

the pearl was ruined by the crude method of boiling them employed to open the shells.

During the pearl excitement near Waynesville, Ohio, in 1876, a few extraordinarily good pearls were found. One, button-shaped on the back, weighing thirty-eight grains, was the gem of the collection. In the early eighties a sky-blue pearl which was found in Caney Fork, Tennessee, was sold for \$950, and subsequently brought \$3,300 in London.

During the summer of 1889 a quantity of magnificently colored pearls were found in creeks and rivers of Wisconsin. One of these pearls sold for over \$500, and some among them were equal to any ever found for beauty and coloring.

The year 1807 saw the pearling craze break out in Arkansas. A deep pink pearl of forty grains weight was found in the mud of one stream by a woman, while a farmer's boy obtained a pink pearl

of thirty-one grains in Black River and sold it for \$35, the purchaser disposing of it in St. Louis a little later for \$500.

In 1898 a fisherman searched the head waters of the Mystic River in Connecticut, and, after a few week's work, gathered a number of pearls, one of which he sold for \$500 and two for \$400 each.

The best price ever received by a finder for an American fresh water pearl was \$10,000 for one from Tennessee. Two others from the same State brought \$650 and \$1,000 each. A Wisconsin pearl sold for \$8,000 dollars, while two Florida pearls of sixty-eight and fifty-eight grain brought \$850 and \$600, respectively.

A year or so ago there was offered for sale by a gem dealer of New York a perfect pearl, white and rounded, weighing sixty-eight grains, which he valued at \$15,000. This pearl was found near the Wis-

consin bank of the Mississippi River, and was sold by the finder, who evidently had not the slightest idea of its value, for seventy-five cents. Another pearl, found about the same time, was recently offered for sale in New York for \$5,000. The latter is a pink, pear-shaped pearl and weighs ninety-nine grains.

A few years ago a fisherman became so agitated on finding a pearl the size of a pigeon's egg in a mussel that he dropped it into the water and it was never recovered.

Many odd-shaped pearls are found. One was found in this country that strikingly resembled the bust of Michelangelo. In a few instances small fishes, crabs, and insects which entered the shell have been imprisoned and covered eventually with nacre, thus making pearls of them, at the same time retaining the animal's shape.

## Charles Darwin\*

### The Justification of the Darwinian Theory

By August Weismann

FORTY ONE years ago, when I delivered my inaugural address as a professor of this university, I took as my subject "The Justification of the Darwinian Theory." It is a great pleasure to me to be able to lecture again on the same subject on the hundredth anniversary of the birth of Darwin.

This time, however, I need not speak of justifying the theory, for in the interval it has conquered the whole world. Yet there remains much that may be said—much, indeed, that ought to be said at the present time. In my former lecture I compared the theory of descent or evolution to the Copernican Cosmogony in its importance for the progress of human knowledge, and there were many who thought the comparison extravagant. But it needs no apology now that the idea of evolution has been thoroughly elaborated, and has become the basis of the science of life.

You know that Darwin was not the only one, and was not even the first, to whom the idea of evolution occurred; it had arisen in several great minds half a century earlier, and it may therefore be thought an injustice to give, as we now do, almost all the credit of this fruitful discovery to Darwin alone.

But history is a severe and inexorable judge. She awards the palm not to him in whose mind an idea first arises, but to him who so establishes it that it takes a permanent place in scientific thought, for it is only then that it becomes fruitful of, and an instrument for, human progress. The credit for thus establishing the theory of evolution is shared with Charles Darwin only by his contemporary, Alfred Russel Wallace, of whom we shall have to speak later.

Nevertheless, a reflection of the discoverer's glory falls upon those who, about the end of the eighteenth and the beginning of the nineteenth century, were able to attain to the conception of evolution, notwithstanding the incomparably smaller number of facts known to them. As one of these pioneers we must not omit to mention our own poet, Goethe, though he rather threw out premonitory hints of a theory of evolution than actually taught it. "Alle Gestalten sind ähnlich, doch keine gleichet der andere, und so deutet der Chor auf ein geheimes Gesetz."

The "secret law" was the law of descent, and the first to define this idea and to formulate it clearly as a theory was, as is well known, also a Darwin, Charles Darwin's grandfather, Erasmus, who set it forth in his book, "Zoonomia," in 1796. A few years later Treviranus, a botanist of Bremen, published a book of similar purport, and he was followed in 1809 by the Frenchman, Lamarck, and the German, Lorenz Oken.

All these disputed the venerable Mosaic mythus of creation, which had till then been accepted as a scientific document, and all of them sought to show that the constancy of species throughout the ages was only an appearance due, as Lamarck in particular pointed out, to the shortness of human life.

But Cuvier, the greatest zoologist of that time, a pupil of the Stuttgart Karlsschule, would have none of his idea, and held fast to the conception of species created once for all, seeing in it the only possible explanation of the enormous diversity of animal and plant forms.

And there was much to be said for this attitude at that time, when the knowledge of facts was not nearly comprehensive enough to afford a secure and scientific basis for the theory of descent. Lamarck alone had attempted to indicate the forces from which in his opinion, the transmutation of species could have resulted.

It was not, however, solely because the basis of fact was insufficient that the theory of the evolution of organic nature did not gain ground at that time; it was even more because such foundation as there was for it was not adhered to. All sorts of vague speculations were indulged in, and these contributed less and less to the support of the theory the more far-reaching they became. Many champions of the "Naturphilosophie" of the time, especially Oken and Schelling, promulgated mere hypotheses as truths; forsaking the realm of fact almost entirely, they attempted to construct the whole world with a free hand, so to speak, and lost themselves more and more in worthless phantasy.

This naturally brought the theory of evolution, and with it "Naturphilosophie," into disrepute, especially with the true naturalists, those who patiently observe and collect new facts. The theory lost all credence, and sank so low in the general estimation that it came to be regarded as hardly fitting for a naturalist to occupy himself with philosophical conceptions.

This was the state of matters onward from 1830, the year in which the final battle between the theory of evolution and the old theory of creation was fought out by Geoffroy St. Hilaire and Cuvier in the Paris Academy. Cuvier triumphed, and thus it came about that an idea so important as that of evolution sank into oblivion again after its emergence, and was expunged from the pages of science so completely that it seemed as if it were for ever buried beyond hope of resurrection.

Scientific men now turned with eagerness toward special problems in all the domains of life, and the following period may well be characterized as that of purely detailed investigation.

Great progress was made during this period; entirely new branches of science were founded, and a wealth of unexpected facts was discovered. The development of individual organisms, of which little had previously been known, began to be revealed in all its marvelous diversity; first, the development of the chick in the egg; then of the frog; then of insects and worms; then of spiders, crustaceans, starfishes, and all the classes and orders of mollusks, as well as of backboneed animals from the lowest fish up to man himself. Within this period of purely detailed investigation there falls also the discovery, in animals and plants, of that smallest microscopically visible building stone of the living body, the cell, and this discovery paved the way for the full development of the newly founded science of tissues, histology.

In botany the chief progress in this period was in regard to the reproduction and development of the lower plants, or cryptogams, and the discovery of alternation of generations, a mode of reproduction that had previously been known in several groups of the animal kingdom, in polyps and medusæ, in various worms; and later in insects and crustaceans.

At the same time it was found that the proposition, which had hitherto been accepted as a matter of course, that an egg can only develop after it has been fertilized, is not universally valid, for there is a development without previous fertilization—parthenogenesis, or virgin birth.

Thus, in the period between the Napoleonic wars and 1859, an ever increasing mass of new facts was accumulated, and among these there were so many of an unexpected nature that further effort was constantly being put forth to elucidate detailed processes in every domain. This was desirable and important—was, indeed, indispensable to a deeper knowledge of organic nature. But in the endeavor to investigate details naturalists forgot to inquire into the deeper causes and correlations, which might have enabled

them to build up out of the wealth of details a more general conception of life. So great was the reaction from the unfortunate speculations of the so-called "Naturphilosophie," that there was a tendency to shrink even from taking a comprehensive survey of isolated facts, which might lead to the induction of general principles.

How deep was the oblivion into which the philosophical conceptions of the beginning of the century had sunk by the middle of it may be gathered from the fact that in my own student days in the fifties I never heard a theory of descent referred to, and I found no mention of it in any book to which I had access. One of the most famous of my teachers, the gifted anatomist, J. Henle, had written as a motto under his picture, "There is a virtue of renunciation, not in the domain of morality alone, but in that of intellect as well." This sentence was entirely obscure to me as a student, because I knew nothing of the intellectual excesses of the "Naturphilosophie," and I only understood later, after the revival of interest in general problems, that this insistence upon the virtue of intellectual renunciation was intended as a counteractive to the over-speculations of that period.

This was one-sided, but it was a necessary reaction from the one-sidedness in the opposite direction which had preceded it.

The next swing of the pendulum was brought about by Charles Darwin in 1859 with his book on "The Origin of Species."

Let us now consider the development of this remarkable man, and note the steps by which he attained to his life work. Charles Darwin was born on the 12th of February, 1809, the same year in which Lamarck published his "Philosophie Zoologique." But he had not sucked in the doctrines of that evolutionist, or of his own grandfather, Erasmus Darwin, with his mother's milk. His youth fell within the period of the reaction from philosophical speculation, and he grew up wholly in the old ideas of the creation of species and their immutability. His birthplace was the little town of Shrewsbury, near the borders of Wales, where his father was a highly respected physician, well to do even according to English standards.

If we think of Charles Darwin's later achievements we are apt to suppose that the bent toward natural science must have been apparent in him at a very early age, but this was not the case, at least not to a degree sufficient to attract the attention of those about him. It is easy now, of course, to say that the pronounced liking for ranging about wood and field and collecting, quite unscientifically, plants, beetles, and minerals, foreshadowed the future naturalist. Even as a boy Darwin was an enthusiastic sportsman and an excellent shot, and the first snipe he brought down excited him so much that he was hardly able to reload.<sup>1</sup> But he must have been not merely a sportsman but an eager observer, especially of birds, for at that time he wondered "in his simplicity" that every gentleman was not an ornithologist, so much was he attracted by what he observed of the habits of birds.

The school which he began to attend at Shrewsbury in his ninth year was probably very similar to our earlier gymnasia. Darwin himself maintained that nothing could have been worse for his intellectual development than this purely classical school, in which

<sup>1</sup> I can say the same of myself for, although in my boyhood I did not shoot birds, I had a passion for butterfly hunting. When I saw the rare *Limentis populi* resting on the ground in front of me for the first time, I became so excited that I could not at first throw my net, and when I did throw it, though my aim was usually very accurate, I struck the butterfly obliquely over the wing with the iron ring of the net. The traces of this awkward aim are visible on the wing to this day.

\* An address delivered at the University of Freiburg on the occasion of the Centenary of Darwin. Reprinted from *The Contemporary Review*.

nothing was taught, in addition to the ancient languages, except a little ancient history and geography.

Darwin had no talent for languages, and no pleasure in them. So he remained a very mediocre scholar, and his father therefore removed him from school in his sixteenth year, and sent him to the University of Edinburgh to study medicine.

The condition of the English universities at that time must have left much to be desired, for Darwin characterizes the majority of the lectures as terribly dull, and the time spent in attending them as lost. Moreover, anatomy disgusted him, and the tedium of the geological lectures repelled him so that he vowed never again to open a book on geology, a resolution which, happily, he did not adhere to.

In his student days, as in his school time, he roamed about in the open air, sometimes shooting, sometimes riding, sometimes making long expeditions afoot. But even then he was not a conscious observer of nature, not a naturalist, but rather a lover of the beauty of nature and a collector of all sorts of natural objects, though he collected still, as he had done at school, rather from the collecting impulse frequently characteristic of youth than from any real scientific interest. If he had had that interest his chief passion would not have been the shooting of birds. His friends even found him one day making a knot in a string attached to his buttonhole for every bird he succeeded in bringing down! Thus he must have been mainly a sportsman, a hunting fanatic whose chief desire was to bring down as many birds as possible in a day. However, this devotion to sport must have stood him in good stead later, especially on his great journey, for through it he not only acquired the technique of shooting, but he sharpened his naturally acute powers of observation.

He remained two years in Edinburgh and then entered the University of Cambridge. His father, who had observed his disinclination for medicine, proposed that he should study theology, and Darwin knew himself so little that he was quite willing to agree to the proposal. He examined himself very conscientiously to see whether he was able to subscribe to the dogmas of the Anglican Church, and he came to the conclusion that he could accept as truth every word that the Bible contained. This was certainly remarkable, and proves that the "Zoonomia" of his grandfather, Erasmus, and the doctrines of Lamarck, as far as he was acquainted with them, had not taken very deep root.

So he proceeded to study theology. But he did it much in the same way as he had studied medicine in Edinburgh; he listened only to what pleased him, and that can not have been very much, for here, too, he complained of the dullness of official lectures. Nevertheless, at the end of three years he passed his examination quite creditably and received the degree of B. A.

Of the greatest advantage to him in Cambridge was his intercourse with two distinguished teachers of the university, and this intercourse probably guided him imperceptibly toward the real work of his life. One of these teachers was Prof. Henslow, a theologian who afterwards accepted a living, but who had a comprehensive knowledge not only of entomology, but of chemistry, botany, mineralogy, and geology. By Henslow, Darwin was introduced to the professor of geology, Sedgwick, and he, too, interested himself greatly in the young man, taking him with him on his longer geological excursions, and thus giving him a most valuable introduction to the science. This proved of the greatest use to Darwin on his travels, and probably enabled him to make his numerous geological observations.

Other older men also admitted Darwin to their friendship, so that it is obvious that there must have

been something about him even then which distinguished him from others of his age. His interests now began to widen; he came under the educative influence of art, and studied the picture gallery in Cambridge, and later the National Gallery in London. He gained the entrance to a musical circle, and derived great pleasure from music, though, curiously enough, as he tells us, he was almost destitute of "ear," and could not even whistle "God Save the King" correctly. He was thus one of those rare persons who are exceedingly sensitive to the emotional effect of music and yet possess little or nothing of its physical basis, the sense of tone.

In addition to all this, Darwin retained his passion for beetles, and collected with such ardor that twenty years later he recognized at sight small rare species he had found under bark or moss at that time. His powers of observation had thus been awakened, although as yet they were employed mainly to minister to his zeal for collecting. But collecting is not a mere amusement for the young naturalist; it is a necessary discipline in surveying a definite range of forms, and it can not well be replaced by anything else. One who has never collected, and thus never made himself thoroughly acquainted with a limited circle of forms, will find it difficult to fill up the gap in his attainments in later life.

In vacation time toward the autumn of each year Darwin turned again with enthusiasm to sport, either at his home in Shrewsbury or on his uncle Wedgewood's large estate of Maer. He did not lose a possible day from this amusement, for as he says in his autobiography, "I should have thought myself mad to give up the first days of partridge shooting for geology or any other science." Thus, notwithstanding his interest in geology and beetle collecting, in pictures and music, the old passion for the chase was still the dominant one; one pleasure crowded upon another, and the whole made his life a joyous symphony, so that he could say of that period, "The three years which I spent at Cambridge were the most joyful in my happy life." But in the midst of all the joyousness of life he was undergoing an inward preparation for the seriousness of it. We can gather from his own account of that time that the strongest impulse toward the study of natural science came from reading two works which aroused his interest, Humboldt's "Personal Narrative" and Herschel's "Introduction to the Study of Natural Philosophy." Darwin says of these: "No other book influenced me so much as these two." He used to copy long passages from Humboldt about Teneriffe and read them aloud to Henslow. He was very anxious to go to Teneriffe, and even made inquiries in London about a ship to take him there, when an event happened which overthrew that project, but at the same time opened up the way to a naturalist's career—the only one really suited to him—in a much more satisfactory manner. He received a proposal to make a voyage round the world.

It must appear to us singular that a young man who had just finished his university course, and had done no scientific work of any kind, should be invited to accompany, as a naturalist, a naval vessel which was being sent round the world by the government for the purpose of making nautical observations. It proves that Darwin's older friends must have had very high expectations in regard to his future.

Capt. Fitzroy, of the English navy, was looking for a young man who would go with him as naturalist, on a voluntary footing, on his voyage in the "Beagle."

Darwin himself was at once eager to accept, but his father objected very decidedly, seeing no reasonable object in spending five years ranging over the globe. But he concluded his letter with the sentence, "If you

can find any man of common sense who advises you to go, I will give my consent."

The necessary adviser was found in his uncle, Wedgewood, who, as soon as he heard of the matter, immediately drove the 40 miles from Maer to Shrewsbury and persuaded the elder Darwin that he must allow his son to go.

Thus it happened that Darwin made the journey which he speaks of later as "the most important event of my life," as it undoubtedly was. It was only later that he learned that even then his going was not a certainty, for Capt. Fitzroy, after seeing him, was in doubt as to whether he should accept him, for a reason not easy to guess—because of the shape of his nose! Fitzroy was an enthusiastic disciple of Lavater, whose doctrine of physiognomy was then widespread. He believed that the shape of Darwin's nose proclaimed a lack of energy, and he was doubtful about taking anyone deficient in that quality on such a journey. Happily, Darwin's friends were able to reassure Fitzroy on this point, and he must often enough afterwards have had opportunity to convince himself of Darwin's energy.

Thus it was apparently by mere chance that Darwin got the opportunity to develop actually into the great naturalist we now know that he must have been potentially. But I do not believe that this is a correct judgment. His inward impulse would certainly have forced a way after he had been led to perceive, through Humboldt and Herschel, what the way for him was to be. And even at that time no serious obstacle would be likely to stand in the path of a young Englishman of fortune who wished to explore foreign lands and seas. But undoubtedly this manner of traveling for five years through the seas and countries of the different zones was particularly advantageous.

And Darwin used his opportunities to the full. On board ship he studied the best books, especially Lyell's "Principles of Geology," but he also collected certain kinds of natural objects, and investigated all that came in his way, keeping a detailed journal of everything that struck him as worthy of note in what he observed. Thus he became a well-informed and many-sided naturalist. But he valued much more highly than any other result of the voyage the habits of energetic industry and concentrated attention to whatever he had in hand that he then acquired. And thus he became the great naturalist for which nature had designed him.

Darwin published his journal later; it fills a closely printed volume of 500 pages. Like all his books, it is characterized by a simplicity and straightforwardness of expression; there is absolutely no striving after sensational effect, but an innate enthusiasm and truth pervades it, and I have always found it most enjoyable reading. Other people must have found it so, too, for by 1884 16,000 copies of the English edition had been sold. I cannot here give even a brief account of the voyage of the "Beagle"; I can only say that its work lay chiefly on the southern coast line of America, and the journey included the east coast of Bahia to Tierra del Fuego, and the inhospitable Falkland Islands, and the western coast to Ecuador and Peru.

This occupied several years, and thus the young explorer had a chance to make himself thoroughly acquainted with a great part of the South American continent, for while the ship lay at anchor taking soundings in some bay or other, Darwin ranged over the country on horseback, in a boat, or on foot. In Brazil, on the plains of the La Plata River, and in Patagonia he made excursions into the interior which lasted for weeks, and he was thus able to see and investigate everything that interested him.

(To be continued.)

### Bienaimé's Proposed Ascension

M. MAURICE BIENAIMÉ is to make an interesting balloon ascension from Paris especially for meteorological and other scientific observations. Without wishing to break the record which was made by the Germant aeronauts Suring and Berson in 1901 at 10,800 meters (35,433 feet) altitude, he expects with a much smaller balloon of 1,600 cubic meters (56,502 cubic feet) of the usual touring size, to go higher than the 8,558 meters altitude (28,077 feet) reached by Balsan and Godard in 1900. Seeing that the aeroplane has not been used as yet for exploring the upper atmosphere to any extent, this must be done by sounding balloons of small size or by regular balloons mounted by an aeronaut. Such observations are more difficult to make than may be thought, seeing that the air pressure becomes much less, and is only one-half of the ordinary when we rise to 15,000 feet. This causes bleeding from the nose and ears and like disorders, while the rarefied air becomes difficult and even impossible to breathe. Intense cold is another

point, and it may reach 40 deg. below zero C., added to which is the "altitude sickness," so that the aeronaut is likely to become paralyzed or in a lethargic state, and this may even cause death. However, by using the proper precautions M. Bienaimé expects to make his ascension a success. The scientific commission of the French Aeronautic Club has laid out a programme for this occasion. The radio-activity of the atmosphere and the solar heat are to be observed.

As the air is always more or less a conductor of electricity, and its conductivity varies with the altitude, it is of interest to measure this at different heights. The value depends on the number of electrified particles or ions in a given amount of air. Experiments made on mountains are not of much value, as the electric charge follows the reliefs of the ground. From a practical standpoint the study of the distribution of these particles in the atmosphere is important in meteorology, seeing that it is now admitted that this is the cause of rainfall,

Besides, electric charges in the upper air allow of explaining the variations of terrestrial magnetism. Such variations are often very considerable, and cause disturbances which may interfere with telegraphs or telephones, as is well known. It is found that magnetic disturbances always coincide with the appearance of the aurora borealis. Apparatus will be carried on board for making observations in this field. For other work there will be used various kinds of instruments, such as a sphymograph for registering arterial tension and a Mathieu instrument for measuring muscular force at different altitudes. Registering instruments of the Richard type will serve to make records of the temperature of the air and the moisture. Other recording devices will take the highest altitude which is reached, and make other measurements. M. Albert Senouque will have this work in charge, and he is well known for his researches in terrestrial magnetism during the Charcot expedition to the Antarctic regions, having also made researches at the Mont Blanc observatory.