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EARTH WORMS.

EVERY one is more or less fully aware of the importance of 'little things;' but few indeed have any adequate conception of the great results effected by the long-continued operation of seemingly insignificant agencies. It is a well-known fact that many of the once famous cities of antiquity have long since disappeared, some of these cities so vast that it is quite impossible the stones of them can have been all removed. Yet where we may have reason to believe that some few centuries ago a city stood, we find to-day a green expanse of pasture-land, with here and there perhaps a few rounded knolls or mounds relieving the flatness of the scene. Turning up the sod beneath us, we probably find a fine black loam, suggestive of a deep rich virgin soil; but digging deeper, we may strike upon the marble plinth of a ruined column, or the tesserae of some old mosaic pavement. The fact that in the course of years great cities are found thus buried many feet below the ground, must often have appeared a mystery to many. We confess to having been frequently puzzled by this strange problem, but without ever obtaining a satisfactory solution of the difficulty till recently; and the explanation was then as unexpected as it possibly could be. Yet, however incredible it may appear, we have it on the trustworthy authority of Darwin that the key to the whole mystery is supplied by the one word, worms; and in his latest work, *The Formation of Vegetable Mould through the Action of Worms, with Observations on their Habits* (London: John Murray), we have abundant proof of the hitherto unrecognised importance of this humble creature.

Forty-four years ago, a paper 'On the Formation of Mould' was read before the Geological Society by Mr Charles Darwin; but so novel were the views expressed in it, that the author's conclusions were received with something like incredulity. Convinced, however, of the truth of what he had written, Mr Darwin determined to investigate the question fully, and so place

his former conclusions beyond the possibility of doubt. Meantime, the world in general had forgotten all about his paper, so that the information contained in the present volume comes upon us almost in the light of a revelation. It is a trite but truthful saying, that people generally know least about the things with which they are most familiar; and this statement receives abundant confirmation from the facts which Darwin brings before us, showing how stupendous is the work accomplished by the agency of worms, and how inadequately the importance of these little creatures in the economy of nature has hitherto been recognised.

In his earlier observations Mr Darwin discovered that small fragments of burnt marl, cinders, &c., which had been strewed over the surface of several meadows, were found after a few years at a depth of some inches below the turf, but still forming an unbroken layer. This apparent sinking of superficial bodies he found was due to the large quantity of fine earth brought up to the surface by worms, in the form of castings, which soon cover up any object left on the surface. He was thus led to the startling conclusion, that all the vegetable mould over the country has passed many times through the intestinal canal of worms; and hence the term 'animal mould' would be more appropriate than the common one of 'vegetable mould.'

After dealing with the subject and the criticisms of his early paper, Mr Darwin goes on to describe the habits and structure of the common earthworm. As every one knows, worms live in holes or burrows in the ground. The interior of these they coat with leaves, to prevent their bodies from coming into contact with the cold damp earth; and as a rule they lie motionless close to the mouth of these holes, so that by looking carefully, one can see their heads quite near the surface of the ground. In winter, however, they completely close the entrance to their holes, and go deeper down, to be beyond the reach of birds or frost, their burrows being often found to penetrate the earth to the depth of even five or six feet. It is

chiefly during the evening and the night, when the earth is moist, that they leave their holes in search of food. They are not at all particular what they feed upon; but such preference as they do exhibit is in favour of cabbage leaves and similar vegetable substances.

The experiments to which Mr Darwin subjected them in order to discover the existence and development of their senses, are particularly interesting. To sound they are absolutely insensible; and not even Orpheus himself could have charmed them with his melodies; for not only did they show the greatest indifference when subjected to the torture of a tin whistle, or the notes of a piano, but even the blast of a bassoon failed to make the slightest impression upon them. With regard to vibrations, however, they manifest extreme sensitiveness; for when the ground is beaten, they will instantly retreat; and if disturbed beneath them, they will quickly crawl out of their holes, probably under the impression that their enemy the mole is after them. This sensitiveness of the worm to vibrations, while unconscious of sounds, was proved by Mr Darwin in a simple and effective manner. Though the tones of the piano did not affect them when separate from it, yet when the pots containing their burrows were placed on the piano itself, the moment any note was struck, the worms instantly disappeared within their burrows. They were thus shown to be sensible of the vibrations, though not of the sounds.

Although destitute of eyes, earthworms are sensitive to intense light; and when the bull's-eye of a lantern is directed upon the creature, it retreats instantly. Their sense of smell, on the other hand, is very limited and weak; for it has been ascertained that not even the odour of tobacco juice or the strong perfume of millefleurs is sufficient to attract their attention; while pieces of cabbage, onions, and raw meat buried in flower-pots near them, did not remain long undiscovered. As already stated, they show a certain preference for particular kinds of food, preferring red cabbage to green, and celery and carrots before either. Of all their senses, however, that of touch, including the perception of vibrations, appears to be the most highly developed.

Regarding their digestive powers, we find they are omnivorous, and drag into their holes anything that appears at all edible, showing no particular objection even to such articles as rose-thorns or splinters of glass. The leaves which they get hold of, they smear over with an alkaline fluid, which partially digests them before they are actually introduced into the body; a fact remarkable as being the only instance recorded of any animal of digestion outside the stomach. But the earthworm does not depend altogether upon meat and leaves for its existence; it finds nourishment in the very soil. Its mouth consists simply of two lips; and as it has no teeth, the particles of sand do not interfere with its mastication, so it goes on swallowing earth, which in its passage through the intestines has all the digestible ingredients thoroughly extracted from it. The indigestible portions are then ejected in the form of little heaps called worm-casts, which every one who lives in the country or possesses a garden

must be quite familiar with. The fine earth brought up to the surface in these little heaps of worm excreta is afterwards spread out by wind and rain more or less uniformly over the ground; the actual weight of these castings thrown up during twelve months being calculated in one case to amount to as much as eighteen and one-eighth tons per acre. Multiplying this by years, we can readily understand how surface objects will soon be covered up, or appear to sink into the ground; and numerous instances are given by Mr Darwin of stones and walls and pavements which have thus been slowly undermined and sunk by worms. Thus we have at any rate one explanation of the hitherto mysterious fact, that the ruins of old cities have been found so far beneath the surface that the soil has been ploughed and reploughed for years without the least suspicion of the existence of the ancient monuments below.

Mr Darwin, in this connection, furnishes a number of striking illustrations of this burying or covering process in regard to fields which a number of years ago were thickly strewn with stones on the surface, and which stones in course of time entirely disappeared. A field near his own residence was ploughed in 1841, and afterwards allowed to remain in pasture; and so thickly covered was the surface with stones, some of them half as large as a child's head, that it was called 'the stony field.' Thirty years afterwards, a cutting was made in the field, when these stones were found to be covered by about two inches of mould, and a man might have ridden a horse from one end of the field to the other without the shoes of the steed striking a single stone. Mr Darwin traces this change entirely to the agency of worms. We would take leave to suggest, however, that perhaps frost has also something to do with this sinking of stones, small and large, into the soil. We all know that frost acts very powerfully on the soil, raising the surface and the stones upon it considerably above their normal level. When the thaw comes, the softer portions of the soil are probably the first to be affected; and as these soften, heavy objects, such as stones, will tend to sink to a lower level than before, and might thus be gradually covered by the surrounding earth. We would not venture, in the face of Mr Darwin's experiments, to withdraw from the worms their share in this transposition of things; yet we would submit that the action of frost is a factor in the change not to be lost sight of.

While, therefore, Mr Darwin regards the earthworm as a preserver of the records of old time, this comparatively humble creature is nevertheless one of the chief agents in the destruction of the land surface of the globe. The rains and the frost act powerfully upon the higher portions of the land; and the glacier and the mountain torrent carry down the materials of the disintegrated rocks; but these when brought down to the lower grounds might remain there for ages longer than they do but for the agency of worms. In the first place the particles of stone and earth which are swallowed by worms are acted on both chemically and mechanically during the process of digestion; then, again, as the old worn burrows collapse and fresh castings are brought to the surface, the whole layer of mould is subjected

to a slow circulation, during which the friction of the particles of earth on one another still further reduces their size. Thus the soil becomes finer and finer; and as the ordinary means of disintegration, namely, running water and the waves of the sea, act with less and less power on rock fragments the smaller they are, we see how great is the assistance which worms lend in the decomposition and disintegration of the soil. The area of cultivable soil is also thus extended, because castings thrown up either during a shower or shortly before rain, are washed down any inclined surface; while during dry weather strong winds blow these little pellets of excreta from one place to another.

There are many other interesting portions of the book which we have not touched upon, but we cannot omit referring to those which treat of the experiments planned and carried out by Mr Darwin with a view to determining whether or not the actions of worms were guided by anything approaching to Intelligence. His chief experiment in this direction had relation to the habit which worms have of plugging up the mouths of their burrows with leaves, bits of paper, feathers, tufts of wool and horse-hair, pebbles, &c. This is one of their strongest instincts, and a worm has been known to drag, with its sucker-like mouth, a stone weighing two ounces over a gravel-walk to the mouth of its burrow. In order to determine the extent of the apparent intelligence displayed in these plugging operations, Mr Darwin 'observed carefully how worms dragged leaves into their burrows; whether by their tips, or bases, or middle parts. It seemed,' he says, 'more especially desirable to do this in the case of plants not natives to our country; for although the habit of dragging leaves into their burrows is undoubtedly instinctive with worms, yet instinct could not tell them how to act in the case of leaves about which their progenitors knew nothing. If, moreover, worms acted solely through instinct or an unvarying inherited impulse, they would draw all kinds of leaves into their burrows in the same manner. If they have no such definite instinct, we might suspect that chance would determine whether the tip, base, or middle was seized. If both these alternatives are excluded, intelligence alone is left; unless the worm in each case first tries many different methods, and follows that alone which proves possible or the most easy; but to act in this manner and to try different methods, makes a near approach to intelligence.'

So argued Mr Darwin with regard to the conclusions that might be drawn from the experiments he was about to make. And this is how he carried out his experiments. First, he offered the worms leaves of various shapes, both of indigenous and exotic species, and the result undoubtedly established the fact that the part of the leaf which the worm seized for the purpose of dragging the whole into its burrow was *not* a matter of chance; and that, in an overwhelming majority of cases, that part of the leaf was seized which would offer least resistance to being drawn into the burrow. After a great number of experiments with leaves of various shapes and sizes—all which experiments supported the above conclusion—Mr Darwin made a further series of experiments by cutting writing-paper into long triangles, short at the base, and offering these to the worms to plug up their

burrows. The result was the same as before; nearly three times as many were drawn in by the apex as by the base. 'We may therefore conclude,' he says, 'that the manner in which the triangles are drawn into the burrows is not a matter of chance.' He further argues that if worms are able to judge, either before or after having drawn an object close to the mouths of their burrows, how best to drag it in, they must acquire some notion of its general shape. This notion, he thinks, they may acquire by their sense of touch, which, as already mentioned, is very fine. Hence, 'if worms have the power of acquiring some notion, however rude, of the shape of an object and of their burrows, as seems to be the case, they deserve to be called intelligent; for they then act in nearly the same manner as would a man under similar circumstances.'

We have said enough, we trust, to interest the reader in the subject, and perhaps induce him to read Mr Darwin's book for himself; and in conclusion we may just briefly sum up the chief purposes the worm fulfils in the economy of nature.

Earthworms we know are valuable as food for birds and fishes; and to worms our thanks are due for assisting to preserve many an ancient monument which has thrown light upon the history of the past. They are ploughers and tillers of the soil, for they are constantly turning it over and loosening it; thus fitting it for seedlings to take root and for roots to penetrate with ease. By their constant labours, the soil is exposed to the improving action of the air and atmospheric agencies; it is enriched by mixture with partially digested leaves and other organic matter dragged into their burrows; and the rain which falls upon the ground sinks deeper through the loosened soil than it might otherwise have done. But their chief work is to sift the finer from the coarser particles, and by their castings to produce a layer of the finest mould, thus proving themselves co-operators with the farmer and the gardener as cultivators and fertilisers of the soil.

Thus in considering all the facts which prove the importance of worms, we may conclude in Mr Darwin's own words: '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 STORY OF A THUMB-MARK.

I.

'YOU'LL be sorry for this, uncle!' The speaker was a young man—little more than a lad indeed, to judge by his smooth face, though in figure he was stalwart and well set up. He spoke passionately, as he closed the door and came out. He did not go back to his desk in the counting-house, but passed straight from his uncle's private office to the street, snatching his hat from the wall in the passage as he left.

'Another row with the governor. Mark my words,' said one of the clerks to his neighbour; 'that young fellow will come to no good.'

The 'governor' thus referred to was sole representative and proprietor of the firm of Anthony