

NATURALISTS are so accustomed to hear of the untiring labors of the venerable author of the "Origin of Species," that the mere announcement of a new publication from his pen no longer creates any surprise; yet there are probably but very few among that thinking body of men who would not confess to surprise at the *character* of the work that may be presented to them. It is but rarely the gift of a scientific mind to be able to grapple with both the broader and the narrower aspects of a scientific problem,—to theorize and at the same time to marshal the data that are to substantiate the generalization; and it is no less rarely that we meet with a mind so equally constituted as to permit of the impartial estimation of all the various facts that may be called forth by the exigencies of a case, and the treatment of both the positive and negative elements of a question with equal consideration. These different qualities of mind are, however, admirably combined in the genius of Mr. Charles Darwin, and it is their expression, as impressed upon the pages of his works, that calls forth anew with each publication the admiration, no less than the wonder, of his readers. Although already a veteran in the path of science,—now in his seventy-third year,—Mr. Darwin exhibits no trace of a decline in his mental vigor; the same freshness of narration, the same masterly exposition of facts, and the no less remarkable consistency and soundness of the conclusions drawn therefrom, that so eminently characterize all his other works, are equally patent in the work now before us.

The scope of the present volume, as briefly stated by the author, is to demonstrate "the share which worms have taken in the formation of the layer of vegetable mould which covers the whole surface of the land in every moderately humid country." This mould, which varies but comparatively little in appearance, has for one of its most characteristic features the uniform fineness of the particles of which it is composed; it is, generally speaking, of a blackish color, and rarely attains more than a few inches in thickness. Mr. Darwin's earliest observations as to its formation were made nearly a half century ago, from which it was concluded that the entire vegetable mould covering a country had been subjected to a species of animal digestion,—if so it may be termed,—it having at successive periods passed through the intestinal canals of worms; through this process of intestinal rotation, which will continue in the future as well as it has continued in the past, it was contended, the ground was brought into a suitable condition for vegetable development. Surprising as these conclusions may at first sight appear, they are, nevertheless, borne out by such an array of well-determined facts that there can be but little—if, indeed, any,—room left for doubt in the matter; and, had the facts that are now so convincingly brought before the reader been known to their full extent when Mr. Darwin first enunciated his far-sighted views, the "*singulière théorie*," as it has been designated by the eminent French geologist, D'Archiac, would doubtless long ago have been recognized as an established law in nature.

The first two chapters, covering somewhat more than one-third of the entire work, deal almost exclusively with the natural history and habits of worms, the nature of their subterranean excavations, and the manner in which these last are conducted. Earth-worms, while they are spread over the greater portion of the earth's surface, appear to be governed in their local distribution by certain particular conditions of the soil, which, however, are not always readily apparent. Thus, they prefer such localities where the moisture of the earth may be retained for a considerable length of time, as in fields, meadows and paved courtyards, and are consequently but rarely to be met with in dry, sandy or gravelly spots,—which support but a scanty vegetation,—and they are usually absent, or at least restricted in their numbers, in such districts where the depth of soil is insufficient to enable them to escape from the cold of winter. That moisture is an essential condition for their existence, is proved by the experiments of M. Perrier, who found that "exposure to the dry air of a room for only a single night was fatal to them. On the other hand, he kept several large worms alive for nearly four months, completely submerged in water." Earth-worms are noc-

\* "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; New York: D. Appleton & Co., 1882.

turnal in their habits, and but rarely, except in the pairing season, expose their bodies during the day-time, lying usually concealed in their burrows at some distance from the surface; even during their nocturnal wanderings, they but rarely emerge completely from their subterranean abodes, and, indeed, it has frequently been stated, that, in a perfectly healthy condition, they never leave them. Their senses are but feebly developed, that of hearing being completely absent. Mr. Darwin found that they were entirely indifferent to the deepest and loudest tones emanating either from the human voice, a bassoon, piano, or metallic whistle. While they are thus insensible, or at least apparently so, to those undulations of the atmosphere which convey the impression of sound to the human ear, they are, on the other hand, extremely sensitive to the vibrations transmitted through any solid body. Worms that, under ordinary circumstances, appeared indifferent to the sound of a piano, retreated instantly into their burrows when the pots containing them were placed on the instrument and the note C in the bass clef was struck; and the same phenomenon presented itself when a high note, as G above the line in the treble, was sounded. The visual organs being completely absent from these lowly creatures, it might naturally be inferred that they would manifest a complete insensibility to light; yet the observations of both Hoffmeister and Darwin seem to prove, that, not only are they cognizant of the difference between night and day, but that even minor changes of luminosity are keenly appreciated by them. While a feeble light may be dependent for its action upon the length of its duration, a more powerful one is frequently very instantaneous in its effects; a worm suddenly illuminated by the concentrated light from a bull's-eye lantern is stated to dash "like a rabbit into its burrow." The power of distinguishing between these various degrees of luminous intensities resides in the anterior portion of the body, or what corresponds to the head, and hence it is conjectured, that, for the exercise of this power, the worm is dependent upon the rays of light passing through the skin and in some manner exciting the cerebral ganglia. The sense of smell is but imperfectly developed, and appears to be restricted to certain odors; the breath saturated with the perfume of tobacco and *mille-fleurs* produced no appreciable effect upon them, but the case was otherwise when, in place of these, the odor of cabbage and onions was substituted. When scraps of these vegetables were buried beneath about one-fourth of an inch of common garden soil, they were usually discovered, although in some cases not before a period of fully two days. Bits of fresh raw meat, of which worms are equally fond, when similarly treated, were not discovered within forty-eight hours. The sense of taste is much more acutely pronounced, and, with the exception of that of touch, is the one most highly developed.

On the subject of the mental qualities of worms, Mr. Darwin remarks, that, judging by their eagerness for certain kinds of food, they must enjoy the pleasure of eating; and, from the circumstance of their not being disturbed by crawling over each other's bodies, as well as from certain manifestations of sexual passion, it would appear that they possess a trace of social feeling. "Although worms are so remarkably deficient in the several sense-organs, this does not necessarily preclude intelligence, as we know from such cases as Laura Bridgman; and we have seen, that, when their attention is engaged, they neglect impressions to which they would otherwise have attended; and attention indicates the presence of a mind of some kind." That worms possess a certain amount of intelligence, appears to be almost indisputably proved by the manner in which they habitually plug up their burrows with leaves, their methods of procedure, as stated by Mr. Darwin, being almost precisely that which would be employed by a man in plugging up a tube with similar objects. In the vast majority of cases, it was found that the leaves were drawn in in such a way as to encounter the least possible amount of resistance, those with broad bases being seized at the tips, and, *per contra*, those which separated (pines,) or spread out towards their apices being seized at the basal ends.

In Chapters III. and IV., the more important parts played by worms in the economy of the earth's history—namely, the formation of vegetable mould,—is discussed at length. It is a singular fact, and one that has been frequently remarked by different observers, that small objects scattered over the surface of a field or meadow disappear in course of time beneath a superficial layer of mould or turf, apparently undergoing a process of sinking, as induced by the force of gravity drawing toward the centre of the earth. Fields that were at one time stony, and considered unfit to be worked, have been found, after a number of years, to be covered with a comparatively deep deposit of soil, and, indeed, in some cases, to such an extent as to have completely obliterated all superficial traces of the previously existing stones. In like manner, paved walks and the floors of ancient ruined buildings have, after a lapse of years, been buried beneath a greater or less depth of soil; and human relics and utensils, that had doubtless been left exposed on the surface, have been turned up by the ploughshare from varying depths of a first-sown field. This disappearance, as has been conclusively shown by Mr. Darwin, is due to the quantity of fresh earth that is constantly being brought to the surface in the form of "worm-castings;" *i. e.*, the earth that is periodically being passed through and ejected from the intestinal canals of worms, as a result of their burrow-

ing operations. Insignificant as this action may at first sight appear, its full importance becomes manifest when a direct calculation of its effects is made. From data accumulated from various sources, and largely as the result of his own personal observations, Mr. Darwin estimates: the quantity of worm-castings annually thrown up, over each square acre of land, to be equal in weight to no less than fifteen tons; and, if these fifteen tons' weight of material were equally distributed over the surface of the acre, they would raise the general level by about fourteen-hundredths of an inch. In other words, about one inch of fresh soil would be deposited in the course of seven years. Assuming, as with Mr. Darwin, that there are, on an average, 26,800 worms to each acre of land,—which is about one-half the number claimed by Hensen for the most favored localities,—then each single individual in the above period of seven years must have brought to the surface no less than one hundred and forty ounces of material! Prodigious as these figures may appear, they are singularly confirmed by observations based directly on the rate at which superficial objects disappear beneath the surface, and which has been determined in favorable localities to be in the neighborhood of one inch in every five years, or less. When we reflect that worms live only in the top layer of the soil, and usually at depths from the surface of from four to twelve inches, and since they are constantly reburrowing and throwing up their castings, it is self-evident, that, in the course of every few years, this top soil, or what constitutes the vegetable mould, must pass in rotation through the intestinal canals of these creatures. This is certainly one of the most interesting, if not the most surprising of facts in the wide range of physiographic science, and one that, by its immensity, as compared with the apparent insignificance of the developing cause, appeals most directly to that class of observers—the geologists,—who are more especially concerned in the investigation of the effects of time.

In concluding our notice of this most fascinating work, we cannot do better than to quote some of Mr. Darwin's closing passages: "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 it existed, the land was, in fact, regularly ploughed, and still continues to be thus ploughed, by earth-worms." ANGELO HEILPRIN.

#### LITERATURE.

##### MORLEY'S LITERATURE IN VICTORIA'S REIGN.

WE frankly own to a severe disappointment in this book ("English Literature in the Reign of Victoria." By Henry Morley), from which we had expected—as we had a right to expect,—a good deal, and whose handsome exterior does so much credit to the publishers. It is a notable work, in that it is the two thousandth volume of that well-known and valuable series, which, for the last forty years, has been identified with the name of Baron Tauchnitz,—a series which the veteran publisher promises, in his brief and touching preface, "will still proceed in its old spirit, and continue to fulfil its mission by spreading and strengthening the love of English literature outside of England and her colonies." An interesting feature of the book is the "frontispiece," containing fac-similes of the signatures of the authors in the Tauchnitz edition, photographed from their letters and agreements, and offering an attractive subject for the study of believers in the science of Père Martin and Don Felix de Salamanca. The American authors, it need hardly be said, are numerously represented in this list of nearly two hundred names. Baron Tauchnitz, we may add, intends to devote a special memorial volume to the rise and progress of the literature of the United States, and it is gratifying to know that it is to be entrusted to an American author. Indeed, when we remember how admirable a book Mr. Edmund Clarence Stedman has produced on a kindred subject, we can hardly repress a feeling of regret that the task confided to Professor Morley was not assigned to an American essayist. Mr. Stedman, Mr. Stoddard, and a dozen others whom we could name, would, we are convinced, have performed it better.

The most aggravating thing about Professor Morley's book, to do all our fault-finding first, is its system of chronology, the most conspicuous detail in the arrangement. To almost everyone else in the world, it would have occurred to classify the authors of the long and eventful reign of Queen Victoria by groups, according to the department of the literary field which they cultivated, sketching briefly the career of those who were identified more closely with an earlier epoch, giving guarded but generous appreciation of the younger writers who have not yet reached the maturity of their intellectual development, and offering some remarks on the general character or tendency of each group. How interesting such an arrangement could be made, may be inferred from a perusal of the two chapters in Mr. Justin McCarthy's "History of Our Own Times," in which the literature of the Victorian period is discussed. Besides, the writers of the reign have grouped themselves in most effective sort, and each group presents an attractive assemblage of similarities and contrasts. Browning, Tennyson and Swinburne among the poets; Thackeray and Dickens among the novelists; Macaulay, Froude, Grote, Green, Stubbs, and all