

By a sympathetic audience, following way of position

THE MACH.

NOVEMBER 1, 1881.

Among Gnomes.

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.

"Earth-worms, though in appearance a small and despicable link in the chain of Nature, yet if not would make a lamentable chain. 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 feebly without them, by boring, perforating, and loosening the soil, and rendering it porous to rains and the fibres of plants by drawing stems and stalks of leaves into it, and, next of all, by throwing up such infinite numbers of mounds 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 in the former, because they disturb their walks unequally, and make them work more, 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 the seed and tender, is favour of worms (which feed on the roots of grass, plants, and flowers, are not so much injured by them as by many species of earth and langousts in their larva or grub-state; and by gnawing leaves, in the case of such insects, as the field mouse, the field vole, and the rabbit). These things we think proper to throw out, in order to set the imaginative and discerning to work.

"A good monograph of worms would afford much entertainment and information at the same time, and would open a large, new field to natural history. Worms work most in the spring; but by no means in total in the food worms; are not very cold soil in the winter, as any person may be convinced, who will examine his grass plots with a needle."—*Edin. Natural History of Scotland*. 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. His "Inheritance in animals," as Thomas said, and for upwards of forty years he has been applying, in the intervals of other labours, his means of observation in studying and experimenting on the habits and uses of worms. These investigations have been conducted with a perseverance, a sagacity and directness of purpose that are remarkable even in Mr Darwin. With such success has he set to work to clear the character of usefulness or positive injuriousness which worms in some quarters unfortunately bore, that the expression he has adopted as an acknowledgment of their beneficial use—"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. Paraphrasing as his generalizations 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 necessary to distinguish precisely

when Mr Darwin tests of worms previously known and where he tests of new kinds which he himself has discovered; because his volume throws so much fresh light over the whole subject, that notwithstanding the subject need be regarded peculiarly as his own. He has taken notice (for granted); but has having taken notice of the subject, he has examined it with a calm and slowly matured belief. 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 considered by Mr Darwin and others are as follows:—Worms are very sensitive to light, and in a low 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 mucus of the wild cherry, and have an aversion to the taste of lead. Their most acute sense is the sense of touch. A very slight vibration even of the air strikes 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 usually, except in the pleasure of eating, and social living.

It has been found that the secretion with which worms maintain their food resembles not only their own excrement, but also that of the larvae of the earth-worms. "The excrement of the larvae is partially deposited below; they are taken into the alimentary canal." No other case of extra-stomachal digestion has been recorded, the non-stomachal which affirms the play before swallowing it, doing so solely for lubricating purposes. Passing from the physiology and general characteristics of worms, Mr Darwin discusses their houses or burrows. The worms first excavate the burrow by pushing the earth aside with their heads or swallowing it. They do not only swallow the finer particles, but many little stones, from one-fourth to one-half 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, or that which is not consumed in 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 stick of the worm-opening. 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 usually 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 hibernates. But from the fact noticed by White that worms are to be obtained in the winter in the earth in a state, it is more likely that they retire there, it is extremely odd weather. One great object of the worm appears to be in lining and coating it dwelling so carefully 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 worms in which the worms go about the houses of man, and the manner in which they drag into their burrows leaves, etc.,

in fact, as well as for architectural purposes, indicate a certain amount of intellect, more inferior to that displayed by ants. Mr Thomas has led it down on a diagram 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 different kinds of soil, it is shown 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 objection to the work accomplished by worms is of great interest. Their duty may be summed up thus:—Accounts of experiments showing the utility of castings thrown up by worms within a certain space in a given time. These experiments show the basis of a calculation in which Mr Darwin declares that each worm annually ejects twenty million of fine earth powder; that the average quantity of castings per acre is ten tons, and so on, and that the total castings over the cultivated soil of England and Scotland is 100 million tons a year. Two important geological processes are aided by worms—first, the denudation of land; second, the distribution of rock. The light powdery earth castings thrown up by worms, especially during rains, 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 hardest rocks is accomplished by worms by the action of acids in their intestines which act as powerful acids, and dissolve particles of iron, and other substances through the solvent attack the rocks, and particles of these rocks are brought to the surface by worms, thereby affecting the composition and appearance of the mould. The fact that the mould has been already noted upon by the digestive acids is most important. But it is thus rendered more so for the case 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 unaided industry and the 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, and have smoothed away many modern ones. 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 called "Arms of the Church. These will describe "The Lake-side Home of Mr Ruskin"—Barnstord, Glos. 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.