

## ON REVERSED SEXUAL CHARACTERS IN A BUTTERFLY.

A paper "On reversed sexual characters in a butterfly, and its interpretation on the theory of modification and adaptive mimicry," was read by Mr. Alfred R. Wallace, as follows:—

Having found an instance in which the usual external sexual characters are reversed, and thinking that it may be well explained by the principles of *natural selection* and *adaptive resemblance* or *mimicry*, I wish to offer a few remarks to the Association, as I look upon it as a kind of *crucial instance*, by which the merits of *different theories* of the origin of species may be tested.

In several groups of the higher animals, the males differ from the females not only in the possession of weapons of offence or defence and characteristic ornamental appendages, but also, whenever a difference of colour exists in the sexes, in the males being ornamented with more varied or richer hues. This is especially the case in the great classes of *Birds* and *Insects*. I am not aware of any case in which the female bird is more richly coloured than the male, though in some cases she is adorned with more variegated colours. From the fact that the males up to a certain age are like the females, and also from the fact that the females of closely allied species are often almost undistinguishable while the males are very distinct,—it is considered that the male characters present an advance or higher development of the characters common to the female and to the group.

Exactly the same phenomena occur in *Insects*, and especially in *Butterflies*, which in many respects are strikingly analogous to *Birds*. The rule holds in all the families of the extensive group of *Diurnal Lepidoptera*, with one or two very curious exceptions.

In arranging my collection I found it necessary to determine the sexes of all the species as accurately as possible, and for this purpose had recourse to certain structural characters, in the *Papilionidæ* and *Pieridæ*, the presence of abdominal valves in the male. In the *Nymphalidæ* and all other groups except the *Hesperidæ*, the difference in the structure of the fore legs, which is readily observable and offers a sure means of separating the sexes.

On coming to the *Diadema antilope*, and an allied species which had been confounded with it, I found to my surprise that the individuals always hitherto considered as *males*, and noted as such in Doub. and Hew. Gen. 1 *Diur. Lepid.*, Sp., page 281, from their bright *metallic blue lustre*, were *females*, while the dull and obscure specimens were *males*.

Many other species of the same *Genus Diadema* have the same gloss of blue, but always in the *males*.

Now to understand the cause of this anomaly we must consider a little the theory of those external sexual characters I have already pointed out in *Birds* and *Insects*.

The only theory that attempts to account for these by any natural law is that of Mr. Darwin, by what he terms sexual selection. According to this view the greater strength and the weapons of offence and defence possessed by the male, are due to the facts that the males fight together for the females, and that therefore every slight variation that gives some individuals the advantage in these struggles is transmitted to their offspring. It is quite in harmony with this view that such male characters are most developed in *polygamous species*—as the spurs of the cock, the horns of the stag and the ram, &c.

Another kind of sexual selection, is when increased beauty of colour or of voice *attracts the female*, and leads to her choice of a favoured partner. Facts have been observed to show that this really does take place, and it is the only hypothesis that accounts for the very general superior beauty of colour and of voice in the male over the female. This acts equally well in *monogamous* as in *polygamous species*—as instanced in our song birds and in diurnal lepidoptera.

In the case of insects, and especially of butterflies, I believe another principle has assisted in producing the diversity of the sexes. It is necessary for the preservation of the race, that the female insect should *live longer* than the male, because she has to deposit her eggs in a proper situation, during which she is necessarily exposed to the attacks of her enemies. She wants protection, therefore,

more than the male does, and anything that makes her less conspicuous is an advantage. Gay colours will therefore be generally injurious, and the inevitable "survival of the fittest" will prevent their development.

But now another principle comes in. It is well known that numbers of insects and some birds derive a great protection from enemies by their colours assimilating with the ground colour of their haunts. Many moths and beetles exactly resemble the bark of the trees on which they usually repose; others closely imitate sticks or leaves, or even the dung of birds. Now, in many cases, the same law of the greater protection of the female applies here,—a striking example of which are the wonderful leaf insects of the genus *Phyllium*, where the females mimic leaves most accurately, while the males, which are smaller and more active, have no such resemblance.

It had been long known that certain insects strikingly resembled other insects externally, although their structure and organization showed them to belong to distinct genera or families, or even orders. There are flies and moths which perfectly resemble stinging hymenoptera. It was Mr. Bates who first investigated these with the view of discovering the rationale of the phenomenon, in which, I think, he quite succeeded. He showed reason for supposing that the species which resembled totally distinct species of other groups, obtained an advantage by this resemblance, just as did those which resembled vegetable or inanimate objects. The most striking case which he brought forward was that of the *Heliconidæ* and *Danaidæ*, two families of butterflies which are the subject of close imitation by species of two distinct families, and in every case the pairs of resembling species inhabit not only the same part of the world, but the very same district and locality, have the same habits, and may be taken flying together. In Africa, in America, and in Asia, are many of these curious cases, species of other groups, always mimicking the *Danaidæ* and *Heliconidæ*. Now, how do these various species which resemble others gain anything by it? It can only be because the insects they resemble are themselves saved from attack, in some way or other, and the species that resemble them being mistaken for them by their enemies, thus gain an advantage over their allies who are not so mistaken. The nature of the protection of the *Danaidæ* and *Heliconidæ* seems to be an odour and taste which is disagreeable to insectivorous birds and insects. They all certainly have a strange medicinal odour which is very powerful; they are excessively abundant in species and individuals; they are generally conspicuous insects; and every one of them—although they vary greatly in size and bulk—have a very slow and weak flight. This combination of characters seems to render it almost certain that they are distasteful to many enemies which check the increase of other groups, and favour in them great powers of flight, or habits which enable them to conceal themselves.

Among the species that mimic these groups we find some in which both sexes are equally protected, while others have only the females so guarded. A striking conformity with other cases in which protection by mimicry is universally admitted *Diadema bolina* is a remarkable instance of this.

The species I propose to name, *Diadema anomala* is another, for here the glossy blue strikingly resembles the common *Euphlæa midamus*, which inhabits the same countries, and thus the females have acquired the colouring generally assumed by the *males*, because each slight variation in that direction was advantageous to the female, and therefore survived in that sex—in the male, from his more rapid flight, and his importance for a shorter time in the economy of nature, the modification has not been so rapid.

That this is the true explanation of the facts is, I think, shown by their being an exactly analogous one in South America, where several species of *Pieris*, *P. pyrrha*, *P. malenka*, have the *females* bright orange and red, while the *males* are white. Here, too, the females exactly resemble *Heleconias*, with which they fly in the forest, and cannot be distinguished from them. This case is, however, not so remarkable because, in it, the male departs from the general colouring of its immediate allies, while in my *Diadema* the colouring is exactly that which is characteristic of the *male sex* in the genus. It is an exact

reversal of the usual sexual characters for a special purpose, which we can distinctly trace, and as such is, I believe, unique. I may state, also, that this species inhabits the same localities as the *Euplexa* it resembles, and flies almost equally slowly, so as to deceive any collector, and, therefore, most probably any insectivorous bird.

Now, if the soundness of a theory is to be tested by the number and variety of the facts which it connects and explains, I would submit that here we have a large number of very curious facts which are explained on the theory of *favourable variations* increased in definite directions by "*survival of the fittest*." I will briefly recapitulate these.

1st. There are numbers of insects which closely resemble the inanimate objects, on or among which they rest.

2nd. There are species of *Lepidoptera* and flies which resemble stinging hymenoptera.

3rd. There are many *Lepidoptera* which resemble in all parts of the world—one particular group, the *Danaoid Butterflies*.

4th. This group is conspicuous in size and colour; is very varied in form and markings; the species do not conceal themselves; the individuals abound everywhere; and out of more than 20 genera and near 1,000 species, not one has a quick or powerful flight.

5th. All the species of this great group have a strong and disagreeable odour, which is given out when the body is crushed or wounded, and which occurs in no other group of butterflies.

6th. Among the cases of mimicry of inanimate objects, it is often the *females* that possess it most perfectly, and sometimes exclusively.

7th. In the cases of mimicry of the *Danaoid* butterflies the same thing occurs, the females alone in several instances possessing the resemblance, and thus sometimes acquiring a colouration like the *males* of other species.

8th. The *species*, and even the *entire genus* in which these resemblances occur, is often very variable, and transitional forms are often found showing the steps in the production of these mimicking species.

Here we have a series of remarkable and undisputed facts. Mr. Darwin's theory, as applied by Mr. Bates and myself, seems to me to connect and explain them, and to clear up such an apparent anomaly as that which has led me to make these remarks; and I am not aware that any other theory or hypothesis has even attempted to do so.

Professor HUXLEY cautioned Mr. Wallace against considering this as a decisive case. It was explained quite as completely by the theological doctrine of the late Dr. Paley.

Mr. HERBERT SPENCER thought he could show that the case described by Mr. Wallace could not be satisfactorily explained by Dr. Paley's teaching. He understood Mr. Wallace that the imitation was *not complete*, and varied in different individuals. This incompleteness was not to be explained were we to assume that the one butterfly was made in imitation of the other by the Creator; but it was readily accounted for by the law of evolution.

#### ON THE ASEQUAL REPRODUCTION AND ANATOMY OF CHÆTOGASTER VERMICULARIS (MULL).

A paper "On the Asexual Reproduction and Anatomy of *Chætogaster vermicularis* (Mull)," was read by Mr. E. Ray Lankester, as follows:—

The *Chætogaster* is a minute worm, one-eighth of an inch long, parasitic on the common water-snail. Its most remarkable peculiarities are, the presence of oral bristles differing from those of the body, the very small number of segments (five) composing it, and the total absence of cilia and reproductive organs. The author described its anatomy minutely, and its mode of reproducing by budding.

#### LIST OF TURBELLARIA AND ANNELIDA OF NORTH UIST, AND A NOTICE OF NEW AND RARE MARINE ANIMALS, LATELY PROCURED ON THE EAST AND WEST COASTS OF SCOTLAND, BY DR. W. C. MCINTOSH, M.D.

The author said, with regard to the annelids of North Uist, I may just mention that there are about 110 species, some of which have hitherto been procured only at rare intervals, either in Britain, or on the continent, while others are new to science. Amongst the rarer known forms may be noticed, *Lineus albus*, *Stylus fasciatus*,

*Serpentaria fragilis*, *Gattiola*, *L. Calibrayma*, *Terebella maculata*, *Terebellides*, &c., &c. Mr. Gwyn Jeffreys has kindly placed at my disposal a collection which he has just made in the Hebrides; and since he dredged in deeper water, a rich addition to the series is expected.

I beg also to draw your attention to the new and rare forms of marine animals represented by the coloured drawings, including a curious ringed Campanularian form, a *Clavelina*, *Cynthia*, two species of *Salpæ*, two of *Eolis*, a new *Synapta*, and other forms, and I have to correct an error made in a previous description,\* in which, what now appears to be the young of *Comatula*, was made a new species.

In reply to Dr. Perceval Wright, and Mr. Ray Lankester, anent the habits of the *Polynœ scolopendrina*, the author said that every example of the species at Lochmaddy occupied the tube of a *Turbella nebulosa*, along with the rightful owner thereof, and, moreover, that the *Polynœ* was phosphorescent. The habit of frequenting tubes is common in allied species, as described by Dr. Baird, and others.

Mr. Gwyn Jeffreys, F.R.S., also made some remarks on the subject.

The following papers were also read:—"On a New Molluscoid Animal," by Dr. W. M. McIntosh; "On the power which some Rotifers have of attaching themselves by means of a thread," by Mr. R. Garner; "Notes on the Structure of the *Echinoidea Regularia*, with special reference to their classification," by Mr. C. Stewart; "On the Crustacea, Echinodermata, Polyzoa, and Coelenterata of the Hebrides," by the Rev. A. Merle Norman; "Report on the Ostracoda dredged amongst the Hebrides," by Mr. C. S. Brady; and "Supplementary Report on experiments with Entozoa," by Dr. Cobbold.

## SECTION D.—BIOLOGY.

### [DEPARTMENT OF PHYSIOLOGY.]

This department resumed its sittings on Monday, under the presidency of Professor Humphry, F.R.S.

#### ON THE MOVEMENTS, STRUCTURE, AND SOUNDS OF THE HEART.

The following paper was read by Francis Sibson, M.D., F.R.S., on "The Movements, Structure, and Sounds of the Heart:—"

*Movements.*—The author made his first experiments on the movements of the heart in Nottingham in 1843, assisted by Mr. Shepperley—the animal being under the influence of wourali, supplied by Mr. Waterton; and his recent observations in London, assisted by Dr. Broadbent and Mr. Edwards, the creatures being rendered unconscious by chloroform. In these, the pericardium was entire, following the plan of Dr. Halford.

A millimetre measure was stretched across the heart, and the precise position of each part of the heart in relation to the measure was noticed, first at the end of diastole, and then of systole. These observations were in each instance made by Dr. Sibson, and corroborated by Dr. Broadbent.

During systole, the ventricles contracted in every direction. This contraction was most marked at the base, where the auricles and great vessels became distended and enlarged, so as to occupy the space just vacated by the ventricles. In this way the whole contents of the pericardium were the same in amount during both systole and diastole, the balance of the distribution being greater in the ventricles at the end of the latter period, in the auricles and great vessels at the end of the former.

The contraction of the right ventricle during systole, owing to its complete exposure at the front of the heart, is marked and vigorous. The movement from right to left of its base, extending along its whole right margin, where the auricle joins on to the ventricle, is very extensive. That of the septum from left to right, is comparatively slight. The pulmonary artery, at the same time, descends, and the whole lower border of the ventricle ascends.

\* Vide Proceedings of Royal Society, Edinburgh, March, 1866.