of the coast-guard during the first week of October, and is now, I believe, in the possession of Mr. Hutchinson, of Derby.—Chas. Dixon (Tenterden Street, W.).

Honey Buzzard in Hertfordshire.—As an interesting coincidence in connection with the notice (p. 472) of a Honey Buzzard being shot in this county, I may mention that a bird of this species was killed on the same day in this parish, which is about six miles distant from where the previous bird was met with.—J. A. Ewing (Westwick Rectory, Herts).

NOTICES OF NEW BOOKS.

The Formation of Vegetable Mould through the action of Worms; with Observations on their Habits. By Charles Darwin, LL.D., F.R.S. Post 8vo, pp. 313. London: Murray. 1881.

The perusal of a paper "On the Formation of Mould," published by Mr. Darwin many years ago in the 'Transactions of the Geological Society,' has in some measure prepared us for the volume just issued, which may be regarded as an expansion of the former essay. Objections having been taken by continental naturalists to some of the statements put forth by Mr. Darwin in his earlier *brochure*, he resolved to make more observations of the same kind as those he had published, and to carry out some experiments, with a view to ascertain the degree of intelligence possessed by earthworms.

By many people these lowly organised creatures are regarded as too insignificant to be worth notice, and few probably have taken sufficient interest in them to examine their structure and investigate their habits.

The body of an earthworm consists externally of a series of rings, from one hundred to two hundred in number, each having short bristles projecting from it. These rings are well seen in the remains of a worm that has been dried by exposure to the sun and air, when they retain their annular shape, and form a hollow tube. They are connected by a membrane or skin, and are moved by strong muscles contained in their interior. The fore part of the body is tapering, and ends in a mouth with lips. Immediately behind the mouth is the gullet or tube leading

to the gizzard; this swells out into a strong muscular throat or pharynx. On each side of the gullet are glands secreting lime. The gullet itself ends in a crop, which leads into a powerful gizzard: this, like the corresponding organ in a bird, contains stones for grinding the food. These stones in a full-sized worm are so large that nine or ten of them laid side by side will measure a full inch. The intestine passes straight from the gizzard to the end of the body. Worms have no lungs, breathing by their moist skin; hence they rapidly perish when exposed to dry air, though capable of prolonged life under water. Their senses are peculiar. They have no eyes, yet appear sensitive to light, which must pass through the transparent skin to reach the nerves. Thus they distinguish day and night, and avoid the dangers of exposure to their enemies, the birds, during the former period. Sound, unless accompanied by vibration of the ground, produces no effect on them, but they are sensitive of the slightest touch, even of a current of air. Their food is chiefly half-decayed leaves, but they are also carnivorous, and even prey upon the dead bodies of their own kind. The dead leaves they drag into their burrows, partly for food, and partly to close the openings. The leaves are seized by the lips, and then the anterior part of the body is formed into a kind of sucker. When leaves are not to be obtained for food, they swallow large quantities of mould, digesting the vegetable matter, and voiding the mineral portion in the form of worm-casts at the mouths of the burrows.

In plugging up the mouths of their burrows, they evince a remarkable degree of intelligence. In order to test this, Mr. Darwin scattered a few hundred elongated triangles of paper over the ground, after removing all the fallen leaves he could see. These triangles, cut out of writing-paper, were rubbed with raw fat on both sides to prevent their becoming too limp when exposed at night to rain and dew. He found that, in the majority of cases, the worm on seizing a triangle selected the most pointed angle to draw into its burrow; in other words, it seized it in the position in which it could most easily be made to effect the object in view. In considering the question whether such action is intelligent or non-intelligent, Mr. Darwin adopts the argument that we can safely infer intelligence only when we see an individual profiting by its own individual experience; and he adds that if worms are able to judge either before 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, and thus guide their actions by the result of individual experience.

The enormous amount of earth brought annually to the surface by worms is very remarkable. By actual experiment—that is, by collecting and weighing the castings—it appears that in some cases 83 lbs. of earth are brought up to the surface of every square yard during the year—an amount which reaches the high total of 18 tons per acre; and 10 tons may be taken as a very fair average. The number of worms in an acre of land has been estimated at between 50,000 and 60,000, their weight being nearly 400 lbs. The numerous experiments of this kind made by Mr. Darwin give some very curious and at the same time astonishing results. One of these experiments lasted about thirty years! It was this:—In 1842 a layer of broken chalk was spread over old pasture land for the sake of observing at some future time the depth to which it would become buried. In 1871 a trench was dug across the field, and the line of white masses was everywhere seven inches from the surface!

After such experiments as these, it is not difficult to understand how boulders, monoliths, and ancient monuments, may in course of time become gradually buried by the agency of earthworms, to whom antiquaries may be said to be truly indebted. The tesselated pavement of Abinger, in Surrey, was covered with at least fourteen inches of worm castings; the remains of a Roman villa at Chedworth, in Gloucestershire, were concealed under thirty-eight inches of similar soil; and the fine villa recently discovered at Brading, in the Isle of Wight, had been buried by worms to the depth of from three to four feet, the floor having gradually sunk as the earth which the annelids piled up was removed by them. In like manner the Roman towns of Silchester, in Hampshire, and Wroxeter, in Shropshire, have experienced the kindly attention of the worms; while one of the fallen blocks at Stonehenge has sunk considerably below the level of the surrounding ground through the same agency.

It must not, however, be forgotten—and Mr. Darwin is careful to remind us of this cause of possible error in his own calculations—that the washing down of soil from the neighbouring higher lands and the deposition of dust have together aided

largely in the work of concealment when the ruins are so placed as to permit of the action of these subsidiary causes.

The assistance which worms lend to the process of denudation is of special importance in the case of flat or gently inclined surfaces, for here it is not improbably the chief agent at work. Castings thrown up during or shortly before rain flow for a short distance down an inclined surface, and the finest earth is washed completely away. Again, during dry weather the disintegrated castings roll as little pellets, and, even on a level field, a strong wind will blow them all to leeward.

In his closing chapter, Mr. Darwin thus summarises the chief benefits confirmed by worms on man as a tiller of the soil. 'Worms," he says, "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 the particles which they can swallow are left in it. They mingle the whole intimately 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-mollusks, leaves, twigs, &c., are before long all buried beneath the accumulated castings of worms, and are thus brought in a more or less decayed state within reach of the roots of plants. Worms likewise drag an infinite number of dead leaves and other parts of plants into their burrows, partly for the sake of plugging them up and partly as food. The leaves which are dragged into the burrows as food, after being torn into the finest shreds, partially digested, and saturated with the intestinal and urinary secretions, are commingled with much earth. This earth forms the dark-coloured, rich humus, which almost everywhere covers the surface of the land with a fairly well-defined layer or mantle. 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."

In the face of such testimony as that adduced by Mr. Darwin's untiring industry in this extremely interesting volume, it may

well be doubted whether there are many other animals which have played so important a part in the history of the world as "the poor worm."

Studies in the Theory of Descent. By Dr. A. Weismann. Translated and edited by Raphael Meldola, F.C.S. Part II. On the origin of the Markings of Caterpillars, and on Phyletic Parallelism in Metamorphic Species. With six coloured plates. 8vo. London: Sampson Low & Co. 1881.

In the first portion of this work, which is announced to be completed in three parts, Dr. Weismann examined the phenomena of seasonal dimorphism in butterflies; in the second part now before us we have two essays with the titles given above. Of these, the former embodies the details of a careful study of the change of markings which the caterpillars of the *Sphingidæ* undergo in the course of their development. From a consideration of these, the author deduces certain laws of development, which are subject to modification through the influence of natural selection, and the necessity for protection, thus giving rise to the various markings observable in different groups. These varieties of colour and markings in the *Sphingidæ*, according to Dr. Weismann, have a distinct biological value, and can in every case be traced to the action of natural selection and correlation of growth.

In his second essay, the author compares different groups of *Sphingidæ* in their three stages of larva, pupa, and imago, and argues that the modifications which are found to occur are due, not to any innate law of variation and development (which would affect all the stages *pari passu*, and produce "a phyletic parallelism" which does not exist), but to an adaptation to special conditions to which, in one or other of its stages, the insect is exposed. This is stated to be the case not only with Lepidoptera generally, but with all creatures which undergo a metamorphosis.

No one but an entomologist well conversant with German would have ventured on a translation of this very interesting work, for the numerous technical terms which everywhere occur require a translator who has not only a knowledge of the language, but a really thorough acquaintance with the subject matter