

only pure gold coins into her lap and she could be crossed or go through the ceremony.

Randolph died in 1862, at the age of seventy-three years. The event is still remembered in Calcutta, for it was followed by a *Shradha*, or funeral feast, that cost £1,000. The whole city overflowed on that occasion with Brahmins and buggies. Every one was dressed, and every one received presents or alms. Gold and silver, horses and elephants, boats and carriages, were given to the Brahmins, while rayers were loaded on every bazaar. No such scene has happened since.

Randolph died more than half a century ago, but the name of the English has undergone no real change. There is a wealth of English education, and some trading of books and newspapers, and much discussion of English and foreign politics, which were unknown in the days of Randolph, but somewhat of public spirit and national life are still in development in the increasing climate of Bengal.

A social revolution has begun, and it has prematurely forced into usages may bring forth good fruit in the future of time; but the soil here which are calculated to bring about this re-formation are far faintly apprehended, and have not as yet been brought into healthy play. English who have visited England, and been brought face to face with English institutions, are far in advance of the backward Hindoo who have never left India. These results are often exaggerated by ill-judged theorists on the part of English boys, which tend to inflame the brains of young Hindoos, and lead them to cherish false ideas of their own merits and powers. But still there is no doubt that a pair or two spent in England is of greater advantage to Hindoo than any amount of training in India, and that Randolph might have turned out a very different man if he had been bred in London instead of Calcutta. The fact is that more instruction in Indian schools and colleges will not change the nature of the Bengalis or make it less favourable to them.

Education in the highest sense of the word, including moral and physical culture, is only to be found in European travel and free intercourse in European society. Without these conditions, not all the teaching that is carried on in India, nor the study of Sanskrit, nor familiarity with modern science, will fit the Hindoo for representative government, and enable them as a people to play a part in the history of the world.

MR. DARWIN ON EARTHWORMS.*

It is a little remark that in book-making everything depends upon the treatment and very little upon the subject; and nothing could better illustrate the truth of this rule than Mr. Darwin's latest contribution to scientific literature. Viewed in himself, the earthworm is not an attractive or dignified subject; but looked at through the light of Mr. Darwin's exhaustive investigations, by drawings into a highly interesting and almost romantic character. For just as those worms are made to be worms for the whole matter, so the fact that the public will read such a book is a fact which never before respected the depth of our obligations. Mr. Darwin, however, has long been engaged in teaching us the vast comparative importance of the infinitely little; and this may be regarded indeed as the link which binds the subject of his present volume to his previous works. At first sight, there would seem to be little connection between the production of mould by earthworms and the Origin of Species or the Descent of Man, but when we come to compare them together we see that there is really a bond of union in the method which alike illustrate—the habit of attending to those infinitesimal factors which find some account up in the long run to such common figures. We may note, too, at the outset, that Mr. Darwin's hand has forgotten none of its training. There is no loss of vivacity, no mark of falling vigour as power, and it is as true the energy of his latest work, we may still return to look forward to more than one other fascinating monograph from his writing pen.

The soft layer of black vegetable mould which covers the surface in all our better cultivated areas is owing to earthworms. That, in fact, is the first and the conclusion of Mr. Darwin's book. But the worm himself deserves a closer description, and Mr. Darwin has kept worms as pets and observed their habits with his accustomed patience, he is able to tell us much more that is interesting about their structure and their theories. A large worm consists of some two hundred cylindrical segments, each furnished with minute bristles, by means of which they creep or cling to their burrows. They have a large mouth with a prehensile lip, and they digest their food by means of a gizzard, aided, as in birds, by small pebbles. Though destitute of eyes, they appear from Mr. Darwin's experiments to be rigidly sensitive to light, and capable of distinguishing day from night. As they are endowed in their habit, this sense power of discrimination doubtless protects them from their diurnal enemies. They do not see, but their sense of smell is very important. But they are endowed with a marked sense of taste, preferring some kinds of food to others, especially onions, cabbages, and horse-radish, for which they neglected all other kinds. They are also fond of animal food. As to their "mental qualities," Mr. Darwin thinks they show some signs of intelligence, and he believes cites the fact of James Douglass suggest the conclusion that the delinquency of some species does not necessarily preclude intelligent action. Surely here, however, we must not allow James Douglass's power to a large intelligent brain. A careful reviewer says which could never have come into existence had the advanced sense-organs of his ancestors; while some have presumably been blind and deaf from their earliest existence. But in this as in life, Mr. Darwin thinks it any time that worms show a slight power of conversing their attention, that they display sagacity and wit, and that they give at least some evidence of adaptation of means

to end in the manner in which they drag leaves or bits of paper into their burrows.

These burrows themselves introduce us to the main subject of the volume. They are not mere holes in the earth, as most people imagine, but regular nests, not unlike that of the mole; consisting of a circular tunnel or gallery and a chamber at the bottom, where several worms pass the winter in company huddled up in a ball. They are lined with mould obtained by a secretion from the body, and the upper part is papered, so to speak, with dry leaves, which serve to keep the interior warm. Here the worms lie during the daytime, only showing out in search of food at night. The lower portion of the burrow is similarly papered with small stones or pebbles. But as the worms are crowded in large numbers by their comings while lying near the surface for the sake of warmth, they have learned to plug up the mouths of their tunnels with leaves, or to pile small pebbles on top of them by means of their succulent mouths. The leaves thus dragged below the surface are plied, or carried down for food, by a large part in the production of the layer of vegetable mould. Some of them decay on the spot; others are passed through the bodies of the worms and ejected with their castings. But the main action of the worms in this respect is selective. In the excavation of their burrows they swallow large quantities of earth, which they reject again at the mouths of the tunnels in small separate coils of soft fine clay. It is to these castings that Mr. Darwin traces the existence of the layer of vegetable mould on which all agriculture and most of our existing vegetation is wholly dependent. Were it not for them, these fine particles would never be worked from the surface, and all the surface of the earth would be composed of the same unyielding stony material as the bedrock.

But the first part of the volume is given by the observations were suggested to Mr. Darwin by the rapid rate at which most similar worms upon the ground, such earthworms and become covered by a layer of mould. He noticed that when sections were made in a field on which such materials had been sown a few years previously, the soil formed a regular stratum at a depth of an inch or two below the surface. The layer of earth above the soil consisted of fine mould, like that produced by worms; castings, while the layer beneath was often similar in character to the soil. Various observations showed that on the whole the worms threw up mould at the rate of an inch in five years. In the case of a small paved path, the worms were actually seen to work between the flags, and often were made at first to sweep it clean; but in the end they were allowed to have their way, and after some years they were found to have entirely covered it beneath an inch thickness of mould. Worms specially affect the shelter of stones, which protect them from birds and other enemies; and so they slowly undermine even good lawns, or the so-called *Devil's* regulates at Sturbridge. This mould brought up from below is piled all round the stone, and then the elevated lawns gradually collapse beneath the superincumbent weight. But it is not the whole mass becomes built buried in the earth. But the first part of the volume, however, is given in greater accuracy than this. He weighed all the castings thrown up in a given space within a given time, and found that they yielded annually from seven to eighteen tons per acre; while if uniformly spread upon the surface, they would amount to a layer of an inch, or sometimes even two inches, in ten years. An acre of seven worms are calculated to inhabit a single acre, this result is less surprising than it looks at first sight.

Mr. Darwin further found that worms have done much for the preservation of ancient monuments and early relics. Not only do they quickly cover up coins and stone implements with their castings, but they also make their way through mosaic or bronzed pavements, and by leaving them beneath a thick coating of mould, secure them from the plough and the hand of man. As *Schlehter*, where a thoroughly competent archaeologist, the Rev. J. J. Joyce, who aided in the investigation, was at first sceptical, Mr. Darwin was finally able to show the action of worms even now actually taking place before his very eyes. The worms find means to penetrate concrete or stone walls, and so at last to bury them, though not so rapidly as houses, which often more numerous children. In the demolition of walls, worms have also done a great share. The vegetable mould covered from the leaves which they bury, or grow off by themselves in the process of digestion, are ultimately spun into the surface of the underlying crystalline or sedimentary rocks, which they slowly disintegrate; and the constant passage of the mould through its leaders brings fresh matter constantly to bear upon the surface in the process. Thus the worms partially create the general soil, in relation to their relative action upon the vegetable mould. Not only—the small solid bodies and pieces of wood which they swallow so and then in digestion are very slowly more upon in their gossamer by melting against one another, and are so partially ground to an impalpable powder. When slightly roughened the particles bound among the castings are seen to have their angles dulled off, and the mould of the castings, in a whole, consists of a very fine soft soil. Finally, the matter thus brought to the surface is washed down the slopes of hills towards the rivers, and deposited at last in a fresh stratum at the bottom of the sea. So that, geologically speaking, the action of worms in promoting disintegration is by no means insignificant. Once more Mr. Darwin has shown us the constant interaction which exists between every member of the fauna or flora and the whole balanced constitution of the globe. He has proved that as if these unconsidered animals were to be blotted out, the face of nature would be immediately changed. Mr. Darwin is at last with the general impression that the earthworm is the greatest of all mankind's benefactors, not only to the human species itself, but to all the plants and animals on our planet as well. Yet we find at the end that, if he had chosen to take up one out of many other factors in the entire order, he could almost equally have proved to us the intimacy of its inter-relationship with all the rest. The great value of the book lies in its importance in this way as an example, and in the patient inductive investigation which so admirably illustrates its author's method.

* "The Formation of Vegetable Mould through the Action of Worms, with Observations on their Habits." By Charles Darwin, F.R.S., etc. (London: Murray, 1881.)