
THE WONDERS OF WORM WORLD :*

BY THE REV. J. W. BURN.

THE distinction between scientific facts and the hypotheses of scientists cannot be too clearly marked or too strongly emphasized. The former we are bound to accept, the latter we are at liberty to question. A discoverer is not necessarily the best expositor of his discoveries. He may easily be the very worst. The temptation to generalize the results of research and observation before he has the complete case before him may hurry him into the formulation of a theory which subsequent discoveries may shatter. That the doctrine promulgated by Mr. Darwin, and which often goes by his name, is based on only a partial survey of the whole ground will not be contested. When the lacunæ between the non-

living and the living, between the non-feeling and the feeling, between the non-thinking and the thinking, are filled up by something better than suppositions postulated by the scientific imagination, it will be time to pronounce on the truth or falsehood of evolution.

In the meantime the discoveries of the great naturalist command not simply our acceptance, but our admiration. The results of a life spent ungrudgingly in seeking and unfolding the secrets of nature deserve no less. We cannot, therefore, withhold our meed of praise from the genius and industry which have made the book before us. Here we are taken out of the familiar regions of ordinary natural history and intro-

* *The Formation of Vegetable Mould through the action of Worms, with Observations on their Habits.* By Charles Darwin, LL.D., F.R.S. With illustrations. London: John Murray.

duced to a sphere which, although open to daily observation, abounds in tracts which have never been hitherto explored. Sir John Lubbock has given new point to Solomon's famous injunction, showing us what interest and instruction may be derived from the study of the ant. Mr. Darwin has taken up a far less promising theme, but has demonstrated, with equal skill, what food for thought there is in the attentive study of the humblest subjects. Few would expect to derive much profit or pleasure from the contemplation of so apparently worthless and repulsive a creature as the worm. But the careful reader of this volume will not be slow to see that in the inimitable system of nature, in which all things have their appointed and appropriate place, and work harmoniously together for good, and in which the lowliest agencies equally with the noblest are employed in executing the loftiest and most beneficent purposes, the worm plays no insignificant part.

'When we behold,' says Mr. Darwin, '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, the land was in fact regularly 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-organized creatures.'

The facts presented in this volume, in that clear and beautiful English of which its author is master, and which the non-scientific reader can peruse with ease and delight, are the results of studies extending over more than half a century. Since 1837, when Mr. Darwin delivered a lecture on *The Formation of Mould*,

in which he discussed the action of worms, he has had the subject ever before him. The better to understand the nature and ways of these creatures, he has withdrawn several specimens from their native haunts, and settled them in his study, where in pots of earth, all over the place, they are subjected to incessant observation and experiment. The outcome of this close and prolonged attention is a book, in which the worm is appraised according to its merits, and shown to deserve a higher place in popular esteem.

A good-sized worm, we are told, has a body composed of from one to two hundred nearly cylindrical rings, surrounded with bristles; a muscular system, well developed, and a nervous system fairly so; a mouth with neither jaws nor teeth, and a kind of proboscis; a gizzard; some calciferous glands which perform an important part in the process of digestion, and a skin through which it breathes. Although utterly destitute of many of the faculties owned by the higher animals and man, it has those which serve its needs as well, and uses them industriously and to good purpose. It has no eyes, yet it has in a measure the sense of sight, inasmuch as it can distinguish between light and darkness, day and night. That it is averse to the former is argued from its nocturnal habits, and from the test afforded by the sudden flashing of a bull's eye lantern; a glare producing the same effect as an obnoxious object does upon a rabbit, speedily sending it back to its burrow. It has no ears, yet has what serves the purpose of to some extent the sense of hearing. Mr. Darwin ascertained by a variety of experiments, such as approaching them with a soft footfall, playing music to them, shouting, and other gentle and noisy manifestations, that 'they were exceedingly sensitive to vibrations among solid objects.' Th

sense of smell in worms is extremely feeble, and limited to the appreciation of some particular odours. Their taste however is acute, certain kinds of food being preferred and eaten with evident satisfaction. This was tested by the supply of various kinds of meat—raw, boiled, roast, fresh, and putrid. It was found that raw, fresh fat was much liked. Of various kinds of cabbage the green was chosen rather than the red. Onions, too, and the leaves of the wild cherry were much approved. The worm, however, is omnivorous, living mostly on decayed leaves, and has been known to swallow rose thorns and broken glass. It devours also, as we have seen, enormous quantities of earth, extracting whatever nutritive matter it contains, and expelling it in a triturated and highly improved form.

But the sense of touch in worms, as the most casual observation will show, is their strong, or their weak, point. 'Of all their senses,' Mr. Darwin remarks, 'that of touch, including in this term the perception of vibration, seems to be most highly developed.' 'The anterior extremity of their bodies . . . serves as a tactile organ. It may be well to remember how perfect the sense of touch becomes in a man when born blind and deaf, as are worms.' But notwithstanding their acute sensitiveness to outside impressions, although our author does not make it out quite as satisfactorily as could be wished, his impression is that they do not suffer so much pain when injured as their writhings would lead us to assume. It is to be hoped that such is the case.

Worms abound on chalk downs and on commons where the grass is not luxuriant; but 'they are almost or quite as numerous in some of the London parks, where the grass grows well and the soil appears rich.' They do not object to paved

courtyards, and in fields and gardens are found in most considerable quantities where there is a moderate degree of damp. In extreme heat or cold they bury themselves deep down and remain idle, although they prefer warmth of the two, and may be seen in the summer lying for hours at the mouths of their holes, to their cost if the blackbird is about. 'They often coat the mouths of their burrows with leaves, apparently to prevent their bodies from coming in contact with the damp earth.' They are most active at night when they emerge from their hiding-places. Generally, however, they keep their tails, which are elastic, in their holes, using the short, slightly reflected bristles with which their bodies are armed, so that it is impossible to drag them forth without mutilation.'

The uses of worms in the economy of Providence are so great and so important as to justify our quoting Mr. Darwin at length.

'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-molluscs, leaves, twigs, etc., 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 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. Von Hensen placed two worms in a vessel eighteen inches in diameter, which was filled with sand, and on which fallen leaves were strewed, and these were soon dragged into their burrows to a depth of three inches. After about six weeks an almost uniform layer of sand, a centimeter (.4 in.) in thickness, was converted into *humus* by having passed through the alimentary canals of these two worms. It is believed by some persons that worm-burrows, which often penetrate the ground almost perpendicularly to a depth of five or six feet, materially aid in its drainage, notwithstanding that the viscid castings piled over the mouths of the burrows prevent or check the rain-water directly entering them. They allow the air to penetrate deeply into the ground. They also greatly facilitate the downward passage of roots of a moderate size, and these will be nourished by the *humus* with which the burrows are lined. Many seeds owe their germination to having been covered by castings, and others, buried to a considerable depth beneath accumulated castings, lie dormant until, at some future time, they are accidentally uncovered and germinate.'

Mr. Darwin contends that, as architects and builders, worms display a very fair degree of intelligence. Prolonged and patient observation, and a series of ingenious experiments, would seem to show that they learn by experience, know how to adapt means to ends, and are almost as skilful in their way as birds or beavers.

'They act in nearly the same manner as would a man under similar circumstances. . . . As chance does not determine the manner in which objects are drawn into the burrows, and as the existence of specialized instincts for each particular case cannot be admitted, the first and most natural supposition is that worms try all methods until they at last succeed; but many appearances are opposed to such a supposition. One alternative alone is left, viz., that worms, although standing low in the scale of organization, possess some degree of intelligence. . . . With respect to the small size of the cerebral ganglia we should remember that a mass of inherited knowledge, with some power of

adapting means to an end, is crowded into the minute brain of the worker ant.'

Notwithstanding all this, it is doubtful whether on once leaving its home the worm can find its way back again; although, as Mr. Darwin says, 'they apparently leave their burrows on a voyage of discovery, and thus find new sites to inhabit.'

These burrows form the subject of one of the most interesting and instructive sections of this charming book. We are informed that they

'Run down perpendicularly, or more commonly a little obliquely. . . . They are generally, or, as I believe, invariably, lined with a thin layer of fine, dark-coloured earth voided by the worms; so that they must at first be made a little wider than their ultimate diameter. I have seen several burrows in undisturbed sand thus lined at a depth of 4 ft. 6 in., and others close to the surface thus lined in recently dug ground. The walls of fresh burrows are often dotted with little globular pellets of voided earth, still soft and viscid; and these, as it appears, are spread out on all sides by the worm as it travels up or down its burrow. The lining thus formed becomes very compact and smooth when nearly dry, and closely fits the worm's body. The minute reflected bristles which project in rows on all sides from the body thus have excellent points of support; and the burrow is rendered well adapted for the rapid movement of the animal. The lining also appears to strengthen the walls, and perhaps saves the worm's body from being scratched. I think so, because several burrows which passed through a layer of sifted coal cinders, spread over the turf to a thickness of one and a-half inch, had been thus lined to an unusual thickness. In this case the worms, judging from the castings, had pushed the cinders away on all sides, and had not swallowed any of them. In another place burrows similarly lined passed through a layer of coarse coal cinders three and a-half inches in thickness. We thus see that the burrows are not mere excavations, but may rather be compared with tunnels lined with cement.'

As a further instance of their remarkable skill in the construction of the walls of their habitations, Mr. Darwin relates his experiments with

two worms kept in pots. Many leaves of the Scotch fir were strewn on the surface, and when, after some weeks, the earth was examined, the worm burrows were found surrounded to the depth of seven, four, and three and a-half inches with fragments of these and other leaves which had been given to the animals as food. In addition to this, glass beads and needles and bits of tile which had been scattered on the soil were found imbedded in the interstices between the leaves, plastered with viscid castings.

‘The structures thus formed cohered so well that I succeeded in removing one with only a little earth adhering to it. It consisted of a slightly curved cylindrical case. . . . The pine leaves had all been drawn in by their bases, and the sharp points of the needles had been pressed into the lining of voided earth. Had not this been effectually done, the sharp points would have prevented the retreat of the worms into their burrows; and these structures would have resembled traps armed with converging points of wire, rendering the ingress of an animal easy, and its egress difficult or impossible.’

The habits of worms throw light on the remarkable disappearance of once familiar objects. The mould which these creatures have made, now covers entirely many an ancient building. This cause alone, of course, will not account for such submergences as the great cities of the East have experienced. Earthquakes and fierce winds, conveying sand from some neighbouring or distant desert, have borne their part. But the soil which in this country conceals in-

numerable Roman remains, and much of Stonehenge, is due to daily worm-castings, on which the grass now grows, and on which the corn now waves. ‘Coins, gold ornaments, stone implements, etc., if dropped on the surface of the ground, will infallibly be buried by the castings of worms in a few years, and will thus be safely preserved until the land is at some future time turned up.’ In moderately favourable circumstances worms deposit one inch of mould in five years. In many parts the earth thus prepared is more than ten tons to an acre; and instances are adduced in which the worm castings must have weighed fourteen, sixteen, and even eighteen tons per acre in the course of the year. Mr. Darwin tells us of a field last ploughed in 1841. It was covered with flints, with scarcely any vegetation, and was known as ‘the stony field;’ but thirty years afterwards, ‘a horse could gallop over the compact turf from one end of the field to the other, and not strike a single stone with his shoes. This was certainly the work of worms.’

These facts, brought forward with so much carefulness and elaboration in this volume, are calculated to brighten many a dull hour, and to invest with interest and instruction many a desultory country walk. But, best of all, they afford no unimportant contribution to the force of ‘the argument from Design,’ and to the ever-accumulating mass of evidence of the existence of a wise and beneficent Creator.