

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 up the epoch making publication of the "Origin of Species." But the fact is, Mr Darwin's skill lies most of all in just such surprise as that which he gives us in this delightful little volume. He takes up some unpromising and seemingly dull study—the growth of coral reefs, the slow movements of climbing plants, the effects of cross-fertilisation—and in his wonder-working hands the mass of dry detail becomes quickened as if by magic into a living romance, full of vivid reality and instinct with evolutionary plot-interest of the most fascinating sort. Something of the same kind he has now done with the common earthworm. In the eyes of most men—nay, even of most naturalists—the earthworm is a mere blind, dumb, senseless, and unpleasantly slimy annelid. Mr Darwin undertakes to rehabilitate his character, and the earthworm steps forth at once as an intelligent and beneficent personage, a worker of vast geological changes, a planer down of mountain sides, a creator of fertile alluvial cornlands, a friend of man in his agricultural operations, and an archæological though unconscious 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 borne in producing and renewing this all-important coat of fruitful soil forms the main subject of Mr Darwin's investigation. As long ago as 1837 his attention had been called to the matter in hand by Mr Wedgwood, who suggested to him that the tendency of marl, cinders, or pebbles strewn over meadows to "work themselves downwards," as the farmers phrase it, was really due to the large quantity of fine earth brought to the surface by worms in the form of castings. Mr Darwin has followed up his enquiries 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 tame worms with the same assiduity as our great naturalist himself, he is kind enough to preface 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, externally closely resembling one another, and distributed apparently 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 lie, however, close to the mouth of the burrows, apparently for the sake of warmth, and are thus devoured in large numbers by birds. 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, the front part of the body, containing the cerebral ganglia, was slightly sensitive to light (a point of much lateral importance as bearing upon the evolution of special organs of sight), and that when the rays from a candle were concentrated 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 metal whistle. By way of compensation they are acutely sensitive to jars, and retreated at once when their pot was actually placed on the piano and a note struck. Smell seems to be present, though feeble; for while they took no notice of perfumes or of acetic acid, they quickly discovered bits of cabbage and onion

buried in the ground. Taste they clearly possessed, as they showed a marked preference for green over red cabbage, and for celery over either; and they distinguished in like manner between the leaves of different trees. But they are as omnivorous as man himself, greedily devouring meat; and when Mr Darwin fixed several pieces by long pins in their pots, they might be seen night after night half out of their burrows tugging at the bits of this rare delicacy. Indeed, so closely do they approach the level of humanity that they are actually cannibals as well.

The evidence of intelligence in worms is slight; but Mr Darwin thinks sufficient. They drag leaves 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 unfamiliar 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 as a protection from their great enemy the scolopender, but it is more likely for the sake of warmth; as Mr Darwin noticed that when kept in a room with a fire they performed the work "in a slovenly manner." They also often coat the upper part of their burrows with leaves, to prevent their bodies from coming in 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 excavation of their homes. 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.

Passing 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 Maer Hall, 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 gravelly or sandy soil. In many other instances similar results were obtained with cinders or marl on chalky 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 a horse could gallop from one end to the other over compact sward, without ever striking a stone. A path on the lawn at the same place was paved with small flags, set edgewise, through which the worms threw up castings; for a while it was swept and weeded, but at last it was left alone; and after several weeks the flags were found buried beneath an inch thickness of fine mould. In the same way worms slowly bury even big stones; for when such a stone is left on the surface it rests at first, of course, on its more protuberant parts; 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 boulders are almost always slightly embedded in the soil. The fallen monoliths at Stonehenge have in this manner been partially buried, as Mr Darwin elaborately proves. But the second method gives even more certain results. Mr Darwin shows (after Hensen) that there must be no less than 53,767 worms living in a single acre of land; and in one case the burrows numbered nine in two square feet. Some barrels of bad vinegar (poisonous to worms) being spilt 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 chief work of worms in the economy of nature is thus to sift the finer from the coarser particles of the soil, to mingle the whole with vegetable *débris*, 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 towns have been largely buried and preserved by their agency. 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., indiscriminately embedded by the impartial worms. Finally, Mr Darwin considers the part played by worms in the disintegration of rocks and denudation of the land. It is known that the disintegration 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 these acids to work more often upon the subjacent rock. Again, the small stones swallowed to aid trituration in the gizzard are themselves slowly ground down, as was proved by their rounded edges under a lens, and this must produce no inconsiderable amount of fine earth, 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 castings thus turned 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, to 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-polyps of tropical seas have played almost as large a part in the ocean as he believes worms are at present playing on the dry land. It is of interest in this connection to note the fact, undermentioned by Mr Darwin, that the burrows of annelids are among the very earliest fossil indications of the presence of life upon the earth.