Oct. 29. 1881

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DARWIN ON WORMS.

The Formation of Vegetable Mould through the Action of Worms, with observations on their Habits. By Charles Darwin. London: John Murray, 1881.

THE GREATEST LYRICAL POET OF MODERN TIMES, in his eloquent "Defence of Poetry," said of it that "it strips the veil of familiarity from the world, and lays bare the naked and sleeping beauty which is the spirit of its forms." It appears to us that this phrase is, *mutatis mutandis*, strongly applicable to Darwin. Whatever subject he may select, however common, inconspicuous, or obscure it may be, it is by his marvellous genius, and patient, unwearied industry, displayed in all its wondrous and beautiful adaptation to the whole scheme of Creation. He shows us that nothing lives for itself alone; that "all are but parts of one stupendous whole." In this his last work he proves that the despised worm, hitherto regarded by man chiefly in reference to its utility as a food for birds and as a bait for fishes, is an indispensable link in the chain of creation, and that all the higher forms of animal life, including man himself, are dependent on this lowly organism for their vegetable food, and consequently for the possibility of their existence.

Mr Darwin not only demonstrates that the formation of vegetable mould, the humus of the agriculturist, on whose presence the growth of the higher vegetables is entirely dependent, is solely due to the action of worms, but he shows us their influence in the preservation of the buried cities of the past, and in the entombment of the monuments of a bygone civilisation.

The scheme of the work is soon told. After a short introduction descriptive of the plan of the book, Mr Darwin devotes a couple of chapters to the consideration of the structure of worms, their habits as noticed by himself and by other observers, and their degree of intelligence. He then proceeds to show the enormous amount of earth brought annually to the surface by these creatures; the important part that they have played in the burial of ancient buildings and monuments; and finally their influence in the denudation and levelling of the land.

The body of an earthworm consists externally of a series of rings, from one hundred to two hundred in number; each of these has short bristles projecting from it. The rings are well seen in the remains of a worm that has been dried by exposure to the sun and air, when they retain their annular shape, and form a hollow tube. The rings are connected by a membrane or skin, and are moved by strong muscles contained in their interior. The fore part of the body is tapering, and ends in a mouth with lips. Immediately behind the mouth is the gullet or tube leading to the gizzard; this swells out into a strong muscular throat or pharynx. By the sides of the gullet are glands secreting lime. The gullet itself ends in a crop, which leads into a powerful gizzard, that, like the corresponding organ in a bird, contains stones for grinding the food. These stones in a full-sized worm are so large that nine or ten of them laid side by side will measure a full inch. The intestine passes straight from the gizzard to the end of the body. Worms have no lungs, breathing by their moist skin; hence they rapidly perish when exposed to dry air, though capable of prolonged life under water. Their senses are peculiar. They have no eyes, yet appear sensitive to light, which must pass through the transparent skin to reach the nerves. Thus they distinguish day and night, and avoid the dangers of exposure to their enemies, the birds, during the former period. Sound, unless accompanied by vibration of the ground, produces no effect on them. Mr Darwin's pet worms, that he kept in pots of earth in his study, were utterly indifferent to music; they were like the deaf adder that would not listen to the voice of charmers, charming never so wisely. The dulcet tones of a piano, the shrill treble of a metal whistle, the deep notes of a bassoon, if reaching them only through the air, were alike unheard; but when the pots were placed on the piano, so that the vibrations reached them through the solid earth, they shrunk back into their holes whenever a note was struck, whether it was C in the bass clef, or G above the line in the treble. To the slightest touch they are sensitive, even of a current of air. They appear insensible to most odours.

Their food is chiefly half-decayed leaves; but they are fond of raw fat, and eat meat and the bodies of their dead brethren. The dead leaves they drag into their burrows, partly for use as food, partly to close the openings. The leaves are seized by the lips, and then the anterior part of the body is formed into a kind of sucker. When leaves are not to be obtained for food, they swallow large quantities of mould, digesting the vegetable matter, and voiding the mineral portion in the form of worm casts at the mouths of the burrows.

In the plugging up of the mouths of the burrows with leaves they evince a degree of intelligence remarkable for animals so low in the scale of organisation. Mr Darwin states:

> On the gravel walks in my garden a very large number of leaves of three species of Pinus (*P. austriaca, nigricans*, and *sylvestris*) are regularly drawn into the mouths of worm-burrows. These leaves consist of two needles, which are of considerable length in the two first and short in the last named species, and are united to a common base; and it is by this part that they are almost invariably drawn into the burrows. I have seen only two or at most three exceptions to this rule with worms in a state of nature. As the sharply pointed needles diverge a little, and as several leaves are drawn into the same burrow, each tuft forms a perfect *chevaux de frise*. On two occasions many of these tufts were pulled up in the evening, but by the following morning fresh leaves had been pulled in, and the burrows were again well protected. These leaves could not be dragged into the burrows to any depth, except by their bases, as a worm cannot seize hold of the two needles at the same time, and if one alone were seized by the apex, the other would be pressed against the ground and would resist the entry of the seized one. This was manifest in the above mentioned two or three exceptional cases. In order, therefore, that worms should do their work well, they must drag pine-leaves into their burrows by their bases, where the two needles are conjoined. But how they are guided in this work is a perplexing question.

Mr Darwin's experiments on this subject were very interesting. Some hundreds of acute-isosceles triangles of paper were spread upon the ground, after removing all the leaves, &c., with which the worm holes were plugged, when it was found that in the great majority of instances the worms selected the most pointed angle to draw into the burrows, and, as Mr Darwin remarks, we may therefore infer—improbable as is the inference—that worms are able by some means to judge which is the best end by which to draw triangles of paper into their burrows.

The influence of worms on the soil of a country depends almost entirely on the amount of earth thrown up in their castings. The experiments and observations of Mr Darwin show that over the whole surface of the land this may be taken in our own country at an average of nearly one quarter of an inch per year. The observations quoted are so numerous that we must refer our readers to the work itself for them; but, as an example of the patient manner in which the author works, we may quote one experiment lasting twenty-nine years. In 1842 a layer of broken chalk was spread over old pasture land for the sake of observing at some future time the depth to which it would become buried. In 1871 a trench was dug across the field, and the line of white masses was everywhere 7 inches from the surface.

The mode in which large stones like the massy monoliths of Stonehenge become buried is fully explained by the author. Many persons may doubt the power of these lowly animals to produce such great results; but their enormous numbers and ceaseless activity must be borne in mind. The number of worms in an acre of land has been estimated at between 50,000 and 60,000, their weight being nearly 400lb.

By actual experiment—viz., collecting and weighing the castings—it is found that in some cases 83lb. of earth are brought up on to the surface of every square yard during the year—an amount which reaches the high amount of 18 tons per acre; and 10 tons may be taken as a very fair average.

For the part which worms have taken in the burial and consequent preservation of ancient buildings, such as the Roman villa recently disinterred at Brading, we must refer our readers to the work itself. The chapters on the denudation or levelling of the land, which is effected in great part by the agency of worms, are particularly interesting; but we must pass on to the consideration of the concluding chapter, in which Mr Darwin summarises the result of the observations of himself and sons, carried out with so much method and regularity during a large number of years. In this he shows us the vast importance of worms to the agriculturist, and the important part they have played in producing the present condition of the surface of the earth.

No reader who has attentively gone through this most interesting volume can refuse to accept his final conclusions, in which he says:

> Worms prepare the ground in an excellent manner for the growth of fibrous-rooted plants and for seedlings of all kinds. They periodically expose the mould to the air, and sift it so that no stones larger than the particles which they can swallow are left in it. They mingle the whole intimately together, like a gardener who prepares fine soil for his choicest plants. In this state it is well fitted to retain moisture and to absorb all soluble substances, as well as for the process of nitrification. The bones of dead animals, the harder parts of insects, the shells of land mollusks, leaves, twigs, &c., are before long all buried beneath the accumulated castings of worms, and are thus brought in a more or less decayed state within reach of the roots of plants. Worms likewise drag an infinite number of dead leaves and other parts of plants into their burrows, partly for the sake of plugging them up and partly as food. The leaves which are dragged into the burrows as food, after being torn into the finest shreds, partially digested, and saturated with the intestinal and urinary secretions, are commingled with much earth. This earth forms the dark-coloured, rich humus, which almost everywhere covers the surface of the land with a fairly well-defined layer or mantle.
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> When we behold a wide, turf-covered expanse, we should remember that its smoothness, on which so much of its beauty depends, is mainly due to all the inequalities having been slowly levelled by worms. It is a marvellous reflection that the whole of the superficial mould over any such expanse has passed, and will again pass, every few years through the bodies of worms. The plough is one of the most ancient and most valuable of man's inventions; but long before he existed the land was in fact regularly ploughed, and still continues to be thus ploughed, by earth-worms. It may be doubted whether there are many other animals which have played so important a part in the history of the world as have these lowly organised creatures.

THE FREE RELIGIOUS INDEX.

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QU'EST-CE QUE LE DARWINISME? Résumé d'une Conférence de Monsieur Leblois, 5 avril, 1881. Strasbourg: J. H. Ed. Heitz.

As early as the end of the last century, a few leading minds had begun to study the question of the origin of species. The French naturalist, Lamarck, and the German poet, Goethe, to cite but two names, solved the difficulty, both in the same way, by substituting for the theory of the creation of different species, independently one of the other, that of the descent of actual types from inferior forms, or, as we now say, that of the *evolution* of beings.

Here is what Lamarck says: "Systematic divisions, such as classes, orders, families, genera, and species, as well as their denominations, are a purely artificial work of man. Species are not all contemporaneous; they are descended from one another, and possess only a relative and temporary fixity. The diversity of the conditions of life has an influence on the organization, the general form, the organs of the animal, etc., which modifies them."

About the same time, Goethe wrote: "If one examines the plants and animals placed at the bottom of the scale of beings, they can scarcely be distinguished from each other. We may therefore say that beings, at first confounded in a common parentage, where it was almost impossible to separate them, have, little by little, become plants and animals, perfecting themselves in two opposite directions so that some have taken on the nature of firm, immovable trees, others, that of man, which represents the highest degree of mobility."

The authority of Cuvier has so extinguished Lamarck that that distinguished thinker is almost unknown. An heir to the ideas of Lamarck, Geoffroi Saint-Hilaire was violently attacked by Cuvier. The discussions occurred at the meetings of the Academy of Sciences the same year that the Revolution of 1830 broke out, and the last days of Goethe were brightened by the news of the support given by Geoffroi Saint-Hilaire to the theory of evolution. The very day that the German newspapers announced the Revolution of July, Goethe's friend Soret visited the poet, who was then eighty-one. "Well!" exclaimed the illustrious old man, "what do you think of this grand event? The volcano is in eruption; all is in flames; it is no longer a discussion in private." Supposing that he referred to the political event of the day, Soret said to him, "It is indeed a great event; but, with such a ministry, the expulsion of the royal family is a matter of course." "We do not understand each other," said Goethe, in reply; "I am not speaking of those people. My mind is on something very different. I am speaking of the bomb-shell which has just burst in the midst of the Academy,—the debate so important to science which has begun between Cuvier and Geoffroi Saint-Hilaire. We have in the latter a powerful ally who will not abandon us. I have noticed the interest with which the French scientific world is watching this discussion. The public has gotten hold of the question; it can no longer be kept secret, disposed of, and smothered with closed doors." Such was not the case, however, for some time thereafter. The theory of evolution had not yet been sufficiently founded in fact.

At the moment of Goethe's death (March 22, 1832), an English vessel, the *Beagle*, sailing in the Indian Ocean, had on board a young naturalist of twenty-three, who, during this voyage around the world, was collecting a quantity of facts which were destined to come to the support of the ideas of Lamarck. This young man was Charles Darwin. During this tour, Darwin, a perspicacious and conscientious observer, was struck with the numerous varieties, the changes in form and character, presented often by one species of animal or vegetable, according to the zone or the climate in which it lives. Returned to England, the young scientist was led to make a comparison between the natural facts which he had observed and the transformations which English gardeners and breeders produce artificially in plants and animals.

In these words, M. Louis Leblois, minister of the Church of the Temple-Neuf at Strasburg, traces briefly but clearly the historical growth of Darwinism, in the excellent little pamphlet whose title is placed at the head of this column. A few citations are added to show the spirit in which M. Leblois treats this question which has so sorely troubled the Church.

Speaking of the repugnance which the Orthodox always profess to the scientific explanation of the origin of man, M. Leblois says: "According to the second chapter of Genesis, man was formed from the 'dust of the earth,' and nobody that we know of has been shocked at this rather mean origin." Referring to the Biblical doctrine that Adam and Eve are the father and mother of the race, he says: "We need not dwell upon the fact that there exist white men, black men, red men, yellow men, etc.; that some have straight hair, others woolly hair, and that, if all descended in a direct line from Adam and Eve, it is difficult to imagine what colored skin and what kind of hair these first ancestors of the human race had." Commenting on the theory of Cuvier, who, in the words of Victor Hugo, may be said to have had "one eye on Genesis and the other on nature, endeavoring to please Orthodoxy by making fossils agree with Scripture and by flattering Moses with the mastodons," M. Leblois says: "It is contrary to good sense, which cannot accept a God performing the task of Penelope, by amusing himself with the production of one series of beings in order to destroy them and then proceed to the 'creation' of new ones. It is not less contradictory to the Bible than to the facts of geology itself." The author quotes with approval this witty sentence from Carl Vogt's scholarly *Lessons on Man*, "Our friends will doubtless admit, with one of their comrades, that it is better to be a perfect monkey than a degenerated Adam."

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