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. I look upon it as a 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 conspicuous ornamentation, 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 Butterflies. 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 facts 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 indistinguishable while the males are very distinct—this led me to consider that the male characters present an order or higher development of the characters common to the female and to the group.

As a rule, the phenomena occur in Insects, and especially in Butterflies, which in many respects are strikingly analogous to Birds. The rule holds in all the familiar cases 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 I had recourse to certain structural characters, in the Papilionides and Pierides, the presence of abdominal valves in the male. In the Nymphalids and all other groups except the Hesperides, 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 Diademæ antilopiæ, 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 How. Gen. 1. Diur. Lepid., Sp. p. 281, from their bright metallic blue tints, were females, while the dull and obscure specimens were males. The other species of the genus Diademæ 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 which I have previously 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 which he terms sexual selection. According to this view the greatest 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, for instance, in the cock, the horns of the stag and the ram, &c.

The only kind of sexual selection is where 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 theory which is generally accepted by those who believe in the importance of colour in the male animal. This theory implies a certain amount of natural selection, and in the case of many species of butterflies is illustrated by the fact that they possess the characteristic of a male or female which is clearly a matter of survival.

In the case of butterflies, and especially of butterflies, I believe another theory 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, and often she is exposed to danger. She wants protection, therefore, more than the male does, and anything that makes her conspicuous is an advantage. Her conspicuousness 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 emulating the colouring of the ground or of the objects which they resemble. Many moths and butterflies exactly resemble the bark of the trees on which they usually repose; others closely imitate flowers, leaves, or even the dung of birds. Now, in many cases, the same law of the greater protection of the female appears. 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 wings. There are flies and moths which precisely resemble stinging hymenoptera.

It was Mr. Bates who first investigated these with the view of discovering the rationale of the phenomenon, and in which, I think, he quite succeeded. He showed, on the supposition that the species of Insects, which have lost their female or male, are those which resemble vegetable or inanimate objects. The most striking case of this was that of the male and female Danaides, 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 do not inhabit the same part of the world, or the 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 Danaides and Heliconides. Now how do these various species, which resemble each other, gain anything by it? It can only be because the insects resemble themselves saved from attack, in some way or other, and the species that resemble them being thus protected from their enemies, thus gain an advantage over their allies who are not so fortunate.

The nature of the protection of the Danaides and Heliconides seems to be an odour and taste which is disagreeable to insectivorous birds and insects. They all certainly have a strange medicinal colour which is very powerful; they are excessively abundant in species and individuals; they are a generally conspicuous insects; and every one of them—although they vary greatly in size and shape—have a very strong and weak flight. This combination seems to render it almost certain that they are distasteful to many enemies which check the increase of other species, and them in them, in their 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 resemblance is universally admitted "Diana boxa" is a remarkable instance of this.

The species I propose to name, "Diana ananidae" is another, for here the glossy blue strikingly resembles the common purple antilopiæ, which inhabits the same country, and thus the females have acquired the colouring generally assumed by the males, because each slight variation in that direction was advantageous to the females, and therefore survived in that sex—the male, from the more rapid flight, and his importance for a shorter time in the economy of nature, the modification has not been so rapid.
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reversal of the usual sexual characters for a special purpose, which we can distinctly trace, and as such, I believe, unique. I may state, also, that this species inhabits the same localities as the *Euploca* 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 *favorable 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 sitting hymenoptera.

3rd. There are many Lepidoptera which resemble in all parts of the world—one particular group, the Danadoi 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 colour 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 mimery of inanimate objects, it is often the *females* that possess it perfectly, and sometimes exclusively.

7th. In the cases of mimery of the Danadoi butterflies, the same thing occurs, the females alone in several instances possessing the resemblance, and thus sometimes acquirings a coloration like the males of other species.

8th. The species, and even the entire genus in which these cases occur, are often very variable, and transitional forms are often found showing the steps in the production of these mimetic 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 individuality was not explained or assumed to be the cause of the one butterfly being made in imitation of the other by the Creator; but it was readily accounted for by the law of evolution.

ON THE ASEXUAL REPRODUCTION AND ANATOMY OF OCHOSTAGASTER VERSICULARIS (Mull). A paper "On the Asexual Reproduction and Anatomy of Ochostagaster versiculatus (Mull.)" was read by Mr. E. Ray Lankester, as follows:

The Ochostagaster is a minute worm, one-eighth of an inch long, parasitic on the common water-snail. Its most remarkable peculiarity is, the presence of oral branches 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 TUBELLARIA AND ANNELIDA OF NORTH UIST, AND A NOTICE OF NEW AND RARE MARINE ANIMALS, LATERLY 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, that the most important fact is the discovery of several species of which the hitherto have been procured only at rare intervals, either in Britain, or on the continent, while others are new to science. Amongst the rarer forms may be noticed, Lineus albula, Stylos fasciatus, Serpentinaria fragilis, Oatisha, L. Caroliniana, Terebellida, Terebella, &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 am 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, Cynthea, two species of Salpa, two of B,o,hia, a new Symbos, 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 Comanula, was made a new species.

In reply to Dr. Persival Wright, and Mr. Ray Lankester, anent the habits of the Polyneis scolopendraria, the author said that every example of the species at Lochmaddy occupied the tube of a Turbellia nematoda, along with the rightful owner thereof; and, moreover, that the Polyneis was phosphorescent. The habits 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 Moluscoid Animal," by Dr. W. M. McIntosh; "On the power which some Rotifers have of attaching themselves by means of a thread," by Mr. K. Onderdonk; "Notes on the Structure of the Echiura of Reunion, with special reference to their classification," by Mr. C. Stewart; "On the Crustacea, Echinodermata, Polyzoa, and Cestodaria of the Hebrides," by the Rev. A. Meroplus Norman; "Report on the Ostracoda dredged on the Hebrides," by Mr. C. S. Brady; and "Supplementary Report on experiments with Enithora," by Dr. Cobbett.

SECTION D.—BIOLOGY.

[DEPARTMENT OF PHYSIOLOGY]

This department resumed its sittings on Monday, under the presidency of Professor Humphrey, 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 1849, assisted by Mr. Shepperly—the animal being under the influence of morphia, supplied by Mr. Waterston; and his recent observations in London were communicated by Dr. Bright, and Mr. Edwards, the creatures being rendered unconscious by chloroform. In these, the pericardium was entire, following the plan of Dr. Halliday.

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 the systole, and then of the diastole. These observations were in each instance made by Mr. Sibson, and corroborated by Dr. Bright.

During systole, the ventricles contracted in every direction. This contraction was most marked at the base, where the auricles and great vessels were most 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, led to its complete exposure at the front of the heart, so marked and vigorous. The movement from right to left of its base, extending along its whole right margin, where the auricles join on to the ventricle, is very extensive, with no particular slight. The pulmonary artery, at the same time, descends, and the whole lower border of the ventricle ascends.