than that of many geologists, who would attribute the greater accumulations of calcareous rocks in secondary and tertiary strata to the creation of lime by organic force. I may further add, that this allotropic condition of matter is not without support from our present experience (similar to that given to the law of natural selection from experiment on breeding), as one of the best living chemists believes it probable that chlorine, bromine, and iodine are really one. If any chemist or mineralogist were to put forward such a geological theory of the origin of soda and lime as the foregoing, he would be regarded as a lunatic by other chemists and mineralogists. How does it happen that a theory of the origin of species which rests on the same basis, is accepted by multitudes of naturalists as if it were a new gospel? I believe it is because our naturalists, as a class, are untrained in the use of the logical faculties which I charitably suppose them to possess in common with other men. No progress in natural science is possible as long as men will take their rude guesses at truth for facts, and substitute the fancies of their imagination for the sober rules of reasoning. It has been well observed by the greatest of living Palæontologists, 'that past experience of the chance aims of human fancy, unchecked and unguided by observed facts, shews how widely they have ever glanced away from the gold centre of truth.'

Mr. W. Ogleby made some remarks.

Mr. Alphonse Gages read a paper on the formation of orpiment in a mass of sulphate of pyrites, found interstratified with the carboniferous

2 Morning Post Dec. 23/81

ON WORMS.*

A new work by Mr. Darwin is certain to create a sensation, not only in the world of science, but also in what is usually called the general reading public. The reason for this popularity is obvious. Darwin is perhaps of all scientific writers the most interesting and readable to those persons who usually dread the mere mention of a book on learned subjects. Nobody knows better than he how to popularise a theory and to cast over it a certain veil of romance which renders it peculiarly fascinating, and this he does so skilfully that scientific truth is never perverted for merely artistic purposes. This latest work "The Formation of Vegetable Mould through the Action of Worms" contains information of the most deeply interesting character, which even the ordinary reader will find surprising, indeed almost incredible. The silent and mysterious agents, so usually despised, who perform day and night the office of Nature's ploughmen, are certainly marvellous illustrations of the old saying, "God often uses the humblest tools to effect His greatest purposes." Worms have hitherto been treated, even by men of science, with contempt, and it is to Professor Darwin that they owe their elevation to their present somewhat novel "social position" in the animal world. They are, indeed, by no means such uninteresting or insignificant creatures as we are apt to believe them, and it seems are not without a certain kind of intelligence, which appears akin to reflection. Ever since 1837, when Mr. Darwin first read a paper upon their habits, they have been the objects of his constant attention and study. By night and by day has he watched them; sometimes spending hours in the dead of night contemplating their creeping movements, and this in his stockinged feet in order to avoid any undue vibration of the floor which might disturb them. That the result of such profound observation should be valuable is unquestionable, but even Professor Darwin's stanchest friends and his bitterest opponents must now confess that this remarkable book has surpassed expectation and is exhaustive. In short, it is a standard work of science, written with a succinctness and care which renders it equally entertaining and instructive.

In his "Introduction," Mr. Darwin at once informs us that "the share which worms have taken in the formation of the layer of vegetable mould which covers the whole surface of the land in any moderately humid country" is the main object of his book. After describing this mould as being of a "generally blackish colour and a few inches in thickness," Mr. Darwin proceeds to explain how by the persistent action of the worm tribe this mould is constantly being turned over, triturated, and improved, thus in verity "all the vegetable mould throughout the country passes many times through the intestinal canals of worms, and that in consequence it would be actually more correct to say 'animal mould' rather than vegetable."

"Earth worms abound in England in many different stations. Their castings may be seen in extraordinary numbers on commons and chalk downs, so as almost to cover the whole surface, where the soil is poor and the grass short and thin. But they are almost or quite as numerous in some of the London parks, where the grass grows well, and the soil appears rich. Even in the same field, worms are much more frequent in some places than in others, without any difference in the nature of the soil. They abound in paved courtyards close to houses, and an instance is known in which they had burrowed through the floor of a very damp cellar. On the mountains of North Wales and on the Alps worms, as I have been informed, are in most places rare, and this may perhaps be due to the close proximity of the subjacent rocks, into which they cannot burrow during the winter so as to escape being frozen. Dr. M'Intosh, however, found them at a height of 1,500 feet, on Schiehallion, in Scotland. They are numerous on mountains near Turin, at from 2,000 to 3,000 feet above the sea."

Earth-worms may be considered as terrestrial animals, though they are still in one sense semi-aquatic, like the other members of the great class of annelids. M. Perrier found that they could not even endure exposure in a dry room for a single night. On the other hand, Darwin tells us he has kept them alive for months under water. Worms are nocturnal in their habits, and can be seen after dark crawling about, but usually with their tails still inserted in their burrows. During the pairing season they come out of their holes even by day, and expose the greater part of their bodies for an hour or two in the early morning. The body of a large worm consists of from 100 to 200 almost cylindrical rings or segments, each furnished with minute bristles. The muscular system is well developed. The mouth is situated at the anterior end of the body, and is provided with a little projection, which is used for prehension. Worms breathe by their skins, as they do not possess any special respiratory organs. The two sexes are united in the same individual, but two individuals pair together.

"Worms are destitute of eyes, and at first I thought that they were quite insensible to light, for those kept in confinement were repeatedly observed by the aid of a candle, and others out of doors by the aid of a lantern, yet they were rarely alarmed, although extremely timid animals. Other persons have found no difficulty in observing worms at night by the same means. I noticed that when worms were illuminated by a bull's-eye lantern having slides of dark red and blue glass, which intercepted so much light that they could be seen only with some difficulty, they were not at all affected by this amount of light, however long exposed to it. Sometimes a strong light appeared to distress them; but I doubt whether it really does, for on two occasions, after withdrawing slowly, they remained for a long time with their anterior extremities protruding a little from the mouths of their burrows, in which position they were ready for instant and complete withdrawal. The light was once concentrated on a worm lying beneath water in a saucer, and it instantly withdrew into its burrow."

As these animals are only affected by light when it falls directly on the head, and as they have no eyes, it is, Dr. Darwin thinks, evident that the light affects the cerebral ganglia through the skin. Worms are quite deaf. Still they are sensible to certain vibrations. For instance, when placed upon a piano they retreated immediately into their burrows when the note C was struck, and so on with other notes. The body of a worm is extremely sensitive to touch.

"There is little to be said on the head of mental qualities of worms. We have seen that they are timid. It may be doubted whether they suffer as much pain when injured as they express by their contortions. Judging by their eagerness for certain kinds of food, they must enjoy the pleasure of eating. Their sexual passions are strong enough to overcome for a time their dread of light. They may perhaps have a trace of social feeling, for they do not object to crawl over each other. According to Hoffmeister, they pass the winter either singly or rolled up with others into a ball at the bottom of their burrows."

Mr. Darwin appears to doubt that a worm has sufficient intelligence to find its way back to a burrow which it has once left. They have a fashion of lying near the mouths of their burrows for hours together, and, of course, readily fall victims to the blackbirds and other enemies.

"If worms are able to judge, either before drawing or after having drawn an object close to the mouths of their burrows, how best to drag it in, they must acquire some notion of its general shape. This they probably acquire by touching it in many places with their anterior extremity, which serves as a tactile organ. It may be well to remember how perfect the sense of touch becomes in a man when born blind and deaf, as are worms. If worms have the power of acquiring some notion, however rude, of the shape of an object and of their burrows, as seems to be the case, they deserve to be called intelligent; for they then act in nearly the same manner as would a man under like circumstances."

Having thus acquired some notion of the construction and attributes of worms, the reader is introduced to the last, and by far the most important, part of this singular book—the use of worms. They are the makers of mould and its greatest fertilisers. These silent creeping creatures, whilst we walk thoughtlessly over them, enjoying the beauties of the land, its greenness and its flowers, are labouring for our benefit. Nay, the very antiquary is greatly indebted to them for the preservation of monuments of remote antiquity. To give some idea of the industry and of the enormous amount of labour performed by these sightless creatures, Mr. Darwin tells us that—

"Coal cinders had been spread over a part of a field near Maer Hall, Staffordshire, in 1824; and when holes were dug to see the condition of things after a lapse of four years the cinders were found to form a line of black spots round the holes, at a depth of one inch beneath the surface, parallel to and above the white line of lime. Over another part of the field cinders had been placed only about half a year before, and these either lay on the surface or were entangled among the roots of the grasses; and I here saw the process, for worm castings had been heaped on several of the smaller fragments. After an interval of four and three-quarter years this field was re-examined, and now the two layers of lime and cinders were found almost everywhere at a greater depth than before by nearly one inch—we will say by three-quarters of an inch. Therefore moulds to an average thickness of the 22d part of an inch had been annually brought up by the worms, and had been spread over the surface of this field. Coal cinders had been strewn over another field, at a date which could not be positively ascertained, so thickly that they formed (October, 1837) a layer one inch in thickness at a depth of about three inches from the surface. The layer was so continuous that the overlying dark vegetable mould was connected with the sub-soil of red clay only by the roots of the grasses, and when these were broken the mould and the red clay fell apart. I will now give some cases of the action of worms on land differing widely from the dry sands or the swampy pastures just described. The chalk formation extends all round my house in Kent, and its surface, from having been exposed during an immense period to the dissolving action of rain water, is extremely irregular, being abruptly festooned and penetrated by many deep well-like cavities. During the dissolution of the chalk the insoluble matter, including a vast number of unrolled flints of all sizes, has been left on the surface, and forms a bed of stiff red clay full of flints, and generally from six to fourteen feet in thickness. Over the red clay, wherever the land has long remained as pasture, there is a layer a few inches in thickness of dark-coloured vegetable mould."

But not only do worms bring an incredible quantity of earth to the surface by their action and their powers of forming what are popularly known as "worm castings," but they speedily bury things by covering them with the earth they throw up. It must always be remembered that the number of worm labourers in the earth is something incredible. Hensen declares that in a hectare of ordinary land there is usually about three hundred and fifty-six pounds of worms, or about 53·767 per acre, and in corn fields pretty nearly double the number. When this fact is taken into consideration it is easy to understand that the labour performed by such a population of workers is prodigious. So great, indeed, that when we reflect that a single worm throws up annually about twenty ounces of earth we may easily comprehend the vastly important part these despised creatures play in nature. Mr. Darwin is certain that archæologists owe an extraordinary debt of gratitude to worms for the careful labours towards the preservation of works of antiquity. The rapidity with which they can cover up an ancient pavement is astonishing, since in less than two years they have been known to conceal a tesselated pavement in a ruined abbey, and actually so thickly that grass and moss has begun to grow upon their earth castings. Worms, moreover, prepare the ground in an excellent manner for the growth of fibrous-rooted plants and for seedlings of all kinds. They periodically expose the mould to the air, and sift it so that no stones larger than those which they can swallow are left in it. They mingle the whole together like a gardener who prepares fine soil for his choicest plants. In this state it is well fitted to retain moisture and to absorb all soluble substances as well as for the process of nitrification. The bones of dead animals, the harder parts of insects, the shells of land molluscs, leaves, twigs, &c., are before long all buried beneath the accumulated castings of worms, and are then brought in a more or less decayed state within the reach of the roots of plants. Worms likewise drag an infinite number of dead leaves and other parts of plants into the burrows, partly for the sake of plugging them up, and partly for food.

The last passage in the book is so full of noble thought and so suggestive that its quotation will, perhaps, more aptly close this review than any further observations or tributes of praise.

"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 through the bodies of worms. The plough is one of the most valuable of man's inventions and one of the most ancient, but long before he existed the land was in fact regularly ploughed by worms. It may be doubted whether there are many other animals which have played so important a part in the history of the world as these lowly-organised creatures. Some other animals, however, still more lowly organised, namely corals, have done far more conspicuous work in having constructed innumerable reefs and islands in the great oceans, but these are almost confined to the tropical zone."

Mr. Darwin's last book is in every sense the equal of any one of its celebrated predecessors; charming in its style and fully evidencing profound learning, and full of evidence of the most patient and self-sacrificing observation. There is something touching in the picture drawn by the thoughtful mind of one of the most learned men of our age passing long hours in the dead of the night (in his stockinged feet, fearing lest the vibrations caused by his shoes might dis-

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turb those sensitive animals) watching the habits and mode of being of the lowly deaf, dumb, and blind worm. Henceforth, few of us who have read this extraordinary work will not turn aside, like St. Francis of Assisi of old, to avoid crushing even a humble worm.

It is certainly somewhat surprising that Dr. Darwin has not mentioned in his work the only known but mortal enemy of the worm, the slug, which sucks him up and destroys annually an astonishing number. The reviewer having recently placed several earth worms in a plate covered with earth and placed under a glass bell, was able to observe the astonishing dread which the large worms felt in the presence of a single slug, who, however, passed unnoticed by the younger ones. It would seem that the little animals had no innate dread of their enemy, and that the fear manifested by their elders was the result of experience. The fact remains that the large worms expressed such terror of the slug as to speedily abandon the earth on which that obnoxious animal was placed and hide themselves under another mound removed from the presence of their enemy, who, on being transferred thither, was greeted by an immediate exodus on the part of the old worms to fresh fields and pastures new and in a safer part of the plate. Not so the little ones, they did not hesitate to creep even over the slugs, who, however, taught them the lessons of experience by seizing upon them and speedily devouring them.

* 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.

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Dec. 15 – 1859

DARWIN'S ORIGIN OF SPECIES.

"On the Origin of Species by means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life." By CHARLES DARWIN, M.A. John Murray.

It is with no intention of offering a positive opinion with regard to the truth of the theory which it unfolds, that we are about to direct the attention of our readers to one of the most remarkable works that has appeared during the present century. The discussion of abstruse scientific questions is neither compatible with the limits nor consistent with the character of a daily journal; and moreover there are few living men whose acquirements qualify them to enter the lists with Mr. Darwin, or justify them in listening, otherwise than with respectful deference, to the opinions to which he has been guided by careful reasoning, based upon extensive observation, and assisted by all the aid that could be derived from the study of the results arrived at by his learned predecessors in the cultivation of the same branch of natural science. The accuracy of his conclusions can only be tested by laborious and conscientious researches, undertaken in a candid spirit, and inspired by no other motive than an honest desire for the discovery of truth. It may, perhaps, be questionable whether man will ever be able, in this life, to penetrate the veil which now shrouds the history of creation, but at any rate it is certain that the present state of human knowledge on the subject is such as to render dogmatism with regard to it nothing less than conceited folly. It is precisely because it is entirely free from this blemish, which could co-exist only with extreme ignorance or excessive vanity, that we welcome this work as a most valuable aid to reflection, and earnestly bespeak for it that impartial consideration to which the learning and experience of its author, and the admirably philosophic and reverential spirit in which he has embodied the fruits of his labours, give him an indefeasible claim.

An apparent similarity in the results at which they arrive may possibly induce some to regard this book as identical in character with the "Vestiges of Creation," which a few years since created so much excitement among the general public, and aroused such a storm of indignant protestation in the scientific world; but such an impression would involve a gross injustice to Mr. Darwin, for the difference between the two works is as great as between night and day. The author of the "Vestiges," whoever he may have been, was evidently a magnified edition of an individual whose scientific studies have been limited to attending some courses of lectures at a Mechanics' Institute. With enough of surface familiarity with the various branches of natural science to dazzle the multitude, and invest himself, in the eyes of the uninitiated, with all the qualifications of a competent teacher, he was yet so destitute of profound acquaintance with any one of them that his blunders in the discussion of points bearing upon each were at once detected and exposed by those who had specially devoted themselves to its investigation. Mr. Darwin, on the contrary, has abundantly earned, by his past labours, the high reputation which he enjoys as a practical naturalist, and, on all questions appertaining to his chosen pursuits, is recognised as an authority by the whole scientific world. Not less considerable than the disparity between the qualifications of the two writers is the difference between the character of the theories which they respectively maintain. The doctrine of the author of the "Vestiges" appears to be that a particular race of animals went on, year after year, reproducing its own kind, until at last a single pair gave birth to something essentially differing from its [illegible]

[illegible]

being constantly [illegible] by the [illegible] of well selected [illegible] the characteristics which it is deemed desirable to preserve. In all these [illegible] the agency of man intervenes, and the examples cited are therefore valuable only as illustrations; but Mr. Darwin then passes to the consideration of the state of things which exists under the exclusive dominion of nature, and, after showing that distinct varieties are to be met with in most existing species, he proceeds to explain the agency by which he supposes that these varieties ultimately become predominant over the original species:—

It may be asked how it is that varieties, which I have called incipient species, become ultimately converted into good and distinct species, which in most cases obviously differ from each other far more than do the varieties of the same species? How do those groups of species, which constitute what are called distinct genera, and which differ from each other more than do the species of the same genus, arise? All these results, as we shall more fully see in the next chapter, follow inevitably from the struggle for life. Owing to this struggle, any variation, however slight, and from whatever cause proceeding, if it be in any degree profitable to an individual of any species, in its infinitely complex relations to other organic beings and to external nature, will tend to the preservation of that individual, and will generally be inherited by its offspring. The offspring [illegible]

[illegible]

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