

## Among Books.

THE FORMATION OF VEGETABLE MOULD THROUGH THE ACTION OF WORMS, WITH OBSERVATIONS ON THEIR HABITS. By Charles Darwin, LL.D., F.R.S. London: John Murray. 1881. 9s.

"Earth-worms, though in appearance a small and despicable link in the chain of Nature, yet if lost would make a lamentable chasm. For to say nothing of half the birds and some quadrupeds, which are almost entirely supported by them, worms seem to be the great promoters of vegetation, which would proceed but lamely without them, by boring, perforating, and loosening the soil, and rendering it pervious to rains and the fibres of plants by drawing straws and stalks of leaves into it, and, most of all, by throwing up such infinite numbers of lumps of earth, called worm casts, which being their excrement, is a fine manure for grain and grass. Worms probably provide new soil for hills and slopes where rain washes the earth away; and they affect slopes, probably, to avoid being flooded. Gardeners and farmers express their detestation of worms—the former, because they render their walks unsightly, and make them much work, and the latter because, as they think, worms eat the green corn. But these men would find that the earth without worms would soon become cold, hard-bound, and void of fermentation, and consequently sterile; and besides, in favour of worms it should be hinted that green corn, plants, and flowers, are not so much injured by them as by many species of scarabs and longlegs in their larva or grub-state; and by unnoticed myriads of small shell-less snails, called slugs, which silently and imperceptibly make amazing havoc in the field and garden. These hints we think proper to throw out, in order to set the inquisitive and discerning to work.

"A good monography of worms would afford much entertainment and information at the same time, and would open a large, new field in natural history. Worms work most in the spring, but by no means lie torpid in the dead months; are out every mild night in the winter, as any person may be convinced that will examine his grass plots with a candle."—*White's Natural History of Selborne. Letter 77. May 20th, 1777.*

A hundred years have elapsed since White made this suggestion, but at last Mr Darwin's volume fulfills all that White predicted a monograph on worms would be. "It affords much entertainment and information" and "opens up a large and new field of Natural History." The subject is not a new one to Mr Darwin. He "hibernates in science," as Thoreau said, and for upwards of forty years he has been employing, in the intervals of other labours, his season of hibernation in studying and experimenting on the habits and uses of worms. These investigations have been conducted with a perseverance, a unity and directness of purpose that are remarkable even in Mr Darwin. With such success has he set to work to clear the character of uselessness or positive injuriousness which worms in some quarters unfortunately bore, that the expression hitherto accepted as an acknowledgment of deep humiliation—"I am a worm," might now almost be used as a boast.

The charm of Mr Darwin's book lies in the clearness and simplicity of his writing and his absolute freedom from dogmatism. Far-reaching as his generalisations are, they are gradually led up to by arrays of evidence and processes of inference so obviously reasonable that it is impossible to avoid agreement with them.

It is unnecessary to distinguish precisely

where Mr Darwin treats of features previously known and where he treats of new features which he himself has discovered; because his volume throws so much fresh light over the whole subject, that henceforward the subject must be regarded peculiarly as his own. He has taken nothing for granted; but has during these many years laboriously conducted his experiments and slowly matured his views. His first chapters are devoted to an examination of worms themselves, and to a detailed account of experiments and observations. His latter chapters discuss the uses of worms in the economy of nature, and the extent of the work which they accomplish.

The principal results of the experiments and observations on the characters and habits of worms conducted by Mr Darwin and others are these:—Worms have no eyes, yet they are sensitive to light, and in a less degree to radiant heat. Their sense of taste is delicate, and they exhibit a decided preference for certain kinds of food. For example, they prefer the onion to cabbage, and have a decided partiality for the leaves of the wild cherry, and have an exceeding fondness for fat. Their most acute sense is the sense of touch. A very slight vibration even of the air startles them, but only if this vibration strikes their bodies; for that they had no power of hearing was proved in a number of ways. Mr Darwin infers, from a variety of circumstances, that their most striking mental qualities are timidity, enjoyment of the pleasures of eating, and social feeling.

It has been found that the secretion with which worms moisten their food resembles not saliva but pancreatic juice. "The result is that the leaves are partially digested before they are taken into the alimentary canal." No other case of extra-stomachal digestion has been recorded, the boa-constrictor, which salivates its prey before swallowing it, doing so solely for lubricating purposes. Passing from the physiology and personal characteristics of worms, Mr Darwin discusses their houses or burrows. These are most ingeniously made. The worms first excavate the burrow by pushing the earth aside with their heads or swallowing it. They not only swallow the finer particles, but many little stones, from one twentieth to one-tenth of an inch in diameter, pass through their intestines. Having excavated the burrow and ejected on the surface the earth it had swallowed, the worm proceeds to draw into the mouth of its hole the pointed leaves of various plants. These leaves are used for the purpose of lining the burrow, and they are smoothed over by an inner lining composed of the castings, so that when completed the burrow is "like a tunnel lined with cement." The method adopted by worms in dragging leaves toward their burrows depend partly on the shape of the leaf, partly on the skill of the worm-operator. For example, most leaves being more easily conveyed by catching them at the apex are dragged in this manner, but leaves such as those of the pine, consisting of two needles springing from a common base, are uniformly dragged in by the base.

Burrows are often five or six feet long, and frequently terminate in a chamber where the worm has been said to hibernate. But from the fact noticed by White that worms are to be observed on or near the surface in winter, it is more likely that they retire there only in extremely cold weather. One great object the worm appears to have in lining and cementing its dwelling so carefully is to prevent the cold and clammy earth from coming in contact with its body. From Mr Darwin's experiments he is led to conclude that the manner in which the worms go about the business of excavating their subterranean dwellings, and the manner in which they drag into their burrows leaves, etc.,

for food as well as for architectural purposes, indicate a certain amount of intelligence not inferior to that displayed by ants. Mr Romanes has laid it down as a dictum that "intelligence in animals is to be safely inferred when we see an individual profiting by its own experience." From experiments made with a view of presenting worms with difficulties and putting them in situations which they could not meet with in their everyday life, Mr Darwin thinks, though he is far from expressing himself dogmatically on the point, that the possession of intelligence by worms is clearly established. The chapters on the work accomplished by worms are of great interest. Their drift may be summed up thus:—Accounts of experiments showing the quantity of castings thrown up by worms within a certain space in a given time. These experiments form the basis of a calculation in which Mr Darwin declares that each worm annually ejects twenty ounces of fine moist powder; that the average quantity of castings per acre is ten tons per annum, and that the total castings over the cultivated soil of England and Scotland is 320 million tons a year. Two important geological processes are aided by worms—first, the denudation of land; second, the disintegration of rock. The light powdery earth castings thrown up by worms, especially during rain, are easily washed down the slopes, and as worms are perpetually bringing up the earth from below this process goes on to the gradual denudation of the land. The disintegration, even of the harder rocks is accomplished by worms by the action of acids in their intestines which are so powerful as to dissolve peroxide of iron. These acids percolating through the subsoil attack the rocks, and particles of these rocks are brought to the upper surface by worms, thereby altering the composition and appearance of the mould. The fact that the mould has been already acted upon by digestive acids is most important. For it is thus rendered more fit for the uses of plants, for the more finely divided and the further advanced it is in decomposition so much the more easily are its elements assimilated by the plants that grow in it.

The work accomplished by worms is most astonishing when we consider the apparent inadequacy of the means at their disposal. Possessed of no limbs, no heart, scarcely anything that could be called a brain, one of the least differentiated of all organic beings, they have, nevertheless, by unflagging industry and sheer force of numbers covered the entire soil of the earth with many inches of fine mould. By disintegrating decayed matter in their intestines and ejecting it in the form of a fine moist powder, they have covered up many ancient buildings, have undermined and ruined many towers; and they have all in all done more good and wrought more havoc than any other of the lower animals.

The *Art Journal* for November and December will contain illustrated papers by the Oxford pupil of Mr Ruskin's who edited "Arrows of the Chace." These will describe "The Lake-side Home of Mr Ruskin"—Brantwood, Coniston. The same numbers will also contain an article on Celtic Art and one on a monument to Shakespeare by Lord Ronald Gower.

Mr W. A. Massey, M.D., has just died. He was the author of "A History of England during the Reign of George III.," a most conscientious and valuable work.

