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THE THEORY OF DESCENT

Studies in the Theory of Descent. By Dr. Aug. Weismann, Professor in the University of Freiburg. Translated and Edited by Raphael Meldola, F.C.S. Part II. On the Origin of the Markings of Caterpillars. On Phyletic Parallelism in Metamorphic Species. With Six Coloured Plates. (London: Sampson Low, Marston, Searle, and Rivington, 1881.)

THE first part of this work, devoted to an examination of the phenomena of seasonal dimorphism in butterflies, was noticed a little more than a year ago (NATURE, vol. xxii. p. 141). We now have a second instalment of much greater bulk, comprising two separate essays. In the first and most important of these Dr. Weismann gives us the results of a detailed study of the changes in the markings of the caterpillars of the Sphingidæ during the course of their growth and development, and enters at great length into the various questions to which the phenomena observed give rise. Accepting the doctrine that the *ontogeny* or development of the individual gives us a more or less accurate notion of the *phylogeny* or course of development of the race, he endeavours with some success to determine the ancestral forms of the various genera of the Sphingidæ by means of the successive changes of form and coloration of the larvæ. The main facts which he has here established are, that all the larvæ are born of a uniform tint—that the first markings are longitudinal lines—that the oblique lines when they exist always appear later, and the ringed or ocellated spots last of all. Great changes of colour also occur in some species, but all the more important changes, whether of colour or marking, only take place after the larvæ have acquired a considerable size. From the whole assemblage of facts in this branch of the inquiry he deduces the following three laws of development:—

“1. The development commences with a state of simplicity, and advances gradually to one of complexity.

“2. New characters first make their appearance in the last stage of the ontogeny.

“3. Such characters then become gradually carried back to the earlier ontogenetic stages, thus displacing the older characters until the latter disappear completely.”

These laws are liable to be modified in various ways by the influence of natural selection, and especially by the need for protection, whence arise the various markings of the different groups, and the peculiar divergences often noted in their development at corresponding ages.

Having thus established the general developmental history of the markings of caterpillars, and explained by a few simple principles the chief anomalies they present, Dr. Weismann passes on to the still more interesting inquiry as to the biological value or actual meaning and use of the markings in each individual case. He first shows that colour itself, irrespective of marking, has a distinct biological value, being always either protective or a signal of uneatableness. The Sphinx larvæ when young are almost always green, resembling the leaves of the plants on which they feed and rest. When they get larger, however, they frequently change to brown, and this change is always accompanied by a change in habits,

the insect feeding at night, but during the day concealing itself on the ground or amidst dead leaves and branches. This occurs chiefly among the species which feed on low shrubs or herbs and can thus easily descend to the ground to conceal themselves during the day; while those which feed on large trees acquire markings which assimilate them more completely to the foliage or flowers which surround them. The simplest form of marking—longitudinal stripes—is common on all caterpillars which feed on grasses or other plants in which straight lines are a prevalent feature, and this style of marking is that which usually appears in the young sphinx larvæ. But as they grow larger diagonal stripes or bands variously tinted or shaded appear, and this style of marking is found to assimilate so well with the oblique veining of the leaves that the caterpillars are very difficult to see when resting among them. This is the case even when the oblique lines are margined with violet or other bright colours, since, however conspicuous these markings may be when the insect is examined in captivity, they are found to blend perfectly with the lights and shadows of the foliage which surround it in its natural habitat. As an example we have the following account of the brilliantly coloured larva of the Death's-Head Moth on one of its natural food-plants:—

“At Cadiz on the hot, sandy shore, *Solanum violaceum* grows to the height of three feet, and on a single plant I often found more than a dozen *Atropis* larvæ resting with the head retracted. It can easily be understood why the lateral stripes are blue when one has seen the South European *Solanææ*, on which this larva is at home. *Solanum violaceum* is scarcely green: violet tints alternate with brown, green, and yellow over the whole plant, and between these appear the yellow-anthered flowers, and golden yellow berries the size of a greengage. Thus it happens that the numerous thorns, an inch long, between which the caterpillar rests on the stem, pass from violet into shades of blue, red, green, and yellow.”

Many of the adult sphinx larvæ however are adorned with ring-spots or eye-spots, and these have been found to serve two distinct purposes. Sometimes they occur on several of the segments, but of slightly different sizes, as in a North American species (*Charocampa tersa*), the red spots on which imitate the small red flowers of the plant on which it feeds; while in the European *Deilephila hippophaes*, the grey-green larva with orange-red spots so exactly assimilates to the foliage and fruit of the sea-buckthorn on which it feeds, that Dr. Weismann has often shown to people as many as six or eight of the large caterpillars on one buckthorn branch without their being able at once to detect them. In other cases we find very large eye-spots on the fourth or fifth segments only, coupled with the habit of retracting the head and first three segments, so that an appearance is produced of a broad head with two very conspicuous eyes. Whenever the insect is disturbed it thus retracts itself, and it has often been conjectured that the effect is to frighten away its enemies. This Dr. Weismann has proved to be actually the case. On placing the larva of the Elephant Hawk-Moth (*Charocampa Elphenor*) in a trough used for feeding fowls, a number of sparrows and chaffinches flew down from the neighbouring trees to pick up some stray food.

“One bird soon flew on to the edge of the trough, and

was just about to hop into it when it caught sight of the caterpillar, and stood jerking its head from side to side, but did not venture to enter. Another bird soon came, and behaved in a precisely similar manner; then a third, and a fourth; others settled on the perch over the trough, and a flock of ten or twelve were finally perched around. They all stretched their heads and looked into the trough, but none flew into it."

On removing the caterpillar the birds again assembled, and at once entered the trough to feed. Fowls were also frightened at first, and would draw back just as they were going to peck at the caterpillar. At last, after several had tried, and even made ineffectual attempts to peck, one more courageous than the rest would actually touch it, and after a time, finding nothing disagreeable, the insect would be swallowed. In the genus *Deilephila*, however, there are uneatable caterpillars, and these have strongly contrasted black and white or yellow spots combined with the habit of fully exposing themselves upon their food plants. Dr. Weismann experimented with two species (*D. galii* and *D. euphorbiae*) and found that they were refused by birds, though the latter was eaten by lizards. It is to be noted however that the experiments were made with a South European species of lizard, not that of Germany, so that the result has not a direct bearing on the point.

The general conclusion at which Dr. Weismann arrives is, that all the varieties of colour and marking occurring in the Sphingidæ have a distinct biological value, and can in every case be traced to the action of natural selection and correlation of growth.

The next essay is not quite so interesting or important. It is an endeavour to prove, by a distinct line of inquiry, that the markings of the larvæ are not due to a "phyletic vital force" or to general laws of growth and development. The different groups of Sphingidæ are minutely examined and compared in their three stages of larva, pupa, and imago, and it is shown that the changes that occur from species to species in each stage are to a great extent independent of the changes in the other stages. Numerous examples of this want of phyletic parallelism are given, and it is hence argued that the modifications which occur must be due to an adaptation to the special conditions to which the insect is exposed in one or other of its states, not to any innate law of variation and development, which, it is argued, would affect all the stages *pari passu* and produce a "phyletic parallelism" which does not actually exist. The same general facts are shown to prevail, not only among Lepidoptera generally, but among all insects and crustacea—or generally among all organisms which undergo a metamorphosis.

This instalment of the work has been admirably translated and edited by Mr. Meldola, who, in a series of valuable notes and an Appendix, has brought up the information on every branch of the inquiry to the latest date. The six coloured plates of larvæ in their several stages are very well executed, and serve to illustrate the somewhat complex discussion in a clear and effective manner.

ALFRED R. WALLACE

OUR BOOK SHELF

The Wandering Jew. By Moncure Daniel Conway. (London: Chatto and Windus, 1881.)

THIS last volume of Mr. Conway's is a study, not only of the legend of the Wandering Jew, but with it of the large

group of analogous myths of undying men who from age to age wander over the earth, or sleep in caverns, or are translated from among men into divine regions, whence however they come back and show themselves still living men. The interest of these stories in the history of philosophy lies in their keeping up men's early ideas of life and death. One of Mr. Conway's purposes in discussing them is to draw attention to their being relics of the primitive period when men were still so far from definitely realising the nature of death, that they had no difficulty in regarding kings, heroes, and prophets as having only departed for a while from among them, to return in a future age to rule and protect their expectant nations. In comparative mythology this group of stories has some importance. They show the beliefs of various races running curiously into one another, as where the Lancashire peasant still hears in the cry of the plover the wail of the Wandering Jew, or in the Harz Mountains his myth has got mixed with that of a grander wanderer, the Wild Huntsman, who courses with his storm-clouds across the sky. The storm-demon whom mythic fancy imagines rushing through the air is often called a *Macabe*, and Mr. Conway points out why he has this name. It is because of a verse in the Second Book of Maccabees, chap. v., which, by the way, is a good instance of the personal forms taken by the fancy of an excited people: "And then it happened, that through all the city, for the space almost of forty days, there were seen horsemen running in the air, in cloth of gold, and armed with lances, like a band of soldiers." Unfortunately some other etymologies made or quoted by Mr. Conway are not so reasonable as this. When the names of biblical personages, *Herod* and *Ahasuerus*, find their way into European myths, it may not be easy to explain how they got there, but at any rate it is better to leave them alone than to make up imaginary and even impossible German or Scandinavian forms, *Haar-Rote*, *As-Vidar*, to account for their presence. It would be easy to take exception to many of the arguments in this volume, but at any rate there are many interesting points in it.

A Short Sketch of the Geology of Yorkshire. By Charles Bird, B.A. (Univ. Lond.) (London: Simpkin, Marshall, and Co.; Bradford: Thomas Brear, 1881; pp. 187 and Map.)

Geological Map of Yorkshire. By the same Author. (Edinburgh and London: W. and A. K. Johnston; Bradford: T. Brear, 1881.)

IN the preface of this book, written by way of dedication, it is represented to be a "small and cheap volume suitable to the 'general reader' and tourist." It is impossible to say that it is not a useful and interesting one. So much good work has been done on the county, though scattered through very various publications, that a short *résumé* cannot fail to be of value; but there are books and books, and if we measure this by what it might have been, it is poor indeed. It resembles, in fact, geologically speaking, a kind of boulder clay, full of fragments of solid rock, brought from a distance—we will not say to be deposited in mud—but certainly scratched and rubbed in the process. In the beginning of the volume is a list of the surrounding mountains whence the boulders have been derived, but it is not a complete one; and the source of each fragment is not indicated in the body of the text. Its great defect is that it is unstratified; in other words, the extracts are not duly digested, but thrown together without sorting, and with very little alteration; so little indeed that it would not be difficult to trace them to their sources. Thus under the head of "The Carboniferous Period" we have a brief explanation, from a popular lecture, "how from the general mineral character of a rock the circumstances under which it was formed can often be predicated." Then under the head of "Salt water deposits" we have twelve pages on the origin and contents of the Victoria