Protective Mimicry as Evidence for the Validity of the Theory of Natural Selection. *By* EDWARD B. POULTON, *M.A., F.R.S., Hope Professor of Zoology, Oxford.*

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Several suggestions have been put forward to account for the superficial resemblances between animals, especially insects, occupying the same geographical area. It has been suggested, and indeed strongly maintained, that food, climate, or some other chemical or physical influence of the locality may have supplied the cause. On the other hand, many naturalists consider that the facts cannot be interpreted by any of these suggested causes, and only receive an intelligible and probable explanation in the theory of natural selection. This theory supposes that the resemblance is advantageous in the struggle for existence, the weaker forms being shielded by their resemblance to the strong and well-defended species (mimicry of H. W. Bates), or the latter gaining by a resemblance which enables their local enemies more easily—and thus with a smaller waste of life—to recognise and avoid them (mimicry of Fritz Müller). The present paper directs attention to certain facts commonly associated with mimetic resemblance which receive a ready explanation upon the theory of natural selection as the efficient cause, but, on the other hand, constitute a serious difficulty in the way of any other theories as yet brought forward.

Natural selection, as is well known, acts upon *any* variations, whatever they may be, which are in the advantageous direction, and are at the same time not injurious in themselves. When the end to be gained (in this case the attainment of a superficial resemblance) is common to a variety of distantly related species possessing entirely different constitutional tendencies, we may feel confident that an approach brought about by natural selection will be by extremely diverse paths of variation. Under natural selection we might predict that such a common end would be reached by great diversity of means, while under the other hypotheses mentioned above a result of the kind is inexplicable. Hence the facts of the case should act as a convenient test between these rival suggestions.

First as to colour. We know but little of the chemical nature of the pigments made use of in mimetic resemblance. One case, however, has been investigated by Gowland Hopkins—viz., the bright tints by which certain S. American *Pierinæ* have come to resemble *Heliconinæ* and *Ithomiinæ* in the same locality. Gowland Hopkins has shown that these close resemblances in colour and pattern are produced by pigments which are characteristic of the *Pierinæ*, and of an entirely different chemical nature from those of their models.

Another very interesting case is that of resemblance to ants. Ants are mimicked more or less closely by a great variety of insects and by spiders. In some cases we find the resemblance brought about by actual alterations in the shape of the body (spiders and many insects), which is modified into a superficial resemblance to the Hymenopteron. In an Acridian—*Myrmecophana fallax*—the shape of an ant is, as it were, painted in black pigment upon the body of the insect, which is elsewhere light in colour and, as it is believed, inconspicuous in the natural environment. In a certain group of Homoptera—the Membracidæ—some of the S. American species closely resemble ants. The Membracidæ are characterised by an enormous growth from the dorsal part of the first thoracic segment (pronotum), which spreads backwards and covers the insect like a shield. In these insects the form of an ant is moulded in the shield beneath which the unmodified body of the insect is concealed. These facts are only explicable by supposing that some great advantage is to be gained by resembling an ant, and

that very different species have attained this end, each by the accumulation of those variations which were rendered possible by its peculiar ancestral history and present constitution—in other words, by the theory of natural selection.

A more elaborate case, which I have recently investigated, is afforded by a large group of tropical American Lepidoptera—moths as well as butterflies—which closely resemble certain common wide-spread species of the Ithomiine genera *Methona* and *Thyridia*. The appearance thus produced consists of a transparent ground with a black border to both wings, the fore wing being also divided by black transverse bars into three transparent areas—the hind wing usually into two. From a comparison with other species of the various families, &c., not altered in this direction, we know that the transparent wings are not ancestral. When we investigate the manner in which transparency has been attained, it is found to be by different methods in the different constituents of the group. Among the numerous genera of Ithomiinæ (*Methona*, *Thyridia*, *Dircenna*, *Eutresis*, *Ithomia*, &c.) the result has been attained by the reduction of the scales to a very minute size, so that they hardly interfere with the passage of light. This reduction affects the two kinds of scales which alternate with each other in the rows upon the wings of this sub-family, a common result being (*e.g.*, in *Methona* and *Thyridia*) the alteration of the more slender scales into hairs, and of the broader ones into minute bifid structures, still retaining scale-like proportions in spite of their extremely small size. In others, again, the two kinds of scales are reduced respectively to simple and Y-shaped hairs, which regularly alternate along the rows. In the *Danainæ* proper, represented by the genus *Ituna*, the transparency is chiefly due to the great diminution in the number of the scales, and those which remain are neither much reduced in size nor altered in shape. In the *Pierinæ*, represented in this group by only a single species, *Dismorphia orise*, the scales are greatly reduced in size, but are neither greatly altered in shape nor diminished in numbers.

Hence in these three sub-families of butterflies transparency is attained in three different ways, viz. (1) by reduction in size and simplification in shape; (2) by reduction in number; and (3) by reduction in size alone.

When we examine the moths which fall into the group, we find a much greater difference in the methods, corresponding to the wider divergence in affinity. In the several species of the genus *Castnia* the scales lose their pigment, although undiminished in size, while they are at the same time set vertically upon the wing, so that light can freely pass between their rows. In the widely separated genus *Hyelosia* the arrangement is nearly the same, except that the vertical scales are much attenuated. In the genus *Anthomyza*, which furnishes the group with many species, the scales retain the normal size, shape, and overlap, but become so completely transparent that the light freely passes through them.

In all the numerous constituents of this large group of Lepidoptera a very close resemblance has been produced by entirely different methods; a result which, it has been argued above, is only consistent with the view that natural selection alone, among all the explanations which have been suggested, has been the cause of the observed phenomena.

I owe to the kindness of Mr. Godman and Mr. Salvin the opportunity of studying all the butterflies of this large transparent-winged group, while Mr. Herbert Druce kindly lent me those moths which are not represented in the Hope Collection in the Oxford University Museum.

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