon discovered that the most available field for observation lay among domesticated animals, whose numerous variations within specific lines are familiar to every one. Thus under domestication creatures so tangibly different as a mastiff and a terrier have sprung from a common stock. So have the Shetland pony, the thoroughbred, and the draught-horse. In short, there is no domesticated animal that has not developed varieties deviating more or less widely from the parent stock. Now how has this been accomplished? Why, clearly, by the preservation, through selective breeding, of seemingly accidental variations. Thus one horseman, by constantly selecting animals that "chance" to have the right build and stamina, finally develops a race of running-horses; while another horseman, by selecting a different series of progenitors, has developed a race of slow, heavy draught-animals.

So far so good; the preservation of "accidental" variations through selective

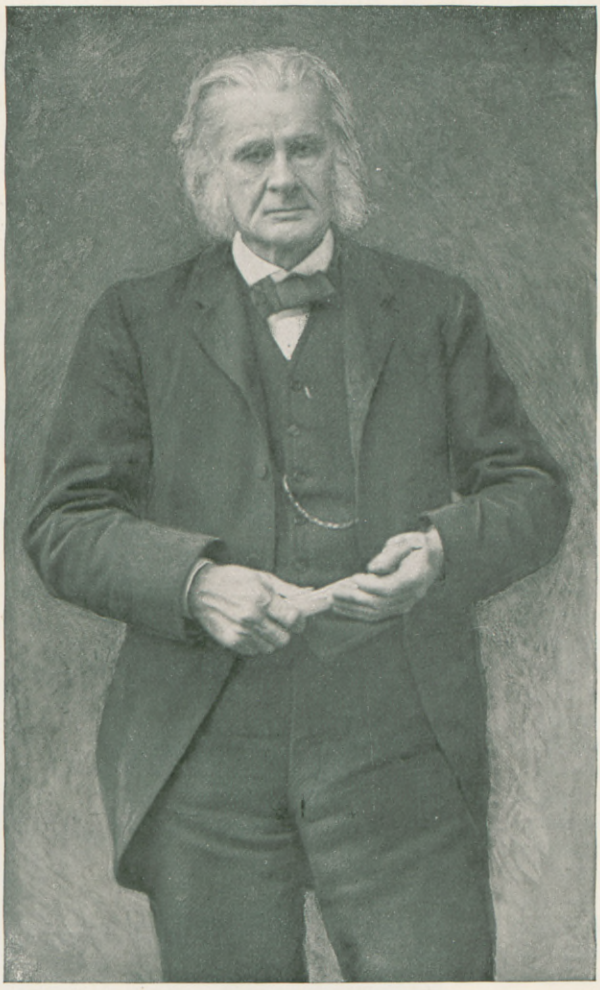
breeding is plainly a means by which races may be developed that are very different from their original parent form. But this is under man's supervision and direction. By what process could such selection be brought about among creatures in a state of nature? Here surely was a puzzle, and one that must be solved before another step could be taken in this direction.

The key to the solution of this puzzle came into Darwin's mind through a chance reading of the famous essay on "Population" which Thomas Robert Malthus had published almost half a century before. This essay, expositing ideas by no means exclusively original with Malthus, emphasizes the fact that organisms tend to increase at a geometrical ratio through successive generations, and hence would overpopulate the earth if not somehow kept in check. Cogitating this thought, Darwin gained a new insight into the processes of nature. He saw that in virtue of this tendency of each race of beings to overpopulate the earth, the entire organic world, animal and vegetable, must be in a state of perpetual carnage and strife, individual against individual, fighting for sustenance and life.

That idea fully imagined, it becomes plain that a selective influence is all the time at work in nature, since only a few individuals, relatively, of each generation can come to maturity, and these few must, naturally, be those best fitted to battle with the particular circumstances in the midst of which they are placed. In other words, the individuals best adapted to their surroundings will, on the average, be those that grow to maturity and produce offspring. To these offspring will be transmitted the favorable peculiarities. Thus these peculiarities will become permanent, and nature will have accomplished precisely what the human breeder is seen to accomplish. Grant that organisms in a state of nature vary, however slightly, one from another (which is indubitable), and that such variations will be transmitted by a parent to its offspring (which no one then doubted); grant, further, that there is incessant strife among the various organisms, so that only a small proportion can come to maturity—grant these things, said Darwin, and we have an explanation of the preservation of variations which leads on to the transmutation of species themselves.

This wonderful coign of vantage Darwin had reached by 1839. Here was the full outline of his theory; here were the ideas which afterward came to be embalmed in familiar speech in the phrases "spontaneous variation," and the "sur-

ALFRED RUSSELL WALLACE.



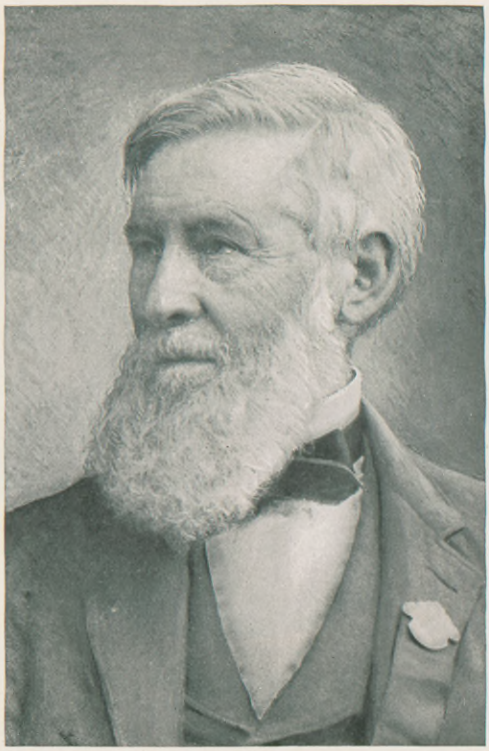
THOMAS HENRY HUXLEY.

From a photograph by W. and D. Downey, London.

vival of the fittest," through "natural selection." After such a discovery any ordinary man would at once have run through the streets of science, so to speak, screaming "Eureka!" Not so Darwin. He placed the manuscript outline of his theory in his portfolio, and went on gathering facts bearing on his discovery. In 1844 he made an abstract in a manuscript book of the mass of facts by that time accumulated. He showed it to his friend Hooker, made careful provision for its publication in the event of his sudden death, then stored it away in his desk, and went ahead with the gathering of more data. This was the unexploded powder-mine to which I have just referred.

Twelve years more elapsed; years during which the silent worker gathered a prodigious mass of facts, answered a multitude of objections that arose in his own mind, vastly fortified his theory. All this time the toiler was an invalid, never knowing a day free from illness and discomfort, obliged to husband his strength, never able to work more than an hour and a half at a stretch; yet he accomplished what would have been vast achievements for half a dozen men of

robust health. Two friends among the eminent scientists of the day knew of his labors—Sir Joseph Hooker, the botanist, and Sir Charles Lyell, the geologist. Gradually Hooker had come to be more than half a convert to Darwin's views. Lyell was still sceptical, yet he urged Darwin to publish his theory without further delay, lest he be forestalled. At last the patient worker decided to comply with this advice, and in 1856 he set to work to make another and fuller abstract of the mass of data he had gathered.

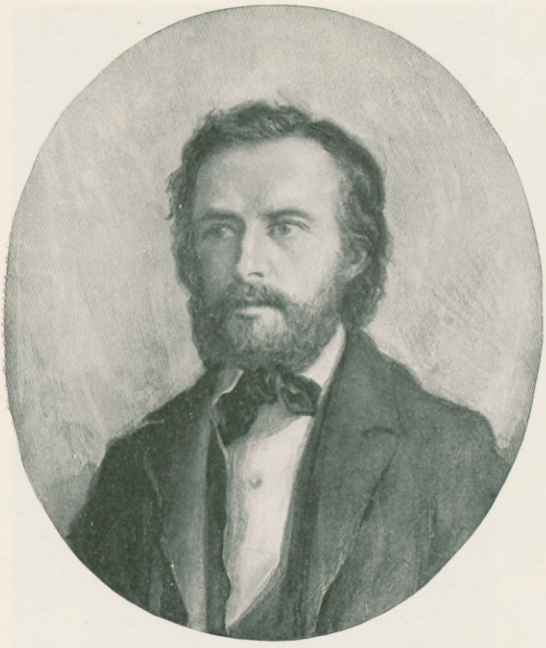


ASA GRAY.

And then a strange thing happened. After Darwin had been at work on his "abstract" about two years, but before he had published a line of it, there came to him one day a paper in manuscript, sent for his approval by a naturalist friend, named Alfred Russell Wallace, who had been for some time at work in the East India Archipelago. He read the paper, and, to his amazement, found that it contained an outline of the same theory of "natural selection" which he himself had originated and for twenty years had worked upon. Working independently, on opposite sides of the globe, Darwin and Wallace had hit upon the same explanation of the cause of transmutation of species. "Were Wallace's paper an abstract of my unpublished manuscript of 1844," said Darwin, "it could not better express my ideas."

Here was a dilemma. To publish this paper with no word from Darwin would give Wallace priority, and wrest from Darwin the credit of a discovery which he had made years before his co-discoverer entered the field. Yet, on the other hand, could Darwin honorably do otherwise than publish his friend's paper and himself remain silent? It was a complication well calculated to try a man's soul. Darwin's was equal to the test. Keenly alive to the delicacy of the position, he placed the whole matter before his friends Hooker and Lyell, and left the decision as to a course of action absolutely to them. Needless to say, these great men did the one thing which ensured full justice to all concerned. They counselled a joint publication, to include on the one hand Wallace's paper, and on the other an abstract of Darwin's ideas, in the exact form in which it had been outlined by the author in a letter to Asa Gray in the previous year—an abstract which was in Gray's hands before Wallace's paper was in existence. This joint production, together with a full statement of the facts of the case, was presented to the Linnæan Society of London by Hooker and Lyell on the evening of July 1, 1858, this being, by an odd coincidence, the twenty-first anniversary of the day on which Darwin had opened his journal to collect facts bearing on the "species question." Not often before in the history of science has it happened that a great theory has been nurtured in its author's brain through infancy and adolescence to its full legal majority before being sent out into the world.

Thus the fuse that led to the great powder-mine had been lighted. The explosion itself came more than a year later, in November, 1859, when Darwin, after thirteen months of further effort, com-



ERNST HEINRICH HAECKEL.

pleted the outline of his theory, which was at first begun as an abstract for the Linnæan Society, but which grew to the size of an independent volume despite his efforts at condensation, and which was given that ever-to-be-famous title, *The Origin of Species by means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life.* And what an explosion it was! The joint paper of 1858 had made a momentary flare, causing the hearers, as Hooker said, to "speak of it with bated breath," but beyond that it made no sensation. What the result was when the *Origin* itself appeared, no one of our generation need be told. The rumble and roar that it made in the intellectual world has not yet altogether ceased to echo after nearly forty years of reverberation.

V.

To the *Origin of Species*, then, and to its author, Charles Darwin, must always be ascribed chief credit for that vast revolution in the fundamental beliefs of our race which has come about since 1859, and made the second half of the century memorable. But it must not be overlooked that no such sudden metamorphosis could have been effected had it not been for the aid of a few notable lieutenants, who rallied to the standards of the leader immediately after the publication of the *Origin*. Darwin had all along felt the utmost confidence in the ultimate triumph of his ideas. "Our posterity" he declared in a letter to Hooker, "will marvel as much about the current belief [in special creation] as we do about fossil shells having been thought to be created as we now see them." But he fully realized that for the present success of his theory of transmutation the championship of a few leaders of science was all-essential. He felt that if he could make converts of Hooker and Lyell and of Thomas Henry Huxley at once, all would be well.

His success in this regard, as in others, exceeded his expectations. Hooker was an ardent disciple from reading the proof-sheets before the book was published; Lyell renounced his former beliefs and fell into line a few months later; while Huxley, so soon as he had mastered the central idea of natural selection, marvelled that so simple yet all-potent a thought had escaped him so long, and then rushed eagerly into the fray, wielding the keenest dialectic blade that was drawn during the entire controversy. Then, too, unexpected recruits were found in Sir John Lubbock and John Tyndall, who carried the war eagerly into their respective territories; while Herbert Spencer, who had advocated a doctrine of transmutation on philosophic grounds some years before Darwin published the key to the mystery—and who himself had barely escaped independent discovery of that key—lent his masterful influence to the cause. In America, the famous botanist Asa Gray, who had long been a correspondent of Darwin's, but whose advocacy of the new theory had not been anticipated, became an ardent propagandist; while in Germany Ernst Heinrich Haeckel, the youthful but already noted zoölogist,

took up the fight with equal enthusiasm.

Against these few doughty champions —with here and there another of less general renown—was arrayed, at the outset, practically all Christendom. The interest of the question came home to every person of intelligence, whatever his calling, and the more deeply as it became more and more clear how far-reaching are the real bearings of the doctrine of natural selection. Soon it was seen that should the doctrine of the survival of favored races through the struggle for existence win, there must come with it as radical a change in man's estimate of his own position as had come in the day when, through the efforts of Copernicus and Galileo, the world was dethroned from its supposed central position in the universe. The whole conservative majority of mankind recoiled from this necessity with horror. And this conservative majority included not laymen merely, but a vast preponderance of the leaders of science also.

With the open-minded minority, on the other hand, the theory of natural selection made its way by leaps and bounds. Its delightful simplicity—which at first sight made it seem neither new nor important—coupled with the marvellous comprehensiveness of its implications, gave it a hold on the imagination, and secured it a hearing where other theories of transmutation of species had been utterly scorned. Men who had found Lamarck's conception of change through voluntary effort ridiculous, and the vaporings of the *Vestiges* altogether despicable, men whose scientific cautions held them back from Spencer's deductive argument, took eager hold of that tangible, ever-present principle of natural selection, and were led on and on to its goal. Hour by hour the attitude of the thinking world toward this new principle changed; never before was so great a revolution wrought so suddenly.

VI.

Wide as are the implications of this great truth which Darwin and his coworkers established, however, it leaves quite untouched the problem of the origin of those "favored variations" upon which it operates. That such variations are due to fixed and determinate causes, no one understood better than Darwin; but in his original exposition of his doctrine he made no assumption as to what these causes are. He accepted the observed fact of variation — as constantly witnessed, for example, in the differences between parents and offspring—and went ahead from this assumption.

But as soon as the validity of the principle of natural selection came to be acknowledged, speculators began to search for the explanation of those variations which, for purposes of argument, had been provisionally called "spontaneous." Herbert Spencer had all along dwelt on this phase of the subject, expounding the Lamarckian conceptions of the direct influence of the invironment (an idea which had especially appealed to Buffon and to Geoffroy Saint-Hilaire), and of effort in response to environment and stimulus as modifying the individual organism, and thus supplying the basis for the operation of natural selection. Haeckel also became an advocate of this idea, and presently there arose a so-called school of neo-Lamarckians, which developed particular strength and prominence in America, under the leadership of Professors A. Hyatt and E. D. Cope.

But just as the tide of opinion was turning strongly in this direction, an utterly unexpected obstacle appeared in the form of the theory of Professor August Weismann, put forward in 1883, which antagonized the Lamarckian conception (though not touching the Darwinian, of which Weismann is a firm upholder) by denying that individual variations, however acquired by the mature organism, are transmissible. The flurry which this denial created has not yet altogether subsided, but subsequent observations seem to show that it was quite disproportionate to the real merits of the case. Notwithstanding Professor Weismann's objections, the balance of evidence appears to favor the view that the Lamarckian factor of acquired variations stands as the complement of the Darwinian factor of natural selection in effecting the transmutation of species.

Even though this partial explanation of what Professor Cope calls the "origin of the fittest" be accepted, there still remains one great life problem which the doctrine of evolution does not touch. The origin of species, genera, orders, and classes of beings through endless transmutations is in a sense explained; but

what of the first term of this long series? Whence came that primordial organism whose transmuted descendants make up the existing faunas and floras of the globe?

There was a time, soon after the doctrine of evolution gained a hearing, when the answer to that question seemed to some scientists of authority to have been given by experiment. Recurring to a former belief, and repeating some earlier experiments, the director of the Museum of Natural History at Rouen, M. F. A. Pouchet, reached the conclusion that organic beings are spontaneously generated about us constantly, in the familiar processes of putrefaction, which were known to be due to the agency of microscopic bacteria. But in 1862 Louis Pasteur proved that this seeming spontaneous generation is in reality due to the existence of germs in the air. Notwithstanding the conclusiveness of these experiments, the claims of Pouchet were revived in England ten years later by Professor Bastian; but then the experiments of John Tyndall, fully corroborating the results of Pasteur, gave a final quietus to the claim of "spontaneous generation" as hitherto formulated.

There for the moment the matter rests. But the end is not yet. Fauna and flora are here, and, thanks to Lamarck and Wallace and Darwin, their development, through the operation of those "secondary causes" which we call laws of nature, has been proximally explained. The lowest forms of life have been linked with the highest in unbroken chains of descent. Meantime, through the efforts of chemists and biologists, the gap between the inorganic and the organic worlds, which once seemed almost infinite, has been constantly narrowed. Already philosophy can throw a bridge across that gap. But inductive science, which builds its own bridges, has not yet spanned the chasm, small though it appear. Until it shall have done so, the bridge of organic evolution is not quite complete; yet even as it stands to-day it is the most stupendous scientific structure of our century.

## NUMBER 1523.

BY WILLIS BOYD ALLEN.

ON a certain sultry afternoon last August I was sitting in my editorial easy-chair, with a pile of accumulated manuscripts on the desk beside me.

The first half-dozen effusions I disposed of in short order, with the usual printed blank (we pride ourselves upon the courtesy of our rejections in the *Home Fireside* office) setting forth our regrets at the necessity of returning the manuscript kindly submitted, the utter absence of any flavor of literary criticism in our decision, and our unhesitating belief that our gifted correspondent would find a ready market for his or her (usually her) production elsewhere.

In that rather reckless mood and desire for more slaughter which grows upon me at such times, I caught up the next package, tore off the brown covering with just enough of a glance at the address to notice the feminine delicacy of the handwriting, and mentally anathematizing the writer for omitting to enclose return stamps, settled myself for that inevitable, even if hasty, reading from which the editorial conscience, morbidly exigent in this one particular, will not let us off.

To my own intense surprise, I found myself, hardened as I was to the attempts of novices in literature, interested at the very outset in a tale which bore undoubted marks of an inexperienced pen. There were three elements in its composition which at once arrested my attention. First, the opening paragraph indicated that the writer was not a woman, unless disguising her sex; second, the strange narrative purported to be true in such passionately earnest language that I could not, for the life of me, doubt the author's veracity; and, third, there was no name, address, or personal direction of any kind appended to the manuscript. If a plagiarism, the writer could certainly expect no material emolument for the fraud.

I read page after page of the close, dainty chirography, which I soon found was more ornamental than easy to decipher. When I turned under the last sheet, and rubbed my eyes as much from bewilderment as weariness, the office-boy was distractedly rattling chairs, and even