BIBLIOGRAPHICAL NOTICE.

The Formation of Vegetable Mould through the Action of Worms, with Observations on their Habits. By CHARLES DARWIN, LL.D., F.R.S. Sm. 8vo. London: Murray, 1881.

EARTHWORMS are probably not regarded with much interest by the public in general. For the most part they are looked upon as nuisances, from their exceedingly unpleasant habit of disfiguring the lawns and gravel-walks of our gardens with their unsightly castings; and the only people who hold them in any degree of esteem (and that manifested in a way that the worms themselves can hardly be expected to appreciate very highly) are the anglers, who occasionally use worms as bait, and then, no doubt, follow the advice of the old piscatorial writer and handle them as if they loved them, always barring the insertion of the hook, which it would be hard to interpret into a sign of affection. This feeling of indifference, perhaps verging upon contempt, has been abundantly reflected in what is by courtesy styled the "comic literature" of the day, since the appearance of the book of which the title stands at the head of this article. The jokers and *soi-disant* jokers who produce that marvellous flood of words with which we are familiar in the so-called comic journals found something exquisitely funny in the notion of a grave philosopher devoting his time to the observation of earthworms, and at once gave utterance to a series of more or less jocular remarks on the subject, most of which serve chiefly to prove (what, indeed, is tolerably evident from their efforts in other directions) that the writers in question have entirely mistaken their vocation in attempting to be funny.

We can quite believe that similar sentiments were entertained by most people when, some forty-four years ago, at a time when probably most of our readers had not begun to think very much, and certainly few of them had turned their thoughts to scientific subjects, the naturalist, who now above all others fulfils the requirements involved in that title, communicated to the Geological Society a short paper, in which he maintained that earthworms have played and are still playing a very important part in the economy of this world of ours.

We do not know how the Fellows of the Society received the novel views put forward by Mr. Darwin in this paper; but they printed it in their Transactions, and the question of the influence of worms on the cultivation both of fields and gardens was for some time a subject of discussion. Many, no doubt, like the Vicomte D'Archiac, regarded Mr. Darwin's earthworm-theory as a singular one; but we fancy that, on the whole, the conclusion arrived at was, that the action of worms upon the soil was beneficial (mechanically at all events) to cultivation, although comparatively little importance was assigned to it. Mr. Darwin, however, continued his observations, and supplemented them with numerous experiments, after the persevering fashion with which he has familiarized us in

his many invaluable works; and he now publishes the results in a most interesting little volume, in which he fully vindicates the claims of his humble clients to be regarded as entities of considerable importance.

Mr. Darwin claims for earthworms the performance of two most important functions. He maintains that they are, to a great extent, the actual makers of what we are accustomed to call "vegetable mould," and, secondly, that they are great workers in, and transporters of, this mould when formed.

These animals are shown to contribute to the formation of the substance called vegetable mould in several ways. They feed chiefly on vegetable substances, which may be either already mixed with the existing mould, or dragged by them into their burrows for the purpose or, in the first instance, to stop the mouth of the hole, or to line the interior of the upper part of the burrow—a practice for the discovery of which we are indebted to Mr. Darwin. These vegetable materials are torn into minute shreds and swallowed by the worms, in addition to the soil which they take for the purpose of extracting nourishment from it; and the residue of this food, passing through their bodies and getting mixed with their intestinal secretions, goes to increase the stratum of mould. They further assist in the process of mould-formation by throwing up their castings over the dead leaves lying on the surface of the ground, which are thus brought at once into the layer of soil and protected from atmospheric action until they either become slowly decomposed or are converted into food for worms, in either case adding to the thickness of mould. And they add to the quantity of mineral matter in the soil by bringing up the finer particles of the subsoil, into which they burrow to some depth, and facilitating their mixture with the other materials. The reality of this influence is proved in a striking manner by an experiment made by Von Hensen and cited by Mr. Darwin from that gentleman's admirable article on the natural history of earthworms, published in Siebold and Kölliker's 'Zeitschrift' for 1877. "Von Hensen," he says, "placed two worms in a vessel 18 inches in diameter, which was filled with sand, on which fallen leaves were strewed; and these were soon dragged into their burrows to a depth of 3 inches. After about six weeks an almost uniform layer of sand, a centimetre (·4 inch) in thickness, was converted into humus by having passed through the alimentary canals of these two worms."

As workers of the soil, their influence seems to be of equal importance. As they are constantly swallowing the mould in which they live, and reducing the organic matter contained in it to the smallest possible particles, they effect a most intimate intermixture of all the parts, acting, as Mr. Darwin points out, "just in the same way as a gardener in preparing the finest soil for his choicest plants, bringing it into a state in which it is well fitted to retain moisture and to absorb all soluble substances, as well as for the process of nitrification." Their burrows, which frequently descend to a considerable depth, give access to air and water, and also, by yielding

to pressure or to atmospheric agencies, facilitate small movements of the soil, changing the position of its component particles. The author says, "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 ploughed, by earth-worms."

But the most striking action of worms in working the soil consists in the transport of great quantities of mould to the surface, where it can be exposed to the action of the air, spread over the surface by rains, and thus serve as new nourishment for growing plants. This is effected by the worms coming to the mouths of their burrows with their intestines full of mould, which is then discharged upon the surface in the well-known convoluted bodies known as worm-casts or castings. It was to this characteristic of the action of worms that Mr. Darwin's first observations related; and he showed by the gradual and uniform sinking of top-dressings of various kinds (lime, cinders, burnt marl, &c.) that it was a real factor in nature. Substances unfit for the food of worms, and too large for them to swallow, if lying on the surface of the soil are slowly but continuously involved in a layer of soil brought up from below them and discharged at the surface, while at the same time and by the same process they are to an equal extent undermined. The phenomenon, in fact, consists of a transfer of the substance of the more deeply-seated layers of mould to the surface; and as such objects as bones, stones, &c. must remain in contact with the surface on which they were originally deposited, they are compelled to sink with it beneath the fresh layers of earth brought up. To show the important effects thus produced upon the general face of the land, we may cite an example adduced by Mr. Darwin from his experience in one of his fields at Down. He says that a sloping part of this field "was last ploughed in 1841, was then harrowed, and left to become pasture-land. For several years it was clothed with an extremely scant vegetation, and was so thickly covered with small and large flints (some of them half as large as a child's head) that the field was always called by my sons 'the stony field.' When they ran down the slope the stones clattered together. I remember doubting whether I should live to see these larger flints covered with vegetable mould and turf. But the smaller stones disappeared before many years had elapsed, as did every one of the larger ones after a time; so that after thirty years (1871) 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 the worms; for, though castings were not frequent for several years, yet some were thrown up month after month, and these gradually increased in numbers as the pasture improved." A trench cut in 1871 showed a thickness of $\frac{1}{2}$ an inch of turf and $2\frac{1}{2}$ inches of vegetable mould, beneath which lay clayey earth full of flints like that in the neighbouring ploughed fields. The rate of formation of the mould in this case is certainly very slow, not more on the average than an inch in twelve years; but, slow as it is, it

justifies the following remarks of Mr. Darwin:—"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." Large stones lying on the surface of grass-land become gradually imbedded, partly by the raising of the surface and partly by the undermining action of worms; and the same influences have been at work, as the author well shows, in the covering up with a layer of mould of the remains of ancient buildings.

The quantity of earth moved in this way is enormous, and such as to surprise those whose minds are not already familiar with the vast effects that are produced in nature by the long-continued working of minute agencies. By collecting, drying, and weighing the worm-casts over a given space of ground Mr. Darwin is enabled, at least approximately, to determine the quantity of soil brought to the surface by worms; and he finds that in many parts of England this amounts to about ten tons per acre annually. Two of his calculations, however, give a much larger amount, namely 16·1 and 18·12 tons per acre. These larger quantities, when corrected, would produce a layer of about $1\frac{1}{2}$ inch spread over the whole surface in ten years. This, of course, does not represent increase of thickness, but only the rate of transfer of the underlying mould to the surface.

This notice has extended to such a length that we must bring it somewhat abruptly to a close, merely remarking in conclusion that, besides their influence upon the formation of mould, Mr. Darwin ascribes to earthworms under certain conditions an important action in aid of the phenomena of denudation, as their castings, when present on the surface, will be peculiarly liable to be washed away by heavy rains, and even in dry weather they will break up into small pellets which may easily be transported by the wind. It is hardly necessary to say further that for the better exposition of the main subject of his book Mr. Darwin thoroughly describes the structure and habits of worms, and dwells especially upon their senses and mental qualities. His book is a most interesting and attractive one, and its teaching of the importance in nature of what are apparently the most contemptible of agents will furnish an excellent lesson to many besides the reading section of the general public.

MISCELLANEOUS.

Dutch Mollusca. By J. Gwyn Jeffreys, LL.D., F.R.S.

While passing a short time in Holland, immediately after sustaining the greatest calamity which can befall a man (the death of a long-loved wife), I spent a day at Scheveningen, a favourite sea-side