

## MR. DARWIN ON WORMS.\*

At first sight the subject of Mr. Darwin's new book seems to promise less of interest to the general reader than almost any among the series of minute and patient monographs which have followed by the epoch-making publication of the "Origin of Species." But the fact is, Mr. Darwin's skill lies most of all in just such surprises as that which he gives us in this delightful little volume. He takes up some unassuming and seemingly odd study—the growth of coal, and the slow movements of climbing plants, the effects of cross-fertilization—and in his wondrous working hands the mass of dry detail becomes quickened as if by magic into a living organism, full of vivid reality and interest with evolutionary processes at the most fascinating work. Something of the same kind he has now done with the common earthworm. In the eyes of most men—men, even of men naturally—the earthworm is a mere blind, dumb, senseless, and unexpressively stupid animal. Mr. Darwin undertakes to rehabilitate his character, and the earthworm steps forth at once as an intelligent and beneficent personage, a worker of great geological changes, a plougher of mountain sides, a creator of fertile elevated continents, a friend of man in his agricultural operations, and an archaeological though unconsciously ally of the Society for the Preservation of Ancient Monuments.

The surface of the earth in all moderately humid countries is covered to a depth of some inches by a rich layer of blackish vegetable mould, composed of uniformly fine and small particles. The part which earthworms have done in producing and renewing this all-important coat of fruitful soil forms the main subject of Mr. Darwin's investigation. As long ago as 1843 his attention had been called to the matter in hand by Mr. Woodcock, who suggested to him that the tendency of wind, winds, or spiders' webs over meadows to "work themselves downwards," as the farmers phrase it, was really due to the large quantity of the earth brought to the surface by worms in the form of castings. Mr. Darwin had followed up his inquiries with his usual minute experimental care, the result being the little work now before us. But as the world at large has not kept and watched these worms with the same industry as our great naturalist himself, he is kind enough to produce his remarks with a full account of the habits and manners of the animals which makes up by no means the least interesting part of his book. Earthworms belong to a few genera, extremely closely resembling one another, and distributed sparsely over the whole world. They abound on bare chalk downs and in London parks; they inhabit the most isolated islands, and they have by some mysterious means found their way even to Kerguelen Land in the Antarctic Ocean. In their habits they are nocturnal, remaining in their burrows during the day, and only coming out to feed at nightfall. They lay, however, close to the mouth of the burrow, signally by the size of worms, and as they descend in large numbers by loads. The most interesting point in their internal structure is their possession of gizzards, in which they triturate their food with the aid of small stones, a function which has important bearings on the production of mould. On their senses and intelligence Mr. Darwin made several curious and careful experiments. He found that though they had no eyes, their part of the body, containing the cerebral ganglia, was slightly sensitive to light in pairs of much lateral appendages, and being upon the production of special organs of sight, and that when they ran from a candle were concerned with a lens upon what we may by courtesy call their heads, they dashed like rabbits into their burrows. If however, the heads were shaded and light cast on other parts of the body, they took no notice of it. This ability to distinguish between day and night doubtless serves to protect them from diurnal animals which prey upon them. On the other hand, worms are absolutely deaf, and when Mr. Darwin played the piano to them, they obstinately refused to listen to the music; nor were they moved even by the strains of a brass band. By way of compensation they are acutely sensitive to jar, and were set in motion when their feet were actually placed on the piano and a note struck. Small stones as he passed, though hidden; for while they took no notice of perfume or of any such thing, they quickly discovered bits of cabbage and onion buried in the ground. Thus they clearly possessed, as they showed a marked preference for green over red cabbage, and for celery over onion; and they distinguished in the manner between the leaves of different roots. But they are no omniscience as man himself, greedily devouring man; and when Mr. Darwin had covered plates by long pins in their path, they might be seen eight or nine half an hour of their burrows tugging at the line of this rare delirium. Indeed, so closely do they approach the level of humanity that they are actually credited as well.

The evidence of intelligence in worms is slight, but Mr. Darwin thinks sufficient. They dig down into their burrows (which are regularly constructed nests, with a chamber at the bottom) partly as food, and partly to plug up the mouth; and Mr. Darwin noticed that the way in which they pulled down even vegetable or foreign leaves and triangles of paper so as to avoid mechanical difficulties was indicative of some intelligence. They always plug the entrance, sometimes with leaves and sometimes with small stones. This may be a protection from their great enemy, the scorpion, but it is more likely for the sake of warmth, as

Mr. Darwin noticed that when kept in a room with a fire they pushed the work "in a slovenly manner." They also often cast the upper part of their burrows with leaves, to prevent their bodies from coming into contact with the cold ground. Besides eating vegetable and animal food, worms seem to some extent to swallow earth for the sake of the organic matter it contains; and their castings are composed of such earth, as well as of that which has been voided for the excretion of their bowels. Even in England these castings often attain a considerable size, but in India they sometimes reach a height of six inches and weigh as much as a quarter of a pound.

Turning on to his more special subject, Mr. Darwin shows that the amount of mould thus brought up to the surface by worms may be measured in two ways, both of which he followed. The first method is by ascertaining the rate at which objects left upon the ground are buried the second and more accurate method is by weighing the quantity brought up within a given time on a given space. At Mass Hill, in Staffordshire, quicklime was spread upon a meadow, which was not disturbed for ten years. At the end of that time square holes were dug in the field, and the lime was found in a layer at a depth of three inches from the surface, covered by dark-coloured, fine mould, and underlaid by a coarse greyish or sandy soil. In many other instances similar results were obtained with quicklime, sand, or chalk, or peaty ground. A field at Down was so thickly covered with flints that it used to be called "the stony field;" and Mr. Darwin remembers doubting whether he would live to see them buried in vegetable mould and turf, but thirty years after the worms had worked so vigorously that the flints could gallop from one side to the other over compact earth, without ever striking a stone. A path on the lawn at the same place was paved with small flags, set edge-wise, through which the worms threw up castings; for a while it was swept and watered, but at last it was left alone; and after several years the flags were found buried beneath an inch thickness of the mould. In the same way worms slowly bury such big stones; for when such a stone is left on the surface it rests at first, of course, on its more protuberant part; but worms soon fill up with their castings the hollows on the lower side, for they like the shelter of stones. When the hollows are filled, they eject their castings beside the stone; and as the empty burrows collapse the stone slowly sinks. Thus moulds are almost always slightly embedded in the soil. The flint mentioned at Stonehenge has in this manner been partially buried, as Mr. Darwin delicately proves. But the second method gives even more certain results. Mr. Darwin shows (after Henson) that there must be no less than 5,000 worms living in a single acre of land, and by one case the burrows numbered nine in two square feet. Some barrels of lead (potatoes in worms) being split on a small piece of land, the heaps of dead worms found piled on the spot were so amazing as to be almost incredible. Mr. Darwin collected and weighed the castings thrown up at various times in various places, and comes to the conclusion that they would amount on the average in many cases to a uniform layer of mould one-fifth of an inch thick every year. The slight work of worms in the economy of nature is thus to wit the finer than the coarse particles of the soil, to mingle the whole with vegetable debris, to saturate it with their intestinal secretions, and so finally to form that upper layer of rich mould which alone man employs in his agricultural operations.

Archæologists, too, have to thank the worm for the preservation of coins, gold ornaments, stone implements, and other objects dropped upon the surface of the soil. The scattered Roman villas and country houses have been largely buried and preserved by their industry. At Abinger Mr. Darwin found that a Roman tessellated pavement had been thus covered up, and near it were discovered coins of the early Empire side by side with a halfpenny of George I., indifferently embedded by the imperial worms. Finally, Mr. Darwin considers the part played by worms in the denudation of rocks and denudation of the land. It is known that the denudation of rocks is largely due to the acids in the humus; and Mr. Darwin shows that such acids are apparently generated within the bodies of worms. Moreover, the constant interchange of particles between top and bottom layers effected by worms brings them into soil work more often upon the subjacent rock. Again, the small stones swallowed to aid mastication in the gizzard are themselves slowly ground down, as was proved by their rounded edges under a lens, and this must produce an innumerable amount of fine sand, when we remember the vast numbers of worms always at work. Not only are the castings composed of very fine matter, but the small fragments of brick or pebble found among them are well rounded. The craters thus formed out on sloping hillsides are washed away in part by the rain towards the valleys, and finally carried by streams and rivers to the sea. So that in the end the insignificant little earthworm turns out to be a geological agent of vast importance, in whose actions the denudation and sculpture of the earth's surface are largely due. And if we doubt the possibility of so small and humble an animal performing such wonders in the history of our planet, Mr. Darwin opportunely reminds us that the coral-polype of tropical seas have played almost as large a part in the course as he believes worms are at present playing on the dry land. It is of interest in this connection to note the fact, unmentioned by Mr. Darwin, that the burrows of earthworms are among the very earliest land indications of the presence of life upon

\* The Formation of Vegetable Mould through the Action of Worms; with Observations on their Habits, by Charles Darwin, F.R.S., F.R.C.E., London, John Murray, 1881.