ART. XXXVI.—*On some Examples of New Zealand Insects illustrating the Darwinian Principle of Sexual Selection.*

By G. V. HUDSON, F.E.S., F.N.Z.Inst.

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NOTWITHSTANDING constant attempts to refute or profoundly modify Darwin's theory of natural selection, or the "survival of the fittest," it cannot be denied that this theory remains to this day the only satisfactory explanation of the innumerable instances of adaptation to conditions which are manifest to the most casual observer of plants and animals. It is not, however, my intention this evening to give instances of the operation of natural selection amongst our New Zealand insects, although practically every species might be utilized in corroboration of Darwin's great theory. My object on this occasion is to direct attention to Darwin's subsidiary theory of sexual selection, which some of his immediate followers were convinced had been a most potent factor in the evolution of the more advanced attributes of the higher animals, but which has unaccountably been allowed to drop into the background by many present-day biologists. Some may perhaps urge that the theory of sexual selection, as propounded by Darwin in his *Descent of Man*, is an out-of-date doctrine, superseded by more precise modern researches into the minute structure of organisms. Before, however, any such general statement can be accepted a more complete explanation than that afforded by sexual selection must be given of the actual facts existing in nature, and this I think I can safely say has not yet been done. Without further preliminaries I will now direct attention to a few of the facts referred to, and will use our New Zealand insects in illustration of my remarks.

1. Order Hemiptera. Suborder Homoptera.

The suborder Homoptera includes the cicadas, lantern-flies, and their allies, as well as the aphides, scale insects, &c.

The family Cicadidae, often popularly known as "locusts" or "singers," the first name being most misleading, is one of the best-known families of New Zealand insects. We have upwards of a dozen species, of which the largest, *Melampsalta cingulata* is often extremely abundant in the late summer. At this season the singing of the males, as they rest on the branches of trees and shrubs, is sometimes almost deafening, and the noise may be best likened to that produced by a number of frying-pans simultaneously in operation on a very hot fire. This sound is produced by two complicated organs connected with the respiratory system of the male, and situated on the underside of the base of the abdomen. It is solely confined to that sex. The singing is undoubtedly attractive to the female, and close observation of the insects in their natural haunts often discloses the fact that the keenest rivalry exists between two or more males to captivate a female by means of their music. It is impossible to assign any other use to these complicated organs, and the instinct to use them, than that here indicated. The sound emitted certainly does not intimidate the enemies of the cicada, as they are all much preyed

upon by birds; and even if it did repel certain potential enemies, such special means of protection would be far more necessary for the preservation of the female whilst depositing her eggs than it would be for the male.

2. Order Orthoptera.

In the small order Orthoptera, which includes the wetas, grasshoppers, crickets, walking-sticks, and allied insects, we have several striking instances of the operation of sexual selection.

The Stenopelmatidae, or wetas, were long supposed to be destitute of sound-producing organs, although possessing an auditory organ on each of the tibiae of the anterior pair of legs. A careful examination of the side of the second abdominal segment of both sexes, however, reveals the presence of about six minute file-like organs, which are operated upon by the inner edge of the base of the femur of the hind legs, these legs being raised above the insect's back when it is stridulating. By this means the weta can produce a harsh grating sound, which is employed to intimidate enemies and also possibly as a call or lure to the female. This stridulation of the weta may often be heard in the bush at night.

In the males of the true grasshoppers with short antennae (Acridiidae) a long file-like structure is situated on the inner side of the thigh of the hind leg, and the sound produced is used to attract the female.

In addition to the stridulating-apparatus, the male of our commonest weta (*Deinacrida megacephala*) has a huge head and jaws, the corresponding parts in the female being of the ordinary size. These males are sometimes found in holes in trees and similar situations, and are often accompanied by several females, the proportion of the sexes in this particular species being about one male to three females. As wetas come abroad only at night, it is difficult to obtain much precise information regarding their habits; but I think there can be little doubt that a very keen rivalry must exist between the males, and the great head and formidable jaws have been acquired as the result of this rivalry, the most ferocious, powerful, and well-equipped males having alone succeeded in leaving descendants. Apart from theoretical considerations, the preponderance in the number of females, the reverse proportion to that usually subsisting amongst insects, is strong presumptive evidence that a large proportion of males must perish, and the only conceivable means by which this unusual disparity in the numbers of the sexes could be brought about is through the destruction of the weaker individual males during their contests to possess the females.

In the Locustidae, or long-horned grasshoppers, a vein on one of the wing-cases of the male is furnished with minute ridges, and the sound is produced by the insect rubbing this against a raised vein on the other wing-case. *Coedicia olivacea*, a beautiful leaf-like insect occurring in Australia, which to my knowledge has been common round Nelson for thirty-five years, is an excellent example of this family. In the autumn evenings its chirping may often be heard in all directions.

In the true crickets (Gryllidae) both wing-cases bear file-like organs which are rasped together by the insect and thus produce the well-known chirping. Our example of this family is the black Australian cricket (*Gryllus servillei*), which is also very abundant in the Nelson Province, and its stridulation is a most familiar sound on fine summer evenings.

Referring to the diversity of these special sound-producing organs in the males of the Orthoptera (crickets and grasshoppers) and the Hemiptera-

Homoptera (cicadas), Darwin remarks, that "throughout the animal kingdom we often find the same object gained by the most diversified means; this seems due to the whole organization having undergone multifarious changes in the course of ages, and as part after part varied different variations were taken advantage of for the same general purpose. The diversity of means for producing sound in the three families of Orthoptera and in the Homoptera impresses the mind with the high importance of these structures to the males, for the sake of calling or alluring the females. We need feel no surprise at the amount of modification which the Orthoptera have undergone in this respect, as we now know, from Dr. Scudder's remarkable discovery, that there has been more than ample time. This naturalist has lately found a fossil insect in the Devonian formation of New Brunswick, which is furnished with 'the well-known tympanum or stridulating-apparatus of the male Locustidae.' The insect, though in most respects related to the Neuroptera, appears, as is so often the case with very ancient forms, to connect the two related Orders of the Neuroptera and Orthoptera."*

The males of the walking-stick insects, or Phasmidae, are extremely attenuated creatures, whilst the females are much stouter and larger, and exhibit such great structural differences that, in the absence of exact knowledge to the contrary, they might easily be referred to a different species, or even genus. In both sexes the appearance of the insect is most perfectly adapted for concealment amongst vegetation, and the extraordinary disparity between the sexes in this case is very difficult to explain.

3. Order Neuroptera.

In the order Neuroptera, which includes the termites, stone-flies, may-flies, dragon-flies, caddis-flies, &c., there is little direct evidence of the operation of sexual selection. In one of our largest may-flies, *Ichthybotus hudsoni*, the male has two caudal setae which are very much longer than the three possessed by the female. It is difficult to say, however, which sex is the more ornamented. Of much greater interest for the purposes of this paper are the nuptial dances in which the may-flies engage, and which must often arrest the attention of those who are not entomologists. This flight takes place shortly before sunset, and during its performance the may-flies rise and fall in the air almost in perpendicular lines, and it is at this time that pairing takes place. Of these remarkable dances Dr. Sharp remarks that to the may-flies themselves the movements may, by the number of the separate eyes, by their curved surfaces, and by the innumerable facets composing them, be multiplied and correlated in a manner of which our own sense of sight allows us to form no conception. We can see on a summer's evening how beautifully and gracefully a crowd of may-flies dance, and we may well believe that to the marvellous ocular organs of the flies themselves these movements form a veritable ballet-dance.

Amongst our small slender-bodied dragon-flies (Agrionina), often known as "demoiselles," the males of *Xanthagrion zealandicum* have crimson bodies, the females being dull bronze; and in *Lestes colensonis* the body of the male is marked with much more vivid blue than that of the female. In the tribe Cordulina it is noteworthy that the male of *Somatochlora smithii* has a brilliant metallic-green head, legs, and thorax, the same parts in the female being much duller.

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* *Descent of Man*, 2nd ed., pp. 288–89, 1890.

4. Order Diptera.

In the great order Diptera, which includes all the two-winged flies, there is usually very little difference in colour between the sexes, and the only striking differences noticeable, so far as our New Zealand species are concerned, occur amongst the Tipulidae, or "daddy-long-legs," in which the males of some of the species either have very long antennae, or antennae furnished with long plumes or branches. The supposed use of these elaborate antennae to the male will be explained when we consider the secondary sexual characters of the Lepidoptera. The male of one of our handsomest Tipulidae, *Cerozodia plumosa*, has magnificently branched antennae. The female is at present unknown, and is possibly semiapterous. This at least would explain why collectors have not yet succeeded in finding her.

5. Order Lepidoptera.

Notwithstanding the fact that ornamental colouring is more in evidence in the great order Lepidoptera, comprising the varied tribes of the butterflies and moths, than in any other order of insects, instances of the direct operation of sexual selection are perhaps not quite so numerous or so striking as might have been anticipated. It is true that in the case of many species, especially amongst tropical butterflies, the males are more brilliantly and beautifully coloured than the females; yet, on the other hand, there are many thousands of species where both sexes are equally ornamental. In such cases Darwin assumes that the highly ornamental colours and patterns were first acquired by the males through sexual selection and afterwards equally inherited by both sexes. He points out that in considering the effects of sexual selection in the Lepidoptera it must be borne in mind that the courtship of butterflies is a prolonged affair. The males sometimes fight together in rivalry; and many may be seen pursuing or crowding round the same female. Unless, then, the females prefer one male to another, pairing must be left to mere chance, and this does not appear probable. If, on the other hand, the females habitually, or even occasionally, prefer the more beautiful males, the colours of the latter will have been rendered brighter by degrees, and will have been transmitted to both sexes or to one sex, according to the law of inheritance which has prevailed. The process of sexual selection will have been much facilitated if the conclusion can be trusted, arrived at from various kinds of evidence, that the males of many Lepidoptera, at least in the imago state, greatly exceed the females in number.*

So far as New Zealand is concerned, there is not a great number of Lepidoptera where the males are more strikingly ornamental than the females. The tropical-looking *Hypolimnas bolina*, a wide-ranging species, found through the Pacific islands and Australia, and casually in New Zealand, has the male blue-black, with a large white blotch in the middle of each wing surrounded by a wide ring of iridescent blue. The female is rather variable, black, with white and orange-brown markings; and, although highly ornamental, almost entirely lacks the brilliant glistening blue which is so characteristic of the male.

The females of our common tussock-butterfly, *Argyrophenga antipodum*, are usually much lighter coloured than the males, and the same applies in a more marked degree to the female of our small mountain-butterfly

* *Descent of Man*, 2nd ed., p. 317, 1890.

Erebia butleri. In this respect these Satyrid butterflies show a striking resemblance to many of their European relatives which have the females lighter coloured than the males, but it is perhaps questionable whether they can be called more brilliant.

A much more striking instance of the direct operation of sexual selection is afforded by our very interesting endemic little butterfly *Chrysophanus boldenarum*. In this species the male is of a most refulgent metallic purple, the female being dull yellowish-brown with a row of blue spots around the margin of each wing. This butterfly frequents stony places in river-beds, where the males may constantly be observed displaying their brilliant colours to the rather dingy-looking females, which generally appear to regard their attentions in an unconcerned manner. Again, the male of our small blue butterfly *Lycaena labradus* is, in common with the males of most members of the genus throughout the world, a glistening blue, whilst the female is drab-grey.

Probably of greater interest than colour and wing-markings are the special scent-producing organs which exist in certain male butterflies and other Lepidoptera for the purpose of attracting the female, and of which no trace can be found in that sex. Attention was first directed to these organs by Fritz Müller in 1877, who at the same time emphasized their significance in connection with Darwin's theories, which were then steadily gaining ground in the scientific world.*

We have in New Zealand several good examples of special scent-producing organs in male Lepidoptera. In the male of that strong-flying, very wide-ranging butterfly *Danaida plexippus* there is a pocket-like structure situated on the hindwing, close to vein 2, which is absent in the female, and is undoubtedly a scent-producing organ. Amongst moths the male of our beautiful moss-green Noctuid *Erana graminosa* has a large fold in the costal edge of the forewings which conceals an extensible tuft of long pink hairs. These hairs when stirred with a pin emit a most agreeable vanilla-like perfume. A similar structure exists in the male of *Rhapsa scotosialis*. The remarkable lobe in the much-contracted hindwing of the males of our curious genus *Tatosoma* is a pocket-like organ, which in the absence of any evidence to the contrary must also be regarded as scent-producing. The male of *Declana leptomera* has large tufts of hair on the tibiae of the hind-legs, similar tufts being found amongst some of our smaller Lepidoptera, and it is almost certain that these structures are for the purpose of emitting perfumes agreeable to the female.

A very great many observations have been made during recent years by Drs. Dixey and Longstaff on the scent-organs and scents emitted by tropical butterflies; and the use of these special structures by the males, for the purpose of attracting the females, has been placed practically beyond a doubt. At the same time it must not be forgotten that certain species of butterflies emit odours of a disagreeable nature which serve to protect them from the attacks of birds and other enemies; but in these instances the scent-producing power is not confined to the male sex.

In regard to our moths, a fair number exhibit considerable differences in the colouring and markings of the sexes, but except in the case of one or two day-flying species the males are not more brilliant or more beautiful than the females. The sexes of *Xanthorhoë semifissata* and

* For translation of Fritz Müller's papers on this subject see appendix to Dr. Longstaff's work, *Butterfly-hunting in many Lands*.

X. orophyla are almost identical in colour, but have very different markings. *Selidosema fenerata* differs strikingly in both wing-outline and colour, the forewings of the male being pale yellowish-brown, those of the female pale grey. The sexes of our beautiful forest-dwelling moths *Azelina gallaria* and *A. ophiopa* differ in size, colour, and wing-outline. *Declana glacialis*, a brilliant day-flying mountain species, which almost certainly mimics the distasteful species belonging to the genus *Metacrias*, has the male much more brilliantly coloured than the female, and this is almost certainly due to the operation of sexual selection.

In the family Tortricidae remarkable sexual disparities exist in certain species belonging to the genus *Harmologa*, which are found high up on our southern mountains, and fly rapidly in the hottest sunshine. Of these probably the largest and handsomest species is *Harmologa trisulca*, recently discovered at Arthur's Pass. The male is a very rich reddish-brown with a vivid orange-yellow longitudinal stripe on the forewings, the hindwings being dark greyish-brown. In the female the forewings are dull ochreous and the hindwings pale straw-colour. The other mountain species of the genus exhibit a similar class of colouring, but in the lowland species, which fly at dusk or by night, the difference between the sexes is unimportant, and the males are not more brilliantly coloured than the females.

Our largest native lepidopteron, the well-known *Hepialus virescens*, exhibits most striking sexual differences in wing-outline, colouring, and markings. All these characters are, in the female, more concordant with the usual type of the genus than in the male, and it is a fair inference that the peculiarities of the male have been more recently acquired. The general colouring of both sexes of *Hepialus virescens* is equally protective when the insect is resting amongst foliage; but probably that of the male is more beautiful, and certainly brighter, than that of the female, and hence may have arisen through sexual selection. In connection with our insect, it may perhaps be of interest to mention that in its close British ally the Ghost-moth (*Hepialus humuli*) all the wings of the male are snow-white, the forewings of the female being dull-yellowish and the hindwings grey. Of this species Mr. Richard South tells us that the males may be seen in the evening, sometimes in numbers, in grassy places, swaying themselves to and fro without making progress, and appearing as though they dangled from the end of an invisible thread; the female flies straight, and, as a rule, in the direction of one or other of the pendulous males.* In this case it would appear that the unusual disparity in colour between the sexes has been beneficial to the species in enabling the female to discover the male, a reverse arrangement to that usually subsisting. In the Shetland Islands the white male of the Ghost-moth is usually replaced by a variety (*thulensis*) in which the male is coloured very similarly to the female, and this is explained by the fact that in that northern latitude the summer nights are never dark, and the conspicuous white colouring of the male is not necessary.

In many species of moths, especially those having females of obscure or retiring habits, the antennae of the males are heavily branched on each side, or, as it is technically termed, bipectinated, those of the female being slightly branched or simple. In these species the males have the power of discovering a female even when situated at a considerable distance. Collectors habitually turn this fact to good account, for if they happen to

* R. South, *The Moths of the British Islands*, ser. 3, p. 361.

breed a female they can, by enclosing the same in a gauze-covered box and placing it at an open window, attract quite a large number of males. Experiments have been made to ascertain the means by which the males are enabled to find the female when situated at such remote distances, and the mode of tracking by scent does not afford a satisfactory explanation. In fact, there appears to be little doubt that the mysterious faculty is located in the heavily branched antennae, and that some sort of communication is set up of the nature of wireless telegraphy.

6. Order Hymenoptera.

In this important order, which includes the ants, bees, wasps, ichneumon flies, and their allies, the principal differences between the sexes relate to special structures, such as the pollen-bearing apparatus of the hive-bee, useful to the female in tending the young. They do not, therefore, concern us in connection with the subject of this paper. A few of the Hymenoptera are brilliantly coloured in both sexes, and in those instances where warning colours are not indicated this may be due to the effects of sexual selection.

7. Order Coleoptera.

The order Coleoptera, comprising the beetles, is the highest order of insects, and also contains the greatest number of species, of which about 150,000 are known to science. Commencing with that division known as the Lamellicorns, on account of the structure of their antennae, we find that a striking disparity between the sexes exists in our native stag-beetles. The males of the genus *Lissotes* have a large head and jaws and a very large prothorax, these salient features being strikingly absent in the females. Amongst allied genera in the tropics the most bizarre forms exist, many of the males having huge horny processes on the crown of the head and on the back of the prothorax; and unless these extraordinary structures are useful in making an impression on the female sex it seems impossible to assign any reason for their presence in the male sex alone.

The male of our interesting, though dull-coloured beetle, *Rhipistena lugubris*, has the joints of the antennae furnished with long lateral processes, the whole organ forming a conspicuous fan. This remarkable structure is also present in the female, but in a very reduced form. In the male of our most beautiful Longicorn beetle, *Coptomma variegata*, the antennae are nearly twice as long as in the female, and in a variable degree this disparity prevails amongst the numerous Longicorns we have in New Zealand. The male in the curious genus *Exilis*, a genus belonging to the Anthribidae, a family of weevils, also possesses enormously long antennae, those of the female being often less than half the length. The male of *Psepholax coronatus*, a short stumpy-looking weevil, has a conspicuous coronet of spines on the back of each of its elytra. This structure is entirely absent in the female and in all the other members of that extensive genus of weevils. Very striking sexual differences are also present in *Paranomocerus spiculus*, the male of this fine weevil being fully twice the size of the female, and furnished with a long rostrum and very long elbowed antennae.

All the sexual disparities amongst our native beetles are, however, completely overshadowed by those present in the huge Brenthid *Lasiorhynchus barbicornis*, undoubtedly one of the most striking and interesting insects we have in New Zealand. The male, which is usually about twice the length of the female, has an enormous rostrum, with the antennae

arising from its extremity. The rostrum of the female is of a totally different structure, with the antennae arising from its middle. Many years ago Dr. Sharp, one of our greatest authorities on the Coleoptera, was so impressed by the extraordinary sexual disparities exhibited by this beetle that he wrote to the late Mr. Helms, at Greymouth, requesting him to endeavour to find out something about the insect's habits. Mr. Helms, who was then one of our keenest entomologists, replied that the female *Lasiorhynchus barbicornis* is indefatigable in her boring efforts, but that the huge male stands by as a witness, apparently of the most apathetic kind. I am not aware that later observers have elicited any further information on this interesting subject.

In addition to the above special examples it should perhaps be added that some beetles are brilliantly coloured and have beautiful markings, and nearly all are ornamented with elaborate sculpture. From a strictly utilitarian standpoint it is difficult to see how such endowments are of any direct benefit to the possessor in the ordinary struggle for existence; but if the principle of sexual selection be admitted the presence of such elaborate adornments is quite intelligible.

This completes the examples specially selected for the purpose of this paper. It should perhaps be explained that other instances of the operation of sexual selection could have been found, even amongst our native insects, but it has not been deemed desirable to extend the paper to an undue length. To those who have studied Part II in Darwin's *Descent of Man* it will be unnecessary to state that even more convincing examples can be found amongst other classes of animals (notably birds), and also in other lands. It may be safely said that sexual selection has been a most powerful factor in organic evolution, operating in countless instances wherever its progress has not been stopped by the more rigorous principle of natural selection. Darwin clearly demonstrated that sexual selection has taken a very prominent part in the evolution of man, and there is no reason why its effects should not continue in the future. That a principle of such profound importance should receive so little practical attention is indeed surprising. We constantly hear of the paramount importance of education, and latterly we have heard a great deal about the benefits of discipline and of physical training. Every naturalist knows, however, that the effects of the most vigorous and successful training are not inherited by the offspring of those who are trained: each generation has to start to learn afresh. Not so, however, in the case of selection, the effect of which is permanent. It is a fact of the highest certainty that individuals possessing certain special attributes, if selected for breeding purposes, will transmit those attributes to their offspring. Hence we can see why the effects of sexual selection are so manifold throughout the whole animal kingdom.