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THE FORMATION OF VEGETABLE MOULD THROUGH THE ACTION OF WORMS.*

Mr. Darwin's books are always interesting, not only from the controversy that has gathered round his name, but from the patient research and aggregation of minute facts which they are sure to display. These were never more strikingly exhibited than in the present volume. The facts are, even for Mr. Darwin, specially minute, relating to the habits of creatures usually left out of sight even by the keenest lovers of nature; and the time devoted to gathering them has been unusually long, the observations beginning in the year 1837, ten years after which date Mr. Darwin read a paper on the subject before the Geological Society of London. Moreover, the book is not marred by any of those risky, startling utterances which have thrown so much discredit on science, and have caused such heart-burnings in rival schools of thought. There is not a hint of evolution or development; the worm, whether he was created what he is, or whether he ceased to change after he had found suitable surroundings, has been a worm through long geological eras, and all that time he has been working for the good of man—"has taken a large share in the formation of the layer of vegetable mould which covers the whole surface of the land in every moderately humid country." This mould is so largely his work that it might better (Mr. Darwin thinks) be called animal than vegetable.

Surely, here is a clear instance of design. Our author says nothing directly about it; but no candid reader, no one whose mind is not unalterably made up the other way, can fail to see in the share which Mr. Darwin shows the worm has had in the economy of nature a striking instance of the adaptation of means to ends.

He begins by briefly but lucidly describing the creature to whom man owes so much; and in this, as in other parts of his book, he manages to write with thorough scientific accuracy, and yet with scarcely any scientific terms. This will increase the popularity of the book, and might well be imitated by writers who think it needful to enwrap their meaning in a net-work of long words and hard phrases.

Worms are found everywhere—in Iceland, in Kerguelen's Land, high up on the Himalayas, in the plains of Bengal. In England, they *seem* most numerous (to judge by their castings) in the poor soil of chalk-downs; but it is calculated that in garden-ground they are twice as numerous as elsewhere. Their habits are nocturnal—those that we meet wandering about by day are sick, generally affected by the parasitic larvæ of a fly. They have a gizzard (some species have several), in which, like fowls, they triturate, by the help of small stones, the earth that they swallow, and extract from it all the organic portion. This is the work which entitles them to the gratitude of man. For ages before he came upon the earth they have been manufacturing the fine mould on which the growth of plants depends, pulverising it over and over again, bringing it constantly up to the surface, transforming the very rocks (on all of which the acids it secretes have some effect) into serviceable soil. Worms breathe through their skin; and their intestines (on the principle of an intestine within an intestine) are so arranged that a very large absorbent surface is gained. They have an apology for a brain, viz., two cerebral ganglia near the anterior end of the body; and their brain power is sufficient to enable them to fix their attention. Thus, though eyeless, they are not insensible to light. A bright flash falling on them generally sends them to their holes at once—unless they are working or otherwise engaged, in which case they do not seem to notice the light. But Mr. Darwin, we shall see, credits them with greater powers than that of mere attention. Indeed, after reading his chapter about their intelligence, as shown by the knowing way in which they laid hold of his paper triangles, we can hardly help concluding that worms must rise in the scale; they have actually a sagacity and intelligence, as opposed to instinct, which the ant does not display. Deaf they appear to be. A bassoon blown close by them moves them not at all. But if the pots in which they are, be placed on a piano and a note be struck, the vibration makes them instantly retreat to their burrows. They have strong preferences in the matter of food—raw fat meat pleasing them best, then onion, then cabbage. But their sense of smell seems small. However, Mr. Darwin reminds us that Laura Bridgman's case proves that deficiency in several sense-organs does not preclude intelligence. Their digestive fluid is much the same (says Léon Frédéricq in the *Archives de Géologie Expérimentale*, 1878, p. 394) as the pancreatic secretion of the higher animals. Their intelligence, Mr. Darwin thinks, is chiefly displayed in the way in which they drag leaves into their burrows. Of course it is easier to do this by the thin end than by the thick; and worms *generally* choose the thin end, though one might think the stalk would be a help to getting the leaf along the surface. To drag it by the stalk as far as its burrow, and then turn it round, surpasses even a worm's intelligence. That they do not act from instinct is proved by their not following any invariable rule—sometimes they pull in even lime leaves, which are broad-based, by base or side, instead of apex; and instinct could not have been developed in regard to foreign trees, rhododendrons and such like, in dealing with which worms displayed a remarkable amount of judgment. The crucial test of intelligence, however, was made by laying very acute-angled paper triangles rubbed with raw fat near worm burrows, and noting how the worms dragged them in. We must refer the reader to the very elaborate experiments conducted by Mr. Darwin and his sons, from whom throughout he received the most efficient help.

The intelligence of these creatures being established, as was right and proper, considering the work they do in the world, the next thing is to show how this work is accomplished. Farmers know that stones and any other things laid upon land "work their way down;" this is owing to their being buried under the fine mould brought up from below by the action of worms. Dress a field with chalk lumps, or cover it with coal ashes, and after ten or more years you will find a layer of chalk or ashes covered very evenly with this mould to a depth varying from 2½ to 3 or more inches. In this way the tesselated pavements of Roman villas have been preserved. Mr. Darwin gives a full account of the work at Brading, in the Isle of Wight, and at other places. Moreover, the worm castings when on a slope get washed by rain and drifted by winds to leeward; some idea of the amount thus displaced was proved by measuring the thickness of mould over the chalk in the shallow circular trenches, with a low embankment outside, which are found near Stonehenge. The mould on the north-east side was nearly double the depth of that on the south-west. This deep foundation prevents the superficial mould from accumulating to such a depth as to check the disintegration of the underlying rock. And we may judge of the earth displaced in this way by considering that in many places 0·2 of an inch is the thickness of mould annually brought to the surface. The worm acts like a plough, only in a far more perfect way, triturating the earth which it afterwards ejects. It is by weighing these worm-castings that Mr. Darwin has been able to calculate the amount of earth displaced. English castings vary in weight, the heaviest (on a Kentish down) weighing nearly 4 ounces. Those at Nice averaged only 1·4 ounce. In the Nilgiris the heaviest were nearly 4½ ounces. The conclusion is, that the amount of castings in a year varies from 7½ to nearly 20 tons an acre. This work is so enormous as to warrant the extreme with which we conclude our notice of this remarkable book—a book which shews that Mr. Darwin's powers of minute research and patient waiting increase rather than diminish:—"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." Except, indeed, adds Mr. Darwin, the coral insects, whose great work he was the first to thoroughly investigate.

* "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. (Murray.)

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