

**The Descent of Man
&
Selection in Relation
To Sex Vol.II**

**By
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THE DESCENT OF MAN; AND SELECTION IN RELATION TO SEX. Vol. II

CHAPTER VIII.

PRINCIPLES OF SEXUAL SELECTION.

Secondary sexual characters Sexual selection Manner of action Excess of males Polygamy The male alone generally modified through sexual selection Eagerness of the male Variability of the male Choice exerted by the female Sexual compared with natural selection Inheritance, at corresponding periods of life, at corresponding seasons of the year, and as limited by sex Relations between the several forms of inheritance Causes why one sex and the young are not modified through sexual selection Supplement on the proportional numbers of the two sexes throughout the animal kingdom The proportion of the sexes in relation to natural selection.

With animals which have their sexes separated, the males necessarily differ from the females in their organs of reproduction; and these are the primary sexual characters. But the sexes often differ in what Hunter has called secondary sexual characters, which are not directly connected with the act of reproduction; for instance, the male possesses certain organs of sense or locomotion, of which the female is quite destitute, or has them more highly developed, in order that he may readily find or reach her; or again the male has special organs of prehension for holding her securely. These latter organs, of infinitely diversified kinds, graduate into those which are commonly ranked as primary, and in some cases can hardly be distinguished from them; we see instances of this in the complex appendages at the apex of the abdomen in male insects. Unless indeed we confine the term "primary" to the reproductive glands, it is scarcely possible to decide which ought to be called primary and which secondary.

The female often differs from the male in having organs for the nourishment or protection of her young, such as the mammary glands of mammals, and the abdominal sacks of the marsupials. In some few cases also the male possesses similar organs, which are wanting in the female, such as the receptacles for the ova in certain male fishes, and those temporarily developed in certain male frogs. The females of most bees are provided with a special apparatus for collecting and carrying pollen, and their ovipositor is modified into a sting for the defence of the larvae and the community. Many similar cases could be given, but they do not here concern us. There are, however, other sexual differences quite unconnected with the primary reproductive organs, and it is with these

that we are more especially concerned such as the greater size, strength, and pugnacity of the male, his weapons of offence or means of defence against rivals, his gaudy colouring and various ornaments, his power of song, and other such characters.

Besides the primary and secondary sexual differences, such as the foregoing, the males and females of some animals differ in structures related to different habits of life, and not at all, or only indirectly, to the reproductive functions. Thus the females of certain flies (Culicidae and Tabanidae) are bloodsuckers, whilst the males, living on flowers, have mouths destitute of mandibles. (. Westwood, 'Modern Classification of Insects,' vol. ii. , . For the statement about Tanais, mentioned below, I am indebted to Fritz Muller.) The males of certain moths and of some crustaceans (e.g. Tanais) have imperfect, closed mouths, and cannot feed. The complementary males of certain Cirripedes live like epiphytic plants either on the female or the hermaphrodite form, and are destitute of a mouth and of prehensile limbs. In these cases it is the male which has been modified, and has lost certain important organs, which the females possess. In other cases it is the female which has lost such parts; for instance, the female glowworm is destitute of wings, as also are many female moths, some of which never leave their cocoons. Many female parasitic crustaceans have lost their natatory legs. In some weevil beetles (Curculionidae) there is a great difference between the male and female in the length of the rostrum or snout (. Kirby and Spence, 'Introduction to Entomology,' vol. iii. , .); but the meaning of this and of many analogous differences, is not at all understood. Differences of structure between the two sexes in relation to different habits of life are generally confined to the lower animals; but with some few birds the beak of the male differs from that of the female. In the Huia of New Zealand the difference is wonderfully great, and we hear from Dr. Buller (. 'Birds of New Zealand,' , .) that the male uses his strong beak in chiselling the larvae of insects out of decayed wood, whilst the female probes the softer parts with her far longer, much curved and pliant beak: and thus they mutually aid each other. In most cases, differences of structure between the sexes are more or less directly connected with the propagation of the species: thus a female, which has to nourish a multitude of ova, requires more food than the male, and consequently requires special means for procuring it. A male animal, which lives for a very short time, might lose its organs for procuring food through disuse, without detriment; but he would retain his locomotive organs in a perfect state, so that he might reach the female. The female, on the other hand, might safely lose her organs for flying, swimming, or walking, if she gradually acquired habits which rendered such powers useless.

We are, however, here concerned only with sexual selection. This depends on the advantage which certain individuals have over others of the same sex and species solely in respect of reproduction. When, as in the cases above mentioned, the two sexes differ in structure in relation to different habits of life, they have no doubt been modified through natural selection, and by inheritance limited to one and the same sex. So again

the primary sexual organs, and those for nourishing or protecting the young, come under the same influence; for those individuals which generated or nourished their offspring best, would leave, *ceteris paribus*, the greatest number to inherit their superiority; whilst those which generated or nourished their offspring badly, would leave but few to inherit their weaker powers. As the male has to find the female, he requires organs of sense and locomotion, but if these organs are necessary for the other purposes of life, as is generally the case, they will have been developed through natural selection. When the male has found the female, he sometimes absolutely requires prehensile organs to hold her; thus Dr. Wallace informs me that the males of certain moths cannot unite with the females if their tarsi or feet are broken. The males of many oceanic crustaceans, when adult, have their legs and antennae modified in an extraordinary manner for the prehension of the female; hence we may suspect that it is because these animals are washed about by the waves of the open sea, that they require these organs in order to propagate their kind, and if so, their development has been the result of ordinary or natural selection. Some animals extremely low in the scale have been modified for this same purpose; thus the males of certain parasitic worms, when fully grown, have the lower surface of the terminal part of their bodies roughened like a rasp and with this they coil round and permanently hold the females. (M. Perrier advances this case ('Revue Scientifique,' Feb. , ,) as one fatal to the belief in sexual selection, inasmuch as he supposes that I attribute all the differences between the sexes to sexual selection. This distinguished naturalist, therefore, like so many other Frenchmen, has not taken the trouble to understand even the first principles of sexual selection. An English naturalist insists that the claspers of certain male animals could not have been developed through the choice of the female! Had I not met with this remark, I should not have thought it possible for any one to have read this chapter and to have imagined that I maintain that the choice of the female had anything to do with the development of the prehensile organs in the male.)

When the two sexes follow exactly the same habits of life, and the male has the sensory or locomotive organs more highly developed than those of the female, it may be that the perfection of these is indispensable to the male for finding the female; but in the vast majority of cases, they serve only to give one male an advantage over another, for with sufficient time, the less well-endowed males would succeed in pairing with the females; and judging from the structure of the female, they would be in all other respects equally well adapted for their ordinary habits of life. Since in such cases the males have acquired their present structure, not from being better fitted to survive in the struggle for existence, but from having gained an advantage over other males, and from having transmitted this advantage to their male offspring alone, sexual selection must here have come into action. It was the importance of this distinction which led me to designate this form of selection as Sexual Selection. So again, if the chief service rendered to the male by his prehensile organs is to prevent the escape of the female

before the arrival of other males, or when assaulted by them, these organs will have been perfected through sexual selection, that is by the advantage acquired by certain individuals over their rivals. But in most cases of this kind it is impossible to distinguish between the effects of natural and sexual selection. Whole chapters could be filled with details on the differences between the sexes in their sensory, locomotive, and prehensile organs. As, however, these structures are not more interesting than others adapted for the ordinary purposes of life I shall pass them over almost entirely, giving only a few instances under each class.

There are many other structures and instincts which must have been developed through sexual selection such as the weapons of offence and the means of defence of the males for fighting with and driving away their rivals their courage and pugnacity their various ornaments their contrivances for producing vocal or instrumental music and their glands for emitting odours, most of these latter structures serving only to allure or excite the female. It is clear that these characters are the result of sexual and not of ordinary selection, since unarmed, unornamented, or unattractive males would succeed equally well in the battle for life and in leaving a numerous progeny, but for the presence of better endowed males. We may infer that this would be the case, because the females, which are unarmed and unornamented, are able to survive and procreate their kind. Secondary sexual characters of the kind just referred to, will be fully discussed in the following chapters, as being in many respects interesting, but especially as depending on the will, choice, and rivalry of the individuals of either sex. When we behold two males fighting for the possession of the female, or several male birds displaying their gorgeous plumage, and performing strange antics before an assembled body of females, we cannot doubt that, though led by instinct, they know what they are about, and consciously exert their mental and bodily powers.

Just as man can improve the breeds of his gamecocks by the selection of those birds which are victorious in the cockpit, so it appears that the strongest and most vigorous males, or those provided with the best weapons, have prevailed under nature, and have led to the improvement of the natural breed or species. A slight degree of variability leading to some advantage, however slight, in reiterated deadly contests would suffice for the work of sexual selection; and it is certain that secondary sexual characters are eminently variable. Just as man can give beauty, according to his standard of taste, to his male poultry, or more strictly can modify the beauty originally acquired by the parent species, can give to the Sebright bantam a new and elegant plumage, an erect and peculiar carriage so it appears that female birds in a state of nature, have by a long selection of the more attractive males, added to their beauty or other attractive qualities. No doubt this implies powers of discrimination and taste on the part of the female which will at first appear extremely improbable; but by the facts to be adduced hereafter, I hope to be able to shew that the females actually have these powers. When, however, it

is said that the lower animals have a sense of beauty, it must not be supposed that such sense is comparable with that of a cultivated man, with his multiform and complex associated ideas. A more just comparison would be between the taste for the beautiful in animals, and that in the lowest savages, who admire and deck themselves with any brilliant, glittering, or curious object.

From our ignorance on several points, the precise manner in which sexual selection acts is somewhat uncertain. Nevertheless if those naturalists who already believe in the mutability of species, will read the following chapters, they will, I think, agree with me, that sexual selection has played an important part in the history of the organic world. It is certain that amongst almost all animals there is a struggle between the males for the possession of the female. This fact is so notorious that it would be superfluous to give instances. Hence the females have the opportunity of selecting one out of several males, on the supposition that their mental capacity suffices for the exertion of a choice. In many cases special circumstances tend to make the struggle between the males particularly severe. Thus the males of our migratory birds generally arrive at their places of breeding before the females, so that many males are ready to contend for each female. I am informed by Mr. Jenner Weir, that the birdcatchers assert that this is invariably the case with the nightingale and blackcaand with respect to the latter he can himself confirm the statement.

Mr. Swaysland of Brighton has been in the habit, during the last forty years, of catching our migratory birds on their first arrival, and he has never known the females of any species to arrive before their males. During one spring he shot thirtynine males of Ray's wagtail (*Budytes Raii*) before he saw a single female. Mr. Gould has ascertained by the dissection of those snipes which arrive the first in this country, that the males come before the females. And the like holds good with most of the migratory birds of the United States. (. J.A. Allen, on the 'Mammals and Winter Birds of Florida,' Bulletin of Comparative Zoology, Harvard College, .) The majority of the male salmon in our rivers, on coming up from the sea, are ready to breed before the females. So it appears to be with frogs and toads. Throughout the great class of insects the males almost always are the first to emerge from the pupal state, so that they generally abound for a time before any females can be seen. (. Even with those plants in which the sexes are separate, the male flowers are generally mature before the female. As first shewn by C.K. Sprengel, many hermaphrodite plants are dichogamous; that is, their male and female organs are not ready at the same time, so that they cannot be selffertilised. Now in such flowers, the pollen is in general matured before the stigma, though there are exceptional cases in which the female organs are beforehand.) The cause of this difference between the males and females in their periods of arrival and maturity is sufficiently obvious. Those males which annually first migrated into any country, or which in the spring were first ready to breed, or were the most eager, would leave the largest number of offspring; and these

would tend to inherit similar instincts and constitutions. It must be borne in mind that it would have been impossible to change very materially the time of sexual maturity in the females, without at the same time interfering with the period of the production of the younga period which must be determined by the seasons of the year. On the whole there can be no doubt that with almost all animals, in which the sexes are separate, there is a constantly recurrent struggle between the males for the possession of the females.

Our difficulty in regard to sexual selection lies in understanding how it is that the males which conquer other males, or those which prove the most attractive to the females, leave a greater number of offspring to inherit their superiority than their beaten and less attractive rivals. Unless this result does follow, the characters which give to certain males an advantage over others, could not be perfected and augmented through sexual selection. When the sexes exist in exactly equal numbers, the worst endowed males will (except where polygamy prevails), ultimately find females, and leave as many offspring, as well fitted for their general habits of life, as the bestendowed males. From various facts and considerations, I formerly inferred that with most animals, in which secondary sexual characters are well developed, the males considerably exceeded the females in number; but this is not by any means always true. If the males were to the females as two to one, or as three to two, or even in a somewhat lower ratio, the whole affair would be simple; for the betterarmed or more attractive males would leave the largest number of offspring. But after investigating, as far as possible, the numerical proportion of the sexes, I do not believe that any great inequality in number commonly exists. In most cases sexual selection appears to have been effective in the following manner.

Let us take any species, a bird for instance, and divide the females inhabiting a district into two equal bodies, the one consisting of the more vigorous and betternourished individuals, and the other of the less vigorous and healthy. The former, there can be little doubt, would be ready to breed in the spring before the others; and this is the opinion of Mr. Jenner Weir, who has carefully attended to the habits of birds during many years. There can also be no doubt that the most vigorous, best nourished and earliest breeders would on an average succeed in rearing the largest number of fine offspring. (. Here is excellent evidence on the character of the offspring from an experienced ornithologist. Mr. J.A. Allen, in speaking ('Mammals and Winter Birds of E. Florida,') of the later broods, after the accidental destruction of the first, says, that these "are found to be smaller and palercoloured than those hatched earlier in the season. In cases where several broods are reared each year, as a general rule the birds of the earlier broods seem in all respects the most perfect and vigorous.") The males, as we have seen, are generally ready to breed before the females; the strongest, and with some species the best armed of the males, drive away the weaker; and the former would then unite with the more vigorous and betternourished females, because they are the first to breed. (.

Hermann Müller has come to this same conclusion with respect to those female bees which are the first to emerge from the pupa each year. See his remarkable essay, 'Anwendung der Darwin'schen Lehre auf Bienen,' 'Verh. d. V. Jahrg.' xxix. .) Such vigorous pairs would surely rear a larger number of offspring than the retarded females, which would be compelled to unite with the conquered and less powerful males, supposing the sexes to be numerically equal; and this is all that is wanted to add, in the course of successive generations, to the size, strength and courage of the males, or to improve their weapons.

But in very many cases the males which conquer their rivals, do not obtain possession of the females, independently of the choice of the latter. The courtship of animals is by no means so simple and short an affair as might be thought. The females are most excited by, or prefer pairing with, the more ornamented males, or those which are the best songsters, or play the best antics; but it is obviously probable that they would at the same time prefer the more vigorous and lively males, and this has in some cases been confirmed by actual observation. (. With respect to poultry, I have received information, hereafter to be given, to this effect. Even with birds, such as pigeons, which pair for life, the female, as I hear from Mr. Jenner Weir, will desert her mate if he is injured or grows weak.) Thus the more vigorous females, which are the first to breed, will have the choice of many males; and though they may not always select the strongest or best armed, they will select those which are vigorous and well armed, and in other respects the most attractive. Both sexes, therefore, of such early pairs would as above explained, have an advantage over others in rearing offspring; and this apparently has sufficed during a long course of generations to add not only to the strength and fighting powers of the males, but likewise to their various ornaments or other attractions.

In the converse and much rarer case of the males selecting particular females, it is plain that those which were the most vigorous and had conquered others, would have the freest choice; and it is almost certain that they would select vigorous as well as attractive females. Such pairs would have an advantage in rearing offspring, more especially if the male had the power to defend the female during the pairingseason as occurs with some of the higher animals, or aided her in providing for the young. The same principles would apply if each sex preferred and selected certain individuals of the opposite sex; supposing that they selected not only the more attractive, but likewise the more vigorous individuals.

NUMERICAL PROPORTION OF THE TWO SEXES.

I have remarked that sexual selection would be a simple affair if the males were considerably more numerous than the females. Hence I was led to investigate, as far as I could, the proportions between the two sexes of as many animals as possible; but the materials are scanty. I will here give only a brief abstract of the results, retaining the details for a supplementary discussion, so as not to interfere with the course of my argument. Domesticated animals alone afford the means of ascertaining the proportional numbers at birth; but no records have been specially kept for this purpose. By indirect means, however, I have collected a considerable body of statistics, from which it appears that with most of our domestic animals the sexes are nearly equal at birth. Thus, births of race horses have been recorded during twentyone years, and the male births were to the female births as . to . In greyhounds the inequality is greater than with any other animal, for out of births during twelve years, the male births were to the female as . to . It is, however, in some degree doubtful whether it is safe to infer that the proportion would be the same under natural conditions as under domestication; for slight and unknown differences in the conditions affect the proportion of the sexes. Thus with mankind, the male births in England are as ., in Russia as ., and with the Jews of Livonia as , to female births. But I shall recur to this curious point of the excess of male births in the supplement to this chapter. At the Cape of Good Hope, however, male children of European extraction have been born during several years in the proportion of between and to female children.

For our present purpose we are concerned with the proportions of the sexes, not only at birth, but also at maturity, and this adds another element of doubt; for it is a wellascertained fact that with man the number of males dying before or during birth, and during the first two years of infancy, is considerably larger than that of females. So it almost certainly is with male lambs, and probably with some other animals. The males of some species kill one another by hting; or they drive one another about until they become greatly emaciated. They must also be often exposed to various dangers, whilst wandering about in eager search for the females. In many kinds of fish the males are much smaller than the females, and they are believed often to be devoured by the latter, or by other fishes. The females of some birds appear to die earlier than the males; they are also liable to be destroyed on their nests, or whilst in charge of their young. With insects the female larvae are often larger than those of the males, and would consequently be more likely to be devoured. In some cases the mature females are less active and less rapid in their movements than the males, and could not escape so well from danger. Hence, with animals in a state of nature, we must rely on mere estimation, in order to judge of the proportions of the sexes at maturity; and this is but little trustworthy, except when the inequality is strongly marked. Nevertheless, as far as a judgment can be formed, we may conclude from the facts given in the supplement, that the males of some few mammals, of many birds, of some fish and insects, are considerably more numerous than the females.

The proportion between the sexes fluctuates slightly during successive years: thus with racehorses, for every mares born the stallions varied from . in one year to . in another year, and with greyhounds from . to .. But had larger numbers been tabulated throughout an area more extensive than England, these fluctuations would probably have disappeared; and such as they are, would hardly suffice to lead to effective sexual selection in a state of nature. Nevertheless, in the cases of some few wild animals, as shewn in the supplement, the proportions seem to fluctuate either during different seasons or in different localities in a sufficient degree to lead to such selection. For it should be observed that any advantage, gained during certain years or in certain localities by those males which were able to conquer their rivals, or were the most attractive to the females, would probably be transmitted to the offspring, and would not subsequently be eliminated. During the succeeding seasons, when, from the equality of the sexes, every male was able to procure a female, the stronger or more attractive males previously produced would still have at least as good a chance of leaving offspring as the weaker or less attractive.

POLYGAMY.

The practice of polygamy leads to the same results as would follow from an actual inequality in the number of the sexes; for if each male secures two or more females, many males cannot pair; and the latter assuredly will be the weaker or less attractive individuals. Many mammals and some few birds are polygamous, but with animals belonging to the lower classes I have found no evidence of this habit. The intellectual powers of such animals are, perhaps, not sufficient to lead them to collect and guard a harem of females. That some relation exists between polygamy and the development of secondary sexual characters, appears nearly certain; and this supports the view that a numerical preponderance of males would be eminently favourable to the action of sexual selection. Nevertheless many animals, which are strictly monogamous, especially birds, display strongly marked secondary sexual characters; whilst some few animals, which are polygamous, do not have such characters.

We will first briefly run through the mammals, and then turn to birds. The gorilla seems to be polygamous, and the male differs considerably from the female; so it is with some baboons, which live in herds containing twice as many adult females as males. In South America the *Mycetes caraya* presents wellmarked sexual differences, in colour, beard, and vocal organs; and the male generally lives with two or three wives: the male of the *Cebus capucinus* differs somewhat from the female, and appears to be polygamous. (. On the Gorilla, Savage and Wyman, 'Boston Journal of Natural History,' vol. v. , . On *Cynocephalus*, Brehm, 'Thierleben,' B. i. , s. . On *Mycetes*, Rengger, 'Naturgeschichte der Säugethiere von Paraguay,' , ss. , . On *Cebus*, Brehm, *ibid.* s. .) Little is known on this

head with respect to most other monkeys, but some species are strictly monogamous. The ruminants are eminently polygamous, and they present sexual differences more frequently than almost any other group of mammals; this holds good, especially in their weapons, but also in other characters. Most deer, cattle, and sheep are polygamous; as are most antelopes, though some are monogamous. Sir Andrew Smith, in speaking of the antelopes of South Africa, says that in herds of about a dozen there was rarely more than one mature male. The Asiatic Antelope saiga appears to be the most inordinate polygamist in the world; for Pallas (. Pallas, 'Spicilegia Zoolog., Fasc.' xii. , . Sir Andrew Smith, 'Illustrations of the Zoology of S. Africa,' , pl. , on the Kobus. Owen, in his 'Anatomy of Vertebrates' (vol. iii. ,) gives a table shewing incidentally which species of antelopes are gregarious.) states that the male drives away all rivals, and collects a herd of about a hundred females and kids together; the female is hornless and has softer hair, but does not otherwise differ much from the male. The wild horse of the Falkland Islands and of the Western States of N. America is polygamous, but, except in his greater size and in the proportions of his body, differs but little from the mare. The wild boar presents wellmarked sexual characters, in his great tusks and some other points. In Europe and in India he leads a solitary life, except during the breedingseason; but as is believed by Sir W. Elliot, who has had many opportunities in India of observing this animal, he consorts at this season with several females. Whether this holds good in Europe is doubtful, but it is supported by some evidence. The adult male Indian elephant, like the boar, passes much of his time in solitude; but as Dr. Campbell states, when with others, "It is rare to find more than one male with a whole herd of females"; the larger males expelling or killing the smaller and weaker ones. The male differs from the female in his immense tusks, greater size, strength, and endurance; so great is the difference in these respects that the males when caught are valued at one-fifth more than the females. (. Dr. Campbell, in 'Proc. Zoolog. Soc.' , . See also an interesting paper by Lieut. Johnstone, in 'Proceedings, Asiatic Society of Bengal,' May .) The sexes of other pachydermatous animals differ very little or not at all, and, as far as known, they are not polygamists. Nor have I heard of any species in the Orders of Cheiroptera, Edentata, Insectivora and Rodents being polygamous, excepting that amongst the Rodents, the common rat, according to some ratcatchers, lives with several females. Nevertheless the two sexes of some sloths (Edentata) differ in the character and colour of certain patches of hair on their shoulders. (. Dr. Gray, in 'Annals and Magazine of Natural History,' , .) And many kinds of bats (Cheiroptera) present wellmarked sexual differences, chiefly in the males possessing odoriferous glands and pouches, and by their being of a lighter colour. (. See Dr. Dobson's excellent paper in 'Proceedings of the Zoological Society,' , .) In the great order of Rodents, as far as I can learn, the sexes rarely differ, and when they do so, it is but slightly in the tint of the fur.

As I hear from Sir Andrew Smith, the lion in South Africa sometimes lives with a single female, but generally with more, and, in one case, was found with as many as five

females; so that he is polygamous. As far as I can discover, he is the only polygamist amongst all the terrestrial Carnivora, and he alone presents wellmarked sexual characters. If, however, we turn to the marine Carnivora, as we shall hereafter see, the case is widely different; for many species of seals offer extraordinary sexual differences, and they are eminently polygamous. Thus, according to Peron, the male seaelephant of the Southern Ocean always possesses several females, and the sealion of Forster is said to be surrounded by from twenty to thirty females. In the North, the male seabear of Steller is accompanied by even a greater number of females. It is an interesting fact, as Dr. Gill remarks (. 'The Eared Seals,' American Naturalist, vol. iv. Jan. .), that in the monogamous species, "or those living in small communities, there is little difference in size between the males and females; in the social species, or rather those of which the males have harems, the males are vastly larger than the females."

Amongst birds, many species, the sexes of which differ greatly from each other, are certainly monogamous. In Great Britain we see wellmarked sexual differences, for instance, in the wildduck which pairs with a single female, the common blackbird, and the bullfinch which is said to pair for life. I am informed by Mr. Wallace that the like is true of the Chatterers or Cotingidae of South America, and of many other birds. In several groups I have not been able to discover whether the species are polygamous or monogamous. Lesson says that birds of paradise, so remarkable for their sexual differences, are polygamous, but Mr. Wallace doubts whether he had sufficient evidence. Mr. Salvin tells me he has been led to believe that hummingbirds are polygamous. The male widowbird, remarkable for his caudal plumes, certainly seems to be a polygamist. (. 'The Ibis,' vol. iii. , , on the Progne Widowbird. See also on the Vidua axillaris, ibid. vol. ii. , . On the polygamy of the Capercailzie and Great Bustard, see L. Lloyd, 'Game Birds of Sweden,' , and . Montagu and Selby speak of the Black Grouse as polygamous and of the Red Grouse as monogamous.) I have been assured by Mr. Jenner Weir and by others, that it is somewhat common for three starlings to frequent the same nest; but whether this is a case of polygamy or polyandry has not been ascertained.

The Gallinaceae exhibit almost as strongly marked sexual differences as birds of paradise or hummingbirds, and many of the species are, as is well known, polygamous; others being strictly monogamous. What a contrast is presented between the sexes of the polygamous peacock or pheasant, and the monogamous guineafowl or partridge! Many similar cases could be given, as in the grouse tribe, in which the males of the polygamous capercailzie and blackcock differ greatly from the females; whilst the sexes of the monogamous red grouse and ptarmigan differ very little. In the Cursorae, except amongst the bustards, few species offer strongly marked sexual differences, and the great bustard (*Otis tarda*) is said to be polygamous. With the Grallatores, extremely few species differ sexually, but the ruff (*Machetes pugnax*) affords a marked exception, and this species is believed by Montagu to be a polygamist. Hence it appears that amongst

birds there often exists a close relation between polygamy and the development of strongly marked sexual differences. I asked Mr. Bartlett, of the Zoological Gardens, who has had very large experience with birds, whether the male tragopan (one of the Gallinaceae) was polygamous, and I was struck by his answering, "I do not know, but should think so from his splendid colours."

It deserves notice that the instinct of pairing with a single female is easily lost under domestication. The wild duck is strictly monogamous, the domestic duck highly polygamous. The Rev. W.D. Fox informs me that out of some half-tamed wild ducks, on a large pond in his neighbourhood, so many mallards were shot by the gamekeeper that only one was left for every seven or eight females; yet unusually large broods were reared. The guinea fowl is strictly monogamous; but Mr. Fox finds that his birds succeed best when he keeps one cock to two or three hens. Canary birds pair in a state of nature, but the breeders in England successfully put one male to four or five females. I have noticed these cases, as rendering it probable that wild monogamous species might readily become either temporarily or permanently polygamous.

Too little is known of the habits of reptiles and fishes to enable us to speak of their marriage arrangements. The stickleback (*Gasterosteus*), however, is said to be a polygamist (Noel Humphreys, 'River Gardens,'); and the male during the breeding season differs conspicuously from the female.

To sum up on the means through which, as far as we can judge, sexual selection has led to the development of secondary sexual characters. It has been shewn that the largest number of vigorous offspring will be reared from the pairing of the strongest and best armed males, victorious in contests over other males, with the most vigorous and best nourished females, which are the first to breed in the spring. If such females select the more attractive, and at the same time vigorous males, they will rear a larger number of offspring than the retarded females, which must pair with the less vigorous and less attractive males. So it will be if the more vigorous males select the more attractive and at the same time healthy and vigorous females; and this will especially hold good if the male defends the female, and aids in providing food for the young. The advantage thus gained by the more vigorous pairs in rearing a larger number of offspring has apparently sufficed to render sexual selection efficient. But a large numerical preponderance of males over females will be still more efficient; whether the preponderance is only occasional and local, or permanent; whether it occurs at birth, or afterwards from the greater destruction of the females; or whether it indirectly follows from the practice of polygamy.

THE MALE GENERALLY MORE MODIFIED THAN THE FEMALE.

Throughout the animal kingdom, when the sexes differ in external appearance, it is, with rare exceptions, the male which has been the more modified; for, generally, the female retains a closer resemblance to the young of her own species, and to other adult members of the same group. The cause of this seems to lie in the males of almost all animals having stronger passions than the females. Hence it is the males that hunt together and sedulously display their charms before the females; and the victors transmit their superiority to their male offspring. Why both sexes do not thus acquire the characters of their fathers, will be considered hereafter. That the males of all mammals eagerly pursue the females is notorious to every one. So it is with birds; but many cock birds do not so much pursue the hen, as display their plumage, perform strange antics, and pour forth their song in her presence. The male in the few fish observed seems much more eager than the female; and the same is true of alligators, and apparently of Batrachians. Throughout the enormous class of insects, as Kirby remarks, "the law is that the male shall seek the female." (. Kirby and Spence, 'Introduction to Entomology,' vol. iii. , .) Two good authorities, Mr. Blackwall and Mr. C. Spence Bate, tell me that the males of spiders and crustaceans are more active and more erratic in their habits than the females. When the organs of sense or locomotion are present in the one sex of insects and crustaceans and absent in the other, or when, as is frequently the case, they are more highly developed in the one than in the other, it is, as far as I can discover, almost invariably the male which retains such organs, or has them most developed; and this shews that the male is the more active member in the courtship of the sexes. (. One parasitic Hymenopterous insect (Westwood, 'Modern Class. of Insects,' vol. ii.) forms an exception to the rule, as the male has rudimentary wings, and never quits the cell in which it is born, whilst the female has welldeveloped wings. Audouin believes that the females of this species are impregnated by the males which are born in the same cells with them; but it is much more probable that the females visit other cells, so that close interbreeding is thus avoided. We shall hereafter meet in various classes, with a few exceptional cases, in which the female, instead of the male, is the seeker and wooer.)

The female, on the other hand, with the rarest exceptions, is less eager than the male. As the illustrious Hunter (. 'Essays and Observations,' edited by Owen, vol. i. , .) long ago observed, she generally "requires to be courted;" she is coy, and may often be seen endeavouring for a long time to escape from the male. Every observer of the habits of animals will be able to call to mind instances of this kind. It is shewn by various facts, given hereafter, and by the results fairly attributable to sexual selection, that the female, though comparatively passive, generally exerts some choice and accepts one male in preference to others. Or she may accept, as appearances would sometimes lead us to believe, not the male which is the most attractive to her, but the one which is the least distasteful. The exertion of some choice on the part of the female seems a law almost as general as the eagerness of the male.

We are naturally led to enquire why the male, in so many and such distinct classes, has become more eager than the female, so that he searches for her, and plays the more active part in courtship. It would be no advantage and some loss of power if each sex searched for the other; but why should the male almost always be the seeker? The ovules of plants after fertilisation have to be nourished for a time; hence the pollen is necessarily brought to the female organs being placed on the stigma, by means of insects or the wind, or by the spontaneous movements of the stamens; and in the Algae, etc., by the locomotive power of the antherozoids. With lowly organised aquatic animals, permanently affixed to the same spot and having their sexes separate, the male element is invariably brought to the female; and of this we can see the reason, for even if the ova were detached before fertilisation, and did not require subsequent nourishment or protection, there would yet be greater difficulty in transporting them than the male element, because, being larger than the latter, they are produced in far smaller numbers. So that many of the lower animals are, in this respect, analogous with plants. (Prof. Sachs ('Lehrbuch der Botanik,' , S.) in speaking of the male and female reproductive cells, remarks, "verhält sich die eine bei der Vereinigung activ, die andere erscheint bei der Vereinigung passiv.") The males of affixed and aquatic animals having been led to emit their fertilising element in this way, it is natural that any of their descendants, which rose in the scale and became locomotive, should retain the same habit; and they would approach the female as closely as possible, in order not to risk the loss of the fertilising element in a long passage of it through the water. With some few of the lower animals, the females alone are fixed, and the males of these must be the seekers. But it is difficult to understand why the males of species, of which the progenitors were primordially free, should invariably have acquired the habit of approaching the females, instead of being approached by them. But in all cases, in order that the males should seek efficiently, it would be necessary that they should be endowed with strong passions; and the acquirement of such passions would naturally follow from the more eager leaving a larger number of offspring than the less eager.

The great eagerness of the males has thus indirectly led to their much more frequently developing secondary sexual characters than the females. But the development of such characters would be much aided, if the males were more liable to vary than the females as I concluded they were after a long study of domesticated animals. Von Nathusius, who has had very wide experience, is strongly of the same opinion. ('Vorträge über Viehzucht,' , .) Good evidence also in favour of this conclusion can be produced by a comparison of the two sexes in mankind. During the Novara Expedition ('Reise der Novara: Anthropolog. Theil,' , ss. . The results were calculated by Dr. Weisbach from measurements made by Drs. K. Scherzer and Schwarz. On the greater variability of the males of domesticated animals, see my 'Variation of Animals and Plants under Domestication,' vol. ii. , .) a vast number of measurements was made of

various parts of the body in different races, and the men were found in almost every case to present a greater range of variation than the women; but I shall have to recur to this subject in a future chapter. Mr. J. Wood (. 'Proceedings of the Royal Society,' vol. xvi. July , p and .), who has carefully attended to the variation of the muscles in man, puts in italics the conclusion that "the greatest number of abnormalities in each subject is found in the males." He had previously remarked that "altogether in subjects, the varieties of redundancy were found to be half as many again as in females, contrasting widely with the greater frequency of deficiency in females before described." Professor Macalister likewise remarks (. 'Proc. Royal Irish Academy,' vol. x. , .) that variations in the muscles "are probably more common in males than females." Certain muscles which are not normally present in mankind are also more frequently developed in the male than in the female sex, although exceptions to this rule are said to occur. Dr. Burt Wilder (. 'Massachusetts Medical Society,' vol. ii. , , .) has tabulated the cases of individuals with supernumerary digits, of which were males, and , or less than half, females, the remaining being of unknown sex. It should not, however, be overlooked that women would more frequently endeavour to conceal a deformity of this kind than men. Again, Dr. L. Meyer asserts that the ears of man are more variable in form than those of a woman. (. 'Archiv fur Path. Anat. und Phys.' , .) Lastly the temperature is more variable in man than in woman. (. The conclusions recently arrived at by Dr. J. Stockton Hough, on the temperature of man, are given in the 'PoSci. Review,' Jan. st, , .)

The cause of the greater general variability in the male sex, than in the female is unknown, except in so far as secondary sexual characters are extraordinarily variable, and are usually confined to the males; and, as we shall presently see, this fact is, to a certain extent, intelligible. Through the action of sexual and natural selection male animals have been rendered in very many instances widely different from their females; but independently of selection the two sexes, from differing constitutionally, tend to vary in a somewhat different manner. The female has to expend much organic matter in the formation of her ova, whereas the male expends much force in fierce contests with his rivals, in wandering about in search of the female, in exerting his voice, pouring out odoriferous secretions, etc.: and this expenditure is generally concentrated within a short period. The great vigour of the male during the season of love seems often to intensify his colours, independently of any marked difference from the female. (. Prof. Mantegazza is inclined to believe ('Lettera a Carlo Darwin,' 'Archivio per l'Anthropologia,' ,) that the bright colours, common in so many male animals, are due to the presence and retention by them of the spermatic fluid; but this can hardly be the case; for many male birds, for instance young pheasants, become brightly coloured in the autumn of their first year.) In mankind, and even as low down in the organic scale as in the Lepidoptera, the temperature of the body is higher in the male than in the female, accompanied in the case of man by a slower pulse. (. For mankind, see Dr. J. Stockton Hough, whose conclusions are given in the 'Popular Science Review,' , . See Girard's

observations on the Lepidoptera, as given in the 'Zoological Record,' , .) On the whole the expenditure of matter and force by the two sexes is probably nearly equal, though effected in very different ways and at different rates.

From the causes just specified the two sexes can hardly fail to differ somewhat in constitution, at least during the breedingseason; and, although they may be subjected to exactly the same conditions, they will tend to vary in a different manner. If such variations are of no service to either sex, they will not be accumulated and increased by sexual or natural selection. Nevertheless, they may become permanent if the exciting cause acts permanently; and in accordance with a frequent form of inheritance they may be transmitted to that sex alone in which they first appeared. In this case the two sexes will come to present permanent, yet unimportant, differences of character. For instance, Mr. Allen shews that with a large number of birds inhabiting the northern and southern United States, the specimens from the south are darkercoloured than those from the north; and this seems to be the direct result of the difference in temperature, light, etc., between the two regions. Now, in some few cases, the two sexes of the same species appear to have been differently affected; in the *Agelaeus phoeniceus* the males have had their colours greatly intensified in the south; whereas with *Cardinalis virginianus* it is the females which have been thus affected; with *Quiscalus major* the females have been rendered extremely variable in tint, whilst the males remain nearly uniform. (. 'Mammals and Birds of E. Florida,' , .)

A few exceptional cases occur in various classes of animals, in which the females instead of the males have acquired well pronounced secondary sexual characters, such as brighter colours, greater size, strength, or pugnacity. With birds there has sometimes been a complete transposition of the ordinary characters proper to each sex; the females having become the more eager in courtshithe males remaining comparatively passive, but apparently selecting the more attractive females, as we may infer from the results. Certain hen birds have thus been rendered more highly coloured or otherwise ornamented, as well as more powerful and pugnacious than the cocks; these characters being transmitted to the female offspring alone.

It may be suggested that in some cases a double process of selection has been carried on; that the males have selected the more attractive females, and the latter the more attractive males. This process, however, though it might lead to the modification of both sexes, would not make the one sex different from the other, unless indeed their tastes for the beautiful differed; but this is a supposition too improbable to be worth considering in the case of any animal, excepting man. There are, however, many animals in which the sexes resemble each other, both being furnished with the same ornaments, which analogy would lead us to attribute to the agency of sexual selection. In such cases it may be suggested with more plausibility, that there has been a double or mutual

process of sexual selection; the more vigorous and precocious females selecting the more attractive and vigorous males, the latter rejecting all except the more attractive females. But from what we know of the habits of animals, this view is hardly probable, for the male is generally eager to pair with any female. It is more probable that the ornaments common to both sexes were acquired by one sex, generally the male, and then transmitted to the offspring of both sexes. If, indeed, during a lengthened period the males of any species were greatly to exceed the females in number, and then during another lengthened period, but under different conditions, the reverse were to occur, a double, but not simultaneous, process of sexual selection might easily be carried on, by which the two sexes might be rendered widely different.

We shall hereafter see that many animals exist, of which neither sex is brilliantly coloured or provided with special ornaments, and yet the members of both sexes or of one alone have probably acquired simple colours, such as white or black, through sexual selection. The absence of bright tints or other ornaments may be the result of variations of the right kind never having occurred, or of the animals themselves having preferred plain black or white. Obscure tints have often been developed through natural selection for the sake of protection, and the acquirement through sexual selection of conspicuous colours, appears to have been sometimes checked from the danger thus incurred. But in other cases the males during long ages may have struggled together for the possession of the females, and yet no effect will have been produced, unless a larger number of offspring were left by the more successful males to inherit their superiority, than by the less successful: and this, as previously shewn, depends on many complex contingencies.

Sexual selection acts in a less rigorous manner than natural selection. The latter produces its effects by the life or death at all ages of the more or less successful individuals. Death, indeed, not rarely ensues from the conflicts of rival males. But generally the less successful male merely fails to obtain a female, or obtains a retarded and less vigorous female later in the season, or, if polygamous, obtains fewer females; so that they leave fewer, less vigorous, or no offspring. In regard to structures acquired through ordinary or natural selection, there is in most cases, as long as the conditions of life remain the same, a limit to the amount of advantageous modification in relation to certain special purposes; but in regard to structures adapted to make one male victorious over another, either in fighting or in charming the female, there is no definite limit to the amount of advantageous modification; so that as long as the proper variations arise the work of sexual selection will go on. This circumstance may partly account for the frequent and extraordinary amount of variability presented by secondary sexual characters. Nevertheless, natural selection will determine that such characters shall not be acquired by the victorious males, if they would be highly injurious, either by expending too much of their vital powers, or by exposing them to any great danger. The development, however, of certain structures of the horns, for instance, in certain

stags has been carried to a wonderful extreme; and in some cases to an extreme which, as far as the general conditions of life are concerned, must be slightly injurious to the male. From this fact we learn that the advantages which favoured males derive from conquering other males in battle or courtship and thus leaving a numerous progeny, are in the long run greater than those derived from rather more perfect adaptation to their conditions of life. We shall further see, and it could never have been anticipated, that the power to charm the female has sometimes been more important than the power to conquer other males in battle.

LAWS OF INHERITANCE.

In order to understand how sexual selection has acted on many animals of many classes, and in the course of ages has produced a conspicuous result, it is necessary to bear in mind the laws of inheritance, as far as they are known. Two distinct elements are included under the term "inheritance" the transmission, and the development of characters; but as these generally go together, the distinction is often overlooked. We see this distinction in those characters which are transmitted through the early years of life, but are developed only at maturity or during old age. We see the same distinction more clearly with secondary sexual characters, for these are transmitted through both sexes, though developed in one alone. That they are present in both sexes, is manifest when two species, having strongly marked sexual characters, are crossed, for each transmits the characters proper to its own male and female sex to the hybrid offspring of either sex. The same fact is likewise manifest, when characters proper to the male are occasionally developed in the female when she grows old or becomes diseased, as, for instance, when the common hen assumes the flowing tail feathers, hackles, comb, spurs, voice, and even pugnacity of the cock. Conversely, the same thing is evident, more or less plainly, with castrated males. Again, independently of old age or disease, characters are occasionally transferred from the male to the female, as when, in certain breeds of the fowl, spurs regularly appear in the young and healthy females. But in truth they are simply developed in the female; for in every breed each detail in the structure of the spur is transmitted through the female to her male offspring. Many cases will hereafter be given, where the female exhibits, more or less perfectly, characters proper to the male, in whom they must have been first developed, and then transferred to the female. The converse case of the first development of characters in the female and of transference to the male, is less frequent; it will therefore be well to give one striking instance. With bees the pollen collecting apparatus is used by the female alone for gathering pollen for the larvae, yet in most of the species it is partially developed in the males to whom it is quite useless, and it is perfectly developed in the males of *Bombus* or the humblebee. (. H. Muller, 'Anwendung der Darwin'schen Lehre,' etc., Verh. d. n. V. Jahrg., xxix. .) As not a single other Hymenopterous insect, not even the wasp which is closely allied to the bee, is provided with a pollen collecting apparatus, we have no

grounds for supposing that male bees primordially collected pollen as well as the females; although we have some reason to suspect that male mammals primordially suckled their young as well as the females. Lastly, in all cases of reversion, characters are transmitted through two, three, or many more generations, and are then developed under certain unknown favourable conditions. This important distinction between transmission and development will be best kept in mind by the aid of the hypothesis of pangenesis. According to this hypothesis, every unit or cell of the body throws off gemmules or undeveloped atoms, which are transmitted to the offspring of both sexes, and are multiplied by selfdivision. They may remain undeveloped during the early years of life or during successive generations; and their development into units or cells, like those from which they were derived, depends on their affinity for, and union with other units or cells previously developed in the due order of growth.

INHERITANCE AT CORRESPONDING PERIODS OF LIFE.

This tendency is well established. A new character, appearing in a young animal, whether it lasts throughout life or is only transient, will, in general, reappear in the offspring at the same age and last for the same time. If, on the other hand, a new character appears at maturity, or even during old age, it tends to reappear in the offspring at the same advanced age. When deviations from this rule occur, the transmitted characters much oftener appear before, than after the corresponding age. As I have dwelt on this subject sufficiently in another work (. The 'Variation of Animals and Plants under Domestication,' vol. ii. , . In the last chapter but one, the provisional hypothesis of pangenesis, above alluded to, is fully explained.), I will here merely give two or three instances, for the sake of recalling the subject to the reader's mind. In several breeds of the Fowl, the downcovered chickens, the young birds in their first true plumage, and the adults differ greatly from one another, as well as from their common parentform, the *Gallus bankiva*; and these characters are faithfully transmitted by each breed to their offspring at the corresponding periods of life. For instance, the chickens of spangled Hamburgs, whilst covered with down, have a few dark spots on the head and rump but are not striped longitudinally, as in many other breeds; in their first true plumage, "they are beautifully pencilled," that is each feather is transversely marked by numerous dark bars; but in their second plumage the feathers all become spangled or tipped with a dark round spot. (. These facts are given on the high authority of a great breeder, Mr. Teebay; see Tegetmeier's 'Poultry Book,' , . On the characters of chickens of different breeds, and on the breeds of the pigeon, alluded to in the following paragraph, see 'Variation of Animals,' etc., vol. i. ; vol. ii. .) Hence in this breed variations have occurred at, and been transmitted to, three distinct periods of life. The Pigeon offers a more remarkable case, because the aboriginal parent species does not undergo any change of plumage with advancing age, excepting that at maturity the breast becomes more iridescent; yet there are breeds which do not acquire their characteristic colours

until they have moulted two, three, or four times; and these modifications of plumage are regularly transmitted.

INHERITANCE AT CORRESPONDING SEASONS OF THE YEAR.

With animals in a state of nature, innumerable instances occur of characters appearing periodically at different seasons. We see this in the horns of the stag, and in the fur of Arctic animals which becomes thick and white during the winter. Many birds acquire bright colours and other decorations during the breedingseason alone. Pallas states (. 'Novae species Quadrupedum e Glirium ordine,' , . On the transmission of colour by the horse, see 'Variation of Animals and Plants under Domestication,' vol. i. . Also vol. ii. , for a general discussion on 'Inheritance as limited by Sex. '), that in Siberia domestic cattle and horses become lightercoloured during the winter; and I have myself observed, and heard of similar strongly marked changes of colour, that is, from brownish creamcolour or reddishbrown to a perfect white, in several ponies in England. Although I do not know that this tendency to change the colour of the coat during different seasons is transmitted, yet it probably is so, as all shades of colour are strongly inherited by the horse. Nor is this form of inheritance, as limited by the seasons, more remarkable than its limitation by age or sex.

INHERITANCE AS LIMITED BY SEX.

The equal transmission of characters to both sexes is the commonest form of inheritance, at least with those animals which do not present strongly marked sexual differences, and indeed with many of these. But characters are somewhat commonly transferred exclusively to that sex, in which they first appear. Ample evidence on this head has been advanced in my work on 'Variation under Domestication,' but a few instances may here be given. There are breeds of the sheep and goat, in which the horns of the male differ greatly in shape from those of the female; and these differences, acquired under domestication, are regularly transmitted to the same sex. As a rule, it is the females alone in cats which are tortoiseshell, the corresponding colour in the males being rustyred. With most breeds of the fowl, the characters proper to each sex are transmitted to the same sex alone. So general is this form of transmission that it is an anomaly when variations in certain breeds are transmitted equally to both sexes. There are also certain subbreeds of the fowl in which the males can hardly be distinguished from one another, whilst the females differ considerably in colour. The sexes of the pigeon in the parentspecies do not differ in any external character; nevertheless, in certain domesticated breeds the male is coloured differently from the female. (. Dr. Chapuis, 'Le Pigeon Voyageur Belge,' , . Boitard et Corbie, 'Les Pigeons de Volière,' etc., , . See, also, on similar differences in certain breeds at Modena, 'Le variazioni dei Colombi domestici,' del Paolo Bonizzi, .) The wattle in the English Carrier pigeon, and the crop in

the Pouter, are more highly developed in the male than in the female; and although these characters have been gained through longcontinued selection by man, the slight differences between the sexes are wholly due to the form of inheritance which has prevailed; for they have arisen, not from, but rather in opposition to, the wish of the breeder.

Most of our domestic races have been formed by the accumulation of many slight variations; and as some of the successive steps have been transmitted to one sex alone, and some to both sexes, we find in the different breeds of the same species all gradations between great sexual dissimilarity and complete similarity. Instances have already been given with the breeds of the fowl and pigeon, and under nature analogous cases are common. With animals under domestication, but whether in nature I will not venture to say, one sex may lose characters proper to it, and may thus come somewhat to resemble the opposite sex; for instance, the males of some breeds of the fowl have lost their masculine tailplumes and hackles. On the other hand, the differences between the sexes may be increased under domestication, as with merino sheep in which the ewes have lost their horns. Again, characters proper to one sex may suddenly appear in the other sex; as in those subbreeds of the fowl in which the hens acquire spurs whilst young; or, as in certain Polish subbreeds, in which the females, as there is reason to believe, originally acquired a crest, and subsequently transferred it to the males. All these cases are intelligible on the hypothesis of pangenesis; for they depend on the gemmules of certain parts, although present in both sexes, becoming, through the influence of domestication, either dormant or developed in either sex.

There is one difficult question which it will be convenient to defer to a future chapter; namely, whether a character at first developed in both sexes, could through selection be limited in its development to one sex alone. If, for instance, a breeder observed that some of his pigeons (of which the characters are usually transferred in an equal degree to both sexes) varied into pale blue, could he by longcontinued selection make a breed, in which the males alone should be of this tint, whilst the females remained unchanged? I will here only say, that this, though perhaps not impossible, would be extremely difficult; for the natural result of breeding from the paleblue males would be to change the whole stock of both sexes to this tint. If, however, variations of the desired tint appeared, which were from the first limited in their development to the male sex, there would not be the least difficulty in making a breed with the two sexes of a different colour, as indeed has been effected with a Belgian breed, in which the males alone are streaked with black. In a similar manner, if any variation appeared in a female pigeon, which was from the first sexually limited in its development to the females, it would be easy to make a breed with the females alone thus characterised; but if the variation was not thus originally limited, the process would be extremely difficult, perhaps impossible. (Since the publication of the first edition of this work, it has been highly satisfactory to

me to find the following remarks (the 'Field,' Sept.) from so experienced a breeder as Mr. Tegetmeier. After describing some curious cases in pigeons, of the transmission of colour by one sex alone, and the formation of a sub breed with this character, he says: "It is a singular circumstance that Mr. Darwin should have suggested the possibility of modifying the sexual colours of birds by a course of artificial selection. When he did so, he was in ignorance of these facts that I have related; but it is remarkable how very closely he suggested the right method of procedure.")

ON THE RELATION BETWEEN THE PERIOD OF DEVELOPMENT OF A CHARACTER AND ITS TRANSMISSION TO ONE SEX OR TO BOTH SEXES.

Why certain characters should be inherited by both sexes, and other characters by one sex alone, namely by that sex in which the character first appeared, is in most cases quite unknown. We cannot even conjecture why with certain subbreeds of the pigeon, black striae, though transmitted through the female, should be developed in the male alone, whilst every other character is equally transferred to both sexes. Why, again, with cats, the tortoiseshell colour should, with rare exceptions, be developed in the female alone. The very same character, such as deficient or supernumerary digits, colourblindness, etc., may with mankind be inherited by the males alone of one family, and in another family by the females alone, though in both cases transmitted through the opposite as well as through the same sex. (. References are given in my 'Variation of Animals and Plants under Domestication,' vol. ii. .) Although we are thus ignorant, the two following rules seem often to hold good that variations which first appear in either sex at a late period of life, tend to be developed in the same sex alone; whilst variations which first appear early in life in either sex tend to be developed in both sexes. I am, however, far from supposing that this is the sole determining cause. As I have not elsewhere discussed this subject, and it has an important bearing on sexual selection, I must here enter into lengthy and somewhat intricate details.

It is in itself probable that any character appearing at an early age would tend to be inherited equally by both sexes, for the sexes do not differ much in constitution before the power of reproduction is gained. On the other hand, after this power has been gained and the sexes have come to differ in constitution, the gemmules (if I may again use the language of pangenesis) which are cast off from each varying part in the one sex would be much more likely to possess the proper affinities for uniting with the tissues of the same sex, and thus becoming developed, than with those of the opposite sex.

I was first led to infer that a relation of this kind exists, from the fact that whenever and in whatever manner the adult male differs from the adult female, he differs in the same manner from the young of both sexes. The generality of this fact is quite remarkable: it holds good with almost all mammals, birds, amphibians, and fishes; also with many

crustaceans, spiders, and some few insects, such as certain orthoptera and libellulae. In all these cases the variations, through the accumulation of which the male acquired his proper masculine characters, must have occurred at a somewhat late period of life; otherwise the young males would have been similarly characterised; and conformably with our rule, the variations are transmitted to and developed in the adult males alone. When, on the other hand, the adult male closely resembles the young of both sexes (these, with rare exceptions, being alike), he generally resembles the adult female; and in most of these cases the variations through which the young and old acquired their present characters, probably occurred, according to our rule, during youth. But there is here room for doubt, for characters are sometimes transferred to the offspring at an earlier age than that at which they first appeared in the parents, so that the parents may have varied when adult, and have transferred their characters to their offspring whilst young. There are, moreover, many animals, in which the two sexes closely resemble each other, and yet both differ from their young; and here the characters of the adults must have been acquired late in life; nevertheless, these characters, in apparent contradiction to our rule, are transferred to both sexes. We must not however, overlook the possibility or even probability of successive variations of the same nature occurring, under exposure to similar conditions, simultaneously in both sexes at a rather late period of life; and in this case the variations would be transferred to the offspring of both sexes at a corresponding late age; and there would then be no real contradiction to the rule that variations occurring late in life are transferred exclusively to the sex in which they first appeared. This latter rule seems to hold true more generally than the second one, namely, that variations which occur in either sex early in life tend to be transferred to both sexes. As it was obviously impossible even to estimate in how large a number of cases throughout the animal kingdom these two propositions held good, it occurred to me to investigate some striking or crucial instances, and to rely on the result.

An excellent case for investigation is afforded by the Deer family. In all the species, but one, the horns are developed only in the males, though certainly transmitted through the females, and capable of abnormal development in them. In the reindeer, on the other hand, the female is provided with horns; so that in this species, the horns ought, according to our rule, to appear early in life, long before the two sexes are mature and have come to differ much in constitution. In all the other species the horns ought to appear later in life, which would lead to their development in that sex alone, in which they first appeared in the progenitor of the whole Family. Now in seven species, belonging to distinct sections of the family and inhabiting different regions, in which the stags alone bear horns, I find that the horns first appear at periods, varying from nine months after birth in the roebuck, to ten, twelve or even more months in the stags of the six other and larger species. (I am much obliged to Mr. Cupples for having made enquiries for me in regard to the Roebuck and Red Deer of Scotland from Mr.

Robertson, the experienced headforester to the Marquis of Breadalbane. In regard to Fallowdeer, I have to thank Mr. Eyton and others for information. For the *Cervus alces* of N. America, see 'Land and Water,' , p and ; and for the *C. Virginianus* and *strongyloceros* of the same continent, see J.D. Caton, in 'Ottawa Acad. of Nat. Sc.' , . For *Cervus Eldi* of Pegu, see Lieut. Beaven, 'Proceedings of the Zoological Society,' , .) But with the reindeer the case is widely different; for, as I hear from Prof. Nilsson, who kindly made special enquiries for me in Lapland, the horns appear in the young animals within four or five weeks after birth, and at the same time in both sexes. So that here we have a structure, developed at a most unusually early age in one species of the family, and likewise common to both sexes in this one species alone.

In several kinds of antelopes, only the males are provided with horns, whilst in the greater number both sexes bear horns. With respect to the period of development, Mr. Blyth informs me that there was at one time in the Zoological Gardens a young koodoo (*Ant. strepsiceros*), of which the males alone are horned, and also the young of a closely allied species, the eland (*Ant. oreas*), in which both sexes are horned. Now it is in strict conformity with our rule, that in the young male koodoo, although ten months old, the horns were remarkably small, considering the size ultimately attained by them; whilst in the young male eland, although only three months old, the horns were already very much larger than in the koodoo. It is also a noticeable fact that in the pronghorned antelope (*Antilocapra Americana*). I have to thank Dr. Canfield for information with respect to the horns of the female: see also his paper in 'Proceedings of the Zoological Society,' , . Also Owen, 'Anatomy of Vertebrates,' vol. iii.), only a few of the females, about one in five, have horns, and these are in a rudimentary state, though sometimes above four inches long: so that as far as concerns the possession of horns by the males alone, this species is in an intermediate condition, and the horns do not appear until about five or six months after birth. Therefore in comparison with what little we know of the development of the horns in other antelopes, and from what we do know with respect to the horns of deer, cattle, etc., those of the pronghorned antelope appear at an intermediate period of life, that is, not very early, as in cattle and sheenor very late, as in the larger deer and antelopes. The horns of sheegoats, and cattle, which are well developed in both sexes, though not quite equal in size, can be felt, or even seen, at birth or soon afterwards. (I have been assured that the horns of the sheep in North Wales can always be felt, and are sometimes even an inch in length, at birth. Youatt says ('Cattle,' ,), that the prominence of the frontal bone in cattle penetrates the cutis at birth, and that the horny matter is soon formed over it.) Our rule, however, seems to fail in some breeds of sheefor instance merinos, in which the rams alone are horned; for I cannot find on enquiry (I am greatly indebted to Prof. Victor Carus for having made enquiries for me, from the highest authorities, with respect to the merino sheep of Saxony. On the Guinea coast of Africa there is, however, a breed of sheep in which, as with merinos, the rams alone bear horns; and Mr. Winwood Reade informs me that in

one case observed by him, a young ram, born on Feb. th, first shewed horns on March th, so that in this instance, in conformity with rule, the development of the horns occurred at a later period of life than in Welsh sheein which both sexes are horned.), that the horns are developed later in life in this breed than in ordinary sheep in which both sexes are horned. But with domesticated sheep the presence or absence of horns is not a firmly fixed character; for a certain proportion of the merino ewes bear small horns, and some of the rams are hornless; and in most breeds hornless ewes are occasionally produced.

Dr. W. Marshall has lately made a special study of the protuberances so common on the heads of birds (. 'Über die knöchernen Schädelhöcker der Vögel,' in the 'Niederland. Archiv für Zoologie,' B.i. Heft , .), and he comes to the following conclusion: that with those species in which they are confined to the males, they are developed late in life; whereas with those species in which they are common to the two sexes, they are developed at a very early period. This is certainly a striking confirmation of my two laws of inheritance.

In most of the species of the splendid family of the Pheasants, the males differ conspicuously from the females, and they acquire their ornaments at a rather late period of life. The eared pheasant (*Crossoptilon auritum*), however, offers a remarkable exception, for both sexes possess the fine caudal plumes, the large eartufts and the crimson velvet about the head; I find that all these characters appear very early in life in accordance with rule. The adult male can, however, be distinguished from the adult female by the presence of spurs; and conformably with our rule, these do not begin to be developed before the age of six months, as I am assured by Mr. Bartlett, and even at this age, the two sexes can hardly be distinguished. (. In the common peacock (*Pavo cristatus*) the male alone possesses spurs, whilst both sexes of the Java Peacock (*muticus*) offer the unusual case of being furnished with spurs. Hence I fully expected that in the latter species they would have been developed earlier in life than in the common peacock; but M. Hegt of Amsterdam informs me, that with young birds of the previous year, of both species, compared on April rd, , there was no difference in the development of the spurs. The spurs, however, were as yet represented merely by slight knobs or elevations. I presume that I should have been informed if any difference in the rate of development had been observed subsequently.) The male and female Peacock differ conspicuously from each other in almost every part of their plumage, except in the elegant headcrest, which is common to both sexes; and this is developed very early in life, long before the other ornaments, which are confined to the male. The wildduck offers an analogous case, for the beautiful green speculum on the wings is common to both sexes, though duller and somewhat smaller in the female, and it is developed early in life, whilst the curled tailfeathers and other ornaments of the male are developed later. (. In some other species of the Duck family the speculum differs in a greater degree

in the two sexes; but I have not been able to discover whether its full development occurs later in life in the males of such species, than in the male of the common duck, as ought to be the case according to our rule. With the allied *Mergus cucullatus* we have, however, a case of this kind: the two sexes differ conspicuously in general plumage, and to a considerable degree in the speculum, which is pure white in the male and greyishwhite in the female. Now the young males at first entirely resemble the females, and have a greyishwhite speculum, which becomes pure white at an earlier age than that at which the adult male acquires his other and more strongly marked sexual differences: see Audubon, 'Ornithological Biography,' vol. iii. , p.) Between such extreme cases of close sexual resemblance and wide dissimilarity, as those of the *Crossoptilon* and peacock, many intermediate ones could be given, in which the characters follow our two rules in their order of development.

As most insects emerge from the pupal state in a mature condition, it is doubtful whether the period of development can determine the transference of their characters to one or to both sexes. But we do not know that the coloured scales, for instance, in two species of butterflies, in one of which the sexes differ in colour, whilst in the other they are alike, are developed at the same relative age in the cocoon. Nor do we know whether all the scales are simultaneously developed on the wings of the same species of butterfly, in which certain coloured marks are confined to one sex, whilst others are common to both sexes. A difference of this kind in the period of development is not so improbable as it may at first appear; for with the *Orthoptera*, which assume their adult state, not by a single metamorphosis, but by a succession of moults, the young males of some species at first resemble the females, and acquire their distinctive masculine characters only at a later moult. Strictly analogous cases occur at the successive moults of certain male crustaceans.

We have as yet considered the transference of characters, relatively to their period of development, only in species in a natural state; we will now turn to domesticated animals, and first touch on monstrosities and diseases. The presence of supernumerary digits, and the absence of certain phalanges, must be determined at an early embryonic period; the tendency to profuse bleeding is at least congenital, as is probably colourblindness; yet these peculiarities, and other similar ones, are often limited in their transmission to one sex; so that the rule that characters, developed at an early period, tend to be transmitted to both sexes, here wholly fails. But this rule, as before remarked, does not appear to be nearly so general as the converse one, namely, that characters which appear late in life in one sex are transmitted exclusively to the same sex. From the fact of the above abnormal peculiarities becoming attached to one sex, long before the sexual functions are active, we may infer that there must be some difference between the sexes at an extremely early age. With respect to sexually limited diseases, we know too little of the period at which they originate, to draw any safe conclusion. Gout, however,

seems to fall under our rule, for it is generally caused by intemperance during manhood, and is transmitted from the father to his sons in a much more marked manner than to his daughters.

In the various domestic breeds of sheegoats, and cattle, the males differ from their respective females in the shape or development of their horns, forehead, mane, dewlatail, and hump on the shoulders; and these peculiarities, in accordance with our rule, are not fully developed until a rather late period of life. The sexes of dogs do not differ, except that in certain breeds, especially in the Scotch deerhound, the male is much larger and heavier than the female; and, as we shall see in a future chapter, the male goes on increasing in size to an unusually late period of life, which, according to rule, will account for his increased size being transmitted to his male offspring alone. On the other hand, the tortoise shell colour, which is confined to female cats, is quite distinct at birth, and this case violates the rule. There is a breed of pigeons in which the males alone are streaked with black, and the streaks can be detected even in the nestlings; but they become more conspicuous at each successive moult, so that this case partly opposes and partly supports the rule. With the English Carrier and Pouter pigeons, the full development of the wattle and the crop occurs rather late in life, and conformably with the rule, these characters are transmitted in full perfection to the males alone. The following cases perhaps come within the class previously alluded to, in which both sexes have varied in the same manner at a rather late period of life, and have consequently transferred their new characters to both sexes at a corresponding late period; and if so, these cases are not opposed to our rule: there exist subbreeds of the pigeon, described by Neumeister (. 'Das Ganze der Taubenzucht,' , ss. , . For the case of the streaked pigeons, see Dr. Chapuis, 'Le pigeon voyageur Belge,' , .), in which both sexes change their colour during two or three moults (as is likewise the case with the Almond Tumbler); nevertheless, these changes, though occurring rather late in life, are common to both sexes. One variety of the Canarybird, namely the London Prize, offers a nearly analogous case.

With the breeds of the Fowl the inheritance of various characters by one or both sexes, seems generally determined by the period at which such characters are developed. Thus in all the many breeds in which the adult male differs greatly in colour from the female, as well as from the wild parentspecies, he differs also from the young male, so that the newly acquired characters must have appeared at a rather late period of life. On the other hand, in most of the breeds in which the two sexes resemble each other, the young are coloured in nearly the same manner as their parents, and this renders it probable that their colours first appeared early in life. We have instances of this fact in all black and white breeds, in which the young and old of both sexes are alike; nor can it be maintained that there is something peculiar in a black or white plumage, which leads to its transference to both sexes; for the males alone of many natural species are either

black or white, the females being differently coloured. With the so-called Cuckoo subbreeds of the fowl, in which the feathers are transversely pencilled with dark stripes, both sexes and the chickens are coloured in nearly the same manner. The laced plumage of the Sebright bantam is the same in both sexes, and in the young chickens the wing feathers are distinctly, though imperfectly laced. Spangled Hamburgs, however, offer a partial exception; for the two sexes, though not quite alike, resemble each other more closely than do the sexes of the aboriginal parent species; yet they acquire their characteristic plumage late in life, for the chickens are distinctly pencilled. With respect to other characters besides colour, in the wild parent species and in most of the domestic breeds, the males alone possess a well-developed comb; but in the young of the Spanish fowl it is largely developed at a very early age, and, in accordance with this early development in the male, it is of unusual size in the adult female. In the Game breeds pugnacity is developed at a wonderfully early age, of which curious proofs could be given; and this character is transmitted to both sexes, so that the hens, from their extreme pugnacity, are now generally exhibited in separate pens. With the Polish breeds the bony protuberance of the skull which supports the crest is partially developed even before the chickens are hatched, and the crest itself soon begins to grow, though at first feebly (. For full particulars and references on all these points respecting the several breeds of the Fowl, see 'Variation of Animals and Plants under Domestication,' vol. i. . In regard to the higher animals, the sexual differences which have arisen under domestication are described in the same work under the head of each species.); and in this breed the adults of both sexes are characterised by a great bony protuberance and an immense crest.

Finally, from what we have now seen of the relation which exists in many natural species and domesticated races, between the period of the development of their characters and the manner of their transmission for example, the striking fact of the early growth of the horns in the reindeer, in which both sexes bear horns, in comparison with their much later growth in the other species in which the male alone bears horns we may conclude that one, though not the sole cause of characters being exclusively inherited by one sex, is their development at a late age. And secondly, that one, though apparently a less efficient cause of characters being inherited by both sexes, is their development at an early age, whilst the sexes differ but little in constitution. It appears, however, that some difference must exist between the sexes even during a very early embryonic period, for characters developed at this age not rarely become attached to one sex.

SUMMARY AND CONCLUDING REMARKS.

From the foregoing discussion on the various laws of inheritance, we learn that the characters of the parents often, or even generally, tend to become developed in the offspring of the same sex, at the same age, and periodically at the same season of the

year, in which they first appeared in the parents. But these rules, owing to unknown causes, are far from being fixed. Hence during the modification of a species, the successive changes may readily be transmitted in different ways; some to one sex, and some to both; some to the offspring at one age, and some to the offspring at all ages. Not only are the laws of inheritance extremely complex, but so are the causes which induce and govern variability. The variations thus induced are preserved and accumulated by sexual selection, which is in itself an extremely complex affair, depending, as it does, on the ardour in love, the courage, and the rivalry of the males, as well as on the powers of perception, the taste, and will of the female. Sexual selection will also be largely dominated by natural selection tending towards the general welfare of the species. Hence the manner in which the individuals of either or both sexes have been affected through sexual selection cannot fail to be complex in the highest degree.

When variations occur late in life in one sex, and are transmitted to the same sex at the same age, the other sex and the young are left unmodified. When they occur late in life, but are transmitted to both sexes at the same age, the young alone are left unmodified. Variations, however, may occur at any period of life in one sex or in both, and be transmitted to both sexes at all ages, and then all the individuals of the species are similarly modified. In the following chapters it will be seen that all these cases frequently occur in nature.

Sexual selection can never act on any animal before the age for reproduction arrives. From the great eagerness of the male it has generally acted on this sex and not on the females. The males have thus become provided with weapons for fighting with their rivals, with organs for discovering and securely holding the female, and for exciting or charming her. When the sexes differ in these respects, it is also, as we have seen, an extremely general law that the adult male differs more or less from the young male; and we may conclude from this fact that the successive variations, by which the adult male became modified, did not generally occur much before the age for reproduction. Whenever some or many of the variations occurred early in life, the young males would partake more or less of the characters of the adult males; and differences of this kind between the old and young males may be observed in many species of animals.

It is probable that young male animals have often tended to vary in a manner which would not only have been of no use to them at an early age, but would have been actually injurious as by acquiring bright colours, which would render them conspicuous to their enemies, or by acquiring structures, such as great horns, which would expend much vital force in their development. Variations of this kind occurring in the young males would almost certainly be eliminated through natural selection. With the adult and experienced males, on the other hand, the advantages derived from the acquisition of

such characters, would more than counterbalance some exposure to danger, and some loss of vital force.

As variations which give to the male a better chance of conquering other males, or of finding, securing, or charming the opposite sex, would, if they happened to arise in the female, be of no service to her, they would not be preserved in her through sexual selection. We have also good evidence with domesticated animals, that variations of all kinds are, if not carefully selected, soon lost through intercrossing and accidental deaths. Consequently in a state of nature, if variations of the above kind chanced to arise in the female line, and to be transmitted exclusively in this line, they would be extremely liable to be lost. If, however, the females varied and transmitted their newly acquired characters to their offspring of both sexes, the characters which were advantageous to the males would be preserved by them through sexual selection, and the two sexes would in consequence be modified in the same manner, although such characters were of no use to the females: but I shall hereafter have to recur to these more intricate contingencies. Lastly, the females may acquire, and apparently have often acquired by transference, characters from the male sex.

As variations occurring later in life, and transmitted to one sex alone, have incessantly been taken advantage of and accumulated through sexual selection in relation to the reproduction of the species; therefore it appears, at first sight, an unaccountable fact that similar variations have not frequently been accumulated through natural selection, in relation to the ordinary habits of life. If this had occurred, the two sexes would often have been differently modified, for the sake, for instance, of capturing prey or of escaping from danger. Differences of this kind between the two sexes do occasionally occur, especially in the lower classes. But this implies that the two sexes follow different habits in their struggles for existence, which is a rare circumstance with the higher animals. The case, however, is widely different with the reproductive functions, in which respect the sexes necessarily differ. For variations in structure which are related to these functions, have often proved of value to one sex, and from having arisen at a late period of life, have been transmitted to one sex alone; and such variations, thus preserved and transmitted, have given rise to secondary sexual characters.

In the following chapters, I shall treat of the secondary sexual characters in animals of all classes, and shall endeavour in each case to apply the principles explained in the present chapter. The lowest classes will detain us for a very short time, but the higher animals, especially birds, must be treated at considerable length. It should be borne in mind that for reasons already assigned, I intend to give only a few illustrative instances of the innumerable structures by the aid of which the male finds the female, or, when found, holds her. On the other hand, all structures and instincts by the aid of which the

male conquers other males, and by which he allures or excites the female, will be fully discussed, as these are in many ways the most interesting.

SUPPLEMENT ON THE PROPORTIONAL NUMBERS OF THE TWO SEXES IN ANIMALS BELONGING TO VARIOUS CLASSES.

As no one, as far as I can discover, has paid attention to the relative numbers of the two sexes throughout the animal kingdom, I will here give such materials as I have been able to collect, although they are extremely imperfect. They consist in only a few instances of actual enumeration, and the numbers are not very large. As the proportions are known with certainty only in mankind, I will first give them as a standard of comparison.

MAN.

In England during ten years (from to) the average number of children born alive yearly was ,, in the proportion of . males to females. But in the male births throughout England were as ., and in as . to . Looking to separate districts, in Buckinghamshire (where about children are annually born) the MEAN proportion of male to female births, during the whole period of the above ten years, was as . to ; whilst in N. Wales (where the average annual births are ,) it was as high as . to . Taking a still smaller district, viz., Rutlandshire (where the annual births average only), in the male births were as ., and in as only . to ; but even in this small district the average of the births during the whole ten years, was as . to : that is in the same ratio as throughout England. (. 'Twentyninth Annual Report of the Registrar General for .' In this report (xii.) a special decennial table is given.) The proportions are sometimes slightly disturbed by unknown causes; thus Prof. Faye states "that in some districts of Norway there has been during a decennial period a steady deficiency of boys, whilst in others the opposite condition has existed." In France during fortyfour years the male to the female births have been as . to ; but during this period it has occurred five times in one department, and six times in another, that the female births have exceeded the males. In Russia the average proportion is as high as ., and in Philadelphia in the United States as . to . (. For Norway and Russia, see abstract of Prof. Faye's researches, in 'British and Foreign MedicoChirurg. Review,' April , . For France, the 'Annuaire pour l'An ,' . For Philadelphia, Dr. Stockton Hough, 'Social Science Assoc.' . For the Cape of Good Hope, Quetelet as quoted by Dr. H.H. Zouteveen, in the Dutch Translation of this work (vol. i.), where much information is given on the proportion of the sexes.) The average for Europe, deduced by Bickes from about seventy million births, is males to females. On the other hand, with white children born at the Cape of Good Hope, the proportion of males is so low as to fluctuate during successive years between and males for every females. It is a singular fact that with Jews the proportion of male births is decidedly larger than with Christians: thus in Prussia the proportion is as , in Breslau as , and in

Livonia as to ; the Christian births in these countries being the same as usual, for instance, in Livonia as to . (In regard to the Jews, see M. Thury, 'La Loi de Production des Sexes,' , .)

Prof. Faye remarks that "a still greater preponderance of males would be met with, if death struck both sexes in equal proportion in the womb and during birth. But the fact is, that for every stillborn females, we have in several countries from . to . stillborn males. During the first four or five years of life, also, more male children die than females, for example in England, during the first year, boys die for every girls a proportion which in France is still more unfavourable." ('British and Foreign MedicoChirurg. Review,' April , . Dr. Stark also remarks ('Tenth Annual Report of Births, Deaths, etc., in Scotland,' , xxviii.) that "These examples may suffice to show that, at almost every stage of life, the males in Scotland have a greater liability to death and a higher deathrate than the females. The fact, however, of this peculiarity being most strongly developed at that infantile period of life when the dress, food, and general treatment of both sexes are alike, seems to prove that the higher male deathrate is an impressed, natural, and constitutional peculiarity due to sex alone.") Dr. Stockton Hough accounts for these facts in part by the more frequent defective development of males than of females. We have before seen that the male sex is more variable in structure than the female; and variations in important organs would generally be injurious. But the size of the body, and especially of the head, being greater in male than female infants is another cause: for the males are thus more liable to be injured during parturition. Consequently the stillborn males are more numerous; and, as a highly competent judge, Dr. Crichton Browne ('West Riding Lunatic Asylum Reports,' vol. i. , . Sir J. Simpson has proved that the head of the male infant exceeds that of the female by $\frac{1}{4}$ ths of an inch in circumference, and by $\frac{1}{4}$ th in transverse diameter. Quetelet has shewn that woman is born smaller than man; see Dr. Duncan, 'Fecundity, Fertility, and Sterility,' , .), believes, male infants often suffer in health for some years after birth. Owing to this excess in the deathrate of male children, both at birth and for some time subsequently, and owing to the exposure of grown men to various dangers, and to their tendency to emigrate, the females in all oldsettled countries, where statistical records have been kept, are found to preponderate considerably over the males. (With the savage Guarany of Paraguay, according to the accurate Azara ('Voyages dans l'Amerique merid.' tom. ii. ,), the women are to the men in the proportion of to .)

It seems at first sight a mysterious fact that in different nations, under different conditions and climates, in Naples, Prussia, Westphalia, Holland, France, England and the United States, the excess of male over female births is less when they are illegitimate than when legitimate. (Babbage, 'Edinburgh Journal of Science,' , vol. i. ; also , on stillborn children. On illegitimate children in England, see 'Report of RegistrarGeneral for ,' xv.) This has been explained by different writers in many different ways, as from

the mothers being generally young, from the large proportion of first pregnancies, etc. But we have seen that male infants, from the large size of their heads, suffer more than female infants during parturition; and as the mothers of illegitimate children must be more liable than other women to undergo bad labours, from various causes, such as attempts at concealment by tight lacing, hard work, distress of mind, etc., their male infants would proportionably suffer. And this probably is the most efficient of all the causes of the proportion of males to females born alive being less amongst illegitimate children than amongst the legitimate. With most animals the greater size of the adult male than of the female, is due to the stronger males having conquered the weaker in their struggles for the possession of the females, and no doubt it is owing to this fact that the two sexes of at least some animals differ in size at birth. Thus we have the curious fact that we may attribute the more frequent deaths of male than female infants, especially amongst the illegitimate, at least in part to sexual selection.

It has often been supposed that the relative age of the two parents determine the sex of the offspring; and Prof. Leuckart (. Leuckart, in Wagner 'Handwörterbuch der Phys.' B. iv. , s. .) has advanced what he considers sufficient evidence, with respect to man and certain domesticated animals, that this is one important though not the sole factor in the result. So again the period of impregnation relatively to the state of the female has been thought by some to be the efficient cause; but recent observations discountenance this belief. According to Dr. Stockton Hough (. 'Social Science Association of Philadelphia,' .), the season of the year, the poverty or wealth of the parents, residence in the country or in cities, the crossing of foreign immigrants, etc., all influence the proportion of the sexes. With mankind, polygamy has also been supposed to lead to the birth of a greater proportion of female infants; but Dr. J. Campbell (. 'Anthropological Review,' April , cviii.) carefully attended to this subject in the harems of Siam, and concludes that the proportion of male to female births is the same as from monogamous unions. Hardly any animal has been rendered so highly polygamous as the English racehorse, and we shall immediately see that his male and female offspring are almost exactly equal in number. I will now give the facts which I have collected with respect to the proportional numbers of the sexes of various animals; and will then briefly discuss how far selection has come into play in determining the result.

HORSES.

Mr. Tegetmeier has been so kind as to tabulate for me from the 'Racing Calendar' the births of racehorses during a period of twentyone years, viz., from to ; being omitted, as no returns were that year published. The total births were , (. During eleven years a record was kept of the number of mares which proved barren or prematurely slipped their foals; and it deserves notice, as shewing how infertile these highly nurtured and rather closelyinterbred animals have become, that not far from onethird of the mares

failed to produce living foals. Thus during , male colts and female colts were born, and mares failed to produce offspring. During , males and females were born, and mares failed.), consisting of , males and , females, or in the proportion of . males to females. As these numbers are tolerably large, and as they are drawn from all parts of England, during several years, we may with much confidence conclude that with the domestic horse, or at least with the racehorse, the two sexes are produced in almost equal numbers. The fluctuations in the proportions during successive years are closely like those which occur with mankind, when a small and thinly populated area is considered; thus in the male horses were as ., and in as only . to females. In the tabulated returns the proportions vary in cycles, for the males exceeded the females during six successive years; and the females exceeded the males during two periods each of four years; this, however, may be accidental; at least I can detect nothing of the kind with man in the decennial table in the Registrar's Report for .

DOGS.

During a period of twelve years, from to , the births of a large number of greyhounds, throughout England, were sent to the 'Field' newspaper; and I am again indebted to Mr. Tegetmeier for carefully tabulating the results. The recorded births were , consisting of males and females, that is, in the proportion of . males to females. The greatest fluctuations occurred in , when the proportion was as . males, and in , as . males to females. The above average proportion of . to is probably nearly correct in the case of the greyhound, but whether it would hold with other domesticated breeds is in some degree doubtful. Mr. Cupples has enquired from several great breeders of dogs, and finds that all without exception believe that females are produced in excess; but he suggests that this belief may have arisen from females being less valued, and from the consequent disappointment producing a stronger impression on the mind.

SHEEP.

The sexes of sheep are not ascertained by agriculturists until several months after birth, at the period when the males are castrated; so that the following returns do not give the proportions at birth. Moreover, I find that several great breeders in Scotland, who annually raise some thousand shee are firmly convinced that a larger proportion of males than of females die during the first year or two. Therefore the proportion of males would be somewhat larger at birth than at the age of castration. This is a remarkable coincidence with what, as we have seen, occurs with mankind, and both cases probably depend on the same cause. I have received returns from four gentlemen in England who have bred Lowland shee chiefly Leicesters, during the last ten to sixteen years; they amount altogether to births, consisting of males and females; that is in the proportion of . males to females. With respect to Cheviot and blackfaced sheep bred in Scotland, I

have received returns from six breeders, two of them on a large scale, chiefly for the years , but some of the returns extend back to . The total number recorded amounts to ,, consisting of , males and , females or in the proportion of . males to females. If we take the English and Scotch returns together, the total number amounts to ,, consisting of , males and , females, or as . to . So that with sheep at the age of castration the females are certainly in excess of the males, but probably this would not hold good at birth. (I am much indebted to Mr. Cupples for having procured for me the above returns from Scotland, as well as some of the following returns on cattle. Mr. R. Elliot, of Laighwood, first called my attention to the premature deaths of the males, a statement subsequently confirmed by Mr. Aitchison and others. To this latter gentleman, and to Mr. Payan, I owe my thanks for large returns as to sheep.)

Of CATTLE I have received returns from nine gentlemen of births, too few to be trusted; these consisted of bullcalves and cowcalves; i.e., in the proportion of . males to females. The Rev. W.D. Fox informs me that in out of calves born on a farm in Derbyshire only one was a bull. Mr. Harrison Weir has enquired from several breeders of PIGS, and most of them estimate the male to the female births as about to . This same gentleman has bred RABBITS for many years, and has noticed that a far greater number of bucks are produced than does. But estimations are of little value.

Of mammalia in a state of nature I have been able to learn very little. In regard to the common rat, I have received conflicting statements. Mr. R. Elliot, of Laighwood, informs me that a ratcatcher assured him that he had always found the males in great excess, even with the young in the nest. In consequence of this, Mr. Elliot himself subsequently examined some hundred old ones, and found the statement true. Mr. F. Buckland has bred a large number of white rats, and he also believes that the males greatly exceed the females. In regard to Moles, it is said that "the males are much more numerous than the females" (. Bell, 'History of British Quadrupeds,' .): and as the catching of these animals is a special occupation, the statement may perhaps be trusted. Sir A. Smith, in describing an antelope of S. Africa (. 'Illustrations of the Zoology of S. Africa,' , pl. .) (*Kobus ellipsiprymnus*), remarks, that in the herds of this and other species, the males are few in number compared with the females: the natives believe that they are born in this proportion; others believe that the younger males are expelled from the herds, and Sir A. Smith says, that though he has himself never seen herds consisting of young males alone, others affirm that this does occur. It appears probable that the young when expelled from the herd, would often fall a prey to the many beasts of prey of the country.

BIRDS.

With respect to the FOWL, I have received only one account, namely, that out of chickens of a highlybred stock of Cochins, reared during eight years by Mr. Stretch,

proved males and females; i.e., as . to . In regard to domestic pigeons there is good evidence either that the males are produced in excess, or that they live longer; for these birds invariably pair, and single males, as Mr. Tegetmeier informs me, can always be purchased cheaper than females. Usually the two birds reared from the two eggs laid in the same nest are a male and a female; but Mr. Harrison Weir, who has been so large a breeder, says that he has often bred two cocks from the same nest, and seldom two hens; moreover, the hen is generally the weaker of the two, and more liable to perish.

With respect to birds in a state of nature, Mr. Gould and others (. Brehm ('Thierleben,' B. iv. s.) comes to the same conclusion.) are convinced that the males are generally the more numerous; and as the young males of many species resemble the females, the latter would naturally appear to be the more numerous. Large numbers of pheasants are reared by Mr. Baker of Leadenhall from eggs laid by wild birds, and he informs Mr. Jenner Weir that four or five males to one female are generally produced. An experienced observer remarks (. On the authority of L. Lloyd, 'Game Birds of Sweden,' , .), that in Scandinavia the broods of the capercaillie and blackcock contain more males than females; and that with the Dalripa (a kind of ptarmigan) more males than females attend the leks or places of courtship; but this latter circumstance is accounted for by some observers by a greater number of hen birds being killed by vermin. From various facts given by White of Selborne (. 'Nat. Hist. of Selborne,' letter xxix. edit. of , vol. i. .), it seems clear that the males of the partridge must be in considerable excess in the south of England; and I have been assured that this is the case in Scotland. Mr. Weir on enquiring from the dealers, who receive at certain seasons large numbers of ruffs (*Machetes pugnax*), was told that the males are much the more numerous. This same naturalist has also enquired for me from the birdcatchers, who annually catch an astonishing number of various small species alive for the London market, and he was unhesitatingly answered by an old and trustworthy man, that with the chaffinch the males are in large excess: he thought as high as males to female, or at least as high as to . (. Mr. Jenner Weir received similar information, on making enquiries during the following year. To shew the number of living chaffinches caught, I may mention that in there was a match between two experts, and one man caught in a day , and another , male chaffinches. The greatest number ever caught by one man in a single day was .) The males of the blackbird, he likewise maintained, were by far the more numerous, whether caught by traps or by netting at night. These statements may apparently be trusted, because this same man said that the sexes are about equal with the lark, the twite (*Linaria montana*), and goldfinch. On the other hand, he is certain that with the common linnet, the females preponderate greatly, but unequally during different years; during some years he has found the females to the males as four to one. It should, however, be borne in mind, that the chief season for catching birds does not begin till September, so that with some species partial migrations may have begun, and the flocks at this period often consist of hens alone. Mr. Salvin paid particular attention to the

sexes of the hummingbirds in Central America, and is convinced that with most of the species the males are in excess; thus one year he procured specimens belonging to ten species, and these consisted of males and of only females. With two other species the females were in excess: but the proportions apparently vary either during different seasons or in different localities; for on one occasion the males of *Campylopterus hemileucurus* were to the females as to , and on another occasion (. 'Ibis,' vol. ii. , as quoted in Gould's 'Trochilidae,' , . For the foregoing proportions, I am indebted to Mr. Salvin for a table of his results.) in exactly the reversed ratio. As bearing on this latter point, I may add, that Mr. Powys found in Corfu and Epirus the sexes of the chaffinch keeping apart, and "the females by far the most numerous"; whilst in Palestine Mr. Tristram found "the male flocks appearing greatly to exceed the female in number." (. 'Ibis,' , ; and , .) So again with the *Quiscalus major*, Mr. G. Taylor says, that in Florida there were "very few females in proportion to the males," (. 'Ibis,' , .) whilst in Honduras the proportion was the other way, the species there having the character of a polygamist.

FISH.

With fish the proportional numbers of the sexes can be ascertained only by catching them in the adult or nearly adult state; and there are many difficulties in arriving at any just conclusion. (. Leuckart quotes Bloch (Wagner, 'Handwörterbuch der Phys.' B. iv. , s.), that with fish there are twice as many males as females.) Infertile females might readily be mistaken for males, as Dr. Gunther has remarked to me in regard to trout. With some species the males are believed to die soon after fertilising the ova. With many species the males are of much smaller size than the females, so that a large number of males would escape from the same net by which the females were caught. M. Carbonnier (. Quoted in the 'Farmer,' March , , .), who has especially attended to the natural history of the pike (*Esox lucius*), states that many males, owing to their small size, are devoured by the larger females; and he believes that the males of almost all fish are exposed from this same cause to greater danger than the females. Nevertheless, in the few cases in which the proportional numbers have been actually observed, the males appear to be largely in excess. Thus Mr. R. Buist, the superintendent of the Stormontfield experiments, says that in , out of salmon first landed for the purpose of obtaining the ova, upwards of were males. In he again "calls attention to the vast disproportion of the males to the females. We had at the outset at least ten males to one female." Afterwards females sufficient for obtaining ova were procured. He adds, "from the great proportion of the males, they are constantly hitting and tearing each other on the spawningbeds." (. 'The Stormontfield Piscicultural Experiments,' , . The 'Field' newspaper, June , .) This disproportion, no doubt, can be accounted for in part, but whether wholly is doubtful, by the males ascending the rivers before the females. Mr. F. Buckland remarks in regard to trout, that "it is a curious fact that the males preponderate very largely in number over the females. It INVARIABLY happens that when the first rush of fish is made to the net,

there will be at least seven or eight males to one female found captive. I cannot quite account for this; either the males are more numerous than the females, or the latter seek safety by concealment rather than flight." He then adds, that by carefully searching the banks sufficient females for obtaining ova can be found. (. 'Land and Water,' , .) Mr. H. Lee informs me that out of trout, taken for this purpose in Lord Portsmouth's park, were males and females.

The males of the Cyprinidae likewise seem to be in excess; but several members of this Family, viz., the cartench, bream and minnow, appear regularly to follow the practice, rare in the animal kingdom, of polyandry; for the female whilst spawning is always attended by two males, one on each side, and in the case of the bream by three or four males. This fact is so well known, that it is always recommended to stock a pond with two male tenches to one female, or at least with three males to two females. With the minnow, an excellent observer states, that on the spawningbeds the males are ten times as numerous as the females; when a female comes amongst the males, "she is immediately pressed closely by a male on each side; and when they have been in that situation for a time, are superseded by other two males." (. Yarrell, 'Hist. British Fishes,' vol. i. , ; on the *Cyprinus carpio*, ; on the *Tinca vulgaris*, ; on the *Abramis brama*, . See, for the minnow (*Leuciscus phoxinus*), 'Loudon's Magazine of Natural History,' vol. v. , .)

INSECTS.

In this great Class, the Lepidoptera almost alone afford means for judging of the proportional numbers of the sexes; for they have been collected with special care by many good observers, and have been largely bred from the egg or caterpillar state. I had hoped that some breeders of silkmoths might have kept an exact record, but after writing to France and Italy, and consulting various treatises, I cannot find that this has ever been done. The general opinion appears to be that the sexes are nearly equal, but in Italy, as I hear from Professor Canestrini, many breeders are convinced that the females are produced in excess. This same naturalist, however, informs me, that in the two yearly broods of the *Ailanthus* silkmoth (*Bombyx cynthia*), the males greatly preponderate in the first, whilst in the second the two sexes are nearly equal, or the females rather in excess.

In regard to Butterflies in a state of nature, several observers have been much struck by the apparently enormous preponderance of the males. (. Leuckart quotes Meinecke (Wagner, 'Handwörterbuch der Phys.' B. iv. , s.) that the males of Butterflies are three or four times as numerous as the females.) Thus Mr. Bates (. 'The Naturalist on the Amazons,' vol. ii. , .), in speaking of several species, about a hundred in number, which inhabit the upper Amazons, says that the males are much more numerous than the females, even in the proportion of a hundred to one. In North America, Edwards, who

had great experience, estimates in the genus *Papilio* the males to the females as four to one; and Mr. Walsh, who informed me of this statement, says that with *turnus* this is certainly the case. In South Africa, Mr. R. Trimen found the males in excess in species (. Four of these cases are given by Mr. Trimen in his '*Rhopalocera Africae Australis*.'); and in one of these, which swarms in open places, he estimated the number of males as fifty to one female. With another species, in which the males are numerous in certain localities, he collected only five females during seven years. In the island of Bourbon, M. Maillard states that the males of one species of *Papilio* are twenty times as numerous as the females. (. Quoted by Trimen, '*Transactions of the Ent. Society*,' vol. v. part iv. , .) Mr. Trimen informs me that as far as he has himself seen, or heard from others, it is rare for the females of any butterfly to exceed the males in number; but three South African species perhaps offer an exception. Mr. Wallace (. '*Transactions, Linnean Society*,' vol. xxv. .) states that the females of *Ornithoptera croesus*, in the Malay archipelago, are more common and more easily caught than the males; but this is a rare butterfly. I may here add, that in *Hyperythra*, a genus of moths, Guenee says, that from four to five females are sent in collections from India for one male.

When this subject of the proportional numbers of the sexes of insects was brought before the Entomological Society (. '*Proceedings, Entomological Society*,' Feb. , .), it was generally admitted that the males of most *Lepidoptera*, in the adult or imago state, are caught in greater numbers than the females: but this fact was attributed by various observers to the more retiring habits of the females, and to the males emerging earlier from the cocoon. This latter circumstance is well known to occur with most *Lepidoptera*, as well as with other insects. So that, as M. Personnat remarks, the males of the domesticated *Bombyx Yamamai*, are useless at the beginning of the season, and the females at the end, from the want of mates. (. Quoted by Dr. Wallace in '*Proceedings, Entomological Society*,' rd series, vol. v. , .) I cannot, however, persuade myself that these causes suffice to explain the great excess of males, in the above cases of certain butterflies which are extremely common in their native countries. Mr. Stainton, who has paid very close attention during many years to the smaller moths, informs me that when he collected them in the imago state, he thought that the males were ten times as numerous as the females, but that since he has reared them on a large scale from the caterpillar state, he is convinced that the females are the more numerous. Several entomologists concur in this view. Mr. Doubleday, however, and some others, take an opposite view, and are convinced that they have reared from the eggs and caterpillars a larger proportion of males than of females.

Besides the more active habits of the males, their earlier emergence from the cocoon, and in some cases their frequenting more open stations, other causes may be assigned for an apparent or real difference in the proportional numbers of the sexes of *Lepidoptera*, when captured in the imago state, and when reared from the egg or

caterpillar state. I hear from Professor Canestrini, that it is believed by many breeders in Italy, that the female caterpillar of the silkmoth suffers more from the recent disease than the male; and Dr. Staudinger informs me that in rearing Lepidoptera more females die in the cocoon than males. With many species the female caterpillar is larger than the male, and a collector would naturally choose the finest specimens, and thus unintentionally collect a larger number of females. Three collectors have told me that this was their practice; but Dr. Wallace is sure that most collectors take all the specimens which they can find of the rarer kinds, which alone are worth the trouble of rearing. Birds when surrounded by caterpillars would probably devour the largest; and Professor Canestrini informs me that in Italy some breeders believe, though on insufficient evidence, that in the first broods of the *Ailanthus* silkmoth, the wasps destroy a larger number of the female than of the male caterpillars. Dr. Wallace further remarks that female caterpillars, from being larger than the males, require more time for their development, and consume more food and moisture: and thus they would be exposed during a longer time to danger from ichneumons, birds, etc., and in times of scarcity would perish in greater numbers. Hence it appears quite possible that in a state of nature, fewer female Lepidoptera may reach maturity than males; and for our special object we are concerned with their relative numbers at maturity, when the sexes are ready to propagate their kind.

The manner in which the males of certain moths congregate in extraordinary numbers round a single female, apparently indicates a great excess of males, though this fact may perhaps be accounted for by the earlier emergence of the males from their cocoons. Mr. Stainton informs me that from twelve to twenty males, may often be seen congregated round a female *Elachista rufocinerea*. It is well known that if a virgin *Lasiocampa quercus* or *Saturnia carpini* be exposed in a cage, vast numbers of males collect round her, and if confined in a room will even come down the chimney to her. Mr. Doubleday believes that he has seen from fifty to a hundred males of both these species attracted in the course of a single day by a female in confinement. In the Isle of Wight Mr. Trimen exposed a box in which a female of the *Lasiocampa* had been confined on the previous day, and five males soon endeavoured to gain admittance. In Australia, Mr. Verreaux, having placed the female of a small *Bombyx* in a box in his pocket, was followed by a crowd of males, so that about entered the house with him. (. Blanchard, 'Metamorphoses, Moeurs des Insectes,' , p.)

Mr. Doubleday has called my attention to M. Staudinger's (. 'Lepidopteren-Doubletten Liste,' Berlin, x. .) list of Lepidoptera, which gives the prices of the males and females of species or well marked varieties of butterflies (*Rhopalocera*). The prices for both sexes of the very common species are of course the same; but in of the rarer species they differ; the males being in all cases, excepting one, the cheaper. On an average of the prices of the species, the price of the male to that of the female is as to ; and this apparently

indicates that inversely the males exceed the females in the same proportion. About species or varieties of moths (Heterocera) are catalogued, those with wingless females being here excluded on account of the difference in habits between the two sexes: of these species, differ in price according to sex, the males of being cheaper, and those of only being dearer than the females. The average price of the males of the species, to that of the females, is as to . With respect to the butterflies in this priced list, Mr. Doubleday thinks (and no man in England has had more experience), that there is nothing in the habits of the species which can account for the difference in the prices of the two sexes, and that it can be accounted for only by an excess in the number of the males. But I am bound to add that Dr. Staudinger informs me, that he is himself of a different opinion. He thinks that the less active habits of the females and the earlier emergence of the males will account for his collectors securing a larger number of males than of females, and consequently for the lower prices of the former. With respect to specimens reared from the caterpillarstate, Dr. Staudinger believes, as previously stated, that a greater number of females than of males die whilst confined to the cocoons. He adds that with certain species one sex seems to preponderate over the other during certain years.

Of direct observations on the sexes of Lepidoptera, reared either from eggs or caterpillars, I have received only the few following cases: (See following table.)

So that in these eight lots of cocoons and eggs, males were produced in excess. Taken together the proportion of males is as . to females. But the numbers are hardly large enough to be trustworthy.

On the whole, from these various sources of evidence, all pointing in the same direction, I infer that with most species of Lepidoptera, the mature males generally exceed the females in number, whatever the proportions may be at their first emergence from the egg.

Males Females

The Rev. J. Hellins* of Exeter reared, during
, imagos of species, which
consisted of

Mr. Albert Jones of Eltham reared, during , imagos of species, which consisted of

During he reared imagos from species consisting of

Mr. Buckler of Emsworth, Hants, during , reared imagos from species, consisting of

Dr. Wallace of Colchester reared from one

brood of *Bombyx cynthia*
Dr. Wallace raised, from cocoons of *Bombyx*
Pernyi sent from China, during
Dr. Wallace raised, during and , from
two lots of cocoons of *Bombyx yamamai*
Total

(* This naturalist has been so kind as to send me some results from former years, in which the females seemed to preponderate; but so many of the ures were estimates, that I found it impossible to tabulate them.)

With reference to the other Orders of insects, I have been able to collect very little reliable information. With the stagbeetle (*Lucanus cervus*) "the males appear to be much more numerous than the females"; but when, as Cornelius remarked during , an unusual number of these beetles appeared in one part of Germany, the females appeared to exceed the males as six to one. With one of the Elateridae, the males are said to be much more numerous than the females, and "two or three are often found united with one female (. Gunther's 'Record of Zoological Literature,' , . On the excess of female *Lucanus*, *ibid.* . On the males of *Lucanus* in England, Westwood, 'Modern Classification of Insects,' vol. i. . On the *Siagonium*, *ibid.* .); so that here polyandry seems to prevail." With *Siagonium* (*Staphylinidae*), in which the males are furnished with horns, "the females are far more numerous than the opposite sex." Mr. Janson stated at the Entomological Society that the females of the bark feeding *Tomicus villosus* are so common as to be a plague, whilst the males are so rare as to be hardly known.

It is hardly worth while saying anything about the proportion of the sexes in certain species and even groups of insects, for the males are unknown or very rare, and the females are parthenogenetic, that is, fertile without sexual union; examples of this are afforded by several of the *Cynipidae*. (. Walsh in 'The American Entomologist,' vol. i. , . F. Smith, 'Record of Zoological Lit.' , .) In all the gallmaking *Cynipidae* known to Mr. Walsh, the females are four or five times as numerous as the males; and so it is, as he informs me, with the gallmaking *Cecidomyiidae* (*Diptera*). With some common species of Sawflies (*Tenthredinae*) Mr. F. Smith has reared hundreds of specimens from larvae of all sizes, but has never reared a single male; on the other hand, Curtis says (. 'Farm Insects,' p.), that with certain species (*Athalia*), bred by him, the males were to the females as six to one; whilst exactly the reverse occurred with the mature insects of the same species caught in the fields. In the family of bees, Hermann Müller (. 'Anwendung der Darwin'schen Lehre,' Verh. d. n. Jahrg., xxiv.), collected a large number of specimens of many species, and reared others from the cocoons, and counted the sexes. He found that the males of some species greatly exceeded the females in number; in others the reverse occurred; and in others the two sexes were nearly equal. But as in

most cases the males emerge from the cocoons before the females, they are at the commencement of the breedingseason practically in excess. Müller also observed that the relative number of the two sexes in some species differed much in different localities. But as H. Müller has himself remarked to me, these remarks must be received with some caution, as one sex might more easily escape observation than the other. Thus his brother Fritz Müller has noticed in Brazil that the two sexes of the same species of bee sometimes frequent different kinds of flowers. With respect to the Orthoptera, I know hardly anything about the relative number of the sexes: Korte ('Die Strich, Zug oder Wanderheuschrecke,' , .), however, says that out of locusts which he examined, the males were to the females as five to six. With the Neuroptera, Mr. Walsh states that in many, but by no means in all the species of the Odonatous group there is a great overplus of males: in the genus Hetaerina, also, the males are generally at least four times as numerous as the females. In certain species in the genus Gomphus the males are equally in excess, whilst in two other species, the females are twice or thrice as numerous as the males. In some European species of Psocus thousands of females may be collected without a single male, whilst with other species of the same genus both sexes are common. ('Observations on N. American Neuroptera,' by H. Hagen and B.D. Walsh, 'Proceedings, Ent. Soc. Philadelphia,' Oct. , , .) In England, Mr. MacLachlan has captured hundreds of the female *Apatania muliebris*, but has never seen the male; and of *Boreus hyemalis* only four or five males have been seen here. ('Proceedings, Ent. Soc. London,' Feb. , .) With most of these species (excepting the Tenthredinae) there is at present no evidence that the females are subject to parthenogenesis; and thus we see how ignorant we are of the causes of the apparent discrepancy in the proportion of the two sexes.

In the other classes of the Articulata I have been able to collect still less information. With spiders, Mr. Blackwall, who has carefully attended to this class during many years, writes to me that the males from their more erratic habits are more commonly seen, and therefore appear more numerous. This is actually the case with a few species; but he mentions several species in six genera, in which the females appear to be much more numerous than the males. (Another great authority with respect to this class, Prof. Thorell of Upsala ('On European Spiders,' , part i.), speaks as if female spiders were generally commoner than the males.) The small size of the males in comparison with the females (a peculiarity which is sometimes carried to an extreme degree), and their widely different appearance, may account in some instances for their rarity in collections. (See, on this subject, Mr. O. Cambridge, as quoted in 'Quarterly Journal of Science,' , page .)

Some of the lower Crustaceans are able to propagate their kind sexually, and this will account for the extreme rarity of the males; thus von Siebold ('Beiträge zur Parthenogenesis,' .) carefully examined no less than , specimens of *Apus* from twentyone

localities, and amongst these he found only males. With some other forms (as *Tanais* and *Cypris*), as Fritz Müller informs me, there is reason to believe that the males are much shorter-lived than the females; and this would explain their scarcity, supposing the two sexes to be at first equal in number. On the other hand, Müller has invariably taken far more males than females of the *Diastylidae* and of *Cypridina* on the shores of Brazil: thus with a species in the latter genus, specimens caught the same day included males; but he suggests that this preponderance may be due to some unknown difference in the habits of the two sexes. With one of the higher Brazilian crabs, namely a *Gelasimus*, Fritz Müller found the males to be more numerous than the females. According to the large experience of Mr. C. Spence Bate, the reverse seems to be the case with six common British crabs, the names of which he has given me.

THE PROPORTION OF THE SEXES IN RELATION TO NATURAL SELECTION.

There is reason to suspect that in some cases man has by selection indirectly influenced his own sex-producing powers. Certain women tend to produce during their whole lives more children of one sex than of the other: and the same holds good of many animals, for instance, cows and horses; thus Mr. Wright of Yeldersley House informs me that one of his Arab mares, though put seven times to different horses, produced seven fillies. Though I have very little evidence on this head, analogy would lead to the belief, that the tendency to produce either sex would be inherited like almost every other peculiarity, for instance, that of producing twins; and concerning the above tendency a good authority, Mr. J. Downing, has communicated to me facts which seem to prove that this does occur in certain families of shorthorn cattle. Col. Marshall (. 'The Todas,' , , .) has recently found on careful examination that the Todas, a hill-tribe of India, consist of males and females of all ages that is in a ratio of . males to females. The Todas, who are polyandrous in their marriages, during former times invariably practised female infanticide; but this practice has now been discontinued for a considerable period. Of the children born within late years, the males are more numerous than the females, in the proportion of to . Colonel Marshall accounts for this fact in the following ingenious manner. "Let us for the purpose of illustration take three families as representing an average of the entire tribe; say that one mother gives birth to six daughters and no sons; a second mother has six sons only, whilst the third mother has three sons and three daughters. The first mother, following the tribal custom, destroys four daughters and preserves two. The second retains her six sons. The third kills two daughters and keeps one, as also her three sons. We have then from the three families, nine sons and three daughters, with which to continue the breed. But whilst the males belong to families in which the tendency to produce sons is great, the females are of those of a converse inclination. Thus the bias strengthens with each generation, until, as we find, families grow to have habitually more sons than daughters."

That this result would follow from the above form of infanticide seems almost certain; that is if we assume that a sexproducing tendency is inherited. But as the above numbers are so extremely scanty, I have searched for additional evidence, but cannot decide whether what I have found is trustworthy; nevertheless the facts are, perhaps, worth giving. The Maories of New Zealand have long practised infanticide; and Mr. Fenton (. 'Aboriginal Inhabitants of New Zealand: Government Report,' , .) states that he "has met with instances of women who have destroyed four, six, and even seven children, mostly females. However, the universal testimony of those best qualified to judge, is conclusive that this custom has for many years been almost extinct. Probably the year may be named as the period of its ceasing to exist." Now amongst the New Zealanders, as with the Todas, male births are considerably in excess. Mr. Fenton remarks (), "One fact is certain, although the exact period of the commencement of this singular condition of the disproportion of the sexes cannot be demonstratively fixed, it is quite clear that this course of decrease was in full operation during the years to , when the nonadult population of was being produced, and has continued with great energy up to the present time." The following statements are taken from Mr. Fenton (), but as the numbers are not large, and as the census was not accurate, uniform results cannot be expected. It should be borne in mind in this and the following cases, that the normal state of every population is an excess of women, at least in all civilised countries, chiefly owing to the greater mortality of the male sex during youth, and partly to accidents of all kinds later in life. In , the native population of New Zealand was estimated as consisting of , males and , females of all ages, that is in the ratio of . males to females. But during this same year, and in certain limited districts, the numbers were ascertained with much care, and the males of all ages were here and the females ; that is in the ratio of . males to females. It is more important for us that during this same year of , the NONADULT males within the same district were found to be , and the NONADULT females , that is in the ratio of . to . It may be added that in , at which period female infanticide had only lately ceased, the NONADULT males in one district were , and the NON ADULT females only , that is in the ratio of . males to females.

In the Sandwich Islands, the males exceed the females in number. Infanticide was formerly practised there to a frightful extent, but was by no means confined to female infants, as is shewn by Mr. Ellis (. 'Narrative of a Tour through Hawaii,' , .), and as I have been informed by Bishop Staley and the Rev. Mr. Coan. Nevertheless, another apparently trustworthy writer, Mr. Jarves (. 'History of the Sandwich Islands,' , .), whose observations apply to the whole archipelago, remarks:"Numbers of women are to be found, who confess to the murder of from three to six or eight children," and he adds, "females from being considered less useful than males were more often destroyed." From what is known to occur in other parts of the world, this statement is probable; but must be received with much caution. The practice of infanticide ceased about the year ,

when idolatry was abolished and missionaries settled in the Islands. A careful census in of the adult and taxable men and women in the island of Kauai and in one district of Oahu (Jarves,), gives males and females; that is in the ratio of . to . At the same time the number of males under fourteen years in Kauai and under eighteen in Oahu was , and of females of the same ages ; and here we have the ratio of . males to females.

In a census of all the islands in (. This is given in the Rev. H.T. Cheever's 'Life in the Sandwich Islands,' , .), the males of all ages amount to ,, and the females to ,, or as . to . The males under seventeen years amounted to ,, and the females under the same age to , or as . to . From the census of , the proportion of males of all ages (including halfcastes) to females, is as . to . It must be borne in mind that all these returns for the Sandwich Islands give the proportion of living males to living females, and not of the births; and judging from all civilised countries the proportion of males would have been considerably higher if the numbers had referred to births. (. Dr. Coulter, in describing ('Journal R. Geograph. Soc.' vol. v. ,) the state of California about the year , says that the natives, reclaimed by the Spanish missionaries, have nearly all perished, or are perishing, although well treated, not driven from their native land, and kept from the use of spirits. He attributes this, in great part, to the undoubted fact that the men greatly exceed the women in number; but he does not know whether this is due to a failure of female offspring, or to more females dying during early youth. The latter alternative, according to all analogy, is very improbable. He adds that "infanticide, properly so called, is not common, though very frequent recourse is had to abortion." If Dr. Coulter is correct about infanticide, this case cannot be advanced in support of Colonel Marshall's view. From the rapid decrease of the reclaimed natives, we may suspect that, as in the cases lately given, their fertility has been diminished from changed habits of life.

I had hoped to gain some light on this subject from the breeding of dogs; inasmuch as in most breeds, with the exception, perhaps, of greyhounds, many more female puppies are destroyed than males, just as with the Toda infants. Mr. Cupples assures me that this is usual with Scotch deer hounds. Unfortunately, I know nothing of the proportion of the sexes in any breed, excepting greyhounds, and there the male births are to the females as . to . Now from enquiries made from many breeders, it seems that the females are in some respects more esteemed, though otherwise troublesome; and it does not appear that the female puppies of the best bred dogs are systematically destroyed more than the males, though this does sometimes take place to a limited extent. Therefore I am unable to decide whether we can, on the above principles, account for the preponderance of male births in greyhounds. On the other hand, we have seen that with horses, cattle, and sheewhich are too valuable for the young of either sex to be destroyed, if there is any difference, the females are slightly in excess.)

From the several foregoing cases we have some reason to believe that infanticide practised in the manner above explained, tends to make a male producing race; but I am far from supposing that this practice in the case of man, or some analogous process with other species, has been the sole determining cause of an excess of males. There may be some unknown law leading to this result in decreasing races, which have already become somewhat infertile. Besides the several causes previously alluded to, the greater facility of parturition amongst savages, and the less consequent injury to their male infants, would tend to increase the proportion of liveborn males to females. There does not, however, seem to be any necessary connection between savage life and a marked excess of males; that is if we may judge by the character of the scanty offspring of the lately existing Tasmanians and of the crossed offspring of the Tahitians now inhabiting Norfolk Island.

As the males and females of many animals differ somewhat in habits and are exposed in different degrees to danger, it is probable that in many cases, more of one sex than of the other are habitually destroyed. But as far as I can trace out the complication of causes, an indiscriminate though large destruction of either sex would not tend to modify the sexproducing power of the species. With strictly social animals, such as bees or ants, which produce a vast number of sterile and fertile females in comparison with the males, and to whom this preponderance is of paramount importance, we can see that those communities would flourish best which contained females having a strong inherited tendency to produce more and more females; and in such cases an unequal sexproducing tendency would be ultimately gained through natural selection. With animals living in herds or troops, in which the males come to the front and defend the herd, as with the bisons of North America and certain baboons, it is conceivable that a male producing tendency might be gained by natural selection; for the individuals of the better defended herds would leave more numerous descendants. In the case of mankind the advantage arising from having a preponderance of men in the tribe is supposed to be one chief cause of the practice of female infanticide.

In no case, as far as we can see, would an inherited tendency to produce both sexes in equal numbers or to produce one sex in excess, be a direct advantage or disadvantage to certain individuals more than to others; for instance, an individual with a tendency to produce more males than females would not succeed better in the battle for life than an individual with an opposite tendency; and therefore a tendency of this kind could not be gained through natural selection. Nevertheless, there are certain animals (for instance, fishes and cirripedes) in which two or more males appear to be necessary for the fertilisation of the female; and the males accordingly largely preponderate, but it is by no means obvious how this maleproducing tendency could have been acquired. I formerly thought that when a tendency to produce the two sexes in equal numbers was

advantageous to the species, it would follow from natural selection, but I now see that the whole problem is so intricate that it is safer to leave its solution for the future.

CHAPTER IX.

SECONDARY SEXUAL CHARACTERS IN THE LOWER CLASSES OF THE ANIMAL KINGDOM.

These characters absent in the lowest classes Brilliant colours Mollusca Annelids Crustacea, secondary sexual characters strongly developed; dimorphism; colour; characters not acquired before maturity Spiders, sexual colours of; stridulation by the males Myriapoda.

With animals belonging to the lower classes, the two sexes are not rarely united in the same individual, and therefore secondary sexual characters cannot be developed. In many cases where the sexes are separate, both are permanently attached to some support, and the one cannot search or struggle for the other. Moreover it is almost certain that these animals have too imperfect senses and much too low mental powers to appreciate each other's beauty or other attractions, or to feel rivalry.

Hence in these classes or subkingdoms, such as the Protozoa, Coelenterata, Echinodermata, Scolecida, secondary sexual characters, of the kind which we have to consider, do not occur: and this fact agrees with the belief that such characters in the higher classes have been acquired through sexual selection, which depends on the will, desire, and choice of either sex. Nevertheless some few apparent exceptions occur; thus, as I hear from Dr. Baird, the males of certain Entozoa, or internal parasitic worms, differ slightly in colour from the females; but we have no reason to suppose that such differences have been augmented through sexual selection. Contrivances by which the male holds the female, and which are indispensable for the propagation of the species, are independent of sexual selection, and have been acquired through ordinary selection.

Many of the lower animals, whether hermaphrodites or with separate sexes, are ornamented with the most brilliant tints, or are shaded and striped in an elegant manner; for instance, many corals and sea anemones (Actiniae), some jellyfish (Medusae, *Porpita*, etc.), some Planariae, many starfishes, Echini, Ascidians, etc.; but we may conclude from the reasons already indicated, namely, the union of the two sexes in some of these animals, the permanently affixed condition of others, and the low mental powers of all, that such colours do not serve as a sexual attraction, and have not been acquired through sexual selection. It should be borne in mind that in no case have we sufficient evidence that colours have been thus acquired, except where one sex is much more brilliantly or conspicuously coloured than the other, and where there is no difference in habits between the sexes sufficient to account for their different colours. But the evidence is rendered as complete as it can ever be, only when the more ornamented individuals, almost always the males, voluntarily display their attractions before the other sex; for we cannot believe that such display is useless, and if it be advantageous, sexual selection will almost inevitably follow. We may, however, extend

this conclusion to both sexes, when coloured alike, if their colours are plainly analogous to those of one sex alone in certain other species of the same group.

How, then, are we to account for the beautiful or even gorgeous colours of many animals in the lowest classes? It appears doubtful whether such colours often serve as a protection; but that we may easily err on this head, will be admitted by every one who reads Mr. Wallace's excellent essay on this subject. It would not, for instance, at first occur to any one that the transparency of the Medusae, or jellyfish, is of the highest service to them as a protection; but when we are reminded by Haeckel that not only the Medusae, but many floating Mollusca, crustaceans, and even small oceanic fishes partake of this same glasslike appearance, often accompanied by prismatic colours, we can hardly doubt that they thus escape the notice of pelagic birds and other enemies. M. Giard is also convinced (. 'Archives de Zoolog. Exper.' Oct. , .) that the bright tints of certain sponges and ascidians serve as a protection. Conspicuous colours are likewise beneficial to many animals as a warning to their wouldbe devourers that they are distasteful, or that they possess some special means of defence; but this subject will be discussed more conveniently hereafter.

We can, in our ignorance of most of the lowest animals, only say that their bright tints result either from the chemical nature or the minute structure of their tissues, independently of any benefit thus derived. Hardly any colour is finer than that of arterial blood; but there is no reason to suppose that the colour of the blood is in itself any advantage; and though it adds to the beauty of the maiden's cheek, no one will pretend that it has been acquired for this purpose. So again with many animals, especially the lower ones, the bile is richly coloured; thus, as I am informed by Mr. Hancock, the extreme beauty of the Eolidae (naked seaslugs) is chiefly due to the biliary glands being seen through the translucent integumentsthis beauty being probably of no service to these animals. The tints of the decaying leaves in an American forest are described by every one as gorgeous; yet no one supposes that these tints are of the least advantage to the trees. Bearing in mind how many substances closely analogous to natural organic compounds have been recently formed by chemists, and which exhibit the most splendid colours, it would have been a strange fact if substances similarly coloured had not often originated, independently of any useful end thus gained, in the complex laboratory of living organisms.

THE SUBKINGDOM OF THE MOLLUSCA.

Throughout this great division of the animal kingdom, as far as I can discover, secondary sexual characters, such as we are here considering, never occur. Nor could they be expected in the three lowest classes, namely, in the Ascidians, Polyzoa, and Brachiopods (constituting the Molluscoida of some authors), for most of these animals

are permanently affixed to a support or have their sexes united in the same individual. In the Lamellibranchiata, or bivalve shells, hermaphroditism is not rare. In the next higher class of the Gasteropoda, or univalve shells, the sexes are either united or separate. But in the latter case the males never possess special organs for finding, securing, or charming the females, or for hting with other males. As I am informed by Mr. Gwyn Jeffreys, the sole external difference between the sexes consists in the shell sometimes differing a little in form; for instance, the shell of the male periwinkle (*Littorina littorea*) is narrower and has a more elongated spire than that of the female. But differences of this nature, it may be presumed, are directly connected with the act of reproduction, or with the development of the ova.

The Gasteropoda, though capable of locomotion and furnished with imperfect eyes, do not appear to be endowed with sufficient mental powers for the members of the same sex to struggle together in rivalry, and thus to acquire secondary sexual characters. Nevertheless with the pulmoniferous gasteropods, or landsnails, the pairing is preceded by courtship; for these animals, though hermaphrodites, are compelled by their structure to pair together. Agassiz remarks, "Quiconque a eu l'occasion d'observer les amours des limaçons, ne saurait mettre en doute la séduction déployée dans les mouvements et les allures qui préparent et accomplissent le double embrassement de ces hermaphrodites." (. 'De l'Espèce et de la Class.' etc., , .) These animals appear also susceptible of some degree of permanent attachment: an accurate observer, Mr. Lonsdale, informs me that he placed a pair of landsnails, (*Helix pomatia*), one of which was weakly, into a small and illprovided garden. After a short time the strong and healthy individual disappeared, and was traced by its track of slime over a wall into an adjoining wellstocked garden. Mr. Lonsdale concluded that it had deserted its sickly mate; but after an absence of twentyfour hours it returned, and apparently communicated the result of its successful exploration, for both then started along the same track and disappeared over the wall.

Even in the highest class of the Mollusca, the Cephalopoda or cuttle fishes, in which the sexes are separate, secondary sexual characters of the present kind do not, as far as I can discover, occur. This is a surprising circumstance, as these animals possess highlydeveloped senseorgans and have considerable mental powers, as will be admitted by every one who has watched their artful endeavours to escape from an enemy. (. See, for instance, the account which I have given in my 'Journal of Researches,' , .) Certain Cephalopoda, however, are characterised by one extraordinary sexual character, namely that the male element collects within one of the arms or tentacles, which is then cast off, and clinging by its suckingdiscs to the female, lives for a time an independent life. So completely does the castoff arm resemble a separate animal, that it was described by Cuvier as a parasitic worm under the name of Hectocotyle. But this marvellous structure may be classed as a primary rather than as a secondary sexual character.

Although with the Mollusca sexual selection does not seem to have come into play; yet many univalve and bivalve shells, such as volutes, cones, scallops, etc., are beautifully coloured and shaped. The colours do not appear in most cases to be of any use as a protection; they are probably the direct result, as in the lowest classes, of the nature of the tissues; the patterns and the sculpture of the shell depending on its manner of growth. The amount of light seems to be influential to a certain extent; for although, as repeatedly stated by Mr. Gwyn Jeffreys, the shells of some species living at a profound depth are brightly coloured, yet we generally see the lower surfaces, as well as the parts covered by the mantle, less highly coloured than the upper and exposed surfaces. (I have given ('Geological Observations on Volcanic Islands,' ,) a curious instance of the influence of light on the colours of a frondescent incrustation, deposited by the surf on the coastrocks of Ascension and formed by the solution of triturated seashells.) In some cases, as with shells living amongst corals or brightly tinted seaweeds, the bright colours may serve as a protection. (Dr. Morse has lately discussed this subject in his paper on the 'Adaptive Coloration of Mollusca,' 'Proc. Boston Soc. of Nat. Hist.' vol. xiv. April .) But that many of the nudibranch Mollusca, or seaslugs, are as beautifully coloured as any shells, may be seen in Messrs. Alder and Hancock's magnificent work; and from information kindly given me by Mr. Hancock, it seems extremely doubtful whether these colours usually serve as a protection. With some species this may be the case, as with one kind which lives on the green leaves of algae, and is itself bright green. But many brightly coloured, white, or otherwise conspicuous species, do not seek concealment; whilst again some equally conspicuous species, as well as other dull coloured kinds live under stones and in dark recesses. So that with these nudibranch molluscs, colour apparently does not stand in any close relation to the nature of the places which they inhabit.

These naked seaslugs are hermaphrodites, yet they pair together, as do landsnails, many of which have extremely pretty shells. It is conceivable that two hermaphrodites, attracted by each other's greater beauty, might unite and leave offspring which would inherit their parents' greater beauty. But with such lowly organised creatures this is extremely improbable. Nor is it at all obvious how the offspring from the more beautiful pairs of hermaphrodites would have any advantage over the offspring of the less beautiful, so as to increase in number, unless indeed vigour and beauty generally coincided. We have not here the case of a number of males becoming mature before the females, with the more beautiful males selected by the more vigorous females. If, indeed, brilliant colours were beneficial to a hermaphrodite animal in relation to its general habits of life, the more brightly tinted individuals would succeed best and would increase in number; but this would be a case of natural and not of sexual selection.

SUBKINGDOM OF THE VERMES: CLASS, ANNELIDA (OR SEAWORMS).

In this class, although the sexes, when separate, sometimes differ from each other in characters of such importance that they have been placed under distinct genera or even families, yet the differences do not seem of the kind which can be safely attributed to sexual selection. These animals are often beautifully coloured, but as the sexes do not differ in this respect, we are but little concerned with them. Even the Nemertians, though so lowly organised, "vie in beauty and variety of colouring with any other group in the invertebrate series"; yet Dr. McIntosh (. See his beautiful monograph on 'British Annelids,' part i. , .) cannot discover that these colours are of any service. The sedentary annelids become duller coloured, according to M. Quatrefages (. See M. Perrier: 'L'Origine de l'Homme d'après Darwin,' 'Revue Scientifique', Feb. , .), after the period of reproduction; and this I presume may be attributed to their less vigorous condition at that time. All these worm like animals apparently stand too low in the scale for the individuals of either sex to exert any choice in selecting a partner, or for the individuals of the same sex to struggle together in rivalry.

SUBKINGDOM OF THE ARTHROPODA: CLASS, CRUSTACEA.

In this great class we first meet with undoubted secondary sexual characters, often developed in a remarkable manner. Unfortunately the habits of crustaceans are very imperfectly known, and we cannot explain the uses of many structures peculiar to one sex. With the lower parasitic species the males are of small size, and they alone are furnished with perfect swimminglegs, antennae and senseorgans; the females being destitute of these organs, with their bodies often consisting of a mere distorted mass. But these extraordinary differences between the two sexes are no doubt related to their widely different habits of life, and consequently do not concern us. In various crustaceans, belonging to distinct families, the anterior antennae are furnished with peculiar threadlike bodies, which are believed to act as smellingorgans, and these are much more numerous in the males than in the females. As the males, without any unusual development of their olfactory organs, would almost certainly be able sooner or later to find the females, the increased number of the smellingthreads has probably been acquired through sexual selection, by the better provided males having been the more successful in finding partners and in producing offspring. Fritz Müller has described a remarkable dimorphic species of *Tanais*, in which the male is represented by two distinct forms, which never graduate into each other. In the one form the male is furnished with more numerous smellingthreads, and in the other form with more powerful and more elongated chelae or pincers, which serve to hold the female. Fritz Müller suggests that these differences between the two male forms of the same species may have originated in certain individuals having varied in the number of the smellingthreads, whilst other individuals varied in the shape and size of their chelae; so that of the former, those which were best able to find the female, and of the latter, those

which were best able to hold her, have left the greatest number of progeny to inherit their respective advantages. (. 'Facts and Arguments for Darwin,' English transl., , . See the previous discussion on the olfactory threads. Sars has described a somewhat analogous case (as quoted in 'Nature,' ,) in a Norwegian crustacean, the *Pontoporeia affinis*.)

[.. *Labidocera Darwinii* (from Lubbock). Labelled are: a. Part of right anterior antenna of male, forming a prehensile organ. b. Posterior pair of thoracic legs of male. c. Ditto of female.]

In some of the lower crustaceans, the right anterior antenna of the male differs greatly in structure from the left, the latter resembling in its simple tapering joints the antennae of the female. In the male the modified antenna is either swollen in the middle or angularly bent, or converted into an elegant, and sometimes wonderfully complex, prehensile organ. (. See Sir J. Lubbock in 'Annals and Mag. of Nat. Hist.' vol. xi. , pl. i. and x.; and vol. xii. (), pl. vii. See also Lubbock in 'Transactions, Entomological Society,' vol. iv. new series, , . With respect to the zigzagged antennae mentioned below, see Fritz Müller, 'Facts and Arguments for Darwin,' , , foot note.) It serves, as I hear from Sir J. Lubbock, to hold the female, and for this same purpose one of the two posterior legs (b) on the same side of the body is converted into a forceps. In another family the inferior or posterior antennae are "curiously zigzagged" in the males alone.

[. . Anterior part of body of *Callianassa* (from MilneEdwards), showing the unequal and differentlyconstructed right and lefthand chelae of the male. N.B.The artist by mistake has reversed the drawing, and made the lefthand chela the largest.

.. Second leg of male *Orchestia Tucuratinga* (from Fritz Müller).

.. Ditto of female.]

In the higher crustaceans the anterior legs are developed into chelae or pincers; and these are generally larger in the male than in the female,so much so that the market value of the male edible crab (*Cancer pagurus*), according to Mr. C. Spence Bate, is five times as great as that of the female. In many species the chelae are of unequal size on the opposite side of the body, the righthand one being, as I am informed by Mr. Bate, generally, though not invariably, the largest. This inequality is also often much greater in the male than in the female. The two chelae of the male often differ in structure (s. , , and), the smaller one resembling that of the female. What advantage is gained by their inequality in size on the opposite sides of the body, and by the inequality being much greater in the male than in the female; and why, when they are of equal size, both are often much larger in the male than in the female, is not known. As I hear from Mr. Bate,

the chelae are sometimes of such length and size that they cannot possibly be used for carrying food to the mouth. In the males of certain freshwater prawns (*Palaemon*) the right leg is actually longer than the whole body. (. See a paper by Mr. C. Spence Bate, with ures, in 'Proceedings, Zoological Society,' ; and on the nomenclature of the genus, *ibid.* . I am greatly indebted to Mr. Spence Bate for nearly all the above statements with respect to the chelae of the higher crustaceans.) The great size of the one leg with its chelae may aid the male in fighting with his rivals; but this will not account for their inequality in the female on the opposite sides of the body. In *Gelasimus*, according to a statement quoted by Milne Edwards (. 'Hist. Nat. des Crust.' tom. ii. , .), the male and the female live in the same burrow, and this shews that they pair; the male closes the mouth of the burrow with one of its chelae, which is enormously developed; so that here it indirectly serves as a means of defence. Their main use, however, is probably to seize and to secure the female, and this in some instances, as with *Gammarus*, is known to be the case. The male of the hermit or soldier crab (*Pagurus*) for weeks together, carries about the shell inhabited by the female. (. Mr. C. Spence Bate, 'British Association, Fourth Report on the Fauna of S. Devon.') The sexes, however, of the common shorecrab (*Carcinus maenas*), as Mr. Bate informs me, unite directly after the female has moulted her hard shell, when she is so soft that she would be injured if seized by the strong pincers of the male; but as she is caught and carried about by the male before moulting, she could then be seized with impunity.

[.. *Orchestia Darwinii* (from Fritz Müller), showing the differently constructed chelae of the two male forms.]

Fritz Müller states that certain species of *Melita* are distinguished from all other amphipods by the females having "the coxal lamellae of the penultimate pair of feet produced into hooklike processes, of which the males lay hold with the hands of the first pair." The development of these hooklike processes has probably followed from those females which were the most securely held during the act of reproduction, having left the largest number of offspring. Another Brazilian amphipod (see *Orchestia darwinii*, .) presents a case of dimorphism, like that of *Tanais*; for there are two male forms, which differ in the structure of their chelae. (. Fritz Müller, 'Facts and Arguments for Darwin,' , p.) As either chela would certainly suffice to hold the female, for both are now used for this purpose, the two male forms probably originated by some having varied in one manner and some in another; both forms having derived certain special, but nearly equal advantages, from their differently shaped organs.

It is not known that male crustaceans fight together for the possession of the females, but it is probably the case; for with most animals when the male is larger than the female, he seems to owe his greater size to his ancestors having fought with other males during many generations. In most of the orders, especially in the highest or the *Brachyura*, the

male is larger than the female; the parasitic genera, however, in which the sexes follow different habits of life, and most of the Entomostraca must be excepted. The chelae of many crustaceans are weapons well adapted for fighting. Thus when a Devilcrab (*Portunus puber*) was seen by a son of Mr. Bate fighting with a *Carcinus maenas*, the latter was soon thrown on its back, and had every limb torn from its body. When several males of a Brazilian *Gelasimus*, a species furnished with immense pincers, were placed together in a glass vessel by Fritz Müller, they mutilated and killed one another. Mr. Bate put a large male *Carcinus maenas* into a pan of water, inhabited by a female which was paired with a smaller male; but the latter was soon dispossessed. Mr. Bate adds, "if they fought, the victory was a bloodless one, for I saw no wounds." This same naturalist separated a male sandskipper (so common on our seashores), *Gammarus marinus*, from its female, both of whom were imprisoned in the same vessel with many individuals of the same species. The female, when thus divorced, soon joined the others. After a time the male was put again into the same vessel; and he then, after swimming about for a time, dashed into the crowd, and without any fighting at once took away his wife. This fact shews that in the Amphipoda, an order low in the scale, the males and females recognise each other, and are mutually attached.

The mental powers of the Crustacea are probably higher than at first sight appears probable. Any one who tries to catch one of the shorecrabs, so common on tropical coasts, will perceive how wary and alert they are. There is a large crab (*Birgus latro*), found on coral islands, which makes a thick bed of the picked fibres of the cocoanut, at the bottom of a deep burrow. It feeds on the fallen fruit of this tree by tearing off the husk, fibre by fibre; and it always begins at that end where the three eyelike depressions are situated. It then breaks through one of these eyes by hammering with its heavy front pincers, and turning round, extracts the albuminous core with its narrow posterior pincers. But these actions are probably instinctive, so that they would be performed as well by a young animal as by an old one. The following case, however, can hardly be so considered: a trustworthy naturalist, Mr. Gardner ('. *Travels in the Interior of Brazil*,', . . I have given, in my '*Journal of Researches*,', an account of the habits of the *Birgus*.), whilst watching a shorecrab (*Gelasimus*) making its burrow, threw some shells towards the hole. One rolled in, and three other shells remained within a few inches of the mouth. In about five minutes the crab brought out the shell which had fallen in, and carried it away to a distance of a foot; it then saw the three other shells lying near, and evidently thinking that they might likewise roll in, carried them to the spot where it had laid the first. It would, I think, be difficult to distinguish this act from one performed by man by the aid of reason.

Mr. Bate does not know of any wellmarked case of difference of colour in the two sexes of our British crustaceans, in which respect the sexes of the higher animals so often differ. In some cases, however, the males and females differ slightly in tint, but Mr. Bate

thinks not more than may be accounted for by their different habits of life, such as by the male wandering more about, and being thus more exposed to the light. Dr. Power tried to distinguish by colour the sexes of the several species which inhabit the Mauritius, but failed, except with one species of *Squilla*, probably *S. stylifera*, the male of which is described as being "of a beautiful bluishgreen," with some of the appendages cherryred, whilst the female is clouded with brown and grey, "with the red about her much less vivid than in the male." (. Mr. Ch. Fraser, in 'Proc. Zoolog. Soc.' , . I am indebted to Mr. Bate for Dr. Power's statement.) In this case, we may suspect the agency of sexual selection. From M. Bert's observations on *Daphnia*, when placed in a vessel illuminated by a prism, we have reason to believe that even the lowest crustaceans can distinguish colours. With *Saphirina* (an oceanic genus of Entomostraca), the males are furnished with minute shields or celllike bodies, which exhibit beautiful changing colours; these are absent in the females, and in both sexes of one species. (. Claus, 'Die freilebenden Copepoden,' , s. .) It would, however, be extremely rash to conclude that these curious organs serve to attract the females. I am informed by Fritz Müller, that in the female of a Brazilian species of *Gelasimus*, the whole body is of a nearly uniform greyishbrown. In the male the posterior part of the cephalo thorax is pure white, with the anterior part of a rich green, shading into dark brown; and it is remarkable that these colours are liable to change in the course of a few minutes the white becoming dirty grey or even black, the green "losing much of its brilliancy." It deserves especial notice that the males do not acquire their bright colours until they become mature. They appear to be much more numerous than the females; they differ also in the larger size of their chelae. In some species of the genus, probably in all, the sexes pair and inhabit the same burrow. They are also, as we have seen, highly intelligent animals. From these various considerations it seems probable that the male in this species has become gaily ornamented in order to attract or excite the female.

It has just been stated that the male *Gelasimus* does not acquire his conspicuous colours until mature and nearly ready to breed. This seems a general rule in the whole class in respect to the many remarkable structural differences between the sexes. We shall hereafter find the same law prevailing throughout the great subkingdom of the Vertebrata; and in all cases it is eminently distinctive of characters which have been acquired through sexual selection. Fritz Müller (. 'Facts and Arguments,' etc., .) gives some striking instances of this law; thus the male sandhopper (*Orchestia*) does not, until nearly full grown, acquire his large claspers, which are very differently constructed from those of the female; whilst young, his claspers resemble those of the female.

CLASS, ARACHNIDA (SPIDERS).

The sexes do not generally differ much in colour, but the males are often darker than the females, as may be seen in Mr. Blackwall's magnificent work. (. 'A History of the Spiders

of Great Britain,' . For the following facts, see , .) In some species, however, the difference is conspicuous: thus the female of *Sparassus smaragdulus* is dullish green, whilst the adult male has the abdomen of a fine yellow, with three longitudinal stripes of rich red. In certain species of *Thomisus* the sexes closely resemble each other, in others they differ much; and analogous cases occur in many other genera. It is often difficult to say which of the two sexes departs most from the ordinary coloration of the genus to which the species belong; but Mr. Blackwall thinks that, as a general rule, it is the male; and Canestrini (. This author has recently published a valuable essay on the 'Caratteri sessuali secondarii degli Arachnidi,' in the 'Atti della Soc. VenetoTrentina di Sc. Nat. Padova,' vol. i. Fasc. , .) remarks that in certain genera the males can be specifically distinguished with ease, but the females with great difficulty. I am informed by Mr. Blackwall that the sexes whilst young usually resemble each other; and both often undergo great changes in colour during their successive moults, before arriving at maturity. In other cases the male alone appears to change colour. Thus the male of the above brightcoloured *Sparassus* at first resembles the female, and acquires his peculiar tints only when nearly adult. Spiders are possessed of acute senses, and exhibit much intelligence; as is well known, the females often shew the strongest affection for their eggs, which they carry about enveloped in a silken web. The males search eagerly for the females, and have been seen by Canestrini and others to ht for possession of them. This same author says that the union of the two sexes has been observed in about twenty species; and he asserts positively that the female rejects some of the males who court her, threatens them with open mandibles, and at last after long hesitation accepts the chosen one. From these several considerations, we may admit with some confidence that the wellmarked differences in colour between the sexes of certain species are the results of sexual selection; though we have not here the best kind of evidence, the display by the male of his ornaments. From the extreme variability of colour in the male of some species, for instance of *Theridion lineatum*, it would appear that these sexual characters of the males have not as yet become well fixed. Canestrini draws the same conclusion from the fact that the males of certain species present two forms, differing from each other in the size and length of their jaws; and this reminds us of the above cases of dimorphic crustaceans.

The male is generally much smaller than the female, sometimes to an extraordinary degree (. Aug. Vinson ('*Araneides des Iles de la Reunion*,' pl. vi. s. and) gives a good instance of the small size of the male, in *Epeira nigra*. In this species, as I may add, the male is testaceous and the female black with legs banded with red. Other even more striking cases of inequality in size between the sexes have been recorded ('*Quarterly Journal of Science*,' July ,); but I have not seen the original accounts.), and he is forced to be extremely cautious in making his advances, as the female often carries her coyness to a dangerous pitch. De Geer saw a male that "in the midst of his preparatory caresses was seized by the object of his attentions, enveloped by her in a web and then devoured,

a sight which, as he adds, filled him with horror and indignation." (. Kirby and Spence, 'Introduction to Entomology,' vol. i. , .) The Rev. O. Cambridge (. 'Proceedings, Zoological Society,' , .) accounts in the following manner for the extreme smallness of the male in the genus *Nephila*. "M. Vinson gives a graphic account of the agile way in which the diminutive male escapes from the ferocity of the female, by gliding about and playing hide and seek over her body and along her gigantic limbs: in such a pursuit it is evident that the chances of escape would be in favour of the smallest males, while the larger ones would fall early victims; thus gradually a diminutive race of males would be selected, until at last they would dwindle to the smallest possible size compatible with the exercise of their generative functions, in fact, probably to the size we now see them, i.e., so small as to be a sort of parasite upon the female, and either beneath her notice, or too agile and too small for her to catch without great difficulty."

Westring has made the interesting discovery that the males of several species of *Theridion* (. *Theridion* (*Asagena*, Sund.) *serratipes*, *punctatum* et *guttatum*; see Westring, in Kroyer, 'Naturhist. Tidsskrift,' vol. iv. , ; and vol. ii. , . See, also, for other species, 'Araneae Suecicae,' .) have the power of making a stridulating sound, whilst the females are mute. The apparatus consists of a serrated ridge at the base of the abdomen, against which the hard hinder part of the thorax is rubbed; and of this structure not a trace can be detected in the females. It deserves notice that several writers, including the wellknown arachnologist Walckenaer, have declared that spiders are attracted by music. (. Dr. H.H. van Zouteveen, in his Dutch translation of this work (vol. i.), has collected several cases.) From the analogy of the Orthoptera and Homoptera, to be described in the next chapter, we may feel almost sure that the stridulation serves, as Westring also believes, to call or to excite the female; and this is the first case known to me in the ascending scale of the animal kingdom of sounds emitted for this purpose. (. Hilgendorf, however, has lately called attention to an analogous structure in some of the higher crustaceans, which seems adapted to produce sound; see 'Zoological Record,' , .)

CLASS, MYRIAPODA.

In neither of the two orders in this class, the millipedes and centipedes, can I find any wellmarked instances of such sexual differences as more particularly concern us. In *Glomeris limbata*, however, and perhaps in some few other species, the males differ slightly in colour from the females; but this *Glomeris* is a highly variable species. In the males of the Diplopoda, the legs belonging either to one of the anterior or of the posterior segments of the body are modified into prehensile hooks which serve to secure the female. In some species of *Iulus* the tarsi of the male are furnished with membranous suckers for the same purpose. As we shall see when we treat of Insects, it is a much more unusual circumstance, that it is the female in *Lithobius*, which is

furnished with prehensile appendages at the extremity of her body for holding the male.
(. Walckenaer et Gervais, 'Hist. Nat. des Insectes: Apterés,' tom. iv. , , .)

CHAPTER X.

SECONDARY SEXUAL CHARACTERS OF INSECTS.

Diversified structures possessed by the males for seizing the females Differences between the sexes, of which the meaning is not understood Difference in size between the sexes Thysanura Diptera Hemiptera Homoptera, musical powers possessed by the males alone Orthoptera, musical instruments of the males, much diversified in structure; pugnacity; colours Neuroptera, sexual differences in colour Hymenoptera, pugnacity and odours Coleoptera, colours; furnished with great horns, apparently as an ornament; battles, stridulating organs generally common to both sexes.

In the immense class of insects the sexes sometimes differ in their locomotive organs, and often in their sense organs, as in the pectinated and beautifully plumose antennae of the males of many species. In *Chloeon*, one of the Ephemerae, the male has great pillared eyes, of which the female is entirely destitute. (. Sir J. Lubbock, 'Transact. Linnean Soc.' vol. xxv, , . With respect to the Mutillidae see Westwood, 'Modern Class. of Insects,' vol. ii. .) The ocelli are absent in the females of certain insects, as in the Mutillidae; and here the females are likewise wingless. But we are chiefly concerned with structures by which one male is enabled to conquer another, either in battle or courtship through his strength, pugnacity, ornaments, or music. The innumerable contrivances, therefore, by which the male is able to seize the female, may be briefly passed over. Besides the complex structures at the apex of the abdomen, which ought perhaps to be ranked as primary organs (. These organs in the male often differ in closely allied species, and afford excellent specific characters. But their importance, from a functional point of view, as Mr. R. MacLachlan has remarked to me, has probably been overrated. It has been suggested, that slight differences in these organs would suffice to prevent the intercrossing of wellmarked varieties or incipient species, and would thus aid in their development. That this can hardly be the case, we may infer from the many recorded cases (see, for instance, Bronn, 'Geschichte der Natur,' B. ii. , s. ; and Westwood, 'Transact. Ent. Soc.' vol. iii. ,) of distinct species having been observed in union. Mr. MacLachlan informs me (vide 'Stett. Ent. Zeitung,' , s.) that when several species of Phryganidae, which present strongly pronounced differences of this kind, were confined together by Dr. Aug. Meyer, THEY COUPLED, and one pair produced fertile ova.), "it is astonishing," as Mr. B.D. Walsh (. 'The Practical Entomologist,' Philadelphia, vol. ii. May , .) has remarked, "how many different organs are worked in by nature for the seemingly insignificant object of enabling the male to grasp the female firmly." The mandibles or jaws are sometimes used for this purpose; thus the male *Corydalis cornutus* (a neuropterous insect in some degree allied to the Dragon flies, etc.) has immense curved jaws, many times longer than those of the female; and they are smooth instead of being toothed, so that he is thus enabled to seize her without injury. (. Mr. Walsh, *ibid.* .) One of the stagbeetles of North America (*Lucanus elaphus*) uses his jaws, which are much larger than those of the female, for the same purpose, but probably

likewise for hting. In one of the sand wasps (*Ammophila*) the jaws in the two sexes are closely alike, but are used for widely different purposes: the males, as Professor Westwood observes, "are exceedingly ardent, seizing their partners round the neck with their sickleshaped jaws" (. 'Modern Classification of Insects,' vol. ii. , . Mr. Walsh, who called my attention to the double use of the jaws, says that he has repeatedly observed this fact.); whilst the females use these organs for burrowing in sandbanks and making their nests.

[. . *Crabro cribrarius*. Upper ure, male; lower ure, female.]

The tarsi of the frontlegs are dilated in many male beetles, or are furnished with broad cushions of hairs; and in many genera of waterbeetles they are armed with a round flat sucker, so that the male may adhere to the slippery body of the female. It is a much more unusual circumstance that the females of some waterbeetles (*Dytiscus*) have their elytra deeply grooved, and in *Acilius sulcatus* thickly set with hairs, as an aid to the male. The females of some other waterbeetles (*Hydroporus*) have their elytra punctured for the same purpose. (. We have here a curious and inexplicable case of dimorphism, for some of the females of four European species of *Dytiscus*, and of certain species of *Hydroporus*, have their elytra smooth; and no intermediate gradations between the sulcated or punctured, and the quite smooth elytra have been observed. See Dr. H. Schaum, as quoted in the 'Zoologist,' vols. v.vi. , . Also Kirby and Spence, 'Introduction to Entomology,' vol. iii. , .) In the male of *Crabro cribrarius* , it is the tibia which is dilated into a broad horny plate, with minute membranous dots, giving to it a singular appearance like that of a riddle. (. Westwood, 'Modern Class.' vol. ii. . The following statement about *Penthe*, and others in inverted commas, are taken from Mr. Walsh, 'Practical Entomologist,' Philadelphia, vol. iii. .) In the male of *Penthe* (a genus of beetles) a few of the middle joints of the antennae are dilated and furnished on the inferior surface with cushions of hair, exactly like those on the tarsi of the *Carabidae*, "and obviously for the same end." In male dragonflies, "the appendages at the tip of the tail are modified in an almost infinite variety of curious patterns to enable them to embrace the neck of the female." Lastly, in the males of many insects, the legs are furnished with peculiar spines, knobs or spurs; or the whole leg is bowed or thickened, but this is by no means invariably a sexual character; or one pair, or all three pairs are elongated, sometimes to an extravagant length. (. Kirby and Spence, 'Introduct.' etc., vol. iii. p.)

[. . *Taphroderes distortus* (much enlarged). Upper ure, male; lower ure, female.]

The sexes of many species in all the orders present differences, of which the meaning is not understood. One curious case is that of a beetle , the male of which has left mandible much enlarged; so that the mouth is greatly distorted. In another *Carabidous* beetle,

Eurygnathus (. 'Insecta Maderensia,' , page .), we have the case, unique as far as known to Mr. Wollaston, of the head of the female being much broader and larger, though in a variable degree, than that of the male. Any number of such cases could be given. They abound in the Lepidoptera: one of the most extraordinary is that certain male butterflies have their forelegs more or less atrophied, with the tibiae and tarsi reduced to mere rudimentary knobs. The wings, also, in the two sexes often differ in neuration (. E. Doubleday, 'Annals and Mag. of Nat. Hist.' vol. i. , . I may add that the wings in certain Hymenoptera (see Shuckard, 'Fossorial Hymenoptera,' , p) differ in neuration according to sex.), and sometimes considerably in outline, as in the *Aricoris epitus*, which was shewn to me in the British Museum by Mr. A. Butler. The males of certain South American butterflies have tufts of hair on the margins of the wings, and horny excrescences on the discs of the posterior pair. (. H.W. Bates, in 'Journal of Proc. Linn. Soc.' vol. vi. , . Mr. Wonfor's observations are quoted in 'Popular Science Review,' , .) In several British butterflies, as shewn by Mr. Wonfor, the males alone are in parts clothed with peculiar scales.

The use of the bright light of the female glowworm has been subject to much discussion. The male is feebly luminous, as are the larvae and even the eggs. It has been supposed by some authors that the light serves to frighten away enemies, and by others to guide the male to the female. At last, Mr. Belt (. 'The Naturalist in Nicaragua,' , p. On the phosphorescence of the eggs, see 'Annals and Magazine of Natural History,' Nov. , .) appears to have solved the difficulty: he finds that all the Lampyridae which he has tried are highly distasteful to insectivorous mammals and birds. Hence it is in accordance with Mr. Bates' view, hereafter to be explained, that many insects mimic the Lampyridae closely, in order to be mistaken for them, and thus to escape destruction. He further believes that the luminous species profit by being at once recognised as unpalatable. It is probable that the same explanation may be extended to the Elaters, both sexes of which are highly luminous. It is not known why the wings of the female glowworm have not been developed; but in her present state she closely resembles a larva, and as larvae are so largely preyed on by many animals, we can understand why she has been rendered so much more luminous and conspicuous than the male; and why the larvae themselves are likewise luminous.

DIFFERENCE IN SIZE BETWEEN THE SEXES.

With insects of all kinds the males are commonly smaller than the females; and this difference can often be detected even in the larval state. So considerable is the difference between the male and female cocoons of the silkworm (*Bombyx mori*), that in France they are separated by a particular mode of weighing. (. Robinet, 'Vers a Soie,' , .) In the lower classes of the animal kingdom, the greater size of the females seems generally to depend on their developing an enormous number of ova; and this may to a certain

extent hold good with insects. But Dr. Wallace has suggested a much more probable explanation. He finds, after carefully attending to the development of the caterpillars of *Bombyx cynthia* and *yamamai*, and especially to that of some dwarfed caterpillars reared from a second brood on unnatural food, "that in proportion as the individual moth is finer, so is the time required for its metamorphosis longer; and for this reason the female, which is the larger and heavier insect, from having to carry her numerous eggs, will be preceded by the male, which is smaller and has less to mature." (. 'Transact. Ent. Soc.' rd series, vol. v. .) Now as most insects are shortlived, and as they are exposed to many dangers, it would manifestly be advantageous to the female to be impregnated as soon as possible. This end would be gained by the males being first matured in large numbers ready for the advent of the females; and this again would naturally follow, as Mr. A.R. Wallace has remarked (. 'Journal of Proc. Ent. Soc.' Feb. , , lxxi.), through natural selection; for the smaller males would be first matured, and thus would procreate a large number of offspring which would inherit the reduced size of their male parents, whilst the larger males from being matured later would leave fewer offspring.

There are, however, exceptions to the rule of male insects being smaller than the females: and some of these exceptions are intelligible. Size and strength would be an advantage to the males, which ht for the possession of the females; and in these cases, as with the stagbeetle (*Lucanus*), the males are larger than the females. There are, however, other beetles which are not known to ht together, of which the males exceed the females in size; and the meaning of this fact is not known; but in some of these cases, as with the huge *Dynastes* and *Megasoma*, we can at least see that there would be no necessity for the males to be smaller than the females, in order to be matured before them, for these beetles are not shortlived, and there would be ample time for the pairing of the sexes. So again, male dragonflies (*Libellulidae*) are sometimes sensibly larger, and never smaller, than the females (. For this and other statements on the size of the sexes, see Kirby and Spence, *ibid.* vol. iii. ; on the duration of life in insects, see .); and as Mr. MacLachlan believes, they do not generally pair with the females until a week or fortnight has elapsed, and until they have assumed their proper masculine colours. But the most curious case, shewing on what complex and easilyoverlooked relations, so trifling a character as difference in size between the sexes may depend, is that of the aculeate Hymenoptera; for Mr. F. Smith informs me that throughout nearly the whole of this large grouthe males, in accordance with the general rule, are smaller than the females, and emerge about a week before them; but amongst the Bees, the males of *Apis mellifica*, *Anthidium manicatum*, and *Anthophora acervorum*, and amongst the Fossores, the males of the *Methoca ichneumonides*, are larger than the females. The explanation of this anomaly is that a marriage flight is absolutely necessary with these species, and the male requires great strength and size in order to carry the female through the air. Increased size has here been acquired in opposition to the usual relation

between size and the period of development, for the males, though larger, emerge before the smaller females.

We will now review the several Orders, selecting such facts as more particularly concern us. The Lepidoptera (Butterflies and Moths) will be retained for a separate chapter.

ORDER, THYSANURA.

The members of this lowly organised order are wingless, dullcoloured, minute insects, with ugly, almost misshapen heads and bodies. Their sexes do not differ, but they are interesting as shewing us that the males pay sedulous court to the females even low down in the animal scale. Sir J. Lubbock (. 'Transact. Linnean Soc.' vol. xxvi. , .) says: "it is very amusing to see these little creatures (*Smynturus luteus*) coquetting together. The male, which is much smaller than the female, runs round her, and they butt one another, standing face to face and moving backward and forward like two playful lambs. Then the female pretends to run away and the male runs after her with a queer appearance of anger, gets in front and stands facing her again; then she turns coyly round, but he, quicker and more active, scuttles round too, and seems to whip her with his antennae; then for a bit they stand face to face, play with their antennae, and seem to be all in all to one another."

ORDER, DIPTERA (FLIES).

The sexes differ little in colour. The greatest difference, known to Mr. F. Walker, is in the genus *Bibio*, in which the males are blackish or quite black, and the females obscure brownishorange. The genus *Elaphomyia*, discovered by Mr. Wallace (. 'The Malay Archipelago,' vol. ii. , .) in New Guinea, is highly remarkable, as the males are furnished with horns, of which the females are quite destitute. The horns spring from beneath the eyes, and curiously resemble those of a stag, being either branched or palmated. In one of the species, they equal the whole body in length. They might be thought to be adapted for hting, but as in one species they are of a beautiful pink colour, edged with black, with a pale central stripe, and as these insects have altogether a very elegant appearance, it is perhaps more probable that they serve as ornaments. That the males of some Diptera ht together is certain; Prof. Westwood (. 'Modern Classification of Insects,' vol. ii. , .) has several times seen this with the *Tipulae*. The males of other Diptera apparently try to win the females by their music: H. Müller (. 'Anwendung,' etc., 'Verh. d. n. V. Jahrg.' xxix. . Mayer, in 'American Naturalist,' , .) watched for some time two males of an *Eristalis* courting a female; they hovered above her, and flew from side to side, making a high humming noise at the same time. Gnats and mosquitoes (*Culicidae*) also seem to attract each other by humming; and Prof. Mayer has recently ascertained that the hairs on the antennae of the male vibrate in unison with the notes of a tuningfork, within the

range of the sounds emitted by the female. The longer hairs vibrate sympathetically with the graver notes, and the shorter hairs with the higher ones. Landois also asserts that he has repeatedly drawn down a whole swarm of gnats by uttering a particular note. It may be added that the mental faculties of the Diptera are probably higher than in most other insects, in accordance with their highly developed nervous system. (See Mr. B.T. Lowne's interesting work, 'On the Anatomy of the Blowfly, *Musca vomitoria*, ' , . He remarks () that, "the captured flies utter a peculiar plaintive note, and that this sound causes other flies to disappear.")

ORDER, HEMIPTERA (FIELDBUGS).

Mr. J.W. Douglas, who has particularly attended to the British species, has kindly given me an account of their sexual differences. The males of some species are furnished with wings, whilst the females are wingless; the sexes differ in the form of their bodies, elytra, antennae and tarsi; but as the signification of these differences are unknown, they may be here passed over. The females are generally larger and more robust than the males. With British, and, as far as Mr. Douglas knows, with exotic species, the sexes do not commonly differ much in colour; but in about six British species the male is considerably darker than the female, and in about four other species the female is darker than the male. Both sexes of some species are beautifully coloured; and as these insects emit an extremely nauseous odour, their conspicuous colours may serve as a signal that they are unpalatable to insectivorous animals. In some few cases their colours appear to be directly protective: thus Prof. Hoffmann informs me that he could hardly distinguish a small pink and green species from the buds on the trunks of limetrees, which this insect frequents.

Some species of Reduviidae make a stridulating noise; and, in the case of *Pirates stridulus*, this is said (. Westwood, 'Modern Classification of Insects,' vol. ii. .) to be effected by the movement of the neck within the prothoracic cavity. According to Westring, *Reduvius personatus* also stridulates. But I have no reason to suppose that this is a sexual character, excepting that with nonsocial insects there seems to be no use for soundproducing organs, unless it be as a sexual call.

ORDER: HOMOPTERA.

Every one who has wandered in a tropical forest must have been astonished at the din made by the male Cicadae. The females are mute; as the Grecian poet Xenarchus says, "Happy the Cicadas live, since they all have voiceless wives." The noise thus made could be plainly heard on board the "Beagle," when anchored at a quarter of a mile from the shore of Brazil; and Captain Hancock says it can be heard at the distance of a mile. The Greeks formerly kept, and the Chinese now keep these insects in cages for the sake of

their song, so that it must be pleasing to the ears of some men. (. These particulars are taken from Westwood's 'Modern Classification of Insects,' vol. ii. , . See, also, on the Fulgoridae, Kirby and Spence, 'Introduct.' vol. ii. .) The Cicadidae usually sing during the day, whilst the Fulgoridae appear to be night-songsters. The sound, according to Landois (. 'Zeitschrift für wissenschaft. Zoolog.' B. xvii. , ss. .), is produced by the vibration of the lips of the spiracles, which are set into motion by a current of air emitted from the tracheae; but this view has lately been disputed. Dr. Powell appears to have proved (. 'Transactions of the New Zealand Institute,' vol. v. , .) that it is produced by the vibration of a membrane, set into action by a special muscle. In the living insect, whilst stridulating, this membrane can be seen to vibrate; and in the dead insect the proper sound is heard, if the muscle, when a little dried and hardened, is pulled with the point of a pin. In the female the whole complex musical apparatus is present, but is much less developed than in the male, and is never used for producing sound.

With respect to the object of the music, Dr. Hartman, in speaking of the *Cicada septemdecim* of the United States, says (. I am indebted to Mr. Walsh for having sent me this extract from 'A Journal of the Doings of *Cicada septemdecim*,' by Dr. Hartman.), "the drums are now (June th and th,) heard in all directions. This I believe to be the marital summons from the males. Standing in thick chestnut sprouts about as high as my head, where hundreds were around me, I observed the females coming around the drumming males." He adds, "this season (Aug.) a dwarf peartree in my garden produced about fifty larvae of *Cic. pruinosa*; and I several times noticed the females to alight near a male while he was uttering his clanging notes." Fritz Müller writes to me from S. Brazil that he has often listened to a musical contest between two or three males of a species with a particularly loud voice, seated at a considerable distance from each other: as soon as one had finished his song, another immediately began, and then another. As there is so much rivalry between the males, it is probable that the females not only find them by their sounds, but that, like female birds, they are excited or allured by the male with the most attractive voice.

I have not heard of any wellmarked cases of ornamental differences between the sexes of the Homoptera. Mr. Douglas informs me that there are three British species, in which the male is black or marked with black bands, whilst the females are palecoloured or obscure.

ORDER, ORTHOPTERA (CRICKETS AND GRASSHOPPERS).

The males in the three saltatorial families in this Order are remarkable for their musical powers, namely the Achetidae or crickets, the Locustidae for which there is no equivalent English name, and the Acridiidae or grasshoppers. The stridulation produced by some of the Locustidae is so loud that it can be heard during the night at the distance

of a mile (. L. Guilding, 'Transactions of the Linnean Society,' vol. xv. .); and that made by certain species is not unmusical even to the human ear, so that the Indians on the Amazons keep them in wicker cages. All observers agree that the sounds serve either to call or excite the mute females. With respect to the migratory locusts of Russia, Korte has given (. I state this on the authority of Koppen, 'Über die Heuschrecken in Südrussland,' , , for I have in vain endeavoured to procure Korte's work.) an interesting case of selection by the female of a male. The males of this species (*Pachytylus migratorius*) whilst coupled with the female stridulate from anger or jealousy, if approached by other males. The housecricket when surprised at night uses its voice to warn its fellows. (. Gilbert White, 'Natural History of Selborne,' vol. ii. , .) In North America the Katydid (*Platyphyllum concavum*, one of the *Locustidae*) is described (. Harris, 'Insects of New England,' , .) as mounting on the upper branches of a tree, and in the evening beginning "his noisy babble, while rival notes issue from the neighbouring trees, and the groves resound with the call of Katydid she did the livelong night." Mr. Bates, in speaking of the European field cricket (one of the *Achetidae*), says "the male has been observed to place himself in the evening at the entrance of his burrow, and stridulate until a female approaches, when the louder notes are succeeded by a more subdued tone, whilst the successful musician caresses with his antennae the mate he has won." (. 'The Naturalist on the Amazons,' vol. i. , . Mr. Bates gives a very interesting discussion on the gradations in the musical apparatus of the three families. See also Westwood, 'Modern Classification of Insects,' vol. ii. p and .) Dr. Scudder was able to excite one of these insects to answer him, by rubbing on a file with a quill. (. 'Proceedings of the Boston Society of Natural History,' vol. xi. April .) In both sexes a remarkable auditory apparatus has been discovered by Von Siebold, situated in the front legs. (. 'Nouveau Manuel d'Anat. Comp.' (French transl.), tom. , , .)

[.. *Gryllus campestris* (from Landois).

Righthand ure, under side of part of a wingnervure, much magnified, showing the teeth, st.

Lefthand ure, upper surface of wingcover, with the projecting, smooth nervure, r, across which the teeth (st) are scraped.

.. Teeth of Nervure of *Gryllus domesticus* (from Landois).]

In the three Families the sounds are differently produced. In the males of the *Achetidae* both wingcovers have the same apparatus; and this in the fieldcricket (see *Gryllus campestris*, .) consists, as described by Landois (. 'Zeitschrift für wissenschaft. Zoolog.' B. xvii. , s. .), of from to shartransverse ridges or teeth (st) on the under side of one of the nervures of the wingcover. This toothed nervure is rapidly scraped across a projecting, smooth, hard nervure (r) on the upper surface of the opposite wing. First one wing is rubbed over the other, and then the movement is reversed. Both wings are raised a little at the same time, so as to increase the resonance. In some species the wingcovers

of the males are furnished at the base with a talclike plate. (. Westwood, 'Modern Classification of Insects,' vol. i. .) I here give a drawing of the teeth on the under side of the nervure of another species of *Gryllus*, viz., *G. domesticus*. With respect to the formation of these teeth, Dr. Gruber has shewn (. 'Ueber der Tonapparat der Locustiden, ein Beitrag zum Darwinismus,' 'Zeitschrift für wissenschaft. Zoolog.' B. xxii. , .) that they have been developed by the aid of selection, from the minute scales and hairs with which the wings and body are covered, and I came to the same conclusion with respect to those of the Coleoptera. But Dr. Gruber further shews that their development is in part directly due to the stimulus from the friction of one wing over the other.

[.. *Chlorocoelus Tanana* (from Bates). a,b. Lobes of opposite wingcovers.]

In the Locustidae the opposite wingcovers differ from each other in structure , and the action cannot, as in the last family, be reversed. The left wing, which acts as the bow, lies over the right wing which serves as the fiddle. One of the nervures (a) on the under surface of the former is finely serrated, and is scraped across the prominent nervures on the upper surface of the opposite or right wing. In our British *Phasgonura viridissima* it appeared to me that the serrated nervure is rubbed against the rounded hindcorner of the opposite wing, the edge of which is thickened, coloured brown, and very sharp. In the right wing, but not in the left, there is a little plate, as transparent as talc, surrounded by nervures, and called the speculum. In *Ephippiger vitium*, a member of this same family, we have a curious subordinate modification; for the wingcovers are greatly reduced in size, but "the posterior part of the prothorax is elevated into a kind of dome over the wingcovers, and which has probably the effect of increasing the sound." (. Westwood 'Modern Classification of Insects,' vol. i. .)

We thus see that the musical apparatus is more differentiated or specialised in the Locustidae (which include, I believe, the most powerful performers in the Order), than in the Achetidae, in which both wingcovers have the same structure and the same function. (. Landois, 'Zeitschrift für wissenschaft. Zoolog.' B. xvii. , ss. , .) Landois, however, detected in one of the Locustidae, namely in *Decticus*, a short and narrow row of small teeth, mere rudiments, on the inferior surface of the right wingcover, which underlies the other and is never used as the bow. I observed the same rudimentary structure on the under side of the right wingcover in *Phasgonura viridissima*. Hence we may infer with confidence that the Locustidae are descended from a form, in which, as in the existing Achetidae, both wingcovers had serrated nervures on the under surface, and could be indifferently used as the bow; but that in the Locustidae the two wingcovers gradually became differentiated and perfected, on the principle of the division of labour, the one to act exclusively as the bow, and the other as the fiddle. Dr. Gruber takes the same view, and has shewn that rudimentary teeth are commonly found

on the inferior surface of the right wing. By what steps the more simple apparatus in the Achetidae originated, we do not know, but it is probable that the basal portions of the wing covers originally overlapped each other as they do at present; and that the friction of the nervures produced a grating sound, as is now the case with the wingcovers of the females. (. Mr. Walsh also informs me that he has noticed that the female of the *Platyphyllum concavum*, "when captured makes a feeble grating noise by shuffling her wingcovers together.") A grating sound thus occasionally and accidentally made by the males, if it served them ever so little as a lovecall to the females, might readily have been intensified through sexual selection, by variations in the roughness of the nervures having been continually preserved.

[.. Hindleg of *Stenobothrus pratorum*: r, the stridulating ridge; lower ure, the teeth forming the ridge, much magnified (from Landois).

.. *Pneumora* (from specimens in the British Museum). Upper ure, male; lower ure, female.]

In the last and third family, namely the Acridiidae or grasshoppers, the stridulation is produced in a very different manner, and according to Dr. Scudder, is not so shrill as in the preceding Families. The inner surface of the femur (. , r) is furnished with a longitudinal row of minute, elegant, lancetshaped, elastic teeth, from to in number (. Landois, *ibid.* s. .); and these are scraped across the sharp projecting nervures on the wingcovers, which are thus made to vibrate and resound. Harris (. 'Insects of New England,' , .) says that when one of the males begins to play, he first "bends the shank of the hindleg beneath the thigh, where it is lodged in a furrow designed to receive it, and then draws the leg briskly up and down. He does not play both fiddles together, but alternately, first upon one and then on the other." In many species, the base of the abdomen is hollowed out into a great cavity which is believed to act as a resounding board. In *Pneumora* , a S. African genus belonging to the same family, we meet with a new and remarkable modification; in the males a small notched ridge projects obliquely from each side of the abdomen, against which the hind femora are rubbed. (. Westwood, 'Modern Classification,' vol i. .) As the male is furnished with wings (the female being wingless), it is remarkable that the thighs are not rubbed in the usual manner against the wingcovers; but this may perhaps be accounted for by the unusually small size of the hindlegs. I have not been able to examine the inner surface of the thighs, which, judging from analogy, would be finely serrated. The species of *Pneumora* have been more profoundly modified for the sake of stridulation than any other orthopterous insect; for in the male the whole body has been converted into a musical instrument, being distended with air, like a great pellucid bladder, so as to increase the resonance. Mr. Trimen informs me that at the Cape of Good Hope these insects make a wonderful noise during the night.

In the three foregoing families, the females are almost always destitute of an efficient musical apparatus. But there are a few exceptions to this rule, for Dr. Gruber has shewn that both sexes of *Ephippiger vitium* are thus provided; though the organs differ in the male and female to a certain extent. Hence we cannot suppose that they have been transferred from the male to the female, as appears to have been the case with the secondary sexual characters of many other animals. They must have been independently developed in the two sexes, which no doubt mutually call to each other during the season of love. In most other Locustidae (but not according to Landois in *Decticus*) the females have rudiments of the stridulatory organs proper to the male; from whom it is probable that these have been transferred. Landois also found such rudiments on the under surface of the wingcovers of the female Achetidae, and on the femora of the female Acridiidae. In the Homoptera, also, the females have the proper musical apparatus in a functionless state; and we shall hereafter meet in other divisions of the animal kingdom with many instances of structures proper to the male being present in a rudimentary condition in the female.

Landois has observed another important fact, namely, that in the females of the Acridiidae, the stridulating teeth on the femora remain throughout life in the same condition in which they first appear during the larval state in both sexes. In the males, on the other hand, they become further developed, and acquire their perfect structure at the last moult, when the insect is mature and ready to breed.

From the facts now given, we see that the means by which the males of the Orthoptera produce their sounds are extremely diversified, and are altogether different from those employed by the Homoptera. (. Landois has recently found in certain Orthoptera rudimentary structures closely similar to the soundproducing organs in the Homoptera; and this is a surprising fact. See 'Zeitschrift für wissenschaft, Zoolog.' B. xxii. Heft , , .) But throughout the animal kingdom we often find the same object gained by the most diversified means; this seems due to the whole organisation 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 the 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 (. 'Transactions, Entomological Society,' rd series, vol. ii. ('Journal of Proceedings,').), 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 wellknown 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.

I have but little more to say on the Orthoptera. Some of the species are very pugnacious: when two male fieldcrickets (*Gryllus campestris*) are confined together, they fight till one kills the other; and the species of Mantis are described as manoeuvring with their swordlike frontlimbs, like hussars with their sabres. The Chinese keep these insects in little bamboo cages, and match them like gamecocks. (. Westwood, 'Modern Classification of Insects,' vol. i. ; for crickets, .) With respect to colour, some exotic locusts are beautifully ornamented; the posterior wings being marked with red, blue, and black; but as throughout the Order the sexes rarely differ much in colour, it is not probable that they owe their bright tints to sexual selection. Conspicuous colours may be of use to these insects, by giving notice that they are unpalatable. Thus it has been observed (. Mr. Ch. Horne, in 'Proceedings of the Entomological Society,' May , , xii.) that a brightcoloured Indian locust was invariably rejected when offered to birds and lizards. Some cases, however, are known of sexual differences in colour in this Order. The male of an American cricket (. *Oecanthus nivalis*, Harris, 'Insects of New England,' , . The two sexes of *OE. pellucidus* of Europe differ, as I hear from Victor Carus, in nearly the same manner.) is described as being as white as ivory, whilst the female varies from almost white to greenishyellow or dusky. Mr. Walsh informs me that the adult male of *Spectrum femoratum* (one of the Phasmidae) "is of a shining brownishyellow colour; the adult female being of a dull, opaque, cinereous brown; the young of both sexes being green." Lastly, I may mention that the male of one curious kind of cricket (. *Platyblemnus*: Westwood, 'Modern Classification,' vol. i. .) is furnished with "a long membranous appendage, which falls over the face like a veil;" but what its use may be, is not known.

ORDER, NEUROPTERA.

Little need here be said, except as to colour. In the Ephemerae the sexes often differ slightly in their obscure tints (. B.D. Walsh, the 'Pseudoneuroptera of Illinois,' in 'Proceedings of the Entomological Society of Philadelphia,' , .); but it is not probable that the males are thus rendered attractive to the females. The Libellulidae, or dragonflies, are ornamented with splendid green, blue, yellow, and vermilion metallic tints; and the sexes often differ. Thus, as Prof. Westwood remarks (. 'Modern Classification,' vol. ii. .), the males of some of the Agrionidae, "are of a rich blue with black wings, whilst the females are fine green with colourless wings." But in *Agrion Ramburii* these colours are exactly reversed in the two sexes. (. Walsh, *ibid.* . I am indebted to this naturalist for the following facts on *Hetaerina*, *Anax*, and *Gomphus*.) In the extensive N. American genus of *Hetaerina*, the males alone have a beautiful carmine spot at the base of each wing. In *Anax junius* the basal part of the abdomen in the male is a vivid ultramarine blue, and in

the female grassgreen. In the allied genus *Gomphus*, on the other hand, and in some other genera, the sexes differ but little in colour. In closely allied forms throughout the animal kingdom, similar cases of the sexes differing greatly, or very little, or not at all, are of frequent occurrence. Although there is so wide a difference in colour between the sexes of many Libellulidae, it is often difficult to say which is the more brilliant; and the ordinary coloration of the two sexes is reversed, as we have just seen, in one species of *Agrion*. It is not probable that their colours in any case have been gained as a protection. Mr. MacLachlan, who has closely attended to this family, writes to me that dragonflies the tyrants of the insect world are the least liable of any insect to be attacked by birds or other enemies, and he believes that their bright colours serve as a sexual attraction. Certain dragonflies apparently are attracted by particular colours: Mr. Patterson observed (. 'Transactions, Ent. Soc.' vol. i. , lxxxii.) that the *Agrionidae*, of which the males are blue, settled in numbers on the blue float of a fishing line; whilst two other species were attracted by shining white colours.

It is an interesting fact, first noticed by Schelver, that, in several genera belonging to two subfamilies, the males on first emergence from the pupal state, are coloured exactly like the females; but that their bodies in a short time assume a conspicuous milky blue tint, owing to the exudation of a kind of oil, soluble in ether and alcohol. Mr. MacLachlan believes that in the male of *Libellula depressa* this change of colour does not occur until nearly a fortnight after the metamorphosis, when the sexes are ready to pair.

Certain species of *Neurothemis* present, according to Brauer (. See abstract in the 'Zoological Record' for , .), a curious case of dimorphism, some of the females having ordinary wings, whilst others have them "very richly netted, as in the males of the same species." Brauer "explains the phenomenon on Darwinian principles by the supposition that the close netting of the veins is a secondary sexual character in the males, which has been abruptly transferred to some of the females, instead of, as generally occurs, to all of them." Mr. MacLachlan informs me of another instance of dimorphism in several species of *Agrion*, in which some individuals are of an orange colour, and these are invariably females. This is probably a case of reversion; for in the true Libellulae, when the sexes differ in colour, the females are orange or yellow; so that supposing *Agrion* to be descended from some primordial form which resembled the typical Libellulae in its sexual characters, it would not be surprising that a tendency to vary in this manner should occur in the females alone.

Although many dragonflies are large, powerful, and fierce insects, the males have not been observed by Mr. MacLachlan to fight together, excepting, as he believes, in some of the smaller species of *Agrion*. In another group in this Order, namely, the Termites or white ants, both sexes at the time of swarming may be seen running about, "the male after the female, sometimes two chasing one female, and contending with great

eagerness who shall win the prize." (. Kirby and Spence, 'Introduction to Entomology,' vol. ii. , .) The *Atropos pulsatorius* is said to make a noise with its jaws, which is answered by other individuals. (. Houzeau, 'Les Facultés Mentales,' etc. Tom. i. .)

ORDER, HYMENOPTERA.

That inimitable observer, M. Fabre (. See an interesting article, 'The Writings of Fabre,' in 'Nat. Hist. Review,' April , .), in describing the habits of *Cerceris*, a wasplike insect, remarks that "fights frequently ensue between the males for the possession of some particular female, who sits an apparently unconcerned beholder of the struggle for supremacy, and when the victory is decided, quietly flies away in company with the conqueror." Westwood (. 'Journal of Proceedings of Entomological Society,' Sept. , , .) says that the males of one of the sawflies (*Tenthredinae*) "have been found fighting together, with their mandibles locked." As M. Fabre speaks of the males of *Cerceris* striving to obtain a particular female, it may be well to bear in mind that insects belonging to this Order have the power of recognising each other after long intervals of time, and are deeply attached. For instance, Pierre Huber, whose accuracy no one doubts, separated some ants, and when, after an interval of four months, they met others which had formerly belonged to the same community, they recognised and caressed one another with their antennae. Had they been strangers they would have fought together. Again, when two communities engage in a battle, the ants on the same side sometimes attack each other in the general confusion, but they soon perceive their mistake, and the one ant soothes the other. (. Huber, 'Recherches sur les Moeurs des Fourmis,' , .)

In this Order slight differences in colour, according to sex, are common, but conspicuous differences are rare except in the family of Bees; yet both sexes of certain groups are so brilliantly coloured for instance in *Chrysis*, in which vermilion and metallic greens prevail that we are tempted to attribute the result to sexual selection. In the *Ichneumonidae*, according to Mr. Walsh (. 'Proceedings of the Entomological Society of Philadelphia,' , .), the males are almost universally lighter coloured than the females. On the other hand, in the *Tenthredinidae* the males are generally darker than the females. In the *Siricidae* the sexes frequently differ; thus the male of *Sirex juvencus* is banded with orange, whilst the female is dark purple; but it is difficult to say which sex is the more ornamented. In *Tremex columbae* the female is much brighter coloured than the male. I am informed by Mr. F. Smith, that the male ants of several species are black, the females being testaceous.

In the family of Bees, especially in the solitary species, as I hear from the same entomologist, the sexes often differ in colour. The males are generally the brighter, and in *Bombus* as well as in *Apathus*, much more variable in colour than the females. In

Anthophora retusa the male is of a rich fulvousbrown, whilst the female is quite black: so are the females of several species of *Xylocopa*, the males being bright yellow. On the other hand the females of some species, as of *Andraena fulva*, are much brighter coloured than the males. Such differences in colour can hardly be accounted for by the males being defenceless and thus requiring protection, whilst the females are well defended by their stings. H. Müller (. 'Anwendung der Darwinschen Lehre auf Bienen,' Verh. d. n. V. Jahrg. xxix.), who has particularly attended to the habits of bees, attributes these differences in colour in chief part to sexual selection. That bees have a keen perception of colour is certain. He says that the males search eagerly and ht for the possession of the females; and he accounts through such contests for the mandibles of the males being in certain species larger than those of the females. In some cases the males are far more numerous than the females, either early in the season, or at all times and places, or locally; whereas the females in other cases are apparently in excess. In some species the more beautiful males appear to have been selected by the females; and in others the more beautiful females by the males. Consequently in certain genera (Müller,), the males of the several species differ much in appearance, whilst the females are almost indistinguishable; in other genera the reverse occurs. H. Müller believes () that the colours gained by one sex through sexual selection have often been transferred in a variable degree to the other sex, just as the pollencollecting apparatus of the female has often been transferred to the male, to whom it is absolutely useless. (. M. Perrier in his article 'la Selection sexuelle d'après Darwin' ('Revue Scientifique,' Feb. ,), without apparently having reflected much on the subject, objects that as the males of social bees are known to be produced from unfertilised ova, they could not transmit new characters to their male offspring. This is an extraordinary objection. A female bee fertilised by a male, which presented some character facilitating the union of the sexes, or rendering him more attractive to the female, would lay eggs which would produce only females; but these young females would next year produce males; and will it be pretended that such males would not inherit the characters of their male grandfathers? To take a case with ordinary animals as nearly parallel as possible: if a female of any white quadruped or bird were crossed by a male of a black breed, and the male and female offspring were paired together, will it be pretended that the grandchildren would not inherit a tendency to blackness from their male grandfather? The acquirement of new characters by the sterile workerbees is a much more difficult case, but I have endeavoured to shew in my 'Origin of Species,' how these sterile beings are subjected to the power of natural selection.)

Mutilla Europaea makes a stridulating noise; and according to Goureau (. Quoted by Westwood, 'Modern Classification of Insects,' vol. ii. .) both sexes have this power. He attributes the sound to the friction of the third and preceding abdominal segments, and I find that these surfaces are marked with very fine concentric ridges; but so is the projecting thoracic collar into which the head articulates, and this collar, when

scratched with the point of a needle, emits the proper sound. It is rather surprising that both sexes should have the power of stridulating, as the male is winged and the female wingless. It is notorious that Bees express certain emotions, as of anger, by the tone of their humming; and according to H. Müller (), the males of some species make a peculiar singing noise whilst pursuing the females.

ORDER, COLEOPTERA (BEETLES).

Many beetles are coloured so as to resemble the surfaces which they habitually frequent, and they thus escape detection by their enemies. Other species, for instance diamondbeetles, are ornamented with splendid colours, which are often arranged in stripes, spots, crosses, and other elegant patterns. Such colours can hardly serve directly as a protection, except in the case of certain flowerfeeding species; but they may serve as a warning or means of recognition, on the same principle as the phosphorescence of the glowworm. As with beetles the colours of the two sexes are generally alike, we have no evidence that they have been gained through sexual selection; but this is at least possible, for they have been developed in one sex and then transferred to the other; and this view is even in some degree probable in those groups which possess other well marked secondary sexual characters. Blind beetles, which cannot of course behold each other's beauty, never, as I hear from Mr. Waterhouse, jun., exhibit bright colours, though they often have polished coats; but the explanation of their obscurity may be that they generally inhabit caves and other obscure stations.

Some Longicorns, especially certain Prionidae, offer an exception to the rule that the sexes of beetles do not differ in colour. Most of these insects are large and splendidly coloured. The males in the genus *Pyrodes* (. *Pyrodes pulcherrimus*, in which the sexes differ conspicuously, has been described by Mr. Bates in 'Transact. Ent. Soc.' , . I will specify the few other cases in which I have heard of a difference in colour between the sexes of beetles. Kirby and Spence ('Introduct. to Entomology,' vol. iii.) mention a *Cantharis*, *Meloe*, *Rhagium*, and the *Leptura testacea*; the male of the latter being testaceous, with a black thorax, and the female of a dull red all over. These two latter beetles belong to the family of Longicorns. Messrs. R. Trimen and Waterhouse, jun., inform me of two Lamellicorns, viz., a *Peritrichia* and *Trichius*, the male of the latter being more obscurely coloured than the female. In *Tillus elongatus* the male is black, and the female always, as it is believed, of a dark blue colour, with a red thorax. The male, also, of *Orsodacna atra*, as I hear from Mr. Walsh, is black, the female (the so called *O. ruficollis*) having a rufous thorax.), which I saw in Mr. Bates's collection, are generally redder but rather duller than the females, the latter being coloured of a more or less splendid goldengreen. On the other hand, in one species the male is goldengreen, the female being richly tinted with red and purple. In the genus *Esmeralda* the sexes differ so greatly in colour that they have been ranked as distinct species; in one species

both are of a beautiful shining green, but the male has a red thorax. On the whole, as far as I could judge, the females of those Prionidae, in which the sexes differ, are coloured more richly than the males, and this does not accord with the common rule in regard to colour, when acquired through sexual selection.

[.. *Chalcosoma atlas*. Upper ure, male (reduced); lower ure, female (nat. size).

.. *Copris isidis*.

.. *Phanaeus faunus*.

.. *Dipelicus cantori*.

.. *Onthophagus rangifer*, enlarged.

(In s. to the lefthand ures are males.)]

A most remarkable distinction between the sexes of many beetles is presented by the great horns which rise from the head, thorax, and clypeus of the males; and in some few cases from the under surface of the body. These horns, in the great family of the Lamellicorns, resemble those of various quadrupeds, such as stags, rhinoceroses, etc., and are wonderful both from their size and diversified shapes. Instead of describing them, I have given ures of the males and females of some of the more remarkable forms. (s. to .) The females generally exhibit rudiments of the horns in the form of small knobs or ridges; but some are destitute of even the slightest rudiment. On the other hand, the horns are nearly as well developed in the female as in the male *Phanaeus lancifer*; and only a little less well developed in the females of some other species of this genus and of *Copris*. I am informed by Mr. Bates that the horns do not differ in any manner corresponding with the more important characteristic differences between the several subdivisions of the family: thus within the same section of the genus *Onthophagus*, there are species which have a single horn, and others which have two.

In almost all cases, the horns are remarkable from their excessive variability; so that a graduated series can be formed, from the most highly developed males to others so degenerate that they can barely be distinguished from the females. Mr. Walsh (. 'Proceedings of the Entomological Society of Philadelphia,' , .) found that in *Phanaeus carnifex* the horns were thrice as long in some males as in others. Mr. Bates, after examining above a hundred males of *Onthophagus rangifer* , thought that he had at last discovered a species in which the horns did not vary; but further research proved the contrary.

The extraordinary size of the horns, and their widely different structure in closelyallied forms, indicate that they have been formed for some purpose; but their excessive

variability in the males of the same species leads to the inference that this purpose cannot be of a definite nature. The horns do not shew marks of friction, as if used for any ordinary work. Some authors suppose (. Kirby and Spence, 'Introduction to Entomology,' vol. iii. .) that as the males wander about much more than the females, they require horns as a defence against their enemies; but as the horns are often blunt, they do not seem well adapted for defence. The most obvious conjecture is that they are used by the males for hting together; but the males have never been observed to ht; nor could Mr. Bates, after a careful examination of numerous species, find any sufficient evidence, in their mutilated or broken condition, of their having been thus used. If the males had been habitual hters, the size of their bodies would probably have been increased through sexual selection, so as to have exceeded that of the females; but Mr. Bates, after comparing the two sexes in above a hundred species of the Copridae, did not find any marked difference in this respect amongst welldeveloped individuals. In Lethrus, moreover, a beetle belonging to the same great division of the Lamellicorns, the males are known to ht, but are not provided with horns, though their mandibles are much larger than those of the female.

The conclusion that the horns have been acquired as ornaments is that which best agrees with the fact of their having been so immensely, yet not fixedly, developed, as shewn by their extreme variability in the same species, and by their extreme diversity in closelyallied species. This view will at first appear extremely improbable; but we shall hereafter find with many animals standing much higher in the scale, namely fishes, amphibians, reptiles and birds, that various kinds of crests, knobs, horns and combs have been developed apparently for this sole purpose.

[.. Onitis furcifer, male viewed from beneath.

.. Onitis furcifer. Lefthand ure, male, viewed laterally. Righthand ure, female. a. Rudiment of cephalic horn. b. Trace of thoracic horn or crest.]

The males of *Onitis furcifer*, and of some other species of the genus, are furnished with singular projections on their anterior femora, and with a great fork or pair of horns on the lower surface of the thorax. Judging from other insects, these may aid the male in clinging to the female. Although the males have not even a trace of a horn on the upper surface of the body, yet the females plainly exhibit a rudiment of a single horn on the head (. , a), and of a crest (b) on the thorax. That the slight thoracic crest in the female is a rudiment of a projection proper to the male, though entirely absent in the male of this particular species, is clear: for the female of *Bubas bison* (a genus which comes next to *Onitis*) has a similar slight crest on the thorax, and the male bears a great projection in the same situation. So, again, there can hardly be a doubt that the little point (a) on the head of the female *Onitis furcifer*, as well as on the head of the females of two or three

allied species, is a rudimentary representative of the cephalic horn, which is common to the males of so many Lamellicorn beetles, as in *Phanaeus* .

The old belief that rudiments have been created to complete the scheme of nature is here so far from holding good, that we have a complete inversion of the ordinary state of things in the family. We may reasonably suspect that the males originally bore horns and transferred them to the females in a rudimentary condition, as in so many other Lamellicorns. Why the males subsequently lost their horns, we know not; but this may have been caused through the principle of compensation, owing to the development of the large horns and projections on the lower surface; and as these are confined to the males, the rudiments of the upper horns on the females would not have been thus obliterated.

[. . *Bledius taurus*, magnified. Lefthand ure, male; righthand ure, female.]

The cases hitherto given refer to the Lamellicorns, but the males of some few other beetles, belonging to two widely distinct groups, namely, the Curculionidae and Staphylinidae, are furnished with horns in the former on the lower surface of the body (. Kirby and Spence, 'Introduction to Entomology,' vol. iii. .), in the latter on the upper surface of the head and thorax. In the Staphylinidae, the horns of the males are extraordinarily variable in the same species, just as we have seen with the Lamellicorns. In *Siagonium* we have a case of dimorphism, for the males can be divided into two sets, differing greatly in the size of their bodies and in the development of their horns, without intermediate gradations. In a species of *Bledius* , also belonging to the Staphylinidae, Professor Westwood states that, "male specimens can be found in the same locality in which the central horn of the thorax is very large, but the horns of the head quite rudimental; and others, in which the thoracic horn is much shorter, whilst the protuberances on the head are long." (. 'Modern Classification of Insects,' vol. i. : *Siagonium*, . In the British Museum I noticed one male specimen of *Siagonium* in an intermediate condition, so that the dimorphism is not strict.) Here we apparently have a case of compensation, which throws light on that just given, of the supposed loss of the upper horns by the males of *Onitis*.

LAW OF BATTLE.

Some male beetles, which seem illfitted for fighting, nevertheless engage in conflicts for the possession of the females. Mr. Wallace (. 'The Malay Archipelago,' vol. ii. , . Riley, Sixth 'Report on Insects of Missouri,' , .) saw two males of *Leptorhynchus angustatus*, a linear beetle with a much elongated rostrum, "fighting for a female, who stood close by busy at her boring. They pushed at each other with their rostra, and clawed and thumped, apparently in the greatest rage." The smaller male, however, "soon ran away,

acknowledging himself vanquished." In some few cases male beetles are well adapted for fighting, by possessing great toothed mandibles, much larger than those of the females. This is the case with the common stagbeetle (*Lucanus cervus*), the males of which emerge from the pupal state about a week before the other sex, so that several may often be seen pursuing the same female. At this season they engage in fierce conflicts. When Mr. A.H. Davis (. 'Entomological Magazine,' vol. i. , . See also on the conflicts of this species, Kirby and Spence, *ibid.* vol. iii. ; and Westwood, *ibid.* vol. i. .) enclosed two males with one female in a box, the larger male severely pinched the smaller one, until he resigned his pretensions. A friend informs me that when a boy he often put the males together to see them fight, and he noticed that they were much bolder and fiercer than the females, as with the higher animals. The males would seize hold of his finger, if held in front of them, but not so the females, although they have stronger jaws. The males of many of the *Lucanidae*, as well as of the abovementioned *Leptorhynchus*, are larger and more powerful insects than the females. The two sexes of *Lethrus cephalotes* (one of the *Lamellicorns*) inhabit the same burrow; and the male has larger mandibles than the female. If, during the breeding season, a strange male attempts to enter the burrow, he is attacked; the female does not remain passive, but closes the mouth of the burrow, and encourages her mate by continually pushing him on from behind; and the battle lasts until the aggressor is killed or runs away. (. Quoted from Fischer, in 'Dict. Class. d'Hist. Nat.' tom. x. .) The two sexes of another *Lamellicorn* beetle, the *Ateuchus cicatricosus*, live in pairs, and seem much attached to each other; the male excites the females to roll the balls of dung in which the ova are deposited; and if she is removed, he becomes much agitated. If the male is removed the female ceases all work, and as M. Brulerie believes, would remain on the same spot until she died. (. 'Ann. Soc. Entomolog. France,' , as quoted in 'Journal of Travel,' by A. Murray, , .)

[. . *Chiasognathus Grantii*, reduced. Upper ure, male; lower ure, female.]

The great mandibles of the male *Lucanidae* are extremely variable both in size and structure, and in this respect resemble the horns on the head and thorax of many male *Lamellicorns* and *Staphylinidae*. A perfect series can be formed from the best provided to the worst provided or degenerate males. Although the mandibles of the common stagbeetle, and probably of many other species, are used as efficient weapons for fighting, it is doubtful whether their great size can thus be accounted for. We have seen that they are used by the *Lucanus elaphus* of N. America for seizing the female. As they are so conspicuous and so elegantly branched, and as owing to their great length they are not well adapted for pinching, the suspicion has crossed my mind that they may in addition serve as an ornament, like the horns on the head and thorax of the various species above described. The male *Chiasognathus grantii* of S. Chilea splendid beetle belonging to the same family has enormously developed mandibles ; he is bold and pugnacious; when

threatened he faces round, opens his great jaws, and at the same time stridulates loudly. But the mandibles were not strong enough to pinch my finger so as to cause actual pain.

Sexual selection, which implies the possession of considerable perceptive powers and of strong passions, seems to have been more effective with the Lamellicorns than with any other family of beetles. With some species the males are provided with weapons for fighting; some live in pairs and shew mutual affection; many have the power of stridulating when excited; many are furnished with the most extraordinary horns, apparently for the sake of ornament; and some, which are diurnal in their habits, are gorgeously coloured. Lastly, several of the largest beetles in the world belong to this family, which was placed by Linnaeus and Fabricius as the head of the Order. (. Westwood, 'Modern Classification,' vol. i. .)

STRIDULATING ORGANS.

Beetles belonging to many and widely distinct families possess these organs. The sound thus produced can sometimes be heard at the distance of several feet or even yards (. Wollaston, 'On Certain Musical Curculionidae,' 'Annals and Mag. of Nat. Hist.' vol. vi. , .), but it is not comparable with that made by the Orthoptera. The rasp generally consists of a narrow, slightly raised surface, crossed by very fine, parallel ribs, sometimes so fine as to cause iridescent colours, and having a very elegant appearance under the microscope. In some cases, as with *Typhoeus*, minute, bristly or scalelike prominences, with which the whole surrounding surface is covered in approximately parallel lines, could be traced passing into the ribs of the rasp. The transition takes place by their becoming confluent and straight, and at the same time more prominent and smooth. A hard ridge on an adjoining part of the body serves as the scraper for the rasp but this scraper in some cases has been specially modified for the purpose. It is rapidly moved across the rasp conversely the rasp across the scraper.

[.. *Necrophorus* (from Landois). r. The two rasps. Lefthand ure, part of the rasp highly magnified.]

These organs are situated in widely different positions. In the carrion beetles (*Necrophorus*) two parallel rasps (r, .) stand on the dorsal surface of the fifth abdominal segment, each rasp (. Landois, 'Zeitschrift fur wissenschaft Zoolog.' B. xvii. , s. .) consisting of to fine ribs. These ribs are scraped against the posterior margins of the elytra, a small portion of which projects beyond the general outline. In many *Crioceridae*, and in *Clythra punctata* (one of the *Chrysomelidae*), and in some *Tenebrionidae*, etc. (. I am greatly indebted to Mr. G.R. Crotch for having sent me many prepared specimens of various beetles belonging to these three families and to others, as well as for valuable information. He believes that the power of stridulation in the

Clythra has not been previously observed. I am also much indebted to Mr. E.W. Janson, for information and specimens. I may add that my son, Mr. F. Darwin, finds that *Dermestes murinus* stridulates, but he searched in vain for the apparatus. *Scolytus* has lately been described by Dr. Chapman as a stridulator, in the 'Entomologist's Monthly Magazine,' vol. vi. .), the rasp is seated on the dorsal apex of the abdomen, on the pygidium or propygidium, and is scraped in the same manner by the elytra. In *Heterocerus*, which belongs to another family, the rasps are placed on the sides of the first abdominal segment, and are scraped by ridges on the femora. (. Schiodte, translated, in 'Annals and Magazine of Natural History,' vol. xx. , .) In certain Curculionidae and Carabidae (. Westring has described (Kroyer, 'Naturhist. Tidsskrift,' B. ii. , .) the stridulating organs in these two, as well as in other families. In the Carabidae I have examined *Elaphrus uliginosus* and *Blethisa multipunctata*, sent to me by Mr. Crotch. In *Blethisa* the transverse ridges on the furrowed border of the abdominal segment do not, as far as I could judge, come into play in scraping the rasps on the elytra.), the parts are completely reversed in position, for the rasps are seated on the inferior surface of the elytra, near their apices, or along their outer margins, and the edges of the abdominal segments serve as the scrapers. In *Pelobius Hermannii* (one of Dytiscidae or waterbeetles) a strong ridge runs parallel and near to the sutural margin of the elytra, and is crossed by ribs, coarse in the middle part, but becoming gradually finer at both ends, especially at the upper end; when this insect is held under water or in the air, a stridulating noise is produced by the extreme horny margin of the abdomen being scraped against the rasps. In a great number of longhorned beetles (*Longicornia*) the organs are situated quite otherwise, the rasp being on the mesothorax, which is rubbed against the prothorax; Landois counted very fine ribs on the rasp of *Cerambyx heros*.

[.. Hindleg of *Geotrupes stercorarius* (from Landois). r. Rasc. Coxa. f. Femur. t. Tibia. tr. Tarsi.]

Many Lamellicorns have the power of stridulating, and the organs differ greatly in position. Some species stridulate very loudly, so that when Mr. F. Smith caught a *Trox sabulosus*, a gamekeeper, who stood by, thought he had caught a mouse; but I failed to discover the proper organs in this beetle. In *Geotrupes* and *Typhoeus*, a narrow ridge runs obliquely across (r. .) the coxa of each hindleg (having in *G. stercorarius* ribs), which is scraped by a specially projecting part of one of the abdominal segments. In the nearly allied *Copris lunaris*, an excessively narrow fine rasp runs along the sutural margin of the elytra, with another short rasp near the basal outer margin; but in some other Coprini the rasp is seated, according to Leconte (. I am indebted to Mr. Walsh, of Illinois, for having sent me extracts from Leconte's 'Introduction to Entomology,' .), on the dorsal surface of the abdomen. In *Oryctes* it is seated on the propygidium; and, according to the same entomologist, in some other Dynastini, on the under surface of the elytra. Lastly, Westring states that in *Omaloplia brunnea* the rasp is placed on the

prosternum, and the scraper on the metasternum, the parts thus occupying the under surface of the body, instead of the upper surface as in the Longicorns.

We thus see that in the different coleopterous families the stridulating organs are wonderfully diversified in position, but not much in structure. Within the same family some species are provided with these organs, and others are destitute of them. This diversity is intelligible, if we suppose that originally various beetles made a shuffling or hissing noise by the rubbing together of any hard and rough parts of their bodies, which happened to be in contact; and that from the noise thus produced being in some way useful, the rough surfaces were gradually developed into regular stridulating organs. Some beetles as they move, now produce, either intentionally or unintentionally, a shuffling noise, without possessing any proper organs for the purpose. Mr. Wallace informs me that the *Euchirus longimanus* (a Lamellicorn, with the anterior legs wonderfully elongated in the male) "makes, whilst moving, a low hissing sound by the protrusion and contraction of the abdomen; and when seized it produces a grating sound by rubbing its hindlegs against the edges of the elytra." The hissing sound is clearly due to a narrow rasp running along the sutural margin of each elytron; and I could likewise make the grating sound by rubbing the shagreened surface of the femur against the granulated margin of the corresponding elytron; but I could not here detect any proper rasp; nor is it likely that I could have overlooked it in so large an insect. After examining *Cychnus*, and reading what Westring has written about this beetle, it seems very doubtful whether it possesses any true rasp though it has the power of emitting a sound.

From the analogy of the Orthoptera and Homoptera, I expected to find the stridulating organs in the Coleoptera differing according to sex; but Landois, who has carefully examined several species, observed no such difference; nor did Westring; nor did Mr. G.R. Crotch in preparing the many specimens which he had the kindness to send me. Any difference in these organs, if slight, would, however, be difficult to detect, on account of their great variability. Thus, in the first pair of specimens of *Necrophorus humator* and of *Pelobius* which I examined, the rasp was considerably larger in the male than in the female; but not so with succeeding specimens. In *Geotrupes stercorarius* the rasp appeared to me thicker, opaquer, and more prominent in three males than in the same number of females; in order, therefore, to discover whether the sexes differed in their power of stridulating, my son, Mr. F. Darwin, collected fiftyseven living specimens, which he separated into two lots, according as they made a greater or lesser noise, when held in the same manner. He then examined all these specimens, and found that the males were very nearly in the same proportion to the females in both the lots. Mr. F. Smith has kept alive numerous specimens of *Monoychnus pseudacori* (Curculionidae), and is convinced that both sexes stridulate, and apparently in an equal degree.

Nevertheless, the power of stridulating is certainly a sexual character in some few Coleoptera. Mr. Crotch discovered that the males alone of two species of *Heliopathes* (Tenebrionidae) possess stridulating organs. I examined five males of *H. gibbus*, and in all these there was a well developed rasp partially divided into two, on the dorsal surface of the terminal abdominal segment; whilst in the same number of females there was not even a rudiment of the rasp, the membrane of this segment being transparent, and much thinner than in the male. In *H. cribratostriatus* the male has a similar rasp excepting that it is not partially divided into two portions, and the female is completely destitute of this organ; the male in addition has on the apical margins of the elytra, on each side of the suture, three or four short longitudinal ridges, which are crossed by extremely fine ribs, parallel to and resembling those on the abdominal rasp; whether these ridges serve as an independent rasp or as a scraper for the abdominal rasp I could not decide: the female exhibits no trace

of this latter structure.

Again, in three species of the Lamellicorn genus *Oryctes*, we have a nearly parallel case. In the females of *O. gryphus* and *O. nasicornis* the ribs on the rasp of the propygidium are less continuous and less distinct than in the males; but the chief difference is that the whole upper surface of this segment, when held in the proper light, is seen to be clothed with hairs, which are absent or are represented by excessively fine down in the males. It should be noticed that in all Coleoptera the effective part of the rasp is destitute of hairs. In *O. senegalensis* the difference between the sexes is more strongly marked, and this is best seen when the proper abdominal segment is cleaned and viewed as a transparent object. In the female the whole surface is covered with little separate crests, bearing spines; whilst in the male these crests in proceeding towards the apex, become more and more confluent, regular, and naked; so that three fourths of the segment is covered with extremely fine parallel ribs, which are quite absent in the female. In the females, however, of all three species of *Oryctes*, a slight grating or stridulating sound is produced, when the abdomen of a softened specimen is pushed backwards and forwards.

In the case of the *Heliopathes* and *Oryctes* there can hardly be a doubt that the males stridulate in order to call or to excite the females; but with most beetles the stridulation apparently serves both sexes as a mutual call. Beetles stridulate under various emotions, in the same manner as birds use their voices for many purposes besides singing to their mates. The great *Chiasognathus* stridulates in anger or defiance; many species do the same from distress or fear, if held so that they cannot escape; by striking the hollow stems of trees in the Canary Islands, Messrs. Wollaston and Crotch were able to discover the presence of beetles belonging to the genus *Acalles* by their stridulation. Lastly, the male *Ateuchus* stridulates to encourage the female in her work, and from distress when

she is removed. (M. de la Brulerie, as quoted in 'Journal of Travel,' A. Murray, vol. i. , .) Some naturalists believe that beetles make this noise to frighten away their enemies; but I cannot think that a quadruped or bird, able to devour a large beetle, would be frightened by so slight a sound. The belief that the stridulation serves as a sexual call is supported by the fact that deathticks (*Anobium tessellatum*) are well known to answer each other's ticking, and, as I have myself observed, a tapping noise artificially made. Mr. Doubleday also informs me that he has sometimes observed a female ticking (. According to Mr. Doubleday, "the noise is produced by the insect raising itself on its legs as high as it can, and then striking its thorax five or six times, in rapid succession, against the substance upon which it is sitting." For references on this subject see Landois, 'Zeitschrift für wissen. Zoolog.' B. xvii. s. . Olivier says (as quoted by Kirby and Spence, 'Introduction to Entomology,' vol. ii.) that the female of *Pimelia striata* produces a rather loud sound by striking her abdomen against any hard substance, "and that the male, obedient to this call, soon attends her, and they pair."), and in an hour or two afterwards has found her united with a male, and on one occasion surrounded by several males. Finally, it is probable that the two sexes of many kinds of beetles were at first enabled to find each other by the slight shuffling noise produced by the rubbing together of the adjoining hard parts of their bodies; and that as those males or females which made the greatest noise succeeded best in finding partners, rugosities on various parts of their bodies were gradually developed by means of sexual selection into true stridulating organs.

CHAPTER XI.

INSECTS, continued.

ORDER LEPIDOPTERA. (BUTTERFLIES AND MOTHS.)

Courtship of butterflies Battles Ticking noise Colours common to both

sexes, or more brilliant in the males Examples Not due to the direct action of the conditions of life Colours adapted for protection Colours of moths Display Perceptive powers of the Lepidoptera Variability Causes of the difference in colour between the males and females Mimicry, female butterflies more brilliantly coloured than the males Bright colours of caterpillars Summary and concluding remarks on the secondary sexual characters of insects Birds and insects compared.

In this great Order the most interesting points for us are the differences in colour between the sexes of the same species, and between the distinct species of the same genus. Nearly the whole of the following chapter will be devoted to this subject; but I will first make a few remarks on one or two other points. Several males may often be seen pursuing and crowding round the same female. Their courtship appears to be a prolonged affair, for I have frequently watched one or more males pirouetting round a female until I was tired, without seeing the end of the courtship. Mr. A.G. Butler also informs me that he has several times watched a male courting a female for a full quarter of an hour; but she pertinaciously refused him, and at last settled on the ground and closed her wings, so as to escape from his addresses.

Although butterflies are weak and fragile creatures, they are pugnacious, and an emperor butterfly (*Apatura Iris*: 'The Entomologist's Weekly Intelligence,' , . For the Bornean Butterflies, see C. Collingwood, 'Rambles of a Naturalist,' , .) has been captured with the tips of its wings broken from a conflict with another male. Mr. Collingwood, in speaking of the frequent battles between the butterflies of Borneo, says, "They whirl round each other with the greatest rapidity, and appear to be incited by the greatest ferocity."

The *Ageronia feronia* makes a noise like that produced by a toothed wheel passing under a spring catch, and which can be heard at the distance of several yards: I noticed this sound at Rio de Janeiro, only when two of these butterflies were chasing each other in an irregular course, so that it is probably made during the courtship of the sexes. (See my 'Journal of Researches,' , . Mr. Doubleday has detected ('Proc. Ent. Soc.' March , ,) a peculiar membranous sac at the base of the front wings, which is probably connected with the production of the sound. For the case of *Thecophora*, see 'Zoological Record,' , . For Mr. Buchanan White's observations, the *Scottish Naturalist*, July , .)

Some moths also produce sounds; for instance, the males *Theocophora fovea*. On two occasions Mr. F. Buchanan White (. 'The Scottish Naturalist,' July , .) heard a sharp quick noise made by the male of *Hylophila prasinana*, and which he believes to be produced, as in Cicada, by an elastic membrane, furnished with a muscle. He quotes, also, Guenee, that *Setina* produces a sound like the ticking of a watch, apparently by the aid of "two large tympaniform vesicles, situated in the pectoral region"; and these "are much more developed in the male than in the female." Hence the soundproducing organs in the Lepidoptera appear to stand in some relation with the sexual functions. I have not alluded to the wellknown noise made by the Death's Head Sphinx, for it is generally heard soon after the moth has emerged from its cocoon.

Giard has always observed that the musky odour, which is emitted by two species of Sphinx moths, is peculiar to the males (. 'Zoological Record,' , .); and in the higher classes we shall meet with many instances of the males alone being odoriferous.

Every one must have admired the extreme beauty of many butterflies and of some moths; and it may be asked, are their colours and diversified patterns the result of the direct action of the physical conditions to which these insects have been exposed, without any benefit being thus derived? Or have successive variations been accumulated and determined as a protection, or for some unknown purpose, or that one sex may be attractive to the other? And, again, what is the meaning of the colours being widely different in the males and females of certain species, and alike in the two sexes of other species of the same genus? Before attempting to answer these questions a body of facts must be given.

With our beautiful English butterflies, the admiral, peacock, and painted lady (*Vanessae*), as well as many others, the sexes are alike. This is also the case with the magnificent *Heliconidae*, and most of the *Danaidae* in the tropics. But in certain other tropical groups, and in some of our English butterflies, as the purple emperor, orangetietc. (*Apatura Iris* and *Anthocharis cardamines*), the sexes differ either greatly or slightly in colour. No language suffices to describe the splendour of the males of some tropical species. Even within the same genus we often find species presenting extraordinary differences between the sexes, whilst others have their sexes closely alike. Thus in the South American genus *Epicalia*, Mr. Bates, to whom I am indebted for most of the following facts, and for looking over this whole discussion, informs me that he knows twelve species, the two sexes of which haunt the same stations (and this is not always the case with butterflies), and which, therefore, cannot have been differently affected by external conditions. (. See also Mr. Bates's paper in 'Proc. Ent. Soc. of Philadelphia,' , . Also Mr. Wallace on the same subject, in regard to *Diadema*, in 'Transactions, Entomological Society of London,' , .) In nine of these twelve species the males rank amongst the most brilliant of all butterflies, and differ so greatly from the

comparatively plain females that they were formerly placed in distinct genera. The females of these nine species resemble each other in their general type of coloration; and they likewise resemble both sexes of the species in several allied genera found in various parts of the world. Hence we may infer that these nine species, and probably all the others of the genus, are descended from an ancestral form which was coloured in nearly the same manner. In the tenth species the female still retains the same general colouring, but the male resembles her, so that he is coloured in a much less gaudy and contrasted manner than the males of the previous species. In the eleventh and twelfth species, the females depart from the usual type, for they are gaily decorated almost like the males, but in a somewhat less degree. Hence in these two latter species the bright colours of the males seem to have been transferred to the females; whilst in the tenth species the male has either retained or recovered the plain colours of the female, as well as of the parentform of the genus. The sexes in these three cases have thus been rendered nearly alike, though in an opposite manner. In the allied genus *Eubagis*, both sexes of some of the species are plaincoloured and nearly alike; whilst with the greater number the males are decorated with beautiful metallic tints in a diversified manner, and differ much from their females. The females throughout the genus retain the same general style of colouring, so that they resemble one another much more closely than they resemble their own males.

In the genus *Papilio*, all the species of the *Aeneas* group are remarkable for their conspicuous and strongly contrasted colours, and they illustrate the frequent tendency to gradation in the amount of difference between the sexes. In a few species, for instance in *ascanius*, the males and females are alike; in others the males are either a little brighter, or very much more superb than the females. The genus *Junonia*, allied to our *Vanessae*, offers a nearly parallel case, for although the sexes of most of the species resemble each other, and are destitute of rich colours, yet in certain species, as in *J. oenone*, the male is rather more brightcoloured than the female, and in a few (for instance *J. andremiaja*) the male is so different from the female that he might be mistaken for an entirely distinct species.

Another striking case was pointed out to me in the British Museum by Mr. A. Butler, namely, one of the tropical American *Theclae*, in which both sexes are nearly alike and wonderfully splendid; in another species the male is coloured in a similarly gorgeous manner, whilst the whole upper surface of the female is of a dull uniform brown. Our common little English blue butterflies of the genus *Lycaena*, illustrate the various differences in colour between the sexes, almost as well, though not in so striking a manner, as the above exotic genera. In *Lycaena agestis* both sexes have wings of a brown colour, bordered with small ocellated orange spots, and are thus alike. In *L. oegon* the wings of the males are of a fine blue, bordered with black, whilst those of the female are brown, with a similar border, closely resembling the wings of *L. agestis*. Lastly, in *L.*

arion both sexes are of a blue colour and are very like, though in the female the edges of the wings are rather duskier, with the black spots plainer; and in a bright blue Indian species both sexes are still more alike.

I have given the foregoing details in order to shew, in the first place, that when the sexes of butterflies differ, the male as a general rule is the more beautiful, and departs more from the usual type of colouring of the group to which the species belongs. Hence in most groups the females of the several species resemble each other much more closely than do the males. In some cases, however, to which I shall hereafter allude, the females are coloured more splendidly than the males. In the second place, these details have been given to bring clearly before the mind that within the same genus, the two sexes frequently present every gradation from no difference in colour, to so great a difference that it was long before the two were placed by entomologists in the same genus. In the third place, we have seen that when the sexes nearly resemble each other, this appears due either to the male having transferred his colours to the female, or to the male having retained, or perhaps recovered, the primordial colours of the group. It also deserves notice that in those groups in which the sexes differ, the females usually somewhat resemble the males, so that when the males are beautiful to an extraordinary degree, the females almost invariably exhibit some degree of beauty. From the many cases of gradation in the amount of difference between the sexes, and from the prevalence of the same general type of coloration throughout the whole of the same group we may conclude that the causes have generally been the same which have determined the brilliant colouring of the males alone of some species, and of both sexes of other species.

As so many gorgeous butterflies inhabit the tropics, it has often been supposed that they owe their colours to the great heat and moisture of these zones; but Mr. Bates ('The Naturalist on the Amazons,' vol. i. , .) has shown by the comparison of various closely allied groups of insects from the temperate and tropical regions, that this view cannot be maintained; and the evidence becomes conclusive when brilliantly coloured males and plaincoloured females of the same species inhabit the same district, feed on the same food, and follow exactly the same habits of life. Even when the sexes resemble each other, we can hardly believe that their brilliant and beautifully arranged colours are the purposeless result of the nature of the tissues and of the action of the surrounding conditions.

With animals of all kinds, whenever colour has been modified for some special purpose, this has been, as far as we can judge, either for direct or indirect protection, or as an attraction between the sexes. With many species of butterflies the upper surfaces of the wings are obscure; and this in all probability leads to their escaping observation and danger. But butterflies would be particularly liable to be attacked by their enemies when at rest; and most kinds whilst resting raise their wings vertically over their backs, so that

the lower surface alone is exposed to view. Hence it is this side which is often coloured so as to imitate the objects on which these insects commonly rest. Dr. Rossler, I believe, first noticed the similarity of the closed wings of certain *Vanessae* and other butterflies to the bark of trees. Many analogous and striking facts could be given. The most interesting one is that recorded by Mr. Wallace (. See the interesting article in the 'Westminster Review,' July , . A woodcut of the *Kallima* is given by Mr. Wallace in 'Hardwicke's Science Gossip,' September , .) of a common Indian and Sumatran butterfly (*Kallima*) which disappears like magic when it settles on a bush; for it hides its head and antennae between its closed wings, which, in form, colour and veining, cannot be distinguished from a withered leaf with its footstalk. In some other cases the lower surfaces of the wings are brilliantly coloured, and yet are protective; thus in *Thecla rubi* the wings when closed are of an emerald green, and resemble the young leaves of the bramble, on which in spring this butterfly may often be seen seated. It is also remarkable that in very many species in which the sexes differ greatly in colour on their upper surface, the lower surface is closely similar or identical in both sexes, and serves as a protection. (. Mr. G. Fraser, in 'Nature,' April , .)

Although the obscure tints both of the upper and under sides of many butterflies no doubt serve to conceal them, yet we cannot extend this view to the brilliant and conspicuous colours on the upper surface of such species as our admiral and peacock *Vanessae*, our white cabbagebutterflies (*Pieris*), or the great swallowtail *Papilio* which haunts the open fens for these butterflies are thus rendered visible to every living creature. In these species both sexes are alike; but in the common brimstone butterfly (*Gonepteryx rhamni*), the male is of an intense yellow, whilst the female is much paler; and in the orangetip (*Anthocharis cardamines*) the males alone have their wings tipped with bright orange. Both the males and females in these cases are conspicuous, and it is not credible that their difference in colour should stand in any relation to ordinary protection. Prof. Weismann remarks (. 'Einfluss der Isolirung auf die Artbildung,' , .), that the female of one of the *Lycaenae* expands her brown wings when she settles on the ground, and is then almost invisible; the male, on the other hand, as if aware of the danger incurred from the bright blue of the upper surface of his wings, rests with them closed; and this shows that the blue colour cannot be in any way protective. Nevertheless, it is probable that conspicuous colours are indirectly beneficial to many species, as a warning that they are unpalatable. For in certain other cases, beauty has been gained through the imitation of other beautiful species, which inhabit the same district and enjoy an immunity from attack by being in some way offensive to their enemies; but then we have to account for the beauty of the imitated species.

As Mr. Walsh has remarked to me, the females of our orangetip butterfly, above referred to, and of an American species (*Anth. genutia*) probably shew us the primordial colours of the parentspecies of the genus; for both sexes of four or five widelydistributed species

are coloured in nearly the same manner. As in several previous cases, we may here infer that it is the males of *Anth. cardamines* and *genutia* which have departed from the usual type of the genus. In the *Anth. sara* from California, the orange tips to the wings have been partially developed in the female; but they are paler than in the male, and slightly different in some other respects. In an allied Indian form, the *Iphias glaucippe*, the orangetips are fully developed in both sexes. In this *Iphias*, as pointed out to me by Mr. A. Butler, the under surface of the wings marvellously resembles a pale coloured leaf; and in our English orangetithe under surface resembles the flowerhead of the wild parsley, on which the butterfly often rests at night. (. See the interesting observations by T.W. Wood, 'The Student,' Sept. , .) The same reason which compels us to believe that the lower surfaces have here been coloured for the sake of protection, leads us to deny that the wings have been tipped with bright orange for the same purpose, especially when this character is confined to the males.

Most Moths rest motionless during the whole or greater part of the day with their wings depressed; and the whole upper surface is often shaded and coloured in an admirable manner, as Mr. Wallace has remarked, for escaping detection. The frontwings of the *Bombycidae* and *Noctuidae* (. Mr. Wallace in 'Hardwicke's Science Gossip,' September , .), when at rest, generally overlap and conceal the hindwings; so that the latter might be brightly coloured without much risk; and they are in fact often thus coloured. During flight, moths would often be able to escape from their enemies; nevertheless, as the hindwings are then fully exposed to view, their bright colours must generally have been acquired at some little risk. But the following fact shews how cautious we ought to be in drawing conclusions on this head. The common Yellow Underwings (*Triphaena*) often fly about during the day or early evening, and are then conspicuous from the colour of their hindwings. It would naturally be thought that this would be a source of danger; but Mr. J. Jenner Weir believes that it actually serves them as a means of escape, for birds strike at these brightly coloured and fragile surfaces, instead of at the body. For instance, Mr. Weir turned into his aviary a vigorous specimen of *Triphaena pronuba*, which was instantly pursued by a robin; but the bird's attention being caught by the coloured wings, the moth was not captured until after about fifty attempts, and small portions of the wings were repeatedly broken off. He tried the same experiment, in the open air, with a swallow and *T. fimbria*; but the large size of this moth probably interfered with its capture. (. See also, on this subject, Mr. Weir's paper in 'Transactions, Entomological Society,' , .) We are thus reminded of a statement made by Mr. Wallace (. 'Westminster Review,' July , .), namely, that in the Brazilian forests and Malayan islands, many common and highlydecorated butterflies are weak flyers, though furnished with a broad expanse of wing; and they "are often captured with pierced and broken wings, as if they had been seized by birds, from which they had escaped: if the wings had been much smaller in proportion to the body, it seems probable that the

insect would more frequently have been struck or pierced in a vital part, and thus the increased expanse of the wings may have been indirectly beneficial."

DISPLAY.

The bright colours of many butterflies and of some moths are specially arranged for display, so that they may be readily seen. During the night colours are not visible, and there can be no doubt that the nocturnal moths, taken as a body, are much less gaily decorated than butterflies, all of which are diurnal in their habits. But the moths of certain families, such as the Zygaenidae, several Sphingidae, Uraniidae, some Arctiidae and Saturniidae, fly about during the day or early evening, and many of these are extremely beautiful, being far brighter coloured than the strictly nocturnal kinds. A few exceptional cases, however, of brightcoloured nocturnal species have been recorded. (. For instance, *Lithosia*; but Prof. Westwood ('Modern Class. of Insects,' vol. ii.) seems surprised at this case. On the relative colours of diurnal and nocturnal Lepidoptera, see *ibid.* p and ; also Harris, 'Treatise on the Insects of New England,' , .)

There is evidence of another kind in regard to display. Butterflies, as before remarked, elevate their wings when at rest, but whilst basking in the sunshine often alternately raise and depress them, thus exposing both surfaces to full view; and although the lower surface is often coloured in an obscure manner as a protection, yet in many species it is as highly decorated as the upper surface, and sometimes in a very different manner. In some tropical species the lower surface is even more brilliantly coloured than the upper. (. Such differences between the upper and lower surfaces of the wings of several species of *Papilio* may be seen in the beautiful plates to Mr. Wallace's 'Memoir on the Papilionidae of the Malayan Region,' in 'Transactions of the Linnean Society,' vol. xxv. part i. .) In the English fritillaries (*Argynnis*) the lower surface alone is ornamented with shining silver. Nevertheless, as a general rule, the upper surface, which is probably more fully exposed, is coloured more brightly and diversely than the lower. Hence the lower surface generally affords to entomologists the more useful character for detecting the affinities of the various species. Fritz Müller informs me that three species of *Castnia* are found near his house in S. Brazil: of two of them the hindwings are obscure, and are always covered by the frontwings when these butterflies are at rest; but the third species has black hindwings, beautifully spotted with red and white, and these are fully expanded and displayed whenever the butterfly rests. Other such cases could be added.

If we now turn to the enormous group of moths, which, as I hear from Mr. Stainton, do not habitually expose the under surface of their wings to full view, we find this side very rarely coloured with a brightness greater than, or even equal to, that of the upper side. Some exceptions to the rule, either real or apparent, must be noticed, as the case of *Hypopyra*. (. See Mr. Wormald on this moth: 'Proceedings of the Entomological Society,'

March, .) Mr. Trimen informs me that in Guenee's great work, three moths are ured, in which the under surface is much the more brilliant. For instance, in the Australian *Gastrophora* the upper surface of the forewing is pale greyishochreous, while the lower surface is magnificently ornamented by an ocellus of cobaltblue, placed in the midst of a black mark, surrounded by orangeyellow, and this by bluishwhite. But the habits of these three moths are unknown; so that no explanation can be given of their unusual style of colouring. Mr. Trimen also informs me that the lower surface of the wings in certain other *Geometrae* (. See also an account of the S. American genus *Erateina* (one of the *Geometrae*) in 'Transactions, Ent. Soc.' new series, vol. v. pl. xv. and xvi.) and quadrifid *Noctuae* are either more variegated or more brightlycoloured than the upper surface; but some of these species have the habit of "holding their wings quite erect over their backs, retaining them in this position for a considerable time," and thus exposing the under surface to view. Other species, when settled on the ground or herbage, now and then suddenly and slightly lift up their wings. Hence the lower surface of the wings being brighter than the upper surface in certain moths is not so anomalous as it at first appears. The *Saturniidae* include some of the most beautiful of all moths, their wings being decorated, as in our British Emperor moth, with fine ocelli; and Mr. T.W. Wood (. 'Proc Ent. Soc. of London,' July , , xxvii.) observes that they resemble butterflies in some of their movements; "for instance, in the gentle waving up and down of the wings as if for display, which is more characteristic of diurnal than of nocturnal *Lepidoptera*."

It is a singular fact that no British moths which are brilliantly coloured, and, as far as I can discover, hardly any foreign species, differ much in colour according to sex; though this is the case with many brilliant butterflies. The male, however, of one American moth, the *Saturnia Io*, is described as having its forewings deep yellow, curiously marked with purplishred spots; whilst the wings of the female are purplebrown, marked with grey lines. (. Harris, 'Treatise,' etc., edited by Flint, , .) The British moths which differ sexually in colour are all brown, or of various dull yellow tints, or nearly white. In several species the males are much darker than the females (. For instance, I observe in my son's cabinet that the males are darker than the females in the *Lasiocampa quercus*, *Odonestis potatoria*, *Hypogymna dispar*, *Dasychira pudibunda*, and *Cycnia mendica*. In this latter species the difference in colour between the two sexes is strongly marked; and Mr. Wallace informs me that we here have, as he believes, an instance of protective mimicry confined to one sex, as will hereafter be more fully explained. The white female of the *Cycnia* resembles the very common *Spilosoma menthrasti*, both sexes of which are white; and Mr. Stainton observed that this latter moth was rejected with utter disgust by a whole brood of young turkeys, which were fond of eating other moths; so that if the *Cycnia* was commonly mistaken by British birds for the *Spilosoma*, it would escape being devoured, and its white deceptive colour would thus be highly beneficial.), and these belong to groups which generally fly about during the afternoon. On the other hand, in many genera, as Mr. Stainton informs me, the males have the hindwings whiter

than those of the female of which fact *Agrotis exclamatoris* offers a good instance. In the Ghost Moth (*Hepialus humuli*) the difference is more strongly marked; the males being white, and the females yellow with darker markings. (It is remarkable, that in the Shetland Islands the male of this moth, instead of differing widely from the female, frequently resembles her closely in colour (see Mr. MacLachlan, 'Transactions, Entomological Society,' vol. ii. ,). Mr. G. Fraser suggests ('Nature,' April ,) that at the season of the year when the ghostmoth appears in these northern islands, the whiteness of the males would not be needed to render them visible to the females in the twilight night.) It is probable that in these cases the males are thus rendered more conspicuous, and more easily seen by the females whilst flying about in the dusk.

From the several foregoing facts it is impossible to admit that the brilliant colours of butterflies, and of some few moths, have commonly been acquired for the sake of protection. We have seen that their colours and elegant patterns are arranged and exhibited as if for display. Hence I am led to believe that the females prefer or are most excited by the more brilliant males; for on any other supposition the males would, as far as we can see, be ornamented to no purpose. We know that ants and certain Lamellicorn beetles are capable of feeling an attachment for each other, and that ants recognise their fellows after an interval of several months. Hence there is no abstract improbability in the Lepidoptera, which probably stand nearly or quite as high in the scale as these insects, having sufficient mental capacity to admire bright colours. They certainly discover flowers by colour. The Hummingbird Sphinx may often be seen to swoop down from a distance on a bunch of flowers in the midst of green foliage; and I have been assured by two persons abroad, that these moths repeatedly visit flowers painted on the walls of a room, and vainly endeavour to insert their proboscis into them. Fritz Müller informs me that several kinds of butterflies in S. Brazil shew an unmistakable preference for certain colours over others: he observed that they very often visited the brilliant red flowers of five or six genera of plants, but never the white or yellow flowering species of the same and other genera, growing in the same garden; and I have received other accounts to the same effect. As I hear from Mr. Doubleday, the common white butterfly often flies down to a bit of paper on the ground, no doubt mistaking it for one of its own species. Mr. Collingwood (. 'Rambles of a Naturalist in the Chinese Seas,' , .) in speaking of the difficulty in collecting certain butterflies in the Malay Archipelago, states that "a dead specimen pinned upon a conspicuous twig will often arrest an insect of the same species in its headlong flight, and bring it down within easy reach of the net, especially if it be of the opposite sex."

The courtship of butterflies is, as before remarked, 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, the 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 in the supplement to the ninth chapter; namely, that the males of many Lepidoptera, at least in the imago state, greatly exceed the females in number.

Some facts, however, are opposed to the belief that female butterflies prefer the more beautiful males; thus, as I have been assured by several collectors, fresh females may frequently be seen paired with battered, faded, or dingy males; but this is a circumstance which could hardly fail often to follow from the males emerging from their cocoons earlier than the females. With moths of the family of the Bombycidae, the sexes pair immediately after assuming the imago state; for they cannot feed, owing to the rudimentary condition of their mouths. The females, as several entomologists have remarked to me, lie in an almost torpid state, and appear not to evince the least choice in regard to their partners. This is the case with the common silkmoth (*B. mori*), as I have been told by some continental and English breeders. Dr. Wallace, who has had great experience in breeding *Bombyx cynthia*, is convinced that the females evince no choice or preference. He has kept above of these moths together, and has often found the most vigorous females mated with stunted males. The reverse appears to occur seldom; for, as he believes, the more vigorous males pass over the weakly females, and are attracted by those endowed with most vitality. Nevertheless, the Bombycidae, though obscurely coloured, are often beautiful to our eyes from their elegant and mottled shades.

I have as yet only referred to the species in which the males are brighter coloured than the females, and I have attributed their beauty to the females for many generations having chosen and paired with the more attractive males. But converse cases occur, though rarely, in which the females are more brilliant than the males; and here, as I believe, the males have selected the more beautiful females, and have thus slowly added to their beauty. We do not know why in various classes of animals the males of some few species have selected the more beautiful females instead of having gladly accepted any female, as seems to be the general rule in the animal kingdom: but if, contrary to what generally occurs with the Lepidoptera, the females were much more numerous than the males, the latter would be likely to pick out the more beautiful females. Mr. Butler shewed me several species of *Callidryas* in the British Museum, in some of which the females equalled, and in others greatly surpassed the males in beauty; for the females alone have the borders of their wings suffused with crimson and orange, and spotted with black. The plainer males of these species closely resemble each other, shewing that

here the females have been modified; whereas in those cases, where the males are the more ornate, it is these which have been modified, the females remaining closely alike.

In England we have some analogous cases, though not so marked. The females alone of two species of *Thecla* have a brightpurple or orange patch on their forewings. In *Hipparchia* the sexes do not differ much; but it is the female of *H. janira* which has a conspicuous lightbrown patch on her wings; and the females of some of the other species are brighter coloured than their males. Again, the females of *Colias edusa* and *hyale* have "orange or yellow spots on the black marginal border, represented in the males only by thin streaks"; and in *Pieris* it is the females which "are ornamented with black spots on the forewings, and these are only partially present in the males." Now the males of many butterflies are known to support the females during their marriage flight; but in the species just named it is the females which support the males; so that the part which the two sexes play is reversed, as is their relative beauty. Throughout the animal kingdom the males commonly take the more active share in wooing, and their beauty seems to have been increased by the females having accepted the more attractive individuals; but with these butterflies, the females take the more active part in the final marriage ceremony, so that we may suppose that they likewise do so in the wooing; and in this case we can understand how it is that they have been rendered the more beautiful. Mr. Meldola, from whom the foregoing statements have been taken, says in conclusion: "Though I am not convinced of the action of sexual selection in producing the colours of insects, it cannot be denied that these facts are strikingly corroborative of Mr. Darwin's views." (. 'Nature,' April , , . Mr. Meldola quotes Donzel, in 'Soc. Ent. de France,' , , on the flight of butterflies whilst pairing. See also Mr. G. Fraser, in 'Nature,' April , , , on the sexual differences of several British butterflies.)

As sexual selection primarily depends on variability, a few words must be added on this subject. In respect to colour there is no difficulty, for any number of highly variable Lepidoptera could be named. One good instance will suffice. Mr. Bates shewed me a whole series of specimens of *Papilio sesostris* and *childrenae*; in the latter the males varied much in the extent of the beautifully enamelled green patch on the forewings, and in the size of the white mark, and of the splendid crimson stripe on the hindwings; so that there was a great contrast amongst the males between the most and the least gaudy. The male of *Papilio sesostris* is much less beautiful than of *childrenae*; and it likewise varies a little in the size of the green patch on the forewings, and in the occasional appearance of the small crimson stripe on the hindwings, borrowed, as it would seem, from its own female; for the females of this and of many other species in the *Aeneas* group possess this crimson stripe. Hence between the brightest specimens of *sesostris* and the dullest of *childrenae*, there was but a small interval; and it was evident that as far as mere variability is concerned, there would be no difficulty in permanently increasing the beauty of either species by means of selection. The variability is here

almost confined to the male sex; but Mr. Wallace and Mr. Bates have shewn (. Wallace on the Papilionidae of the Malayan Region, in 'Transact. Linn. Soc.' vol. xxv. , . A striking case of a rare variety, strictly intermediate between two other wellmarked female varieties, is given by Mr. Wallace. See also Mr. Bates, in 'Proc. Entomolog. Soc.' Nov. , , xl.) that the females of some species are extremely variable, the males being nearly constant. In a future chapter I shall have occasion to shew that the beautiful eyelike spots, or ocelli, found on the wings of many Lepidoptera, are eminently variable. I may here add that these ocelli offer a difficulty on the theory of sexual selection; for though appearing to us so ornamental, they are never present in one sex and absent in the other, nor do they ever differ much in the two sexes. (. Mr. Bates was so kind as to lay this subject before the Entomological Society, and I have received answers to this effect from several entomologists.) This fact is at present inexplicable; but if it should hereafter be found that the formation of an ocellus is due to some change in the tissues of the wings, for instance, occurring at a very early period of development, we might expect, from what we know of the laws of inheritance, that it would be transmitted to both sexes, though arising and perfected in one sex alone.

On the whole, although many serious objections may be urged, it seems probable that most of the brilliantly coloured species of Lepidoptera owe their colours to sexual selection, excepting in certain cases, presently to be mentioned, in which conspicuous colours have been gained through mimicry as a protection. From the ardour of the male throughout the animal kingdom, he is generally willing to accept any female; and it is the female which usually exerts a choice. Hence, if sexual selection has been efficient with the Lepidoptera, the male, when the sexes differ, ought to be the more brilliantly coloured, and this undoubtedly is the case. When both sexes are brilliantly coloured and resemble each other, the characters acquired by the males appear to have been transmitted to both. We are led to this conclusion by cases, even within the same genus, of gradation from an extraordinary amount of difference to identity in colour between the two sexes.

But it may be asked whether the difference in colour between the sexes may not be accounted for by other means besides sexual selection. Thus the males and females of the same species of butterfly are in several cases known (. H.W. Bates, 'The Naturalist on the Amazons,' vol. ii. , . A.R. Wallace, in 'Transactions, Linnean Society,' vol. xxv. , .) to inhabit different stations, the former commonly basking in the sunshine, the latter haunting gloomy forests. It is therefore possible that different conditions of life may have acted directly on the two sexes; but this is not probable (. On this whole subject see 'The Variation of Animals and Plants under Domestication,' , vol. ii. chaxxiii.) as in the adult state they are exposed to different conditions during a very short period; and the larvae of both are exposed to the same conditions. Mr. Wallace believes that the difference between the sexes is due not so much to the males having been modified, as

to the females having in all or almost all cases acquired dull colours for the sake of protection. It seems to me, on the contrary, far more probable that it is the males which have been chiefly modified through sexual selection, the females having been comparatively little changed. We can thus understand how it is that the females of allied species generally resemble one another so much more closely than do the males. They thus shew us approximately the primordial colouring of the parentspecies of the group to which they belong. They have, however, almost always been somewhat modified by the transfer to them of some of the successive variations, through the accumulation of which the males were rendered beautiful. But I do not wish to deny that the females alone of some species may have been specially modified for protection. In most cases the males and females of distinct species will have been exposed during their prolonged larval state to different conditions, and may have been thus affected; though with the males any slight change of colour thus caused will generally have been masked by the brilliant tints gained through sexual selection. When we treat of Birds, I shall have to discuss the whole question, as to how far the differences in colour between the sexes are due to the males having been modified through sexual selection for ornamental purposes, or to the females having been modified through natural selection for the sake of protection, so that I will here say but little on the subject.

In all the cases in which the more common form of equal inheritance by both sexes has prevailed, the selection of brightcoloured males would tend to make the females brightcoloured; and the selection of dullcoloured females would tend to make the males dull. If both processes were carried on simultaneously, they would tend to counteract each other; and the final result would depend on whether a greater number of females from being well protected by obscure colours, or a greater number of males by being brightlycoloured and thus finding partners, succeeded in leaving more numerous offspring.

In order to account for the frequent transmission of characters to one sex alone, Mr. Wallace expresses his belief that the more common form of equal inheritance by both sexes can be changed through natural selection into inheritance by one sex alone, but in favour of this view I can discover no evidence. We know from what occurs under domestication that new characters often appear, which from the first are transmitted to one sex alone; and by the selection of such variations there would not be the slightest difficulty in giving bright colours to the males alone, and at the same time or subsequently, dull colours to the females alone. In this manner the females of some butterflies and moths have, it is probable, been rendered inconspicuous for the sake of protection, and widely different from their males.

I am, however, unwilling without distinct evidence to admit that two complex processes of selection, each requiring the transference of new characters to one sex alone, have

been carried on with a multitude of species, that the males have been rendered more brilliant by beating their rivals, and the females more dullcoloured by having escaped from their enemies. The male, for instance, of the common brimstone butterfly (*Gonepteryx*), is of a far more intense yellow than the female, though she is equally conspicuous; and it does not seem probable that she specially acquired her pale tints as a protection, though it is probable that the male acquired his bright colours as a sexual attraction. The female of *Anthocharis cardamines* does not possess the beautiful orange wingtips of the male; consequently she closely resembles the white butterflies (*Pieris*) so common in our gardens; but we have no evidence that this resemblance is beneficial to her. As, on the other hand, she resembles both sexes of several other species of the genus inhabiting various quarters of the world, it is probable that she has simply retained to a large extent her primordial colours.

Finally, as we have seen, various considerations lead to the conclusion that with the greater number of brilliantlycoloured Lepidoptera it is the male which has been chiefly modified through sexual selection; the amount of difference between the sexes mostly depending on the form of inheritance which has prevailed. Inheritance is governed by so many unknown laws or conditions, that it seems to us to act in a capricious manner (. The 'Variation of Animals and Plants under Domestication,' vol. ii. chaxii. .); and we can thus, to a certain extent, understand how it is that with closely allied species the sexes either differ to an astonishing degree, or are identical in colour. As all the successive steps in the process of variation are necessarily transmitted through the female, a greater or less number of such steps might readily become developed in her; and thus we can understand the frequent gradations from an extreme difference to none at all between the sexes of allied species. These cases of gradation, it may be added, are much too common to favour the supposition that we here see females actually undergoing the process of transition and losing their brightness for the sake of protection; for we have every reason to conclude that at any one time the greater number of species are in a fixed condition.

MIMICRY.

This principle was first made clear in an admirable paper by Mr. Bates (. 'Transact. Linn. Soc.' vol. xxiii. , .), who thus threw a flood of light on many obscure problems. It had previously been observed that certain butterflies in S. America belonging to quite distinct families, resembled the *Heliconidae* so closely in every stripe and shade of colour, that they could not be distinguished save by an experienced entomologist. As the *Heliconidae* are coloured in their usual manner, whilst the others depart from the usual colouring of the groups to which they belong, it is clear that the latter are the imitators, and the *Heliconidae* the imitated. Mr. Bates further observed that the imitating species are comparatively rare, whilst the imitated abound, and that the two sets live mingled

together. From the fact of the Heliconidae being conspicuous and beautiful insects, yet so numerous in individuals and species, he concluded that they must be protected from the attacks of enemies by some secretion or odour; and this conclusion has now been amply confirmed (. 'Proc. Entomological Soc.' Dec. , , xlv.), especially by Mr. Belt. Hence Mr. Bates inferred that the butterflies which imitate the protected species have acquired their present marvellously deceptive appearance through variation and natural selection, in order to be mistaken for the protected kinds, and thus to escape being devoured. No explanation is here attempted of the brilliant colours of the imitated, but only of the imitating butterflies. We must account for the colours of the former in the same general manner, as in the cases previously discussed in this chapter. Since the publication of Mr. Bates' paper, similar and equally striking facts have been observed by Mr. Wallace in the Malayan region, by Mr. Trimen in South Africa, and by Mr. Riley in the United States. (. Wallace, 'Transact. Linn. Soc.' vol. xxv. i.; also, 'Transact. Ent. Soc.' vol. iv. (rd series), , . Trimen, 'Linn. Transact.' vol. xxvi. , . Riley, 'Third Annual Report on the Noxious Insects of Missouri,' , p. This latter essay is valuable, as Mr. Riley here discusses all the objections which have been raised against Mr. Bates's theory.)

As some writers have felt much difficulty in understanding how the first steps in the process of mimicry could have been effected through natural selection, it may be well to remark that the process probably commenced long ago between forms not widely dissimilar in colour. In this case even a slight variation would be beneficial, if it rendered the one species more like the other; and afterwards the imitated species might be modified to an extreme degree through sexual selection or other means, and if the changes were gradual, the imitators might easily be led along the same track, until they differed to an equally extreme degree from their original condition; and they would thus ultimately assume an appearance or colouring wholly unlike that of the other members of the group to which they belonged. It should also be remembered that many species of Lepidoptera are liable to considerable and abrupt variations in colour. A few instances have been given in this chapter; and many more may be found in the papers of Mr. Bates and Mr. Wallace.

With several species the sexes are alike, and imitate the two sexes of another species. But Mr. Trimen gives, in the paper already referred to, three cases in which the sexes of the imitated form differ from each other in colour, and the sexes of the imitating form differ in a like manner. Several cases have also been recorded where the females alone imitate brilliantly coloured and protected species, the males retaining "the normal aspect of their immediate congeners." It is here obvious that the successive variations by which the female has been modified have been transmitted to her alone. It is, however, probable that some of the many successive variations would have been transmitted to, and developed in, the males had not such males been eliminated by being thus rendered less attractive to the females; so that only those variations were preserved which were

from the first strictly limited in their transmission to the female sex. We have a partial illustration of these remarks in a statement by Mr. Belt (. 'The Naturalist in Nicaragua,' , .); that the males of some of the Leptalides, which imitate protected species, still retain in a concealed manner some of their original characters. Thus in the males "the upper half of the lower wing is of a pure white, whilst all the rest of the wings is barred and spotted with black, red and yellow, like the species they mimic. The females have not this white patch, and the males usually conceal it by covering it with the upper wing, so that I cannot imagine its being of any other use to them than as an attraction in courtship when they exhibit it to the females, and thus gratify their deep-seated preference for the normal colour of the Order to which the Leptalides belong."

BRIGHT COLOURS OF CATERPILLARS.

Whilst reflecting on the beauty of many butterflies, it occurred to me that some caterpillars were splendidly coloured; and as sexual selection could not possibly have here acted, it appeared rash to attribute the beauty of the mature insect to this agency, unless the bright colours of their larvae could be somehow explained. In the first place, it may be observed that the colours of caterpillars do not stand in any close correlation with those of the mature insect. Secondly, their bright colours do not serve in any ordinary manner as a protection. Mr. Bates informs me, as an instance of this, that the most conspicuous caterpillar which he ever beheld (that of a Sphinx) lived on the large green leaves of a tree on the open llanos of South America; it was about four inches in length, transversely banded with black and yellow, and with its head, legs, and tail of a bright red. Hence it caught the eye of any one who passed by, even at the distance of many yards, and no doubt that of every passing bird.

I then applied to Mr. Wallace, who has an innate genius for solving difficulties. After some consideration he replied: "Most caterpillars require protection, as may be inferred from some kinds being furnished with spines or irritating hairs, and from many being coloured green like the leaves on which they feed, or being curiously like the twigs of the trees on which they live." Another instance of protection, furnished me by Mr. J. Mansel Weale, may be added, namely, that there is a caterpillar of a moth which lives on the mimosas in South Africa, and fabricates for itself a case quite indistinguishable from the surrounding thorns. From such considerations Mr. Wallace thought it probable that conspicuously coloured caterpillars were protected by having a nauseous taste; but as their skin is extremely tender, and as their intestines readily protrude from a wound, a slight peck from the beak of a bird would be as fatal to them as if they had been devoured. Hence, as Mr. Wallace remarks, "distastefulness alone would be insufficient to protect a caterpillar unless some outward sign indicated to its would-be destroyer that its prey was a disgusting morsel." Under these circumstances it would be highly advantageous to a caterpillar to be instantaneously and certainly recognised as

unpalatable by all birds and other animals. Thus the most gaudy colours would be serviceable, and might have been gained by variation and the survival of the most easily recognised individuals.

This hypothesis appears at first sight very bold, but when it was brought before the Entomological Society (. 'Proceedings, Entomological Society,' Dec. , , xlv. and March , , lxxx.) it was supported by various statements; and Mr. J. Jenner Weir, who keeps a large number of birds in an aviary, informs me that he has made many trials, and finds no exception to the rule, that all caterpillars of nocturnal and retiring habits with smooth skins, all of a green colour, and all which imitate twigs, are greedily devoured by his birds. The hairy and spinose kinds are invariably rejected, as were four conspicuously coloured species. When the birds rejected a caterpillar, they plainly shewed, by shaking their heads, and cleansing their beaks, that they were disgusted by the taste. (. See Mr. J. Jenner Weir's paper on Insects and Insectivorous Birds, in 'Transact. Ent. Soc.' , ; also Mr. Butler's paper, *ibid.* . Mr. Riley has given analogous facts in the 'Third Annual Report on the Noxious Insects of Missouri,' , . Some opposed cases are, however, given by Dr. Wallace and M. H. d'Orville; see 'Zoological Record,' , .) Three conspicuous kinds of caterpillars and moths were also given to some lizards and frogs, by Mr. A. Butler, and were rejected, though other kinds were eagerly eaten. Thus the probability of Mr. Wallace's view is confirmed, namely, that certain caterpillars have been made conspicuous for their own good, so as to be easily recognised by their enemies, on nearly the same principle that poisons are sold in coloured bottles by druggists for the good of man. We cannot, however, at present thus explain the elegant diversity in the colours of many caterpillars; but any species which had at some former period acquired a dull, mottled, or striped appearance, either in imitation of surrounding objects, or from the direct action of climate, etc., almost certainly would not become uniform in colour, when its tints were rendered intense and bright; for in order to make a caterpillar merely conspicuous, there would be no selection in any definite direction.

SUMMARY AND CONCLUDING REMARKS ON INSECTS.

Looking back to the several Orders, we see that the sexes often differ in various characters, the meaning of which is not in the least understood. The sexes, also, often differ in their organs of sense and means of locomotion, so that the males may quickly discover and reach the females. They differ still oftener in the males possessing diversified contrivances for retaining the females when found. We are, however, here concerned only in a secondary degree with sexual differences of these kinds.

In almost all the Orders, the males of some species, even of weak and delicate kinds, are known to be highly pugnacious; and some few are furnished with special weapons for

hting with their rivals. But the law of battle does not prevail nearly so widely with insects as with the higher animals. Hence it probably arises, that it is in only a few cases that the males have been rendered larger and stronger than the females. On the contrary, they are usually smaller, so that they may be developed within a shorter time, to be ready in large numbers for the emergence of the females.

In two families of the Homoptera and in three of the Orthoptera, the males alone possess soundproducing organs in an efficient state. These are used incessantly during the breedingseason, not only for calling the females, but apparently for charming or exciting them in rivalry with other males. No one who admits the agency of selection of any kind, will, after reading the above discussion, dispute that these musical instruments have been acquired through sexual selection. In four other Orders the members of one sex, or more commonly of both sexes, are provided with organs for producing various sounds, which apparently serve merely as callnotes. When both sexes are thus provided, the individuals which were able to make the loudest or most continuous noise would gain partners before those which were less noisy, so that their organs have probably been gained through sexual selection. It is instructive to reflect on the wonderful diversity of the means for producing sound, possessed by the males alone, or by both sexes, in no less than six Orders. We thus learn how effectual sexual selection has been in leading to modifications which sometimes, as with the Homoptera, relate to important parts of the organisation.

From the reasons assigned in the last chapter, it is probable that the great horns possessed by the males of many Lamellicorn, and some other beetles, have been acquired as ornaments. From the small size of insects, we are apt to undervalue their appearance. If we could imagine a male Chalcosoma, with its polished bronzed coat of mail, and its vast complex horns, magnified to the size of a horse, or even of a dog, it would be one of the most imposing animals in the world.

The colouring of insects is a complex and obscure subject. When the male differs slightly from the female, and neither are brilliantlycoloured, it is probable that the sexes have varied in a slightly different manner, and that the variations have been transmitted by each sex to the same without any benefit or evil thus accruing. When the male is brilliantlycoloured and differs conspicuously from the female, as with some dragonflies and many butterflies, it is probable that he owes his colours to sexual selection; whilst the female has retained a primordial or very ancient type of colouring, slightly modified by the agencies before explained. But in some cases the female has apparently been made obscure by variations transmitted to her alone, as a means of direct protection; and it is almost certain that she has sometimes been made brilliant, so as to imitate other protected species inhabiting the same district. When the sexes resemble each other and both are obscurely coloured, there is no doubt that they have been in a

multitude of cases so coloured for the sake of protection. So it is in some instances when both are brightly coloured, for they thus imitate protected species, or resemble surrounding objects such as flowers; or they give notice to their enemies that they are unpalatable. In other cases in which the sexes resemble each other and are both brilliant, especially when the colours are arranged for display, we may conclude that they have been gained by the male sex as an attraction, and have been transferred to the female. We are more especially led to this conclusion whenever the same type of coloration prevails throughout a whole group and we find that the males of some species differ widely in colour from the females, whilst others differ slightly or not at all with intermediate gradations connecting these extreme states.

In the same manner as bright colours have often been partially transferred from the males to the females, so it has been with the extraordinary horns of many Lamellicorn and some other beetles. So again, the sound-producing organs proper to the males of the Homoptera and Orthoptera have generally been transferred in a rudimentary, or even in a nearly perfect condition, to the females; yet not sufficiently perfect to be of any use. It is also an interesting fact, as bearing on sexual selection, that the stridulating organs of certain male Orthoptera are not fully developed until the last moult; and that the colours of certain male dragonflies are not fully developed until some little time after their emergence from the pupal state, and when they are ready to breed.

Sexual selection implies that the more attractive individuals are preferred by the opposite sex; and as with insects, when the sexes differ, it is the male which, with some rare exceptions, is the more ornamented, and departs more from the type to which the species belongs; and as it is the male which searches eagerly for the female, we must suppose that the females habitually or occasionally prefer the more beautiful males, and that these have thus acquired their beauty. That the females in most or all the Orders would have the power of rejecting any particular male, is probable from the many singular contrivances possessed by the males, such as great jaws, adhesive cushions, spines, elongated legs, etc., for seizing the female; for these contrivances show that there is some difficulty in the act, so that her concurrence would seem necessary. Judging from what we know of the perceptive powers and affections of various insects, there is no antecedent improbability in sexual selection having come largely into play; but we have as yet no direct evidence on this head, and some facts are opposed to the belief. Nevertheless, when we see many males pursuing the same female, we can hardly believe that the pairing is left to blind chance that the female exerts no choice, and is not influenced by the gorgeous colours or other ornaments with which the male is decorated.

If we admit that the females of the Homoptera and Orthoptera appreciate the musical tones of their male partners, and that the various instruments have been perfected

through sexual selection, there is little improbability in the females of other insects appreciating beauty in form or colour, and consequently in such characters having been thus gained by the males. But from the circumstance of colour being so variable, and from its having been so often modified for the sake of protection, it is difficult to decide in how large a proportion of cases sexual selection has played a part. This is more especially difficult in those Orders, such as Orthoptera, Hymenoptera, and Coleoptera, in which the two sexes rarely differ much in colour; for we are then left to mere analogy. With the Coleoptera, however, as before remarked, it is in the great Lamellicorn group placed by some authors at the head of the Order, and in which we sometimes see a mutual attachment between the sexes, that we find the males of some species possessing weapons for sexual strife, others furnished with wonderful horns, many with stridulating organs, and others ornamented with splendid metallic tints. Hence it seems probable that all these characters have been gained through the same means, namely sexual selection. With butterflies we have the best evidence, as the males sometimes take pains to display their beautiful colours; and we cannot believe that they would act thus, unless the display was of use to them in their courtship.

When we treat of Birds, we shall see that they present in their secondary sexual characters the closest analogy with insects. Thus, many male birds are highly pugnacious, and some are furnished with special weapons for fighting with their rivals. They possess organs which are used during the breeding season for producing vocal and instrumental music. They are frequently ornamented with combs, horns, wattles and plumes of the most diversified kinds, and are decorated with beautiful colours, all evidently for the sake of display. We shall find that, as with insects, both sexes in certain groups are equally beautiful, and are equally provided with ornaments which are usually confined to the male sex. In other groups both sexes are equally plain coloured and unornamented. Lastly, in some few anomalous cases, the females are more beautiful than the males. We shall often find, in the same group of birds, every gradation from no difference between the sexes, to an extreme difference. We shall see that female birds, like female insects, often possess more or less plain traces or rudiments of characters which properly belong to the males and are of use only to them. The analogy, indeed, in all these respects between birds and insects is curiously close. Whatever explanation applies to the one class probably applies to the other; and this explanation, as we shall hereafter attempt to shew in further detail, is sexual selection.

CHAPTER XII.

SECONDARY SEXUAL CHARACTERS OF FISHES, AMPHIBIANS, AND REPTILES.

FISHES: Courtship and battles of the males Larger size of the females Males, bright colours and ornamental appendages; other strange characters Colours and appendages acquired by the males during the breedingseason aloneFishes with both sexes brilliantly colouredProtective coloursThe less conspicuous colours of the female cannot be accounted for on the principle of protectionMale fishes building nests, and taking charge of the ova and young.

AMPHIBIANS: Differences in structure and colour between the sexesVocal organs.

REPTILES: CheloniansCrocodilesSnakes, colours in some cases protectiveLizards, battles ofOrnamental appendagesStrange differences in structure between the sexesColoursSexual differences almost as great as with birds.

We have now arrived at the great subkingdom of the Vertebrata, and will commence with the lowest class, that of fishes. The males of Plagiostomous fishes (sharks, rays) and of Chimaeroid fishes are provided with claspers which serve to retain the female, like the various structures possessed by many of the lower animals. Besides the claspers, the males of many rays have clusters of strong sharp spines on their heads, and several rows along "the upper outer surface of their pectoral fins." These are present in the males of some species, which have other parts of their bodies smooth. They are only temporarily developed during the breedingseason; and Dr. Gunther suspects that they are brought into action as prehensile organs by the doubling inwards and downwards of the two sides of the body. It is a remarkable fact that the females and not the males of some species, as of *Raia clavata*, have their backs studded with large hookformed spines. (. Yarrell's 'Hist. of British Fishes,' vol. ii. , pp , , . Dr. Gunther informs me that the spines in *R. clavata* are peculiar to the female.)

The males alone of the capelin (*Mallotus villosus*, one of Salmonidae), are provided with a ridge of closelyset, brushlike scales, by the aid of which two males, one on each side, hold the female, whilst she runs with great swiftness on the sandy beach, and there deposits her spawn. (. The 'American Naturalist,' April , .) The widely distinct *Monacanthus scopas* presents a somewhat analogous structure. The male, as Dr. Gunther informs me, has a cluster of stiff, straight spines, like those of a comb, on the sides of the tail; and these in a specimen six inches long were nearly one and a half inches in length; the female has in the same place a cluster of bristles, which may be compared with those of a toothbrush. In another species, *M. peronii*, the male has a brush like that possessed by the female of the last species, whilst the sides of the tail in the female are smooth. In some other species of the same genus the tail can be perceived

to be a little roughened in the male and perfectly smooth in the female; and lastly in others, both sexes have smooth sides.

The males of many fish fight for the possession of the females. Thus the male stickleback (*Gasterosteus leiurus*) has been described as "mad with delight," when the female comes out of her hidingplace and surveys the nest which he has made for her. "He darts round her in every direction, then to his accumulated materials for the nest, then back again in an instant; and as she does not advance he endeavours to push her with his snout, and then tries to pull her by the tail and sidespine to the nest." (See Mr. R. Warington's interesting articles in 'Annals and Magazine of Natural History,' October , and November .) The males are said to be polygamists (. Noel Humphreys, 'River Gardens,' .); they are extraordinarily bold and pugnacious, whilst "the females are quite pacific." Their battles are at times desperate; "for these puny combatants fasten tight on each other for several seconds, tumbling over and over again until their strength appears completely exhausted." With the rough tailed stickleback (*G. trachurus*) the males whilst fighting swim round and round each other, biting and endeavouring to pierce each other with their raised lateral spines. The same writer adds (. Loudon's 'Magazine of Natural History,' vol. iii. , .), "the bite of these little furies is very severe. They also use their lateral spines with such fatal effect, that I have seen one during a battle absolutely rip his opponent quite open, so that he sank to the bottom and died." When a fish is conquered, "his gallant bearing forsakes him; his gay colours fade away; and he hides his disgrace among his peaceable companions, but is for some time the constant object of his conqueror's persecution."

The male salmon is as pugnacious as the little stickleback; and so is the male trout, as I hear from Dr. Gunther. Mr. Shaw saw a violent contest between two male salmon which lasted the whole day; and Mr. R. Buist, Superintendent of Fisheries, informs me that he has often watched from the bridge at Perth the males driving away their rivals, whilst the females were spawning. The males "are constantly fighting and tearing each other on the spawningbeds, and many so injure each other as to cause the death of numbers, many being seen swimming near the banks of the river in a state of exhaustion, and apparently in a dying state." (. The 'Field,' June , . For Mr. Shaw's Statement, see 'Edinburgh Review,' . Another experienced observer (Scrope's 'Days of Salmon Fishing,') remarks that like the stag, the male would, if he could, keep all other males away.) Mr. Buist informs me, that in June , the keeper of the Stormontfield breedingponds visited the northern Tyne and found about dead salmon, all of which with one exception were males; and he was convinced that they had lost their lives by fighting.

[. . Head of male common salmon (*Salmo salar*) during the breeding season.

[This drawing, as well as all the others in the present chapter, have been

executed by the wellknown artist, Mr. G. Ford, from specimens in the British Museum, under the kind superintendence of Dr. Gunther.]
.. Head of female salmon.]

The most curious point about the male salmon is that during the breeding season, besides a slight change in colour, "the lower jaw elongates, and a cartilaginous projection turns upwards from the point, which, when the jaws are closed, occupies a deep cavity between the intermaxillary bones of the upper jaw." (. Yarrell, 'History of British Fishes,' vol. ii. , .) (s. and .) In our salmon this change of structure lasts only during the breedingseason; but in the *Salmo lycaodon* of N.W. America the change, as Mr. J.K. Lord (. 'The Naturalist in Vancouver's Island,' vol. i. , .) believes, is permanent, and best marked in the older males which have previously ascended the rivers. In these old males the jaw becomes developed into an immense hooklike projection, and the teeth grow into regular fangs, often more than half an inch in length. With the European salmon, according to Mr. Lloyd (. 'Scandinavian Adventures,' vol. i. , .), the temporary hooklike structure serves to strengthen and protect the jaws, when one male charges another with wonderful violence; but the greatly developed teeth of the male American salmon may be compared with the tusks of many male mammals, and they indicate an offensive rather than a protective purpose.

The salmon is not the only fish in which the teeth differ in the two sexes; as this is the case with many rays. In the thornback (*Raia clavata*) the adult male has sharp pointed teeth, directed backwards, whilst those of the female are broad and flat, and form a pavement; so that these teeth differ in the two sexes of the same species more than is usual in distinct genera of the same family. The teeth of the male become sharp only when he is adult: whilst young they are broad and flat like those of the female. As so frequently occurs with secondary sexual characters, both sexes of some species of rays (for instance *R. batis*), when adult, possess sharp pointed teeth; and here a character, proper to and primarily gained by the male, appears to have been transmitted to the offspring of both sexes. The teeth are likewise pointed in both sexes of *R. maculata*, but only when quite adult; the males acquiring them at an earlier age than the females. We shall hereafter meet with analogous cases in certain birds, in which the male acquires the plumage common to both sexes when adult, at a somewhat earlier age than does the female. With other species of rays the males even when old never possess sharp teeth, and consequently the adults of both sexes are provided with broad, flat teeth like those of the young, and like those of the mature females of the abovementioned species. (. See Yarrell's account of the rays in his 'History of British Fishes,' vol. ii. , , with an excellent ure, and .) As the rays are bold, strong and voracious fish, we may suspect that the males require their sharp teeth for hting with their rivals; but as they possess many parts modified and adapted for the prehension of the female, it is possible that their teeth may be used for this purpose.

In regard to size, M. Carbonnier (. As quoted in 'The Farmer,' , .) maintains that the female of almost all fishes is larger than the male; and Dr. Gunther does not know of a single instance in which the male is actually larger than the female. With some Cyprinodonts the male is not even half as large. As in many kinds of fishes the males habitually ht together, it is surprising that they have not generally become larger and stronger than the females through the effects of sexual selection. The males suffer from their small size, for according to M. Carbonnier, they are liable to be devoured by the females of their own species when carnivorous, and no doubt by other species. Increased size must be in some manner of more importance to the females, than strength and size are to the males for hting with other males; and this perhaps is to allow of the production of a vast number of ova.

[. . Callionymus lyra.

Upper ure, male;

lower ure, female.

N.B. The lower ure is more reduced than the upper.]

In many species the male alone is ornamented with bright colours; or these are much brighter in the male than the female. The male, also, is sometimes provided with appendages which appear to be of no more use to him for the ordinary purposes of life, than are the tail feathers to the peacock. I am indebted for most of the following facts to the kindness of Dr. Gunther. There is reason to suspect that many tropical fishes differ sexually in colour and structure; and there are some striking cases with our British fishes. The male *Callionymus lyra* has been called the gemmeous dragonet "from its brilliant gemlike colours." When fresh caught from the sea the body is yellow of various shades, striped and spotted with vivid blue on the head; the dorsal fins are pale brown with dark longitudinal bands; the ventral, caudal, and anal fins being bluishblack. The female, or sordid dragonet, was considered by Linnaeus, and by many subsequent naturalists, as a distinct species; it is of a dingy reddishbrown, with the dorsal fin brown and the other fins white. The sexes differ also in the proportional size of the head and mouth, and in the position of the eyes (. I have drawn up this description from Yarrell's 'British Fishes,' vol. i. , p and .); but the most striking difference is the extraordinary elongation in the male of the dorsal fin. Mr. W. Saville Kent remarks that this "singular appendage appears from my observations of the species in confinement, to be subservient to the same end as the wattles, crests, and other abnormal adjuncts of the male in gallinaceous birds, for the purpose of fascinating their mates." (. 'Nature,' July , .) The young males resemble the adult females in structure and colour. Throughout the genus *Callionymus* (. 'Catalogue of Acanth. Fishes in the British Museum,' by Dr. Gunther, , p .), the male is generally much more brightly spotted than the female, and in several species, not only the dorsal, but the anal fin is much elongated in the males.

The male of the *Cottus scorpius*, or seascorpion, is slenderer and smaller than the female. There is also a great difference in colour between them. It is difficult, as Mr. Lloyd (. 'Game Birds of Sweden,' etc., , .) remarks, "for any one, who has not seen this fish during the spawningseason, when its hues are brightest, to conceive the admixture of brilliant colours with which it, in other respects so illfavoured, is at that time adorned." Both sexes of the *Labrus mixtus*, although very different in colour, are beautiful; the male being orange with bright blue stripes, and the female bright red with some black spots on the back.

[. . *Xiphophorus Hellerii*. Upper ure, male; lower ure, female.]

In the very distinct family of the *Cyprinodontidae* inhabitants of the fresh waters of foreign landsthe sexes sometimes differ much in various characters. In the male of the *Mollienesia petenensis* (. With respect to this and the following species I am indebted to Dr. Gunther for information: see also his paper on the 'Fishes of Central America,' in 'Transact. Zoological Soc.' vol. vi. , .), the dorsal fin is greatly developed and is marked with a row of large, round, ocellated, brightcoloured spots; whilst the same fin in the female is smaller, of a different shape, and marked only with irregularly curved brown spots. In the male the basal margin of the anal fin is also a little produced and dark coloured. In the male of an allied form, the *Xiphophorus Hellerii* , the inferior margin of the caudal fin is developed into a long filament, which, as I hear from Dr. Gunther, is striped with bright colours. This filament does not contain any muscles, and apparently cannot be of any direct use to the fish. As in the case of the *Callionymus*, the males whilst young resemble the adult females in colour and structure. Sexual differences such as these may be strictly compared with those which are so frequent with gallinaceous birds. (. Dr. Gunther makes this remark; 'Catalogue of Fishes in the British Museum,' vol. iii. , .)

[.. *Plecostomus barbatus*. Upper ure, head of male; lower ure, female.]

In a siluroid fish, inhabiting the fresh waters of South America, the *Plecostomus barbatus* (. See Dr. Gunther on this genus, in 'Proceedings of the Zoological Society,' , .) , the male has its mouth and interoperculum fringed with a beard of stiff hairs, of which the female shows hardly a trace. These hairs are of the nature of scales. In another species of the same genus, soft flexible tentacles project from the front part of the head of the male, which are absent in the female. These tentacles are prolongations of the true skin, and therefore are not homologous with the stiff hairs of the former species; but it can hardly be doubted that both serve the same purpose. What this purpose may be, it is difficult to conjecture; ornament does not here seem probable, but we can hardly suppose that stiff hairs and flexible filaments can be useful in any ordinary way to the males alone. In that strange monster, the *Chimaera monstrosa*, the male has a

hookshaped bone on the top of the head, directed forwards, with its end rounded and covered with sharp spines; in the female "this crown is altogether absent," but what its use may be to the male is utterly unknown. (. F. Buckland, in 'Land and Water,' July , , with a ure. Many other cases could be added of structures peculiar to the male, of which the uses are not known.)

The structures as yet referred to are permanent in the male after he has arrived at maturity; but with some Blennies, and in another allied genus (. Dr. Gunther, 'Catalogue of Fishes,' vol. iii. p and .), a crest is developed on the head of the male only during the breedingseason, and the body at the same time becomes more brightlycoloured. There can be little doubt that this crest serves as a temporary sexual ornament, for the female does not exhibit a trace of it. In other species of the same genus both sexes possess a crest, and in at least one species neither sex is thus provided. In many of the Chromidae, for instance in *Geophagus* and especially in *Cichla*, the males, as I hear from Professor Agassiz (. See also 'A Journey in Brazil,' by Prof. and Mrs. Agassiz, , .), have a conspicuous protuberance on the forehead, which is wholly wanting in the females and in the young males. Professor Agassiz adds, "I have often observed these fishes at the time of spawning when the protuberance is largest, and at other seasons when it is totally wanting, and the two sexes shew no difference whatever in the outline of the profile of the head. I never could ascertain that it subserves any special function, and the Indians on the Amazon know nothing about its use." These protuberances resemble, in their periodical appearance, the fleshy carbuncles on the heads of certain birds; but whether they serve as ornaments must remain at present doubtful.

I hear from Professor Agassiz and Dr. Gunther, that the males of those fishes, which differ permanently in colour from the females, often become more brilliant during the breedingseason. This is likewise the case with a multitude of fishes, the sexes of which are identical in colour at all other seasons of the year. The tench, roach, and perch may be given as instances. The male salmon at this season is "marked on the cheeks with orangecoloured stripes, which give it the appearance of a *Labrus*, and the body partakes of a golden orange tinge. The females are dark in colour, and are commonly called blackfish." (. Yarrell, 'History of British Fishes,' vol. ii. , , .) An analogous and even greater change takes place with the *Salmo eriox* or bull trout; the males of the char (*S. umbla*) are likewise at this season rather brighter in colour than the females. (. W. Thompson, in 'Annals and Magazine of Natural History,' vol. vi. , .) The colours of the pike (*Esox reticulatus*) of the United States, especially of the male, become, during the breedingseason, exceedingly intense, brilliant, and iridescent. (. 'The American Agriculturalist,' , .) Another striking instance out of many is afforded by the male stickleback (*Gasterosteus leiurus*), which is described by Mr. Warrington (. 'Annals and Mag. of Nat. Hist.' Oct. .), as being then "beautiful beyond description." The back and eyes of the female are simply brown, and the belly white. The eyes of the male, on the

other hand, are "of the most splendid green, having a metallic lustre like the green feathers of some hummingbirds. The throat and belly are of a bright crimson, the back of an ashygreen, and the whole fish appears as though it were somewhat translucent and glowed with an internal incandescence." After the breeding season these colours all change, the throat and belly become of a paler red, the back more green, and the glowing tints subside.

With respect to the courtship of fishes, other cases have been observed since the first edition of this book appeared, besides that already given of the stickleback. Mr. W.S. Kent says that the male of the *Labrus mixtus*, which, as we have seen, differs in colour from the female, makes "a deep hollow in the sand of the tank, and then endeavours in the most persuasive manner to induce a female of the same species to share it with him, swimming backwards and forwards between her and the completed nest, and plainly exhibiting the greatest anxiety for her to follow." The males of *Cantharus lineatus* become, during the breedingseason, of deep leaden black; they then retire from the shoal, and excavate a hollow as a nest. "Each male now mounts vigilant guard over his respective hollow, and vigorously attacks and drives away any other fish of the same sex. Towards his companions of the opposite sex his conduct is far different; many of the latter are now distended with spawn, and these he endeavours by all the means in his power to lure singly to his prepared hollow, and there to deposit the myriad ova with which they are laden, which he then protects and guards with the greatest care." (. 'Nature,' May , .)

A more striking case of courtshias well as of display, by the males of a Chinese *Macropus* has been given by M. Carbonnier, who carefully observed these fishes under confinement. (. 'Bulletin de la Societé d'Acclimat.' Paris, July , and Jan. .) The males are most beautifully coloured, more so than the females. During the breedingseason they contend for the possession of the females; and, in the act of courtshiexpand their fins, which are spotted and ornamented with brightly coloured rays, in the same manner, according to M. Carbonnier, as the peacock. They then also bound about the females with much vivacity, and appear by "l'étalage de leurs vives couleurs chercher a attirer l'attention des femelles, lesquelles ne paraissaient indifférentes a ce manège, elles nageaient avec une molle lenteur vers les males et semblaient se complaire dans leur voisinage." After the male has won his bride, he makes a little disc of froth by blowing air and mucus out of his mouth. He then collects the fertilised ova, dropped by the female, in his mouth; and this caused M. Carbonnier much alarm, as he thought that they were going to be devoured. But the male soon deposits them in the disc of froth, afterwards guarding them, repairing the froth, and taking care of the young when hatched. I mention these particulars because, as we shall presently see, there are fishes, the males of which hatch their eggs in their mouths; and those who do not believe in the principle of gradual evolution might ask how could such a habit have originated; but the

difficulty is much diminished when we know that there are fishes which thus collect and carry the eggs; for if delayed by any cause in depositing them, the habit of hatching them in their mouths might have been acquired.

To return to our more immediate subject. The case stands thus: female fishes, as far as I can learn, never willingly spawn except in the presence of the males; and the males never fertilise the ova except in the presence of the females. The males fight for the possession of the females. In many species, the males whilst young resemble the females in colour; but when adult become much more brilliant, and retain their colours throughout life. In other species the males become brighter than the females and otherwise more highly ornamented, only during the season of love. The males sedulously court the females, and in one case, as we have seen, take pains in displaying their beauty before them. Can it be believed that they would thus act to no purpose during their courtship? And this would be the case, unless the females exert some choice and select those males which please or excite them most. If the female exerts such choice, all the above facts on the ornamentation of the males become at once intelligible by the aid of sexual selection.

We have next to inquire whether this view of the bright colours of certain male fishes having been acquired through sexual selection can, through the law of the equal transmission of characters to both sexes, be extended to those groups in which the males and females are brilliant in the same, or nearly the same degree and manner. In such a genus as *Labrus*, which includes some of the most splendid fishes in the world for instance, the Peacock *Labrus* (*L. pavo*), described (Bory Saint Vincent, in 'Dict. Class. d'Hist. Nat.' tom. ix. , .), with pardonable exaggeration, as formed of polished scales of gold, encrusting lapislazuli, rubies, sapphires, emeralds, and amethysts we may, with much probability, accept this belief; for we have seen that the sexes in at least one species of the genus differ greatly in colour. With some fishes, as with many of the lowest animals, splendid colours may be the direct result of the nature of their tissues and of the surrounding conditions, without the aid of selection of any kind. The goldfish (*Cyprinus auratus*), judging from the analogy of the golden variety of the common caris perhaps a case in point, as it may owe its splendid colours to a single abrupt variation, due to the conditions to which this fish has been subjected under confinement. It is, however, more probable that these colours have been intensified through artificial selection, as this species has been carefully bred in China from a remote period. (Owing to some remarks on this subject, made in my work 'On the Variation of Animals under Domestication,' Mr. W.F. Mayers ('Chinese Notes and Queries,' Aug. ,) has searched the ancient Chinese encyclopedias. He finds that goldfish were first reared in confinement during the Sung Dynasty, which commenced A.D. . In the year these fishes abounded. In another place it is said that since the year there has been "produced at Hangchow a variety called the firefish, from its intensely red colour. It is universally admired, and

there is not a household where it is not cultivated, IN RIVALRY AS TO ITS COLOUR, and as a source of profit.") Under natural conditions it does not seem probable that beings so highly organised as fishes, and which live under such complex relations, should become brilliantly coloured without suffering some evil or receiving some benefit from so great a change, and consequently without the intervention of natural selection.

What, then, are we to conclude in regard to the many fishes, both sexes of which are splendidly coloured? Mr. Wallace (. 'Westminster Review,' July , .) believes that the species which frequent reefs, where corals and other brightly coloured organisms abound, are brightly coloured in order to escape detection by their enemies; but according to my recollection they were thus rendered highly conspicuous. In the fresh waters of the tropics there are no brilliantly coloured corals or other organisms for the fishes to resemble; yet many species in the Amazons are beautifully coloured, and many of the carnivorous Cyprinidae in India are ornamented with "bright longitudinal lines of various tints." (. 'Indian Cyprinidae,' by Mr. M'Clelland, 'Asiatic Researches,' vol. xix. part ii. , .) Mr. M'Clelland, in describing these fishes, goes so far as to suppose that "the peculiar brilliancy of their colours" serves as "a better mark for kingfishers, terns, and other birds which are destined to keep the number of these fishes in check"; but at the present day few naturalists will admit that any animal has been made conspicuous as an aid to its own destruction. It is possible that certain fishes may have been rendered conspicuous in order to warn birds and beasts of prey that they were unpalatable, as explained when treating of caterpillars; but it is not, I believe, known that any fish, at least any freshwater fish, is rejected from being distasteful to fishdevouring animals. On the whole, the most probable view in regard to the fishes, of which both sexes are brilliantly coloured, is that their colours were acquired by the males as a sexual ornament, and were transferred equally, or nearly so, to the other sex.

We have now to consider whether, when the male differs in a marked manner from the female in colour or in other ornaments, he alone has been modified, the variations being inherited by his male offspring alone; or whether the female has been specially modified and rendered inconspicuous for the sake of protection, such modifications being inherited only by the females. It is impossible to doubt that colour has been gained by many fishes as a protection: no one can examine the speckled upper surface of a flounder, and overlook its resemblance to the sandy bed of the sea on which it lives. Certain fishes, moreover, can through the action of the nervous system change their colours in adaptation to surrounding objects, and that within a short time. (. G. Pouchet, 'L'Institut.' Nov. , , .) One of the most striking instances ever recorded of an animal being protected by its colour (as far as it can be judged of in preserved specimens), as well as by its form, is that given by Dr. Gunther (. 'Proc. Zoolog. Soc.' , , pl. xiv. and xv.) of a pipefish, which, with its reddish streaming filaments, is hardly distinguishable from the seaweed to which it clings with its prehensile tail. But the question now under

consideration is whether the females alone have been modified for this object. We can see that one sex will not be modified through natural selection for the sake of protection more than the other, supposing both to vary, unless one sex is exposed for a longer period to danger, or has less power of escaping from such danger than the other; and it does not appear that with fishes the sexes differ in these respects. As far as there is any difference, the males, from being generally smaller and from wandering more about, are exposed to greater danger than the females; and yet, when the sexes differ, the males are almost always the more conspicuously coloured. The ova are fertilised immediately after being deposited; and when this process lasts for several days, as in the case of the salmon (. Yarrell, 'British Fishes,' vol. ii. .), the female, during the whole time, is attended by the male. After the ova are fertilised they are, in most cases, left unprotected by both parents, so that the males and females, as far as oviposition is concerned, are equally exposed to danger, and both are equally important for the production of fertile ova; consequently the more or less brightly coloured individuals of either sex would be equally liable to be destroyed or preserved, and both would have an equal influence on the colours of their offspring.

Certain fishes, belonging to several families, make nests, and some of them take care of their young when hatched. Both sexes of the bright coloured *Crenilabrus massa* and *melops* work together in building their nests with seaweed, shells, etc. (. According to the observations of M. Gerbe; see Gunther's 'Record of Zoolog. Literature,' , .) But the males of certain fishes do all the work, and afterwards take exclusive charge of the young. This is the case with the dull coloured gobies (. Cuvier, 'Regne Animal,' vol. ii. , .), in which the sexes are not known to differ in colour, and likewise with the sticklebacks (*Gasterosteus*), in which the males become brilliantly coloured during the spawning season. The male of the smooth tailed stickleback (*G. leiurus*) performs the duties of a nurse with exemplary care and vigilance during a long time, and is continually employed in gently leading back the young to the nest, when they stray too far. He courageously drives away all enemies including the females of his own species. It would indeed be no small relief to the male, if the female, after depositing her eggs, were immediately devoured by some enemy, for he is forced incessantly to drive her from the nest. (. See Mr. Warrington's most interesting description of the habits of the *Gasterosteus leiurus* in 'Annals and Magazine of Nat. History,' November .)

The males of certain other fishes inhabiting South America and Ceylon, belonging to two distinct Orders, have the extraordinary habit of hatching within their mouths, or branchial cavities, the eggs laid by the females. (. Prof. Wyman, in 'Proc. Boston Soc. of Nat. Hist.' Sept. , . Also Prof. Turner, in 'Journal of Anatomy and Physiology,' Nov. , , . Dr. Gunther has likewise described other cases.) I am informed by Professor Agassiz that the males of the Amazonian species which follow this habit, "not only are generally brighter than the females, but the difference is greater at the spawning season than at

any other time." The species of *Geophagus* act in the same manner; and in this genus, a conspicuous protuberance becomes developed on the forehead of the males during the breeding season. With the various species of Chromids, as Professor Agassiz likewise informs me, sexual differences in colour may be observed, "whether they lay their eggs in the water among aquatic plants, or deposit them in holes, leaving them to come out without further care, or build shallow nests in the river mud, over which they sit, as our *Pomotis* does. It ought also to be observed that these sitters are among the brightest species in their respective families; for instance, *Hydrogonus* is bright green, with large black ocelli, encircled with the most brilliant red." Whether with all the species of Chromids it is the male alone which sits on the eggs is not known. It is, however, manifest that the fact of the eggs being protected or unprotected by the parents, has had little or no influence on the differences in colour between the sexes. It is further manifest, in all the cases in which the males take exclusive charge of the nests and young, that the destruction of the brighter coloured males would be far more influential on the character of the race, than the destruction of the brighter coloured females; for the death of the male during the period of incubation or nursing would entail the death of the young, so that they could not inherit his peculiarities; yet, in many of these very cases the males are more conspicuously coloured than the females.

In most of the Lophobranchii (Pipefish, Hippocampi, etc.) the males have either marsupial sacks or hemispherical depressions on the abdomen, in which the ova laid by the female are hatched. The males also shew great attachment to their young. (. Yarrell, 'History of British Fishes,' vol. ii. , .) The sexes do not commonly differ much in colour; but Dr. Gunther believes that the male Hippocampi are rather brighter than the females. The genus *Solenostoma*, however, offers a curious exceptional case (. Dr. Gunther, since publishing an account of this species in 'The Fishes of Zanzibar,' by Col. Playfair, , , has reexamined the specimens, and has given me the above information.), for the female is much more vividly coloured and spotted than the male, and she alone has a marsupial sack and hatches the eggs; so that the female of *Solenostoma* differs from all the other Lophobranchii in this latter respect, and from almost all other fishes, in being more brightly coloured than the male. It is improbable that this remarkable double inversion of character in the female should be an accidental coincidence. As the males of several fishes, which take exclusive charge of the eggs and young, are more brightly coloured than the females, and as here the female *Solenostoma* takes the same charge and is brighter than the male, it might be argued that the conspicuous colours of that sex which is the more important of the two for the welfare of the offspring, must be in some manner protective. But from the large number of fishes, of which the males are either permanently or periodically brighter than the females, but whose life is not at all more important for the welfare of the species than that of the female, this view can hardly be maintained. When we treat of birds we shall meet with analogous cases, where there has been a complete inversion of the usual attributes of the two sexes, and we shall then give

what appears to be the probable explanation, namely, that the males have selected the more attractive females, instead of the latter having selected, in accordance with the usual rule throughout the animal kingdom, the more attractive males.

On the whole we may conclude, that with most fishes, in which the sexes differ in colour or in other ornamental characters, the males originally varied, with their variations transmitted to the same sex, and accumulated through sexual selection by attracting or exciting the females. In many cases, however, such characters have been transferred, either partially or completely, to the females. In other cases, again, both sexes have been coloured alike for the sake of protection; but in no instance does it appear that the female alone has had her colours or other characters specially modified for this latter purpose.

The last point which need be noticed is that fishes are known to make various noises, some of which are described as being musical. Dr. Dufosse, who has especially attended to this subject, says that the sounds are voluntarily produced in several ways by different fishes: by the friction of the pharyngeal bones by the vibration of certain muscles attached to the swim bladder, which serves as a resounding board and by the vibration of the intrinsic muscles of the swim bladder. By this latter means the Trigla produces pure and long drawn sounds which range over nearly an octave. But the most interesting case for us is that of two species of Ophidium, in which the males alone are provided with a sound producing apparatus, consisting of small movable bones, with proper muscles, in connection with the swim bladder. (. 'Comptes Rendus,' tom. xlvi. , ; tom. xlvii. , ; tom. liv. , . The noise made by the Umbrinas (*Sciaena aquila*), is said by some authors to be more like that of a flute or organ, than drumming: Dr. Zouteveen, in the Dutch translation of this work (vol. ii.), gives some further particulars on the sounds made by fishes.) The drumming of the Umbrinas in the European seas is said to be audible from a depth of twenty fathoms; and the fishermen of Rochelle assert "that the males alone make the noise during the spawning time; and that it is possible by imitating it, to take them without bait." (. The Rev. C. Kingsley, in 'Nature,' May , .) From this statement, and more especially from the case of Ophidium, it is almost certain that in this, the lowest class of the Vertebrata, as with so many insects and spiders, sound producing instruments have, at least in some cases, been developed through sexual selection, as a means for bringing the sexes together.

AMPHIBIANS.

URODELA.

[. . Triton cristatus (half natural size, from Bell's 'British Reptiles').

Upper ure, male during the breeding season;
lower ure, female.]

I will begin with the tailed amphibians. The sexes of salamanders or newts often differ much both in colour and structure. In some species prehensile claws are developed on the forelegs of the males during the breeding season: and at this season in the male Triton palmipes the hindfeet are provided with a swimmingweb, which is almost completely absorbed during the winter; so that their feet then resemble those of the female. (. Bell, 'History of British Reptiles,' nd ed., , p.) This structure no doubt aids the male in his eager search and pursuit of the female. Whilst courting her he rapidly vibrates the end of his tail. With our common newts (Triton punctatus and cristatus) a deemuch indented crest is developed along the back and tail of the male during the breeding season, which disappears during the winter. Mr. St. George Mivart informs me that it is not furnished with muscles, and therefore cannot be used for locomotion. As during the season of courtship it becomes edged with bright colours, there can hardly be a doubt that it is a masculine ornament. In many species the body presents strongly contrasted, though lurid tints, and these become more vivid during the breedingseason. The male, for instance, of our common little newt (Triton punctatus) is "brownishgrey above, passing into yellow beneath, which in the spring becomes a rich bright orange, marked everywhere with round dark spots." The edge of the crest also is then tipped with bright red or violet. The female is usually of a yellowishbrown colour with scattered brown dots, and the lower surface is often quite plain. (. Bell, 'History of British Reptiles,' nd ed., , .) The young are obscurely tinted. The ova are fertilised during the act of deposition, and are not subsequently tended by either parent. We may therefore conclude that the males have acquired their stronglymarked colours and ornamental appendages through sexual selection; these being transmitted either to the male offspring alone, or to both sexes.

ANURA OR BATRACHIA.

With many frogs and toads the colours evidently serve as a protection, such as the bright green tints of tree frogs and the obscure mottled shades of many terrestrial species. The most conspicuouslycoloured toad which I ever saw, the Phryniscus nigricans (. 'Zoology of the Voyage of the "Beagle,'" . Bell, ibid. .), had the whole upper surface of the body as black as ink, with the soles of the feet and parts of the abdomen spotted with the brightest vermilion. It crawled about the bare sandy or open grassy plains of La Plata under a scorching sun, and could not fail to catch the eye of every passing creature. These colours are probably beneficial by making this animal known to all birds of prey as a nauseous mouthful.

In Nicaragua there is a little frog "dressed in a bright livery of red and blue" which does not conceal itself like most other species, but hops about during the daytime, and Mr. Belt says (. 'The Naturalist in Nicaragua,' , .) that as soon as he saw its happy sense of security, he felt sure that it was uneatable. After several trials he succeeded in tempting a young duck to snatch up a young one, but it was instantly rejected; and the duck "went about jerking its head, as if trying to throw off some unpleasant taste."

With respect to sexual differences of colour, Dr. Gunther does not know of any striking instance either with frogs or toads; yet he can often distinguish the male from the female by the tints of the former being a little more intense. Nor does he know of any striking difference in external structure between the sexes, excepting the prominences which become developed during the breedingseason on the front legs of the male, by which he is enabled to hold the female. (. The male alone of the *Bufo sikimmensis* (Dr. Anderson, 'Proc. Zoolog. Soc.' , .) has two platelike callosities on the thorax and certain rugosities on the fingers, which perhaps subserve the same end as the abovementioned prominences.) It is surprising that these animals have not acquired more stronglymarked sexual characters; for though coldblooded their passions are strong. Dr. Gunther informs me that he has several times found an unfortunate female toad dead and smothered from having been so closely embraced by three or four males. Frogs have been observed by Professor Hoffman in Giessen hting all day long during the breedingseason, and with so much violence that one had its body ripped open.

Frogs and toads offer one interesting sexual difference, namely, in the musical powers possessed by the males; but to speak of music, when applied to the discordant and overwhelming sounds emitted by male bullfrogs and some other species, seems, according to our taste, a singularly inappropriate expression. Nevertheless, certain frogs sing in a decidedly pleasing manner. Near Rio Janeiro I used often to sit in the evening to listen to a number of little *Hylae*, perched on blades of grass close to the water, which sent forth sweet chirping notes in harmony. The various sounds are emitted chiefly by the males during the breedingseason, as in the case of the croaking of our common frog. (. Bell, 'History British Reptiles,' , .) In accordance with this fact the vocal organs of the males are more highlydeveloped than those of the females. In some genera the males alone are provided with sacs which open into the larynx. (. J. Bishoin 'Todd's Cyclopaedia of Anatomy and Physiology,' vol. iv. .) For instance, in the edible frog (*Rana esculenta*) "the sacs are peculiar to the males, and become, when filled with air in the act of croaking, large globular bladders, standing out one on each side of the head, near the corners of the mouth." The croak of the male is thus rendered exceedingly powerful; whilst that of the female is only a slight groaning noise. (. Bell, *ibid.* p.) In the several genera of the family the vocal organs differ considerably in structure, and their development in all cases may be attributed to sexual selection.

REPTILES.

CHELONIA.

Tortoises and turtles do not offer wellmarked sexual differences. In some species, the tail of the male is longer than that of the female. In some, the plastron or lower surface of the shell of the male is slightly concave in relation to the back of the female. The male of the mudturtle of the United States (*Chrysemys picta*) has claws on its front feet twice as long as those of the female; and these are used when the sexes unite. (. Mr. C.J. Maynard, 'The American Naturalist,' Dec. , .) With the huge tortoise of the Galapagos Islands (*Testudo nigra*) the males are said to grow to a larger size than the females: during the pairingseason, and at no other time, the male utters a hoarse bellowing noise, which can be heard at the distance of more than a hundred yards; the female, on the other hand, never uses her voice. (. See my 'Journal of Researches during the Voyage of the "Beagle,"' , .)

With the *Testudo elegans* of India, it is said "that the combats of the males may be heard at some distance, from the noise they produce in butting against each other." (. Dr. Gunther, 'Reptiles of British India,' , .)

CROCODILIA.

The sexes apparently do not differ in colour; nor do I know that the males ht together, though this is probable, for some kinds make a prodigious display before the females. Bartram (. 'Travels through Carolina,' etc., , .) describes the male alligator as striving to win the female by splashing and roaring in the midst of a lagoon, "swollen to an extent ready to burst, with its head and tail lifted uhe springs or twirls round on the surface of the water, like an Indian chief rehearsing his feats of war." During the season of love, a musky odour is emitted by the submaxillary glands of the crocodile, and pervades their haunts. (. Owen, 'Anatomy of Vertebrates,' vol. i. , .)

OPHIDIA.

Dr. Gunther informs me that the males are always smaller than the females, and generally have longer and slenderer tails; but he knows of no other difference in external structure. In regard to colour, he can almost always distinguish the male from the female, by his more strongly pronounced tints; thus the black zigzag band on the back of the male English viper is more distinctly defined than in the female. The difference is much plainer in the rattlesnakes of N. America, the male of which, as the keeper in the Zoological Gardens shewed me, can at once be distinguished from the female by having

more lurid yellow about its whole body. In S. Africa the *Bucephalus capensis* presents an analogous difference, for the female "is never so fully variegated with yellow on the sides as the male." (. Sir Andrew Smith, 'Zoology of S. Africa: Reptilia,' , pl. x.) The male of the Indian *Dipsas cynodon*, on the other hand, is blackishbrown, with the belly partly black, whilst the female is reddish or yellowisholive, with the belly either uniform yellowish or marbled with black. In the *Tragops dispar* of the same country the male is bright green, and the female bronzedcoloured. (. Dr. A. Gunther, 'Reptiles of British India,' Ray Soc., , .) No doubt the colours of some snakes are protective, as shewn by the green tints of treesnakes, and the various mottled shades of the species which live in sandy places; but it is doubtful whether the colours of many kinds, for instance of the common English snake and viper, serve to conceal them; and this is still more doubtful with the many foreign species which are coloured with extreme elegance. The colours of certain species are very different in the adult and young states. (. Dr. Stoliczka, 'Journal of Asiatic Society of Bengal,' vol. xxxix, , .)

During the breedingseason the anal scentglands of snakes are in active function (. Owen, 'Anatomy of Vertebrates,' vol. i. , .); and so it is with the same glands in lizards, and as we have seen with the submaxillary glands of crocodiles. As the males of most animals search for the females, these odoriferous glands probably serve to excite or charm the female, rather than to guide her to the spot where the male may be found. Male snakes, though appearing so sluggish, are amorous; for many have been observed crowding round the same female, and even round her dead body. They are not known to ht together from rivalry. Their intellectual powers are higher than might have been anticipated. In the Zoological Gardens they soon learn not to strike at the iron bar with which their cages are cleaned; and Dr. Keen of Philadelphia informs me that some snakes which he kept learned after four or five times to avoid a noose, with which they were at first easily caught. An excellent observer in Ceylon, Mr. E. Layard, saw (. 'Rambles in Ceylon,' in 'Annals and Magazine of Natural History,' nd series, vol. ix. , .) a cobra thrust its head through a narrow hole and swallow a toad. "With this encumbrance he could not withdraw himself; finding this, he reluctantly disgorged the precious morsel, which began to move off; this was too much for snake philosophy to bear, and the toad was again seized, and again was the snake, after violent efforts to escape, compelled to part with its prey. This time, however, a lesson had been learnt, and the toad was seized by one leg, withdrawn, and then swallowed in triumph."

The keeper in the Zoological Gardens is positive that certain snakes, for instance *Crotalus* and *Python*, distinguish him from all other persons. Cobras kept together in the same cage apparently feel some attachment towards each other. (. Dr. Gunther, 'Reptiles of British India,' , .)

It does not, however, follow because snakes have some reasoning power, strong passions and mutual affection, that they should likewise be endowed with sufficient taste to admire brilliant colours in their partners, so as to lead to the adornment of the species through sexual selection. Nevertheless, it is difficult to account in any other manner for the extreme beauty of certain species; for instance, of the coral snakes of S. America, which are of a rich red with black and yellow transverse bands. I well remember how much surprise I felt at the beauty of the first coral snake which I saw gliding across a path in Brazil. Snakes coloured in this peculiar manner, as Mr. Wallace states on the authority of Dr. Gunther (. 'Westminster Review,' July st, , .), are found nowhere else in the world except in S. America, and here no less than four genera occur. One of these, Elaps, is venomous; a second and widely distinct genus is doubtfully venomous, and the two others are quite harmless. The species belonging to these distinct genera inhabit the same districts, and are so like each other that no one "but a naturalist would distinguish the harmless from the poisonous kinds." Hence, as Mr. Wallace believes, the innocuous kinds have probably acquired their colours as a protection, on the principle of imitation; for they would naturally be thought dangerous by their enemies. The cause, however, of the bright colours of the venomous Elaps remains to be explained, and this may perhaps be sexual selection.

Snakes produce other sounds besides hissing. The deadly *Echis carinata* has on its sides some oblique rows of scales of a peculiar structure with serrated edges; and when this snake is excited these scales are rubbed against each other, which produces "a curious prolonged, almost hissing sound." (. Dr. Anderson, 'Proc. Zoolog. Soc.' , .) With respect to the rattling of the rattlesnake, we have at last some definite information: for Professor Aughey states (. The 'American Naturalist,' , .), that on two occasions, being himself unseen, he watched from a little distance a rattlesnake coiled up with head erect, which continued to rattle at short intervals for half an hour: and at last he saw another snake approach, and when they met they paired. Hence he is satisfied that one of the uses of the rattle is to bring the sexes together. Unfortunately he did not ascertain whether it was the male or the female which remained stationary and called for the other. But it by no means follows from the above fact that the rattle may not be of use to these snakes in other ways, as a warning to animals which would otherwise attack them. Nor can I quite disbelieve the several accounts which have appeared of their thus paralysing their prey with fear. Some other snakes also make a distinct noise by rapidly vibrating their tails against the surrounding stalks of plants; and I have myself heard this in the case of a *Trigonocephalus* in S. America.

LACERTILIA.

The males of some, probably of many kinds of lizards, fight together from rivalry. Thus the arboreal *Anolis cristatellus* of S. America is extremely pugnacious: "During the spring

and early part of the summer, two adult males rarely meet without a contest. On first seeing one another, they nod their heads up and down three or four times, and at the same time expanding the frill or pouch beneath the throat; their eyes glisten with rage, and after waving their tails from side to side for a few seconds, as if to gather energy, they dart at each other furiously, rolling over and over, and holding firmly with their teeth. The conflict generally ends in one of the combatants losing his tail, which is often devoured by the victor." The male of this species is considerably larger than the female (. Mr. N.L. Austen kept these animals alive for a considerable time; see 'Land and Water,' July , .); and this, as far as Dr. Gunther has been able to ascertain, is the general rule with lizards of all kinds. The male alone of the *Cyrtodactylus rubidus* of the Andaman Islands possesses preanal pores; and these pores, judging from analogy, probably serve to emit an odour. (. Stoliczka, 'Journal of the Asiatic Society of Bengal,' vol. xxxiv. , .)

[.. *Sitana minor*.

Male with the gular pouch expanded (from Gunther's 'Reptiles of India')]

The sexes often differ greatly in various external characters. The male of the abovementioned *Anolis* is furnished with a crest which runs along the back and tail, and can be erected at pleasure; but of this crest the female does not exhibit a trace. In the Indian *Cophotis ceylanica*, the female has a dorsal crest, though much less developed than in the male; and so it is, as Dr. Gunther informs me, with the females of many Iguanas, Chameleons, and other lizards. In some species, however, the crest is equally developed in both sexes, as in the *Iguana tuberculata*. In the genus *Sitana*, the males alone are furnished with a large throat pouch, which can be folded up like a fan, and is coloured blue, black, and red; but these splendid colours are exhibited only during the pairingseason. The female does not possess even a rudiment of this appendage. In the *Anolis cristatellus*, according to Mr. Austen, the throat pouch, which is bright red marbled with yellow, is present in the female, though in a rudimental condition. Again, in certain other lizards, both sexes are equally well provided with throat pouches. Here we see with species belonging to the same groups in so many previous cases, the same character either confined to the males, or more largely developed in them than in the females, or again equally developed in both sexes. The little lizards of the genus *Draco*, which glide through the air on their rib supported parachutes, and which in the beauty of their colours baffle description, are furnished with skinny appendages to the throat "like the wattles of gallinaceous birds." These become erected when the animal is excited. They occur in both sexes, but are best developed when the male arrives at maturity, at which age the middle appendage is sometimes twice as long as the head. Most of the species likewise have a low crest running along the neck; and this is much more developed in the fullgrown males than in the females or young males. (. All the foregoing statements and quotations, in regard to *Cophotis*, *Sitana* and *Draco*, as well as the following facts in regard to *Ceratophora* and *Chamaeleon*, are from Dr. Gunther himself, or from his magnificent work on the 'Reptiles of British India,' Ray Soc., , , .)

A Chinese species is said to live in pairs during the spring; "and if one is caught, the other falls from the tree to the ground, and allows itself to be captured with impunity" I presume from despair. (. Mr. Swinhoe, 'Proc. Zoolog. Soc.' , .)

[. . Ceratophora Stoddartii. Upper ure; lower ure, female.]

There are other and much more remarkable differences between the sexes of certain lizards. The male of *Ceratophora aspera* bears on the extremity of his snout an appendage half as long as the head. It is cylindrical, covered with scales, flexible, and apparently capable of erection: in the female it is quite rudimental. In a second species of the same genus a terminal scale forms a minute horn on the summit of the flexible appendage; and in a third species (*C. Stoddartii*, .) the whole appendage is converted into a horn, which is usually of a white colour, but assumes a purplish tint when the animal is excited. In the adult male of this latter species the horn is half an inch in length, but it is of quite minute size in the female and in the young. These appendages, as Dr. Gunther has remarked to me, may be compared with the combs of gallinaceous birds, and apparently serve as ornaments.

[. . *Chamaeleo bifurcus*. Upper ure, male; lower ure, female.]

[. . *Chamaeleo Owenii*. Upper ure, male; lower ure, female.]

In the genus *Chamaeleon* we come to the acme of difference between the sexes. The upper part of the skull of the male *C. bifurcus*, an inhabitant of Madagascar, is produced into two great, solid, bony projections, covered with scales like the rest of the head; and of this wonderful modification of structure the female exhibits only a rudiment. Again, in *Chamaeleo Owenii*, from the West Coast of Africa, the male bears on his snout and forehead three curious horns, of which the female has not a trace. These horns consist of an excrescence of bone covered with a smooth sheath, forming part of the general integuments of the body, so that they are identical in structure with those of a bull, goat, or other sheathhorned ruminant. Although the three horns differ so much in appearance from the two great prolongations of the skull in *C. bifurcus*, we can hardly doubt that they serve the same general purpose in the economy of these two animals. The first conjecture, which will occur to every one, is that they are used by the males for hting together; and as these animals are very quarrelsome (. Dr. Buchholz, 'Monatsbericht K. Preuss. Akad.' Jan. , .), this is probably a correct view. Mr. T.W. Wood also informs me that he once watched two individuals of *C. pumilus* hting violently on the branch of a tree; they flung their heads about and tried to bite each other; they then rested for a time and afterwards continued their battle.

With many lizards the sexes differ slightly in colour, the tints and stripes of the males being brighter and more distinctly defined than in the females. This, for instance, is the case with the above *Cophotis* and with the *Acanthodactylus capensis* of S. Africa. In a *Cordylus* of the latter country, the male is either much redder or greener than the female. In the Indian *Calotes nigrilabris* there is a still greater difference; the lips also of the male are black, whilst those of the female are green. In our common little viviparous lizard (*Zootoca vivipara*) "the under side of the body and base of the tail in the male are bright orange, spotted with black; in the female these parts are pale greyish green without spots." (. Bell, 'History of British Reptiles,' 2nd ed., , .) We have seen that the males alone of *Sitana* possess a throatpouch; and this is splendidly tinted with blue, black, and red. In the *Proctotretus tenuis* of Chile the male alone is marked with spots of blue, green, and coppery red. (. For *Proctotretus*, see 'Zoology of the Voyage of the "Beagle"; Reptiles,' by Mr. Bell, . For the Lizards of S. Africa, see 'Zoology of S. Africa: Reptiles,' by Sir Andrew Smith, pl. and . For the Indian *Calotes*, see 'Reptiles of British India,' by Dr. Gunther, .) In many cases the males retain the same colours throughout the year, but in others they become much brighter during the breeding season; I may give as an additional instance the *Calotes maria*, which at this season has a bright red head, the rest of the body being green. (. Gunther in 'Proceedings, Zoological Society,' , , with a coloured ure.)

Both sexes of many species are beautifully coloured exactly alike; and there is no reason to suppose that such colours are protective. No doubt with the bright green kinds which live in the midst of vegetation, this colour serves to conceal them; and in N. Patagonia I saw a lizard (*Proctotretus multimaculatus*) which, when frightened, flattened its body, closed its eyes, and then from its mottled tints was hardly distinguishable from the surrounding sand. But the bright colours with which so many lizards are ornamented, as well as their various curious appendages, were probably acquired by the males as an attraction, and then transmitted either to their male offspring alone, or to both sexes. Sexual selection, indeed, seems to have played almost as important a part with reptiles as with birds; and the less conspicuous colours of the females in comparison with the males cannot be accounted for, as Mr. Wallace believes to be the case with birds, by the greater exposure of the females to danger during incubation.

CHAPTER XIII.

SECONDARY SEXUAL CHARACTERS OF BIRDS.

Sexual differences Law of battle Special weapons Vocal organs Instrumental music Love antics and dances Decorations, permanent and seasonal Double and single annual moults Display of ornaments by the males.

Secondary sexual characters are more diversified and conspicuous in birds, though not perhaps entailing more important changes of structure, than in any other class of animals. I shall, therefore, treat the subject at considerable length. Male birds sometimes, though rarely, possess special weapons for fighting with each other. They charm the female by vocal or instrumental music of the most varied kinds. They are ornamented by all sorts of combs, wattles, protuberances, horns, air-distended sacks, top knots, naked shafts, plumes and lengthened feathers gracefully springing from all parts of the body. The beak and naked skin about the head, and the feathers, are often gorgeously coloured. The males sometimes pay their court by dancing, or by fantastic antics performed either on the ground or in the air. In one instance, at least, the male emits a musky odour, which we may suppose serves to charm or excite the female; for that excellent observer, Mr. Ramsay (. 'Ibis,' vol. iii. (new series), , .), says of the Australian muskduck (*Biziura lobata*) that "the smell which the male emits during the summer months is confined to that sex, and in some individuals is retained throughout the year; I have never, even in the breeding season, shot a female which had any smell of musk." So powerful is this odour during the pairing season, that it can be detected long before the bird can be seen. (. Gould, 'Handbook of the Birds of Australia,' , vol. ii. .) On the whole, birds appear to be the most aesthetic of all animals, excepting of course man, and they have nearly the same taste for the beautiful as we have. This is shewn by our enjoyment of the singing of birds, and by our women, both civilised and savage, decking their heads with borrowed plumes, and using gems which are hardly more brilliantly coloured than the naked skin and wattles of certain birds. In man, however, when cultivated, the sense of beauty is manifestly a far more complex feeling, and is associated with various intellectual ideas.

Before treating of the sexual characters with which we are here more particularly concerned, I may just allude to certain differences between the sexes which apparently depend on differences in their habits of life; for such cases, though common in the lower, are rare in the higher classes. Two hummingbirds belonging to the genus *Eustephanus*, which inhabit the island of Juan Fernandez, were long thought to be specifically distinct, but are now known, as Mr. Gould informs me, to be the male and female of the same species, and they differ slightly in the form of the beak. In another genus of hummingbirds (*Grypus*), the beak of the male is serrated along the margin and hooked at the extremity, thus differing much from that of the female. In the *Neomorpha* of New Zealand, there is, as we have seen, a still wider difference in the form of the beak in relation to the manner of feeding of the two sexes. Something of the same kind has

been observed with the goldfinch (*Carduelis elegans*), for I am assured by Mr. J. Jenner Weir that the birdcatchers can distinguish the males by their slightly longer beaks. The flocks of males are often found feeding on the seeds of the teasle (*Dipsacus*), which they can reach with their elongated beaks, whilst the females more commonly feed on the seeds of the betony or *Scrophularia*. With a slight difference of this kind as a foundation, we can see how the beaks of the two sexes might be made to differ greatly through natural selection. In some of the above cases, however, it is possible that the beaks of the males may have been first modified in relation to their contests with other males; and that this afterwards led to slightly changed habits of life.

LAW OF BATTLE.

Almost all male birds are extremely pugnacious, using their beaks, wings, and legs for fighting together. We see this every spring with our robins and sparrows. The smallest of all birds, namely the hummingbird, is one of the most quarrelsome. Mr. Gosse (Quoted by Mr. Gould, 'Introduction to the Trochilidae,' page .) describes a battle in which a pair seized hold of each other's beaks, and whirled round and round, till they almost fell to the ground; and M. Montes de Oca, in speaking of another genus of hummingbird, says that two males rarely meet without a fierce aerial encounter: when kept in cages "their fighting has mostly ended in the splitting of the tongue of one of the two, which then surely dies from being unable to feed." (Gould, *ibid.* .) With waders, the males of the common waterhen (*Gallinula chloropus*) "when pairing, fight violently for the females: they stand nearly upright in the water and strike with their feet." Two were seen to be thus engaged for half an hour, until one got hold of the head of the other, which would have been killed had not the observer interfered; the female all the time looking on as a quiet spectator. (W. Thompson, 'Natural History of Ireland: Birds,' vol. ii. , .) Mr. Blyth informs me that the males of an allied bird (*Gallinago cristatus*) are a third larger than the females, and are so pugnacious during the breedingseason that they are kept by the natives of Eastern Bengal for the sake of fighting. Various other birds are kept in India for the same purpose, for instance, the bulbuls (*Pycnonotus hoemorrhous*) which "fight with great spirit." (Jerdon, 'Birds of India,' vol. ii. .)

[. . The Ruff or *Machetes pugnax* (from Brehm's 'Thierleben').]

The polygamous ruff (*Machetes pugnax*, .) is notorious for his extreme pugnacity; and in the spring, the males, which are considerably larger than the females, congregate day after day at a particular spot, where the females propose to lay their eggs. The fowlers discover these spots by the turf being trampled somewhat bare. Here they fight very much like game cocks, seizing each other with their beaks and striking with their wings. The great ruff of feathers round the neck is then erected, and according to Col. Montagu "sweeps the ground as a shield to defend the more tender parts"; and this is the only

instance known to me in the case of birds of any structure serving as a shield. The ruff of feathers, however, from its varied and rich colours probably serves in chief part as an ornament. Like most pugnacious birds, they seem always ready to fight, and when closely confined, often kill each other; but Montagu observed that their pugnacity becomes greater during the spring, when the long feathers on their necks are fully developed; and at this period the least movement by any one bird provokes a general battle. (Macgillivray, 'History of British Birds,' vol. iv. , p.) Of the pugnacity of webfooted birds, two instances will suffice: in Guiana "bloody fights occur during the breeding season between the males of the wild muskduck (*Cairina moschata*); and where these fights have occurred the river is covered for some distance with feathers." (Sir R. Schomburgk, in 'Journal of Royal Geographic Society,' vol. xiii. , .) Birds which seem ill adapted for fighting engage in fierce conflicts; thus the stronger males of the pelican drive away the weaker ones, snapping with their huge beaks and giving heavy blows with their wings. Male snipe fight together, "tugging and pushing each other with their bills in the most curious manner imaginable." Some few birds are believed never to fight; this is the case, according to Audubon, with one of the woodpeckers of the United States (*Picus auratus*), although "the hens are followed by even half a dozen of their gay suitors." ('Ornithological Biography,' vol. i. . For pelicans and snipes, see vol. iii. .)

The males of many birds are larger than the females, and this no doubt is the result of the advantage gained by the larger and stronger males over their rivals during many generations. The difference in size between the two sexes is carried to an extreme point in several Australian species; thus the male muskduck (*Biziura*), and the male *Cincloramphus cruralis* (allied to our pipits) are by measurement actually twice as large as their respective females. (Gould, 'Handbook of Birds of Australia,' vol. i. ; vol. ii. .) With many other birds the females are larger than the males; and, as formerly remarked, the explanation often given, namely, that the females have most of the work in feeding their young, will not suffice. In some few cases, as we shall hereafter see, the females apparently have acquired their greater size and strength for the sake of conquering other females and obtaining possession of the males.

The males of many gallinaceous birds, especially of the polygamous kinds, are furnished with special weapons for fighting with their rivals, namely spurs, which can be used with fearful effect. It has been recorded by a trustworthy writer (Mr. Hewitt, in the 'Poultry Book' by Tegetmeier, , .) that in Derbyshire a kite struck at a gamehen accompanied by her chickens, when the cock rushed to the rescue, and drove his spur right through the eye and skull of the aggressor. The spur was with difficulty drawn from the skull, and as the kite, though dead, retained his grasp the two birds were firmly locked together; but the cock when disentangled was very little injured. The invincible courage of the game cock is notorious: a gentleman who long ago witnessed the brutal scene, told me that a bird had both its legs broken by some accident in the cockpit, and the owner laid a wager that

if the legs could be spliced so that the bird could stand upright, he would continue fighting. This was effected on the spot, and the bird fought with undaunted courage until he received his deathstroke. In Ceylon a closely allied, wild species, the *Gallus Stanleyi*, is known to fight desperately "in defence of his seraglio," so that one of the combatants is frequently found dead. (. Layard, 'Annals and Magazine of Natural History,' vol. xiv. , .) An Indian partridge (*Ortygornis gularis*), the male of which is furnished with strong and sharp spurs, is so quarrelsome "that the scars of former fights disfigure the breast of almost every bird you kill." (. Jerdon, 'Birds of India,' vol. iii. .)

The males of almost all gallinaceous birds, even those which are not furnished with spurs, engage during the breeding season in fierce conflicts. The Capercaillie and Blackcock (*Tetrao urogallus* and *T. tetrix*), which are both polygamists, have regular appointed places, where during many weeks they congregate in numbers to fight together and to display their charms before the females. Dr. W. Kovalevsky informs me that in Russia he has seen the snow all bloody on the arenas where the capercaillie have fought; and the blackcocks "make the feathers fly in every direction," when several "engage in a battle royal." The elder Brehm gives a curious account of the Balz, as the lovedances and lovesongs of the Blackcock are called in Germany. The bird utters almost continuously the strangest noises: "he holds his tail up and spreads it out like a fan, he lifts up his head and neck with all the feathers erect, and stretches his wings from the body. Then he takes a few jumps in different directions, sometimes in a circle, and presses the under part of his beak so hard against the ground that the chin feathers are rubbed off. During these movements he beats his wings and turns round and round. The more ardent he grows the more lively he becomes, until at last the bird appears like a frantic creature." At such times the blackcocks are so absorbed that they become almost blind and deaf, but less so than the capercaillie: hence bird after bird may be shot on the same spot, or even caught by the hand. After performing these antics the males begin to fight: and the same blackcock, in order to prove his strength over several antagonists, will fight in the course of one morning several Balzplaces, which remain the same during successive years. (. Brehm, 'Thierleben,' B. iv. s. . Some of the foregoing statements are taken from L. Lloyd, 'The Game Birds of Sweden,' etc., , .)

The peacock with his long train appears more like a dandy than a warrior, but he sometimes engages in fierce contests: the Rev. W. Darwin Fox informs me that at some little distance from Chester two peacocks became so excited whilst fighting, that they flew over the whole city, still engaged, until they alighted on the top of St. John's tower.

The spur, in those gallinaceous birds which are thus provided, is generally single; but *Polyplectron* has two or more on each leg; and one of the Bloodpheasants (*Ithaginis cruentus*) has been seen with five spurs. The spurs are generally confined to the male, being represented by mere knobs or rudiments in the female; but the females of the Java

peacock (*Pavo muticus*) and, as I am informed by Mr. Blyth, of the small firebacked pheasant (*Euplocamus erythrophthalmus*) possess spurs. In Galloperdix it is usual for the males to have two spurs, and for the females to have only one on each leg. (. Jerdon, 'Birds of India': on Ithaginis, vol. iii. ; on Galloperdix, .) Hence spurs may be considered as a masculine structure, which has been occasionally more or less transferred to the females. Like most other secondary sexual characters, the spurs are highly variable, both in number and development, in the same species.

[.. *Palamedea cornuta* (from Brehm), shewing the double wingspurs, and the filament on the head.]

Various birds have spurs on their wings. But the Egyptian goose (*Chenalopex aegyptiacus*) has only "bare obtuse knobs," and these probably shew us the first steps by which true spurs have been developed in other species. In the spurwinged goose, *Plectropterus gambensis*, the males have much larger spurs than the females; and they use them, as I am informed by Mr. Bartlett, in hitting together, so that, in this case, the wingspurs serve as sexual weapons; but according to Livingstone, they are chiefly used in the defence of the young. The *Palamedea* is armed with a pair of spurs on each wing; and these are such formidable weapons that a single blow has been known to drive a dog howling away. But it does not appear that the spurs in this case, or in that of some of the spurwinged rails, are larger in the male than in the female. (. For the Egyptian goose, see Macgillivray, 'British Birds,' vol. iv. . For *Plectropterus*, Livingstone's 'Travels,' . For *Palamedea*, Brehm's 'Thierleben,' B. iv. s. . See also on this bird Azara, 'Voyages dans l'Amerique merid.' tom. iv. , .) In certain plovers, however, the wingspurs must be considered as a sexual character. Thus in the male of our common peewit (*Vanellus cristatus*) the tubercle on the shoulder of the wing becomes more prominent during the breedingseason, and the males hit together. In some species of *Lobivanellus* a similar tubercle becomes developed during the breedingseason "into a short horny spur." In the Australian *L. lobatus* both sexes have spurs, but these are much larger in the males than in the females. In an allied bird, the *Hoplopterus armatus*, the spurs do not increase in size during the breeding season; but these birds have been seen in Egypt to hit together, in the same manner as our peewits, by turning suddenly in the air and striking sideways at each other, sometimes with fatal results. Thus also they drive away other enemies. (. See, on our peewit, Mr. R. Carr in 'Land and Water,' Aug. th, , . In regard to *Lobivanellus*, see Jerdon's 'Birds of India,' vol. iii. , and Gould's 'Handbook of Birds of Australia,' vol. ii. . For the *Hoplopterus*, see Mr. Allen in the 'Ibis,' vol. v. , .)

The season of love is that of battle; but the males of some birds, as of the gamefowl and ruff, and even the young males of the wild turkey and grouse (. Audubon, 'Ornithological Biography,' vol. ii. ; vol. i. p.), are ready to hit whenever they meet. The presence of the female is the teterrima belli causa. The Bengali baboos make the pretty little males of

the amadavat (*Estrela amandava*) fight together by placing three small cages in a row, with a female in the middle; after a little time the two males are turned loose, and immediately a desperate battle ensues. (. Mr. Blyth, 'Land and Water,' , .) When many males congregate at the same appointed spot and fight together, as in the case of grouse and various other birds, they are generally attended by the females (. Richardson on *Tetrao umbellus*, 'Fauna Bor. Amer.: Birds,' , . L. Lloyd, 'Game Birds of Sweden,' , , on the capercaillie and blackcock. Brehm, however, asserts ('Thierleben,' B. iv. s.) that in Germany the greyhens do not generally attend the Balzen of the blackcocks, but this is an exception to the common rule; possibly the hens may lie hidden in the surrounding bushes, as is known to be the case with the grayhens in Scandinavia, and with other species in N. America.), which afterwards pair with the victorious combatants. But in some cases the pairing precedes instead of succeeding the combat: thus according to Audubon (. 'Ornithological Biography,' vol. ii. .), several males of the Virginian goatsucker (*Caprimulgus virginianus*) "court, in a highly entertaining manner the female, and no sooner has she made her choice, than her approved gives chase to all intruders, and drives them beyond his dominions." Generally the males try to drive away or kill their rivals before they pair. It does not, however, appear that the females invariably prefer the victorious males. I have indeed been assured by Dr. W. Kovalevsky that the female capercaillie sometimes steals away with a young male who has not dared to enter the arena with the older cocks, in the same manner as occasionally happens with the does of the reddeer in Scotland. When two males contend in presence of a single female, the victor, no doubt, commonly gains his desire; but some of these battles are caused by wandering males trying to distract the peace of an already mated pair. (. Brehm, 'Thierleben,' etc., B. iv. , . Audubon, 'Ornithological Biography,' vol. ii. .)

Even with the most pugnacious species it is probable that the pairing does not depend exclusively on the mere strength and courage of the male; for such males are generally decorated with various ornaments, which often become more brilliant during the breedingseason, and which are sedulously displayed before the females. The males also endeavour to charm or excite their mates by lovenotes, songs, and antics; and the courtship is, in many instances, a prolonged affair. Hence it is not probable that the females are indifferent to the charms of the opposite sex, or that they are invariably compelled to yield to the victorious males. It is more probable that the females are excited, either before or after the conflict, by certain males, and thus unconsciously prefer them. In the case of *Tetrao umbellus*, a good observer (. 'Land and Water,' July , , .) goes so far as to believe that the battles of the male "are all a sham, performed to show themselves to the greatest advantage before the admiring females who assemble around; for I have never been able to find a maimed hero, and seldom more than a broken feather." I shall have to recur to this subject, but I may here add that with the *Tetrao cupido* of the United States, about a score of males assemble at a particular spot, and, strutting about, make the whole air resound with their extraordinary noises. At the first

answer from a female the males begin to fight furiously, and the weaker give way; but then, according to Audubon, both the victors and vanquished search for the female, so that the females must either then exert a choice, or the battle must be renewed. So, again, with one of the fieldstarlings of the United States (*Sturnella ludoviciana*) the males engage in fierce conflicts, "but at the sight of a female they all fly after her as if mad." (. Audubon's 'Ornithological Biography;' on *Tetrao cupido*, vol. ii. ; on the *Sturnus*, vol. ii. .)

VOCAL AND INSTRUMENTAL MUSIC.

With birds the voice serves to express various emotions, such as distress, fear, anger, triumph, or mere happiness. It is apparently sometimes used to excite terror, as in the case of the hissing noise made by some nestlingbirds. Audubon (. 'Ornithological Biography,' vol. v. .), relates that a night heron (*Ardea nycticorax*, Linn.), which he kept tame, used to hide itself when a cat approached, and then "suddenly start up uttering one of the most frightful cries, apparently enjoying the cat's alarm and flight." The common domestic cock clucks to the hen, and the hen to her chickens, when a dainty morsel is found. The hen, when she has laid an egg, "repeats the same note very often, and concludes with the sixth above, which she holds for a longer time" (. The Hon. Daines Barrington, 'Philosophical Transactions,' , .); and thus she expresses her joy. Some social birds apparently call to each other for aid; and as they flit from tree to tree, the flock is kept together by chirp answering chirp. During the nocturnal migrations of geese and other waterfowl, sonorous clangs from the van may be heard in the darkness overhead, answered by clangs in the rear. Certain cries serve as danger signals, which, as the sportsman knows to his cost, are understood by the same species and by others. The domestic cock crows, and the hummingbird chirps, in triumph over a defeated rival. The true song, however, of most birds and various strange cries are chiefly uttered during the breeding season, and serve as a charm, or merely as a callnote, to the other sex.

Naturalists are much divided with respect to the object of the singing of birds. Few more careful observers ever lived than Montagu, and he maintained that the "males of songbirds and of many others do not in general search for the female, but, on the contrary, their business in the spring is to perch on some conspicuous spot, breathing out their full and amorous notes, which, by instinct, the female knows, and repairs to the spot to choose her mate." (. 'Ornithological Dictionary,' , .) Mr. Jenner Weir informs me that this is certainly the case with the nightingale. Bechstein, who kept birds during his whole life, asserts, "that the female canary always chooses the best singer, and that in a state of nature the female finch selects that male out of a hundred whose notes please her most." (. 'Naturgeschichte der Stubenvögel,' , s. . Mr. Harrison Weir likewise writes to me: "I am informed that the best singing males generally get a mate first, when they are bred in the same room.") There can be no doubt that birds closely attend to

each other's song. Mr. Weir has told me of the case of a bullfinch which had been taught to pipe a German waltz, and who was so good a performer that he cost ten guineas; when this bird was first introduced into a room where other birds were kept and he began to sing, all the others, consisting of about twenty linnets and canaries, ranged themselves on the nearest side of their cages, and listened with the greatest interest to the new performer. Many naturalists believe that the singing of birds is almost exclusively "the effect of rivalry and emulation," and not for the sake of charming their mates. This was the opinion of Daines Barrington and White of Selborne, who both especially attended to this subject. (. 'Philosophical Transactions,' , . White's 'Natural History of Selborne,' , vol. i. .) Barrington, however, admits that "superiority in song gives to birds an amazing ascendancy over others, as is well known to bird catchers."

It is certain that there is an intense degree of rivalry between the males in their singing. Birdfanciers match their birds to see which will sing longest; and I was told by Mr. Yarrell that a first-rate bird will sometimes sing till he drops down almost dead, or according to Bechstein (. 'Naturgesch. der Stubenvögel,' , s. .), quite dead from rupturing a vessel in the lungs. Whatever the cause may be, male birds, as I hear from Mr. Weir, often die suddenly during the season of song. That the habit of singing is sometimes quite independent of love is clear, for a sterile, hybrid canarybird has been described (. Mr. Bold, 'Zoologist,' , .) as singing whilst viewing itself in a mirror, and then dashing at its own image; it likewise attacked with fury a female canary, when put into the same cage. The jealousy excited by the act of singing is constantly taken advantage of by birdcatchers; a male, in good song, is hidden and protected, whilst a stuffed bird, surrounded by limed twigs, is exposed to view. In this manner, as Mr. Weir informs me, a man has in the course of a single day caught fifty, and in one instance, seventy, male chaffinches. The power and inclination to sing differ so greatly with birds that although the price of an ordinary male chaffinch is only sixpence, Mr. Weir saw one bird for which the birdcatcher asked three pounds; the test of a really good singer being that it will continue to sing whilst the cage is swung round the owner's head.

That male birds should sing from emulation as well as for charming the female, is not at all incompatible; and it might have been expected that these two habits would have concurred, like those of display and pugnacity. Some authors, however, argue that the song of the male cannot serve to charm the female, because the females of some few species, such as of the canary, robin, lark, and bullfinch, especially when in a state of widowhood, as Bechstein remarks, pour forth fairly melodious strains. In some of these cases the habit of singing may be in part attributed to the females having been highly fed and confined (. D. Barrington, 'Philosophical Transactions,' , . Bechstein, 'Stubenvögel,' , s. .), for this disturbs all the functions connected with the reproduction of the species. Many instances have already been given of the partial transference of secondary masculine characters to the female, so that it is not at all surprising that the females of

some species should possess the power of song. It has also been argued, that the song of the male cannot serve as a charm, because the males of certain species, for instance of the robin, sing during the autumn. (. This is likewise the case with the waterouzel; see Mr. Hepburn in the 'Zoologist,' , .) But nothing is more common than for animals to take pleasure in practising whatever instinct they follow at other times for some real good. How often do we see birds which fly easily, gliding and sailing through the air obviously for pleasure? The cat plays with the captured mouse, and the cormorant with the captured fish. The weaverbird (*Ploceus*), when confined in a cage, amuses itself by neatly weaving blades of grass between the wires of its cage. Birds which habitually ht during the breedingseason are generally ready to ht at all times; and the males of the capercailzie sometimes hold their Balzen or leks at the usual place of assemblage during the autumn. (. L. Lloyd, 'Game Birds of Sweden,' , .) Hence it is not at all surprising that male birds should continue singing for their own amusement after the season for courtship is over.

As shewn in a previous chapter, singing is to a certain extent an art, and is much improved by practice. Birds can be taught various tunes, and even the unmelodious sparrow has learnt to sing like a linnet. They acquire the song of their foster parents (. Barrington, *ibid.* , Bechstein, *ibid.* s. .), and sometimes that of their neighbours. (. Dureau de la Malle gives a curious instance ('Annales des Sc. Nat.' rd series, Zoolog., tom. x.) of some wild blackbirds in his garden in Paris, which naturally learnt a republican air from a caged bird.) All the common songsters belong to the Order of Insectores, and their vocal organs are much more complex than those of most other birds; yet it is a singular fact that some of the Insectores, such as ravens, crows, and magpies, possess the proper apparatus (. Bishoin 'Todd's Cyclopaedia of Anatomy and Physiology,' vol. iv. .), though they never sing, and do not naturally modulate their voices to any great extent. Hunter asserts (. As stated by Barrington in 'Philosophical Transactions,' , .) that with the true songsters the muscles of the larynx are stronger in the males than in the females; but with this slight exception there is no difference in the vocal organs of the two sexes, although the males of most species sing so much better and more continuously than the females.

It is remarkable that only small birds properly sing. The Australian genus *Menura*, however, must be excepted; for the *Menura Alberti*, which is about the size of a halfgrown turkey, not only mocks other birds, but "its own whistle is exceedingly beautiful and varied." The males congregate and form "corroborating places," where they sing, raising and spreading their tails like peacocks, and drooping their wings. (. Gould, 'Handbook to the Birds of Australia,' vol. i. , p. See also Mr. T.W. Wood in the 'Student,' April , .) It is also remarkable that birds which sing well are rarely decorated with brilliant colours or other ornaments. Of our British birds, excepting the bullfinch and goldfinch, the best songsters are plaincoloured. The kingfisher, beeeater, roller, hoopoe,

woodpeckers, etc., utter harsh cries; and the brilliant birds of the tropics are hardly ever songsters. (. See remarks to this effect in Gould's 'Introduction to the Trochilidae,' , .) Hence bright colours and the power of song seem to replace each other. We can perceive that if the plumage did not vary in brightness, or if bright colours were dangerous to the species, other means would be employed to charm the females; and melody of voice offers one such means.

[. . Tetrao cupido: male. (T.W. Wood.)]

In some birds the vocal organs differ greatly in the two sexes. In the Tetrao cupido the male has two bare, orangecoloured sacks, one on each side of the neck; and these are largely inflated when the male, during the breedingseason, makes his curious hollow sound, audible at a great distance. Audubon proved that the sound was intimately connected with this apparatus (which reminds us of the airsacks on each side of the mouth of certain male frogs), for he found that the sound was much diminished when one of the sacks of a tame bird was pricked, and when both were pricked it was altogether stopped. The female has "a somewhat similar, though smaller naked space of skin on the neck; but this is not capable of inflation." (. 'The Sportsman and Naturalist in Canada,' by Major W. Ross King, , p. Mr. T.W. Wood gives in the 'Student' (April ,) an excellent account of the attitude and habits of this bird during its courtshiHe states that the eartufts or neckplumes are erected, so that they meet over the crown of the head. See his drawing, . .) The male of another kind of grouse (Tetrao urophasianus), whilst courting the female, has his "bare yellow oesophagus inflated to a prodigious size, fully half as large as the body"; and he then utters various grating, deehollow tones. With his neckfeathers erect, his wings lowered, and buzzing on the ground, and his long pointed tail spread out like a fan, he displays a variety of grotesque attitudes. The oesophagus of the female is not in any way remarkable. (. Richardson, 'Fauna Bor. Americana: Birds,' , . Audubon, *ibid.* vol. iv. .)

[. . The Umbrellabird or Cephalopterus ornatus, male (from Brehm).]

It seems now well made out that the great throat pouch of the European male bustard (*Otis tarda*), and of at least four other species, does not, as was formerly supposed, serve to hold water, but is connected with the utterance during the breedingseason of a peculiar sound resembling "oak." (. The following papers have been lately written on this subject: Prof. A. Newton, in the 'Ibis,' , ; Dr. Cullen, *ibid.* , ; Mr. Flower, in 'Proc. Zool. Soc.' , ; and Dr. Murie, in 'Proc. Zool. Soc.' , . In this latter paper an excellent ure is given of the male Australian Bustard in full display with the sack distended. It is a singular fact that the sack is not developed in all the males of the same species.) A crowlike bird inhabiting South America (see *Cephalopterus ornatus*, .) is called the umbrellabird, from its immense top knot, formed of bare white quills surmounted by darkblue plumes,

which it can elevate into a great dome no less than five inches in diameter, covering the whole head. This bird has on its neck a long, thin, cylindrical fleshy appendage, which is thickly clothed with scalelike blue feathers. It probably serves in part as an ornament, but likewise as a resounding apparatus; for Mr. Bates found that it is connected "with an unusual development of the trachea and vocal organs." It is dilated when the bird utters its singularly decloud and long sustained fluty note. The head crest and neckappendage are rudimentary in the female. (. Bates, 'The Naturalist on the Amazons,' , vol. ii. ; Wallace, in 'Proceedings, Zoological Society,' , . A new species, with a still larger neckappendage (*C. penduliger*), has lately been discovered, see 'Ibis,' vol. i. .)

The vocal organs of various webfooted and wading birds are extraordinarily complex, and differ to a certain extent in the two sexes. In some cases the trachea is convoluted, like a French horn, and is deeply embedded in the sternum. In the wild swan (*Cygnus ferus*) it is more deeply embedded in the adult male than in the adult female or young male. In the male Merganser the enlarged portion of the trachea is furnished with an additional pair of muscles. (. Bishoin Todd's 'Cyclopaedia of Anatomy and Physiology,' vol. iv. .) In one of the ducks, however, namely *Anas punctata*, the bony enlargement is only a little more developed in the male than in the female. (. Prof. Newton, 'Proc. Zool. Soc.' , .) But the meaning of these differences in the trachea of the two sexes of the Anatidae is not understood; for the male is not always the more vociferous; thus with the common duck, the male hisses, whilst the female utters a loud quack. (. The spoonbill (*Platalea*) has its trachea convoluted into a ure of eight, and yet this bird (Jerdon, 'Birds of India,' vol. iii. .) is mute; but Mr. Blyth informs me that the convolutions are not constantly present, so that perhaps they are now tending towards abortion.) In both sexes of one of the cranes (*Grus virgo*) the trachea penetrates the sternum, but presents "certain sexual modifications." In the male of the black stork there is also a wellmarked sexual difference in the length and curvature of the bronchi. (. 'Elements of Comparative Anatomy,' by R. Wagner, Eng. transl. , . With respect to the swan, as given above, Yarrell's 'History of British Birds,' nd edition, , vol. iii. .) Highly important structures have, therefore, in these cases been modified according to sex.

It is often difficult to conjecture whether the many strange cries and notes uttered by male birds during the breedingseason serve as a charm or merely as a call to the female. The soft cooing of the turtledove and of many pigeons, it may be presumed, pleases the female. When the female of the wild turkey utters her call in the morning, the male answers by a note which differs from the gobbling noise made, when with erected feathers, rustling wings and distended wattles, he puffs and struts before her. (. C.L. Bonaparte, quoted in the 'Naturalist Library: Birds,' vol. xiv. .) The spel of the blackcock certainly serves as a call to the female, for it has been known to bring four or five females from a distance to a male under confinement; but as the blackcock continues his spel for hours during successive days, and in the case of the capercaillie "with an agony

of passion," we are led to suppose that the females which are present are thus charmed. (L. Lloyd, 'The Game Birds of Sweden,' etc., , .) The voice of the common rook is known to alter during the breedingseason, and is therefore in some way sexual. (Jenner, 'Philosophical Transactions,' , .) But what shall we say about the harsh screams of, for instance, some kinds of macaws; have these birds as bad taste for musical sounds as they apparently have for colour, judging by the inharmonious contrast of their bright yellow and blue plumage? It is indeed possible that without any advantage being thus gained, the loud voices of many male birds may be the result of the inherited effects of the continued use of their vocal organs when excited by the strong passions of love, jealousy and rage; but to this point we shall recur when we treat of quadrupeds.

We have as yet spoken only of the voice, but the males of various birds practise, during their courtship what may be called instrumental music. Peacocks and Birds of Paradise rattle their quills together. Turkeycocks scrape their wings against the ground, and some kinds of grouse thus produce a buzzing sound. Another North American grouse, the Tetrao umbellus, when with his tail erect, his ruffs displayed, "he shows off his finery to the females, who lie hid in the neighbourhood," drums by rapidly striking his wings together above his back, according to Mr. R. Haymond, and not, as Audubon thought, by striking them against his sides. The sound thus produced is compared by some to distant thunder, and by others to the quick roll of a drum. The female never drums, "but flies directly to the place where the male is thus engaged." The male of the Kalijpheasant, in the Himalayas, often makes a singular drumming noise with his wings, not unlike the sound produced by shaking a stiff piece of cloth." On the west coast of Africa the little blackweavers (Ploceus?) congregate in a small party on the bushes round a small open space, and sing and glide through the air with quivering wings, "which make a rapid whirring sound like a child's rattle." One bird after another thus performs for hours together, but only during the courtingseason. At this season, and at no other time, the males of certain nightjars (Caprimulgus) make a strange booming noise with their wings. The various species of woodpeckers strike a sonorous branch with their beaks, with so rapid a vibratory movement that "the head appears to be in two places at once." The sound thus produced is audible at a considerable distance but cannot be described; and I feel sure that its source would never be conjectured by any one hearing it for the first time. As this jarring sound is made chiefly during the breedingseason, it has been considered as a lovesong; but it is perhaps more strictly a love call. The female, when driven from her nest, has been observed thus to call her mate, who answered in the same manner and soon appeared. Lastly, the male hoopoe (Upupa epops) combines vocal and instrumental music; for during the breedingseason this bird, as Mr. Swinhoe observed, first draws in air, and then taps the end of its beak perpendicularly down against a stone or the trunk of a tree, "when the breath being forced down the tubular bill produces the correct sound." If the beak is not thus struck against some object, the sound is quite different. Air is at the same time swallowed, and the oesophagus thus

becomes much swollen; and this probably acts as a resonator, not only with the hoopoe, but with pigeons and other birds. (. For the foregoing facts see, on Birds of Paradise, Brehm, 'Thierleben,' Band iii. s. . On Grouse, Richardson, 'Fauna Bor. Americ.: Birds,' p and ; Major W. Ross King, 'The Sportsman in Canada,' ; ; Mr. Haymond, in Prof. Cox's 'Geol. Survey of Indiana,' ; Audubon, 'American Ornitholog. Biograph.' vol. i. . On the Kalijpheasant, Jerdon, 'Birds of India,' vol. iii. . On the Weavers, Livingstone's 'Expedition to the Zambesi,' , . On Woodpeckers, Macgillivray, 'Hist. of British Birds,' vol. iii. , , , and . On the Hoopoe, Mr. Swinhoe, in 'Proc. Zoolog. Soc.' June , and , . On the Nightjar, Audubon, *ibid.* vol. ii. , and 'American Naturalist,' , . The English Nightjar likewise makes in the spring a curious noise during its rapid flight.)

[. . Outer tailfeather of *Scolopax gallinago* (from 'Proc. Zool. Soc.').

. . Outer tailfeather of *Scolopax frenata*.

. . Outer tailfeather of *Scolopax javensis*.]

In the foregoing cases sounds are made by the aid of structures already present and otherwise necessary; but in the following cases certain feathers have been specially modified for the express purpose of producing sounds. The drumming, bleating, neighing, or thundering noise (as expressed by different observers) made by the common snipe (*Scolopax gallinago*) must have surprised every one who has ever heard it. This bird, during the pairingseason, flies to "perhaps a thousand feet in height," and after zigzagging about for a time descends to the earth in a curved line, with outspread tail and quivering pinions, and surprising velocity. The sound is emitted only during this rapid descent. No one was able to explain the cause until M. Meves observed that on each side of the tail the outer feathers are peculiarly formed , having a stiff sabreshaped shaft with the oblique barbs of unusual length, the outer webs being strongly bound together. He found that by blowing on these feathers, or by fastening them to a long thin stick and waving them rapidly through the air, he could reproduce the drumming noise made by the living bird. Both sexes are furnished with these feathers, but they are generally larger in the male than in the female, and emit a deeper note. In some species, as in *S. frenata* , four feathers, and in *S. javensis* , no less than eight on each side of the tail are greatly modified. Different tones are emitted by the feathers of the different species when waved through the air; and the *Scolopax Wilsonii* of the United States makes a switching noise whilst descending rapidly to the earth. (. See M. Meves' interesting paper in 'Proc. Zool. Soc.' , . For the habits of the snipe, Macgillivray, 'History of British Birds,' vol. iv. . For the American snipe, Capt. Blakiston, 'Ibis,' vol. v. , .)

[. . Primary wingfeather of a Hummingbird, the *Selasphorus platycercus* (from a sketch by Mr. Salvin). Upper ure, that of male; lower ure, corresponding feather of female.]

In the male of the *Chamaepetes unicolor* (a large gallinaceous bird of America), the first primary wingfeather is arched towards the tip and is much more attenuated than in the female. In an allied bird, the *Penelope nigra*, Mr. Salvin observed a male, which, whilst it flew downwards "with outstretched wings, gave forth a kind of crashing rushing noise," like the falling of a tree. (. Mr. Salvin, in 'Proceedings, Zoological Society,' , . I am much indebted to this distinguished ornithologist for sketches of the feathers of the *Chamaepetes*, and for other information.) The male alone of one of the Indian bustards (*Sypheotides auritus*) has its primary wingfeathers greatly acuminate; and the male of an allied species is known to make a humming noise whilst courting the female. (. Jerdon, 'Birds of India,' vol. iii. .) In a widely different group of birds, namely Hummingbirds, the males alone of certain kinds have either the shafts of their primary wingfeathers broadly dilated, or the webs abruptly excised towards the extremity. The male, for instance, of *Selasphorus platycercus*, when adult, has the first primary wingfeather , thus excised. Whilst flying from flower to flower he makes "a shrill, almost whistling noise" (. Gould, 'Introduction to the Trochilidae,' , . Salvin, 'Proceedings, Zoological Society,' , .); but it did not appear to Mr. Salvin that the noise was intentionally made.

[. . Secondary wingfeathers of *Pipra deliciosa* (from Mr. Sclater, in 'Proc. Zool. Soc.'). The three upper feathers, a, b, c, from the male; the three lower corresponding feathers, d, e, f, from the female. a and d, fifth secondary wingfeather of male and female, upper surface. b and e, sixth secondary, upper surface. c and f, seventh secondary, lower surface.]

Lastly, in several species of a subgenus of *Pipra* or Manakin, the males, as described by Mr. Sclater, have their SECONDARY wingfeathers modified in a still more remarkable manner. In the brilliantly coloured *deliciosa* the first three secondaries are thickstemmed and curved towards the body; in the fourth and fifth (. , a) the change is greater; and in the sixth and seventh (b, c) the shaft "is thickened to an extraordinary degree, forming a solid horny lump." The barbs also are greatly changed in shape, in comparison with the corresponding feathers (d, e, f) in the female. Even the bones of the wing, which support these singular feathers in the male, are said by Mr. Fraser to be much thickened. These little birds make an extraordinary noise, the first "sharp note being not unlike the crack of a whip." (. Sclater, in 'Proceedings, Zoological Society,' , , and in 'Ibis,' vol. iv. , . Also Salvin, in 'Ibis,' , .)

The diversity of the sounds, both vocal and instrumental, made by the males of many birds during the breeding season, and the diversity of the means for producing such sounds, are highly remarkable. We thus gain a high idea of their importance for sexual purposes, and are reminded of the conclusion arrived at as to insects. It is not difficult to

imagine the steps by which the notes of a bird, primarily used as a mere call or for some other purpose, might have been improved into a melodious love song. In the case of the modified feathers, by which the drumming, whistling, or roaring noises are produced, we know that some birds during their courtship flutter, shake, or rattle their unmodified feathers together; and if the females were led to select the best performers, the males which possessed the strongest or thickest, or most attenuated feathers, situated on any part of the body, would be the most successful; and thus by slow degrees the feathers might be modified to almost any extent. The females, of course, would not notice each slight successive alteration in shape, but only the sounds thus produced. It is a curious fact that in the same class of animals, sounds so different as the drumming of the snipe's tail, the tapping of the woodpecker's beak, the harsh trumpetlike cry of certain waterfowl, the cooing of the turtledove, and the song of the nightingale, should all be pleasing to the females of the several species. But we must not judge of the tastes of distinct species by a uniform standard; nor must we judge by the standard of man's taste. Even with man, we should remember what discordant noises, the beating of tomtoms and the shrill notes of reeds, please the ears of savages. Sir S. Baker remarks (. 'The Nile Tributaries of Abyssinia,' , .), that "as the stomach of the Arab prefers the raw meat and reeking liver taken hot from the animal, so does his ear prefer his equally coarse and discordant music to all other."

LOVE ANTICS AND DANCES.

The curious love gestures of some birds have already been incidentally noticed; so that little need here be added. In Northern America large numbers of a grouse, the Tetrao phasianellus, meet every morning during the breedingseason on a selected level spot, and here they run round and round in a circle of about fifteen or twenty feet in diameter, so that the ground is worn quite bare, like a fairyring. In these Partridgedances, as they are called by the hunters, the birds assume the strangest attitudes, and run round, some to the left and some to the right. Audubon describes the males of a heron (*Ardea herodias*) as walking about on their long legs with great dignity before the females, bidding defiance to their rivals. With one of the disgusting carrionvultures (*Cathartes jota*) the same naturalist states that "the gesticulations and parade of the males at the beginning of the loveseason are extremely ludicrous." Certain birds perform their loveantics on the wing, as we have seen with the black African weaver, instead of on the ground. During the spring our little whitethroat (*Sylvia cinerea*) often rises a few feet or yards in the air above some bush, and "flutters with a fitful and fantastic motion, singing all the while, and then drops to its perch." The great English bustard throws himself into indescribably odd attitudes whilst courting the female, as has been ured by Wolf. An allied Indian bustard (*Otis bengalensis*) at such times "rises perpendicularly into the air with a hurried flapping of his wings, raising his crest and puffing out the feathers of his neck and breast, and then drops to the ground;" he repeats this manoeuvre several

times, at the same time humming in a peculiar tone. Such females as happen to be near "obey this saltatory summons," and when they approach he trails his wings and spreads his tail like a turkeycock. (. For *Tetrao phasianellus*, see Richardson, 'Fauna, Bor. America,' , and for further particulars Capt. Blakiston, 'Ibis,' , . For the *Cathartes* and *Ardea*, Audubon, 'Ornithological Biography,' vol. ii. , and vol. iii. . On the Whitethroat, Macgillivray, 'History of British Birds,' vol. ii. . On the Indian Bustard, Jerdon, 'Birds of India,' vol. iii. .)

[. . Bowerbird, *Chlamydera maculata*, with bower (from Brehm).]

But the most curious case is afforded by three allied genera of Australian birds, the famous Bowerbirds, no doubt the codescendants of some ancient species which first acquired the strange instinct of constructing bowers for performing their loveantics. The bowers , which, as we shall hereafter see, are decorated with feathers, shells, bones, and leaves, are built on the ground for the sole purpose of courtshifor their nests are formed in trees. Both sexes assist in the erection of the bowers, but the male is the principal workman. So strong is this instinct that it is practised under confinement, and Mr. Strange has described (. Gould, 'Handbook to the Birds of Australia,' vol. i. , . The bower of the Satin Bowerbird may be seen in the Zoological Society's Gardens, Regent's Park.) the habits of some Satin Bowerbirds which he kept in an aviary in New South Wales. "At times the male will chase the female all over the aviary, then go to the bower, pick up a gay feather or a large leaf, utter a curious kind of note, set all his feathers erect, run round the bower and become so excited that his eyes appear ready to start from his head; he continues opening first one wing then the other, uttering a low, whistling note, and, like the domestic cock, seems to be picking up something from the ground, until at last the female goes gently towards him." Captain Stokes has described the habits and "playhouses" of another species, the Great Bowerbird, which was seen "amusing itself by flying backwards and forwards, taking a shell alternately from each side, and carrying it through the archway in its mouth." These curious structures, formed solely as halls of assemblage, where both sexes amuse themselves and pay their court, must cost the birds much labour. The bower, for instance, of the Fawnbreasted species, is nearly four feet in length, eighteen inches in height, and is raised on a thick platform of sticks.

DECORATION.

I will first discuss the cases in which the males are ornamented either exclusively or in a much higher degree than the females, and in a succeeding chapter those in which both sexes are equally ornamented, and finally the rare cases in which the female is somewhat more brightly coloured than the male. As with the artificial ornaments used by savage and civilised men, so with the natural ornaments of birds, the head is the chief seat of decoration. (. See remarks to this effect, on the 'Feeling of Beauty among

Animals,' by Mr. J. Shaw, in the 'Athenaeum,' Nov. th, , .) The ornaments, as mentioned at the commencement of this chapter, are wonderfully diversified. The plumes on the front or back of the head consist of variouslyshaped feathers, sometimes capable of erection or expansion, by which their beautiful colours are fully displayed. Elegant eartufts are occasionally present. The head is sometimes covered with velvety down, as with the pheasant; or is naked and vividly coloured. The throat, also, is sometimes ornamented with a beard, wattles, or caruncles. Such appendages are generally brightly coloured, and no doubt serve as ornaments, though not always ornamental in our eyes; for whilst the male is in the act of courting the female, they often swell and assume vivid tints, as in the male turkey. At such times the fleshy appendages about the head of the male Tragopan pheasant (*Ceriornis Temminckii*) swell into a large lappet on the throat and into two horns, one on each side of the splendid topknot; and these are then coloured of the most intense blue which I have ever beheld. (. See Dr. Murie's account with coloured ures in 'Proceedings, Zoological Society,' , .) The African hornbill (*Bucorax abyssinicus*) inflates the scarlet bladderlike wattle on its neck, and with its wings drooping and tail expanded "makes quite a grand appearance." (. Mr. Monteiro, 'Ibis,' vol. iv. , .) Even the iris of the eye is sometimes more brightlycoloured in the male than in the female; and this is frequently the case with the beak, for instance, in our common blackbird. In *Buceros corrugatus*, the whole beak and immense casque are coloured more conspicuously in the male than in the female; and "the oblique grooves upon the sides of the lower mandible are peculiar to the male sex." (. 'Land and Water,' , .)

The head, again, often supports fleshy appendages, filaments, and solid protuberances. These, if not common to both sexes, are always confined to the males. The solid protuberances have been described in detail by Dr. W. Marshall (. 'Ueber die Schädelhöcker,' etc., 'Niederland. Archiv. fur Zoologie,' B. I. Heft , .), who shews that they are formed either of cancellated bone coated with skin, or of dermal and other tissues. With mammals true horns are always supported on the frontal bones, but with birds various bones have been modified for this purpose; and in species of the same group the protuberances may have cores of bone, or be quite destitute of them, with intermediate gradations connecting these two extremes. Hence, as Dr. Marshall justly remarks, variations of the most different kinds have served for the development through sexual selection of these ornamental appendages. Elongated feathers or plumes spring from almost every part of the body. The feathers on the throat and breast are sometimes developed into beautiful ruffs and collars. The tailfeathers are frequently increased in length; as we see in the tailcoverts of the peacock, and in the tail itself of the Argus pheasant. With the peacock even the bones of the tail have been modified to support the heavy tail coverts. (. Dr. W. Marshall, 'Über den Vogelschwanz,' *ibid.* B. I. Heft , .) The body of the Argus is not larger than that of a fowl; yet the length from the end of the beak to the extremity of the tail is no less than five feet three inches (. Jardine's 'Naturalist Library: Birds,' vol. xiv. .), and that of the beautifully ocellated secondary

wing feathers nearly three feet. In a small African nightjar (*Cosmetornis vexillarius*) one of the primary wingfeathers, during the breedingseason, attains a length of twentysix inches, whilst the bird itself is only ten inches in length. In another closelyallied genus of nightjars, the shafts of the elongated wingfeathers are naked, except at the extremity, where there is a disc. (. Sclater, in the 'Ibis,' vol. vi. , ; Livingstone, 'Expedition to the Zambesi,' , .) Again, in another genus of nightjars, the tailfeathers are even still more prodigiously developed. In general the feathers of the tail are more often elongated than those of the wings, as any great elongation of the latter impedes flight. We thus see that in closelyallied birds ornaments of the same kind have been gained by the males through the development of widely different feathers.

It is a curious fact that the feathers of species belonging to very distinct groups have been modified in almost exactly the same peculiar manner. Thus the wingfeathers in one of the abovementioned nightjars are bare along the shaft, and terminate in a disc; or are, as they are sometimes called, spoon or racketshaped. Feathers of this kind occur in the tail of a motmot (*Eumomota superciliaris*), of a kingfisher, finch, hummingbird, parrot, several Indian drongos (*Dicrurus* and *Edolius*, in one of which the disc stands vertically), and in the tail of certain birds of paradise. In these latter birds, similar feathers, beautifully ocellated, ornament the head, as is likewise the case with some gallinaceous birds. In an Indian bustard (*Sypheotides auritus*) the feathers forming the ear tufts, which are about four inches in length, also terminate in discs. (. Jerdon, 'Birds of India,' vol. iii. .) It is a most singular fact that the motmots, as Mr. Salvin has clearly shewn (. 'Proceedings, Zoological Society,' , .), give to their tail feathers the racketshape by biting off the barbs, and, further, that this continued mutilation has produced a certain amount of inherited effect.

[. . *Paradisea Papuana* (T.W. Wood).]

Again, the barbs of the feathers in various widelydistinct birds are filamentous or plumose, as with some herons, ibises, birds of paradise, and Gallinaceae. In other cases the barbs disappear, leaving the shafts bare from end to end; and these in the tail of the *Paradisea apoda* attain a length of thirtyfour inches (. Wallace, in 'Annals and Magazine of Natural History,' vol. xx. , , and in his 'Malay Archipelago,' vol. ii. , .): in *Papuana* they are much shorter and thin. Smaller feathers when thus denuded appear like bristles, as on the breast of the turkeycock. As any fleeting fashion in dress comes to be admired by man, so with birds a change of almost any kind in the structure or colouring of the feathers in the male appears to have been admired by the female. The fact of the feathers in widely distinct groups having been modified in an analogous manner no doubt depends primarily on all the feathers having nearly the same structure and manner of development, and consequently tending to vary in the same manner. We often see a tendency to analogous variability in the plumage of our domestic breeds belonging to

distinct species. Thus topknots have appeared in several species. In an extinct variety of the turkey, the topknot consisted of bare quills surmounted with plumes of down, so that they somewhat resembled the racket shaped feathers above described. In certain breeds of the pigeon and fowl the feathers are plumose, with some tendency in the shafts to be naked. In the Sebastopol goose the scapular feathers are greatly elongated, curled, or even spirally twisted, with the margins plumose. (. See my work on 'The Variation of Animals and Plants under Domestication,' vol. i. .)

In regard to colour, hardly anything need here be said, for every one knows how splendid are the tints of many birds, and how harmoniously they are combined. The colours are often metallic and iridescent. Circular spots are sometimes surrounded by one or more differently shaded zones, and are thus converted into ocelli. Nor need much be said on the wonderful difference between the sexes of many birds. The common peacock offers a striking instance. Female birds of paradise are obscurely coloured and destitute of all ornaments, whilst the males are probably the most highly decorated of all birds, and in so many different ways that they must be seen to be appreciated. The elongated and goldenorange plumes which spring from beneath the wings of the *Paradisea apoda*, when vertically erected and made to vibrate, are described as forming a sort of halo, in the centre of which the head "looks like a little emerald sun with its rays formed by the two plumes." (. Quoted from M. de Lafresnaye in 'Annals and Mag. of Natural History,' vol. xiii. , : see also Mr. Wallace's much fuller account in vol. xx. , , and in his 'Malay Archipelago.') In another most beautiful species the head is bald, "and of a rich cobalt blue, crossed by several lines of black velvety feathers." (. Wallace, 'The Malay Archipelago,' vol. ii. , .)

[. . *Lophornis ornatus*, male and female (from Brehm).

. . *Spathura underwoodi*, male and female (from Brehm).]

Male hummingbirds (s. and) almost vie with birds of paradise in their beauty, as every one will admit who has seen Mr. Gould's splendid volumes, or his rich collection. It is very remarkable in how many different ways these birds are ornamented. Almost every part of their plumage has been taken advantage of, and modified; and the modifications have been carried, as Mr. Gould shewed me, to a wonderful extreme in some species belonging to nearly every subgroup. Such cases are curiously like those which we see in our fancy breeds, reared by man for the sake of ornament; certain individuals originally varied in one character, and other individuals of the same species in other characters; and these have been seized on by man and much augmented as shewn by the tail of the fantail pigeon, the hood of the jacobin, the beak and wattle of the carrier, and so forth. The sole difference between these cases is that in the one, the result is due to man's

selection, whilst in the other, as with humming birds, birds of paradise, etc., it is due to the selection by the females of the more beautiful males.

I will mention only one other bird, remarkable from the extreme contrast in colour between the sexes, namely the famous bellbird (*Chasmorhynchus niveus*) of S. America, the note of which can be distinguished at the distance of nearly three miles, and astonishes every one when first hearing it. The male is pure white, whilst the female is duskygreen; and white is a very rare colour in terrestrial species of moderate size and inoffensive habits. The male, also, as described by Waterton, has a spiral tube, nearly three inches in length, which rises from the base of the beak. It is jetblack, dotted over with minute downy feathers. This tube can be inflated with air, through a communication with the palate; and when not inflated hangs down on one side. The genus consists of four species, the males of which are very distinct, whilst the females, as described by Mr. Sclater in a very interesting paper, closely resemble each other, thus offering an excellent instance of the common rule that within the same group the males differ much more from each other than do the females. In a second species (*C. nudicollis*) the male is likewise snowwhite, with the exception of a large space of naked skin on the throat and round the eyes, which during the breedingseason is of a fine green colour. In a third species (*C. tricarunculatus*) the head and neck alone of the male are white, the rest of the body being chestnutbrown, and the male of this species is provided with three filamentous projections half as long as the bodyone rising from the base of the beak, and the two others from the corners of the mouth. (. Mr. Sclater, 'Intellectual Observer,' Jan. . Waterton's 'Wanderings,' . See also Mr. Salvin's interesting paper, with a plate, in the 'Ibis,' , .)

The coloured plumage and certain other ornaments of the adult males are either retained for life, or are periodically renewed during the summer and breedingseason. At this same season the beak and naked skin about the head frequently change colour, as with some herons, ibises, gulls, one of the bellbirds just noticed, etc. In the white ibis, the cheeks, the inflatable skin of the throat, and the basal portion of the beak then become crimson. (. 'Land and Water,' , .) In one of the rails, *Gallicrex cristatus*, a large red caruncle is developed during this period on the head of the male. So it is with a thin horny crest on the beak of one of the pelicans, *erythrorhynchus*; for, after the breeding season, these horny crests are shed, like horns from the heads of stags, and the shore of an island in a lake in Nevada was found covered with these curious exuviae. (. Mr. D.G. Elliot, in 'Proc. Zool. Soc.' , .)

Changes of colour in the plumage according to the season depend, firstly on a double annual moult, secondly on an actual change of colour in the feathers themselves, and thirdly on their dullcoloured margins being periodically shed, or on these three processes more or less combined. The shedding of the deciduary margins may be

compared with the shedding of their down by very young birds; for the down in most cases arises from the summits of the first true feathers. (. Nitzsch's 'Pterylography,' edited by P.L. Sclater, Ray Society, , .)

With respect to the birds which annually undergo a double moult, there are, firstly, some kinds, for instance snipes, swallowplovers (*Glareolae*), and curlews, in which the two sexes resemble each other, and do not change colour at any season. I do not know whether the winter plumage is thicker and warmer than the summer plumage, but warmth seems the most probable end attained of a double moult, where there is no change of colour. Secondly, there are birds, for instance, certain species of *Totanus* and other *Grallatores*, the sexes of which resemble each other, but in which the summer and winter plumage differ slightly in colour. The difference, however, in these cases is so small that it can hardly be an advantage to them; and it may, perhaps, be attributed to the direct action of the different conditions to which the birds are exposed during the two seasons. Thirdly, there are many other birds the sexes of which are alike, but which are widely different in their summer and winter plumage. Fourthly, there are birds the sexes of which differ from each other in colour; but the females, though moulting twice, retain the same colours throughout the year, whilst the males undergo a change of colour, sometimes a great one, as with certain bustards. Fifthly and lastly, there are birds the sexes of which differ from each other in both their summer and winter plumage; but the male undergoes a greater amount of change at each recurrent season than the female of which the ruff (*Machetes pugnax*) offers a good instance.

With respect to the cause or purpose of the differences in colour between the summer and winter plumage, this may in some instances, as with the ptarmigan (. The brown mottled summer plumage of the ptarmigan is of as much importance to it, as a protection, as the white winter plumage; for in Scandinavia during the spring, when the snow has disappeared, this bird is known to suffer greatly from birds of prey, before it has acquired its summer dress: see Wilhelm von Wright, in Lloyd, 'Game Birds of Sweden,' , .), serve during both seasons as a protection. When the difference between the two plumages is slight it may perhaps be attributed, as already remarked, to the direct action of the conditions of life. But with many birds there can hardly be a doubt that the summer plumage is ornamental, even when both sexes are alike. We may conclude that this is the case with many herons, egrets, etc., for they acquire their beautiful plumes only during the breeding season. Moreover, such plumes, topknots, etc., though possessed by both sexes, are occasionally a little more developed in the male than in the female; and they resemble the plumes and ornaments possessed by the males alone of other birds. It is also known that confinement, by affecting the reproductive system of male birds, frequently checks the development of their secondary sexual characters, but has no immediate influence on any other characters; and I am informed by Mr. Bartlett that eight or nine specimens of the Knot (*Tringa*

canutus) retained their unadorned winter plumage in the Zoological Gardens throughout the year, from which fact we may infer that the summer plumage, though common to both sexes, partakes of the nature of the exclusively masculine plumage of many other birds. (. In regard to the previous statements on moulting, see, on snipes, etc., Macgillivray, 'Hist. Brit. Birds,' vol. iv. ; on Glareolae, curlews, and bustards, Jerdon, 'Birds of India,' vol. iii. , ; on Totanus, ibid. ; on the plumes of herons, ibid. , and Macgillivray, vol. iv. p and , and Mr. Stafford Allen, in the 'Ibis,' vol. v. , .)

From the foregoing facts, more especially from neither sex of certain birds changing colour during either annual moult, or changing so slightly that the change can hardly be of any service to them, and from the females of other species moulting twice yet retaining the same colours throughout the year, we may conclude that the habit of annually moulting twice has not been acquired in order that the male should assume an ornamental character during the breedingseason; but that the double moult, having been originally acquired for some distinct purpose, has subsequently been taken advantage of in certain cases for gaining a nuptial plumage.

It appears at first sight a surprising circumstance that some closely allied species should regularly undergo a double annual moult, and others only a single one. The ptarmigan, for instance, moults twice or even thrice in the year, and the blackcock only once: some of the splendidly coloured honey suckers (Nectariniae) of India and some subgenera of obscurely coloured pipits (Anthus) have a double, whilst others have only a single annual moult. (. On the moulting of the ptarmigan, see Gould's 'Birds of Great Britain.' On the honey suckers, Jerdon, 'Birds of India,' vol. i. , . On the moulting of Anthus, see Blyth, in 'Ibis,' , .) But the gradations in the manner of moulting, which are known to occur with various birds, shew us how species, or whole groups, might have originally acquired their double annual moult, or having once gained the habit, have again lost it. With certain bustards and plovers the vernal moult is far from complete, some feathers being renewed, and some changed in colour. There is also reason to believe that with certain bustards and rail-like birds, which properly undergo a double moult, some of the older males retain their nuptial plumage throughout the year. A few highly modified feathers may merely be added during the spring to the plumage, as occurs with the discformed tailfeathers of certain drongos (Bhringa) in India, and with the elongated feathers on the back, neck, and crest of certain herons. By such steps as these, the vernal moult might be rendered more and more complete, until a perfect double moult was acquired. Some of the birds of paradise retain their nuptial feathers throughout the year, and thus have only a single moult; others cast them directly after the breedingseason, and thus have a double moult; and others again cast them at this season during the first year, but not afterwards; so that these latter species are intermediate in their manner of moulting. There is also a great difference with many birds in the length of time during which the two annual plumages are retained; so that the one might come to be retained

for the whole year, and the other completely lost. Thus in the spring *Machetes pugnax* retains his ruff for barely two months. In Natal the male widowbird (*Chera progné*) acquires his fine plumage and long tailfeathers in December or January, and loses them in March; so that they are retained only for about three months. Most species, which undergo a double moult, keep their ornamental feathers for about six months. The male, however, of the wild *Gallus bankiva* retains his neckhackles for nine or ten months; and when these are cast off, the underlying black feathers on the neck are fully exposed to view. But with the domesticated descendant of this species, the neckhackles of the male are immediately replaced by new ones; so that we here see, as to part of the plumage, a double moult changed under domestication into a single moult. (. For the foregoing statements in regard to partial moults, and on old males retaining their nuptial plumage, see Jerdon, on bustards and plovers, in 'Birds of India,' vol. iii. , , . Also Blyth in 'Land and Water,' , . On the moulting of *Paradisea*, see an interesting article by Dr. W. Marshall, 'Archives Neerlandaises,' tom. vi. . On the *Vidua*, 'Ibis,' vol. iii. , . On the Drongo shrikes, Jerdon, *ibid.* vol. i. . On the vernal moult of the *Herodias bubulcus*, Mr. S.S. Allen, in 'Ibis,' , . On *Gallus bankiva*, Blyth, in 'Annals and Mag. of Natural History,' vol. i. , ; see, also, on this subject, my 'Variation of Animals under Domestication,' vol. i. .)

The common drake (*Anas boschas*), after the breedingseason, is well known to lose his male plumage for a period of three months, during which time he assumes that of the female. The male pintail duck (*Anas acuta*) loses his plumage for the shorter period of six weeks or two months; and Montagu remarks that "this double moult within so short a time is a most extraordinary circumstance, that seems to bid defiance to all human reasoning." But the believer in the gradual modification of species will be far from feeling surprise at finding gradations of all kinds. If the male pintail were to acquire his new plumage within a still shorter period, the new male feathers would almost necessarily be mingled with the old, and both with some proper to the female; and this apparently is the case with the male of a not distant ally bird, namely the Merganser serrator, for the males are said to "undergo a change of plumage, which assimilates them in some measure to the female." By a little further acceleration in the process, the double moult would be completely lost. (. See Macgillivray, 'Hist. British Birds' (vol. v. , and), on the moulting of the Anatidae, with quotations from Waterton and Montagu. Also Yarrell, 'History of British Birds,' vol. iii. .)

Some male birds, as before stated, become more brightly coloured in the spring, not by a vernal moult, but either by an actual change of colour in the feathers, or by their obscurely coloured deciduary margins being shed. Changes of colour thus caused may last for a longer or shorter time. In the *Pelecanus onocrotalus* a beautiful rosy tint, with lemon coloured marks on the breast, overspreads the whole plumage in the spring; but these tints, as Mr. Sclater states, "do not last long, disappearing generally in about six

weeks or two months after they have been attained." Certain finches shed the margins of their feathers in the spring, and then become brighter coloured, while other finches undergo no such change. Thus the *Fringilla tristis* of the United States (as well as many other American species) exhibits its bright colours only when the winter is past, whilst our goldfinch, which exactly represents this bird in habits, and our siskin, which represents it still more closely in structure, undergo no such annual change. But a difference of this kind in the plumage of allied species is not surprising, for with the common linnet, which belongs to the same family, the crimson forehead and breast are displayed only during the summer in England, whilst in Madeira these colours are retained throughout the year. (. On the pelican, see Sclater, in 'Proc. Zool. Soc.' , . On the American finches, see Audubon, 'Ornithological Biography,' vol. i. , and Jerdon, 'Birds of India,' vol. ii. . On the *Fringilla cannabina* of Madeira, Mr. E. Vernon Harcourt, 'Ibis,' vol. v. , .)

DISPLAY BY MALE BIRDS OF THEIR PLUMAGE.

Ornaments of all kinds, whether permanently or temporarily gained, are sedulously displayed by the males, and apparently serve to excite, attract, or fascinate the females. But the males will sometimes display their ornaments, when not in the presence of the females, as occasionally occurs with grouse at their balzplaces, and as may be noticed with the peacock; this latter bird, however, evidently wishes for a spectator of some kind, and, as I have often seen, will shew off his finery before poultry, or even pigs. (. See also 'Ornamental Poultry,' by Rev. E.S. Dixon, , .) All naturalists who have closely attended to the habits of birds, whether in a state of nature or under confinement, are unanimously of opinion that the males take delight in displaying their beauty. Audubon frequently speaks of the male as endeavouring in various ways to charm the female. Mr. Gould, after describing some peculiarities in a male humming bird, says he has no doubt that it has the power of displaying them to the greatest advantage before the female. Dr. Jerdon (. 'Birds of India,' introduct., vol. i. xxiv.; on the peacock, vol. iii. . See Gould's 'Introduction to Trochilidae,' , p and .) insists that the beautiful plumage of the male serves "to fascinate and attract the female." Mr. Bartlett, at the Zoological Gardens, expressed himself to me in the strongest terms to the same effect.

[. . *Rupicola crocea*, male (T.W. Wood).]

It must be a grand sight in the forests of India "to come suddenly on twenty or thirty peafowl, the males displaying their gorgeous trains, and strutting about in all the pomp of pride before the gratified females." The wild turkeycock erects his glittering plumage, expands his finely zoned tail and barred wingfeathers, and altogether, with his crimson and blue wattles, makes a superb, though, to our eyes, grotesque appearance. Similar facts have already been given with respect to grouse of various kinds. Turning to another

Order: The male *Rupicola crocea* is one of the most beautiful birds in the world, being of a splendid orange, with some of the feathers curiously truncated and plumose. The female is brownishgreen, shaded with red, and has a much smaller crest. Sir R. Schomburgk has described their courtship; he found one of their meeting places where ten males and two females were present. The space was from four to five feet in diameter, and appeared to have been cleared of every blade of grass and smoothed as if by human hands. A male "was capering, to the apparent delight of several others. Now spreading its wings, throwing up its head, or opening its tail like a fan; now strutting about with a hopping gait until tired, when it gabbled some kind of note, and was relieved by another. Thus three of them successively took the field, and then, with selfapprobation, withdrew to rest." The Indians, in order to obtain their skins, wait at one of the meetingplaces till the birds are eagerly engaged in dancing, and then are able to kill with their poisoned arrows four or five males, one after the other. (. 'Journal of R. Geograph. Soc.' vol. x. , .) With birds of paradise a dozen or more fullplumaged males congregate in a tree to hold a dancingparty, as it is called by the natives: and here they fly about, raise their wings, elevate their exquisite plumes, and make them vibrate, and the whole tree seems, as Mr. Wallace remarks, to be filled with waving plumes. When thus engaged, they become so absorbed that a skilful archer may shoot nearly the whole party. These birds, when kept in confinement in the Malay Archipelago, are said to take much care in keeping their feathers clean; often spreading them out, examining them, and removing every speck of dirt. One observer, who kept several pairs alive, did not doubt that the display of the male was intended to please the female. (. 'Annals and Mag. of Nat. Hist.' vol. xiii. , ; also Wallace, *ibid.* vol. xx. , , and 'The Malay Archipelago,' vol. ii. , . Also Dr. Bennett, as quoted by Brehm, 'Thierleben,' B. iii. s. .)

[. . Polyplectron chinquis, male (T.W. Wood).]

The Gold and Amherst pheasants during their courtship not only expand and raise their splendid frills, but twist them, as I have myself seen, obliquely towards the female on whichever side she may be standing, obviously in order that a large surface may be displayed before her. (. Mr. T.W. Wood has given ('The Student,' April ,) a full account of this manner of display, by the Gold pheasant and by the Japanese pheasant, *Ph. versicolor*; and he calls it the lateral or onesided display.) They likewise turn their beautiful tails and tailcoverts a little towards the same side. Mr. Bartlett has observed a male Polyplectron in the act of courtship and has shewn me a specimen stuffed in the attitude then assumed. The tail and wingfeathers of this bird are ornamented with beautiful ocelli, like those on the peacock's train. Now when the peacock displays himself, he expands and erects his tail transversely to his body, for he stands in front of the female, and has to shew off, at the same time, his rich blue throat and breast. But the breast of the Polyplectron is obscurely coloured, and the ocelli are not confined to the tailfeathers. Consequently the Polyplectron does not stand in front of the female; but he

erects and expands his tailfeathers a little obliquely, lowering the expanded wing on the same side, and raising that on the opposite side. In this attitude the ocelli over the whole body are exposed at the same time before the eyes of the admiring female in one grand bespangled expanse. To whichever side she may turn, the expanded wings and the obliquelyheld tail are turned towards her. The male Tragopan pheasant acts in nearly the same manner, for he raises the feathers of the body, though not the wing itself, on the side which is opposite to the female, and which would otherwise be concealed, so that nearly all the beautifully spotted feathers are exhibited at the same time.

[. . Side view of male Argus pheasant, whilst displaying before the female. Observed and sketched from nature by T.W. Wood.]

The Argus pheasant affords a much more remarkable case. The immensely developed secondary wingfeathers are confined to the male; and each is ornamented with a row of from twenty to twentythree ocelli, above an inch in diameter. These feathers are also elegantly marked with oblique stripes and rows of spots of a dark colour, like those on the skin of a tiger and leopard combined. These beautiful ornaments are hidden until the male shows himself off before the female. He then erects his tail, and expands his wingfeathers into a great, almost upright, circular fan or shield, which is carried in front of the body. The neck and head are held on one side, so that they are concealed by the fan; but the bird in order to see the female, before whom he is displaying himself, sometimes pushes his head between two of the long wingfeathers (as Mr. Bartlett has seen), and then presents a grotesque appearance. This must be a frequent habit with the bird in a state of nature, for Mr. Bartlett and his son on examining some perfect skins sent from the East, found a place between two of the feathers which was much frayed, as if the head had here frequently been pushed through. Mr. Wood thinks that the male can also peep at the female on one side, beyond the margin of the fan.

The ocelli on the wingfeathers are wonderful objects; for they are so shaded that, as the Duke of Argyll remarks (. 'The Reign of Law,' , .), they stand out like balls lying loosely within sockets. When I looked at the specimen in the British Museum, which is mounted with the wings expanded and trailing downwards, I was however greatly disappointed, for the ocelli appeared flat, or even concave. But Mr. Gould soon made the case clear to me, for he held the feathers erect, in the position in which they would naturally be displayed, and now, from the light shining on them from above, each ocellus at once resembled the ornament called a ball and socket. These feathers have been shown to several artists, and all have expressed their admiration at the perfect shading. It may well be asked, could such artistically shaded ornaments have been formed by means of sexual selection? But it will be convenient to defer giving an answer to this question until we treat in the next chapter of the principle of gradation.

The foregoing remarks relate to the secondary wingfeathers, but the primary wingfeathers, which in most gallinaceous birds are uniformly coloured, are in the Argus pheasant equally wonderful. They are of a soft brown tint with numerous dark spots, each of which consists of two or three black dots with a surrounding dark zone. But the chief ornament is a space parallel to the darkblue shaft, which in outline forms a perfect second feather lying within the true feather. This inner part is coloured of a lighter chestnut, and is thickly dotted with minute white points. I have shewn this feather to several persons, and many have admired it even more than the ball and socket feathers, and have declared that it was more like a work of art than of nature. Now these feathers are quite hidden on all ordinary occasions, but are fully displayed, together with the long secondary feathers, when they are all expanded together so as to form the great fan or shield.

The case of the male Argus pheasant is eminently interesting, because it affords good evidence that the most refined beauty may serve as a sexual charm, and for no other purpose. We must conclude that this is the case, as the secondary and primary wingfeathers are not at all displayed, and the ball and socket ornaments are not exhibited in full perfection until the male assumes the attitude of courtship. The Argus pheasant does not possess brilliant colours, so that his success in love appears to depend on the great size of his plumes, and on the elaboration of the most elegant patterns. Many will declare that it is utterly incredible that a female bird should be able to appreciate fine shading and exquisite patterns. It is undoubtedly a marvellous fact that she should possess this almost human degree of taste. He who thinks that he can safely gauge the discrimination and taste of the lower animals may deny that the female Argus pheasant can appreciate such refined beauty; but he will then be compelled to admit that the extraordinary attitudes assumed by the male during the act of courtship by which the wonderful beauty of his plumage is fully displayed, are purposeless; and this is a conclusion which I for one will never admit.

Although so many pheasants and allied gallinaceous birds carefully display their plumage before the females, it is remarkable, as Mr. Bartlett informs me, that this is not the case with the dullcoloured Eared and Cheer pheasants (*Crossoptilon auritum* and *Phasianus wallichii*); so that these birds seem conscious that they have little beauty to display. Mr. Bartlett has never seen the males of either of these species fighting together, though he has not had such good opportunities for observing the Cheer as the Eared pheasant. Mr. Jenner Weir, also, finds that all male birds with rich or strongly characterised plumage are more quarrelsome than the dull coloured species belonging to the same groups. The goldfinch, for instance, is far more pugnacious than the linnet, and the blackbird than the thrush. Those birds which undergo a seasonal change of plumage likewise become much more pugnacious at the period when they are most gaily ornamented. No doubt the males of some obscurely coloured birds ht

desperately together, but it appears that when sexual selection has been highly influential, and has given bright colours to the males of any species, it has also very often given a strong tendency to pugnacity. We shall meet with nearly analogous cases when we treat of mammals. On the other hand, with birds the power of song and brilliant colours have rarely been both acquired by the males of the same species; but in this case the advantage gained would have been the same, namely success in charming the female. Nevertheless it must be owned that the males of several brilliantly coloured birds have had their feathers specially modified for the sake of producing instrumental music, though the beauty of this cannot be compared, at least according to our taste, with that of the vocal music of many songsters.

We will now turn to male birds which are not ornamented in any high degree, but which nevertheless display during their courtship whatever attractions they may possess. These cases are in some respects more curious than the foregoing, and have been but little noticed. I owe the following facts to Mr. Weir, who has long kept confined birds of many kinds, including all the British Fringillidae and Emberizidae. The facts have been selected from a large body of valuable notes kindly sent me by him. The bullfinch makes his advances in front of the female, and then puffs out his breast, so that many more of the crimson feathers are seen at once than otherwise would be the case. At the same time he twists and bows his black tail from side to side in a ludicrous manner. The male chaffinch also stands in front of the female, thus shewing his red breast and "blue bell," as the fanciers call his head; the wings at the same time being slightly expanded, with the pure white bands on the shoulders thus rendered conspicuous. The common linnet distends his rosy breast, slightly expands his brown wings and tail, so as to make the best of them by exhibiting their white edgings. We must, however, be cautious in concluding that the wings are spread out solely for display, as some birds do so whose wings are not beautiful. This is the case with the domestic cock, but it is always the wing on the side opposite to the female which is expanded, and at the same time scraped on the ground. The male goldfinch behaves differently from all other finches: his wings are beautiful, the shoulders being black, with the darktipped wingfeathers spotted with white and edged with golden yellow. When he courts the female, he sways his body from side to side, and quickly turns his slightly expanded wings first to one side, then to the other, with a golden flashing effect. Mr. Weir informs me that no other British finch turns thus from side to side during his courtship not even the closely allied male siskin, for he would not thus add to his beauty.

Most of the British Buntings are plain coloured birds; but in the spring the feathers on the head of the male reedbunting (*Emberiza schoeniculus*) acquire a fine black colour by the abrasion of the dusky tips; and these are erected during the act of courtship. Mr. Weir has kept two species of *Amadina* from Australia: the *A. castanotis* is a very small and chastely coloured finch, with a dark tail, white rump and jetblack upper tail coverts, each

of the latter being marked with three large conspicuous oval spots of white. (. For the description of these birds, see Gould's 'Handbook to the Birds of Australia,' vol. i. , .) This species, when courting the female, slightly spreads out and vibrates these parti coloured tailcoverts in a very peculiar manner. The male *Amadina Lathamii* behaves very differently, exhibiting before the female his brilliantly spotted breast, scarlet rufous and scarlet upper tailcoverts. I may here add from Dr. Jerdon that the Indian bulbul (*Pycnonotus hoemorrhous*) has its under tailcoverts of a crimson colour, and these, it might be thought, could never be well exhibited; but the bird "when excited often spreads them out laterally, so that they can be seen even from above." (. 'Birds of India,' vol. ii. .) The crimson under tailcoverts of some other birds, as with one of the woodpeckers, *Picus major*, can be seen without any such display. The common pigeon has iridescent feathers on the breast, and every one must have seen how the male inflates his breast whilst courting the female, thus shewing them off to the best advantage. One of the beautiful bronzewinged pigeons of Australia (*Ocyphaps lophotes*) behaves, as described to me by Mr. Weir, very differently: the male, whilst standing before the female, lowers his head almost to the ground, spreads out and raises his tail, and half expands his wings. He then alternately and slowly raises and depresses his body, so that the iridescent metallic feathers are all seen at once, and glitter in the sun.

Sufficient facts have now been given to shew with what care male birds display their various charms, and this they do with the utmost skill. Whilst preening their feathers, they have frequent opportunities for admiring themselves, and of studying how best to exhibit their beauty. But as all the males of the same species display themselves in exactly the same manner, it appears that actions, at first perhaps intentional, have become instinctive. If so, we ought not to accuse birds of conscious vanity; yet when we see a peacock strutting about, with expanded and quivering tail feathers, he seems the very emblem of pride and vanity.

The various ornaments possessed by the males are certainly of the highest importance to them, for in some cases they have been acquired at the expense of greatly impeded powers of flight or of running. The African nightjar (*Cosmetornis*), which during the pairingseason has one of its primary wingfeathers developed into a streamer of very great length, is thereby much retarded in its flight, although at other times remarkable for its swiftness. The "unwieldy size" of the secondary wingfeathers of the male Argus pheasant is said "almost entirely to deprive the bird of flight." The fine plumes of male birds of paradise trouble them during a high wind. The extremely long tailfeathers of the male widowbirds (*Vidua*) of Southern Africa render "their flight heavy;" but as soon as these are cast off they fly as well as the females. As birds always breed when food is abundant, the males probably do not suffer much inconvenience in searching for food from their impeded powers of movement; but there can hardly be a doubt that they must be much more liable to be struck down by birds of prey. Nor can we doubt that the

long train of the peacock and the long tail and wingfeathers of the Argus pheasant must render them an easier prey to any prowling tigercat than would otherwise be the case. Even the bright colours of many male birds cannot fail to make them conspicuous to their enemies of all kinds. Hence, as Mr. Gould has remarked, it probably is that such birds are generally of a shy disposition, as if conscious that their beauty was a source of danger, and are much more difficult to discover or approach, than the sombre coloured and comparatively tame females or than the young and as yet unadorned males. (. On the Cosmetornis, see Livingstone's 'Expedition to the Zambesi,' , . On the Argus pheasant, Jardine's 'Nat. Hist. Lib.: Birds,' vol. xiv. . On Birds of Paradise, Lesson, quoted by Brehm, 'Thierleben,' B. iii. s. . On the widowbird, Barrow's 'Travels in Africa,' vol. i. , and 'Ibis,' vol. iii. . Mr. Gould, on the shyness of male birds, 'Handbook to Birds of Australia,' vol. i. , .)

It is a more curious fact that the males of some birds which are provided with special weapons for battle, and which in a state of nature are so pugnacious that they often kill each other, suffer from possessing certain ornaments. Cockhters trim the hackles and cut off the combs and gills of their cocks; and the birds are then said to be dubbed. An undubbed bird, as Mr. Tegetmeier insists, "is at a fearful disadvantage; the comb and gills offer an easy hold to his adversary's beak, and as a cock always strikes where he holds, when once he has seized his foe, he has him entirely in his power. Even supposing that the bird is not killed, the loss of blood suffered by an undubbed cock is much greater than that sustained by one that has been trimmed." (. Tegetmeier, 'The Poultry Book,' , .) Young turkeycocks in hting always seize hold of each other's wattles; and I presume that the old birds ht in the same manner. It may perhaps be objected that the comb and wattles are not ornamental, and cannot be of service to the birds in this way; but even to our eyes, the beauty of the glossy black Spanish cock is much enhanced by his white face and crimson comb; and no one who has ever seen the splendid blue wattles of the male Tragopan pheasant distended in courtship can for a moment doubt that beauty is the object gained. From the foregoing facts we clearly see that the plumes and other ornaments of the males must be of the highest importance to them; and we further see that beauty is even sometimes more important than success in battle.

CHAPTER XIV.

BIRDScontinued.

Choice exerted by the femaleLength of courtshipUnpaired birdsMental qualities and taste for the beautifulPreference or antipathy shewn by the female for particular

males Variability of birds Variations sometimes abrupt Laws of variation Formation of ocelli Gradations of character Case of Peacock, Argus pheasant, and Urostickte.

When the sexes differ in beauty or in the power of singing, or in producing what I have called instrumental music, it is almost invariably the male who surpasses the female. These qualities, as we have just seen, are evidently of high importance to the male. When they are gained for only a part of the year it is always before the breeding season. It is the male alone who elaborately displays his varied attractions, and often performs strange antics on the ground or in the air, in the presence of the female. Each male drives away, or if he can, kills his rivals. Hence we may conclude that it is the object of the male to induce the female to pair with him, and for this purpose he tries to excite or charm her in various ways; and this is the opinion of all those who have carefully studied the habits of living birds. But there remains a question which has an all important bearing on sexual selection, namely, does every male of the same species excite and attract the female equally? Or does she exert a choice, and prefer certain males? This latter question can be answered in the affirmative by much direct and indirect evidence. It is far more difficult to decide what qualities determine the choice of the females; but here again we have some direct and indirect evidence that it is to a large extent the external attractions of the male; though no doubt his vigour, courage, and other mental qualities come into play. We will begin with the indirect evidence.

LENGTH OF COURTSHIP.

The lengthened period during which both sexes of certain birds meet day after day at an appointed place probably depends partly on the courtship being a prolonged affair, and partly on reiteration in the act of pairing. Thus in Germany and Scandinavia the balzen or leks of the blackcocks last from the middle of March, all through April into May. As many as forty or fifty, or even more birds congregate at the leks; and the same place is often frequented during successive years. The lek of the capercaillie lasts from the end of March to the middle or even end of May. In North America "the partridge dances" of the *Tetrao phasianellus* "last for a month or more." Other kinds of grouse, both in North America and Eastern Siberia (Nordman describes ('Bull. Soc. Indes Nat. Moscou,' , tom. xxxiv.) the balzen of *Tetrao urogalloides* in Amur Land. He estimated the number of birds assembled at above a hundred, not counting the females, which lie hid in the surrounding bushes. The noises uttered differ from those of *T. urogallus*.), follow nearly the same habits. The fowlers discover the hillocks where the ruffs congregate by the grass being trampled bare, and this shews that the same spot is long frequented. The Indians of Guiana are well acquainted with the cleared arenas, where they expect to find the beautiful cocks of the Rock; and the natives of New Guinea know the trees where from ten to twenty male birds of paradise in full plumage congregate. In this latter case it is not expressly stated that the females meet on the same trees, but the hunters, if not

specially asked, would probably not mention their presence, as their skins are valueless. Small parties of an African weaver (*Ploceus*) congregate, during the breedingseason, and perform for hours their graceful evolutions. Large numbers of the Solitary snipe (*Scolopax major*) assemble during dusk in a morass; and the same place is frequented for the same purpose during successive years; here they may be seen running about "like so many large rats," puffing out their feathers, flapping their wings, and uttering the strangest cries. (. With respect to the assemblages of the above named grouse, see Brehm, 'Thierleben,' B. iv. s. ; also L. Lloyd, 'Game Birds of Sweden,' , . Richardson, 'Fauna Bor. Americana: Birds,' . References in regard to the assemblages of other birds have already been given. On Paradisea, see Wallace, in 'Annals and Mag. of Nat. Hist.' vol. xx. , . On the snipe, Lloyd, *ibid.* .)

Some of the above birds, the blackcock, capercaillie, pheasantgrouse, ruff, solitary snipe, and perhaps others, are, as is believed, polygamists. With such birds it might have been thought that the stronger males would simply have driven away the weaker, and then at once have taken possession of as many females as possible; but if it be indispensable for the male to excite or please the female, we can understand the length of the courtship and the congregation of so many individuals of both sexes at the same spot. Certain strictly monogamous species likewise hold nuptial assemblages; this seems to be the case in Scandinavia with one of the ptarmigans, and their leks last from the middle of March to the middle of May. In Australia the lyrebird (*Menura superba*) forms "small round hillocks," and the *M. Alberti* scratches for itself shallow holes, or, as they are called by the natives, "corroborating places," where it is believed both sexes assemble. The meetings of the *M. superba* are sometimes very large; and an account has lately been published (. Quoted by Mr. T.W. Wood, in the 'Student,' April , .) by a traveller, who heard in a valley beneath him, thickly covered with scrub, "a din which completely astonished" him; on crawling onwards he beheld, to his amazement, about one hundred and fifty of the magnificent lyrecocks, "ranged in order of battle, and hting with indescribable fury." The bowers of the Bower birds are the resort of both sexes during the breedingseason; and "here the males meet and contend with each other for the favours of the female, and here the latter assemble and coquet with the males." With two of the genera, the same bower is resorted to during many years. (. Gould, 'Handbook to the Birds of Australia,' vol. i. , , . On the ptarmigan, above alluded to, see Lloyd, *ibid.* .)

The common magpie (*Corvus pica*, Linn.), as I have been informed by the Rev. W. Darwin Fox, used to assemble from all parts of Delamere Forest, in order to celebrate the "great magpie marriage." Some years ago these birds abounded in extraordinary numbers, so that a gamekeeper killed in one morning nineteen males, and another killed by a single shot seven birds at roost together. They then had the habit of assembling very early in the spring at particular spots, where they could be seen in flocks, chattering, sometimes hting, bustling and flying about the trees. The whole affair

was evidently considered by the birds as one of the highest importance. Shortly after the meeting they all separated, and were then observed by Mr. Fox and others to be paired for the season. In any district in which a species does not exist in large numbers, great assemblages cannot, of course, be held, and the same species may have different habits in different countries. For instance, I have heard of only one instance, from Mr. Wedderburn, of a regular assemblage of black game in Scotland, yet these assemblages are so well known in Germany and Scandinavia that they have received special names.

UNPAIRED BIRDS.

From the facts now given, we may conclude that the courtship of birds belonging to widely different groups, is often a prolonged, delicate, and troublesome affair. There is even reason to suspect, improbable as this will at first appear, that some males and females of the same species, inhabiting the same district, do not always please each other, and consequently do not pair. Many accounts have been published of either the male or female of a pair having been shot, and quickly replaced by another. This has been observed more frequently with the magpie than with any other bird, owing perhaps to its conspicuous appearance and nest. The illustrious Jenner states that in Wiltshire one of a pair was daily shot no less than seven times successively, "but all to no purpose, for the remaining magpie soon found another mate"; and the last pair reared their young. A new partner is generally found on the succeeding day; but Mr. Thompson gives the case of one being replaced on the evening of the same day. Even after the eggs are hatched, if one of the old birds is destroyed a mate will often be found; this occurred after an interval of two days, in a case recently observed by one of Sir J. Lubbock's keepers. (. On magpies, Jenner, in 'Philosophical Transactions,' , . Macgillivray, 'Hist. British Birds,' vol. i. . Thompson, in 'Annals and Magazine of Natural History,' vol. viii. , .) The first and most obvious conjecture is that male magpies must be much more numerous than females; and that in the above cases, as well as in many others which could be given, the males alone had been killed. This apparently holds good in some instances, for the gamekeepers in Delamere Forest assured Mr. Fox that the magpies and carrioncrows which they formerly killed in succession in large numbers near their nests, were all males; and they accounted for this fact by the males being easily killed whilst bringing food to the sitting females. Macgillivray, however, gives, on the authority of an excellent observer, an instance of three magpies successively killed on the same nest, which were all females; and another case of six magpies successively killed whilst sitting on the same eggs, which renders it probable that most of them were females; though, as I hear from Mr. Fox, the male will sit on the eggs when the female is killed.

Sir J. Lubbock's gamekeeper has repeatedly shot, but how often he could not say, one of a pair of jays (*Garrulus glandarius*), and has never failed shortly afterwards to find the survivor rematched. Mr. Fox, Mr. F. Bond, and others have shot one of a pair of

carrioncrows (*Corvus corone*), but the nest was soon again tenanted by a pair. These birds are rather common; but the peregrine falcon (*Falco peregrinus*) is rare, yet Mr. Thompson states that in Ireland "if either an old male or female be killed in the breeding season (not an uncommon circumstance), another mate is found within a very few days, so that the eyries, notwithstanding such casualties, are sure to turn out their complement of young." Mr. Jenner Weir has known the same thing with the peregrine falcons at Beachy Head. The same observer informs me that three kestrels (*Falco tinnunculus*), all males, were killed one after the other whilst attending the same nest; two of these were in mature plumage, but the third was in the plumage of the previous year. Even with the rare golden eagle (*Aquila chrysaetos*), Mr. Birkbeck was assured by a trustworthy gamekeeper in Scotland, that if one is killed, another is soon found. So with the white owl (*Strix flammea*), "the survivor readily found a mate, and the mischief went on."

White of Selborne, who gives the case of the owl, adds that he knew a man, who from believing that partridges when paired were disturbed by the males hting, used to shoot them; and though he had widowed the same female several times, she always soon found a fresh partner. This same naturalist ordered the sparrows, which deprived the housemartins of their nests, to be shot; but the one which was left, "be it cock or hen, presently procured a mate, and so for several times following." I could add analogous cases relating to the chaffinch, nightingale, and redstart. With respect to the latter bird (*Phoenicurus phoenicurus*), a writer expresses much surprise how the sitting female could so soon have given effectual notice that she was a widow, for the species was not common in the neighbourhood. Mr. Jenner Weir has mentioned to me a nearly similar case; at Blackheath he never sees or hears the note of the wild bullfinch, yet when one of his caged males has died, a wild one in the course of a few days has generally come and perched near the widowed female, whose callnote is not loud. I will give only one other fact, on the authority of this same observer; one of a pair of starlings (*Sturnus vulgaris*) was shot in the morning; by noon a new mate was found; this was again shot, but before night the pair was complete; so that the disconsolate widow or widower was thrice consoled during the same day. Mr. Engleheart also informs me that he used during several years to shoot one of a pair of starlings which built in a hole in a house at Blackheath; but the loss was always immediately repaired. During one season he kept an account, and found that he had shot thirtyfive birds from the same nest; these consisted of both males and females, but in what proportion he could not say: nevertheless, after all this destruction, a brood was reared. (On the peregrine falcon, see Thompson, 'Nat. Hist. of Ireland: Birds,' vol. i. , . On owls, sparrows, and partridges, see White, 'Nat. Hist. of Selborne,' edit. of , vol. i. . On the *Phoenicurus*, see Loudon's 'Mag. of Nat. Hist.' vol. vii. , . Brehm ('Thierleben,' B. iv. s.) also alludes to cases of birds thrice mated during the same day.)

These facts well deserve attention. How is it that there are birds enough ready to replace immediately a lost mate of either sex? Magpies, jays, carrioncrows, partridges, and some other birds, are always seen during the spring in pairs, and never by themselves; and these offer at first sight the most perplexing cases. But birds of the same sex, although of course not truly paired, sometimes live in pairs or in small parties, as is known to be the case with pigeons and partridges. Birds also sometimes live in triplets, as has been observed with starlings, carrioncrows, parrots, and partridges. With partridges two females have been known to live with one male, and two males with one female. In all such cases it is probable that the union would be easily broken; and one of the three would readily pair with a widow or widower. The males of certain birds may occasionally be heard pouring forth their lovesong long after the proper time, shewing that they have either lost or never gained a mate. Death from accident or disease of one of a pair would leave the other free and single; and there is reason to believe that female birds during the breedingseason are especially liable to premature death. Again, birds which have had their nests destroyed, or barren pairs, or retarded individuals, would easily be induced to desert their mates, and would probably be glad to take what share they could of the pleasures and duties of rearing offspring although not their own. (. See White ('Nat. Hist. of Selborne,' , vol. i.) on the existence, early in the season, of small coveys of male partridges, of which fact I have heard other instances. See Jenner, on the retarded state of the generative organs in certain birds, in 'Phil. Transact.' . In regard to birds living in triplets, I owe to Mr. Jenner Weir the cases of the starlings and parrots, and to Mr. Fox, of partridges; on carrioncrows, see the 'Field,' , . On various male birds singing after the proper period, see Rev. L. Jenyns, 'Observations in Natural History,' , .) Such contingencies as these probably explain most of the foregoing cases. (. The following case has been given ('The Times,' Aug. ,) by the Rev. F.O. Morris, on the authority of the Hon. and Rev. O.W. Forester. "The gamekeeper here found a hawk's nest this year, with five young ones on it. He took four and killed them, but left one with its wings clipped as a decoy to destroy the old ones by. They were both shot next day, in the act of feeding the young one, and the keeper thought it was done with. The next day he came again and found two other charitable hawks, who had come with an adopted feeling to succour the orphan. These two he killed, and then left the nest. On returning afterwards he found two more charitable individuals on the same errand of mercy. One of these he killed; the other he also shot, but could not find. No more came on the like fruitless errand.") Nevertheless, it is a strange fact that within the same district, during the height of the breedingseason, there should be so many males and females always ready to repair the loss of a mated bird. Why do not such spare birds immediately pair together? Have we not some reason to suspect, and the suspicion has occurred to Mr. Jenner Weir, that as the courtship of birds appears to be in many cases prolonged and tedious, so it occasionally happens that certain males and females do not succeed, during the proper season, in exciting each other's love, and consequently do not pair? This suspicion will

appear somewhat less improbable after we have seen what strong antipathies and preferences female birds occasionally evince towards particular males.

MENTAL QUALITIES OF BIRDS, AND THEIR TASTE FOR THE BEAUTIFUL.

Before we further discuss the question whether the females select the more attractive males or accept the first whom they may encounter, it will be advisable briefly to consider the mental powers of birds. Their reason is generally, and perhaps justly, ranked as low; yet some facts could be given leading to an opposite conclusion. (I am indebted to Prof. Newton for the following passage from Mr. Adam's 'Travels of a Naturalist,' . Speaking of Japanese nuthatches in confinement, he says: "Instead of the more yielding fruit of the yew, which is the usual food of the nut hatch of Japan, at one time I substituted hard hazelnuts. As the bird was unable to crack them, he placed them one by one in his waterglass, evidently with the notion that they would in time become softer an interesting proof of intelligence on the part of these birds.") Low powers of reasoning, however, are compatible, as we see with mankind, with strong affections, acute perception, and a taste for the beautiful; and it is with these latter qualities that we are here concerned. It has often been said that parrots become so deeply attached to each other that when one dies the other pines for a long time; but Mr. Jenner Weir thinks that with most birds the strength of their affection has been much exaggerated. Nevertheless when one of a pair in a state of nature has been shot, the survivor has been heard for days afterwards uttering a plaintive call; and Mr. St. John gives various facts proving the attachment of mated birds. ('A Tour in Sutherlandshire,' vol. i. , . Dr. Buller says ('Birds of New Zealand,' ,) that a male King Lory was killed; and the female "fretted and moped, refused her food, and died of a broken heart.") Mr. Bennett relates ('Wanderings in New South Wales,' vol. ii. , .) that in China after a drake of the beautiful mandarin Teal had been stolen, the duck remained disconsolate, though sedulously courted by another mandarin drake, who displayed before her all his charms. After an interval of three weeks the stolen drake was recovered, and instantly the pair recognised each other with extreme joy. On the other hand, starlings, as we have seen, may be consoled thrice in the same day for the loss of their mates. Pigeons have such excellent local memories, that they have been known to return to their former homes after an interval of nine months, yet, as I hear from Mr. Harrison Weir, if a pair which naturally would remain mated for life be separated for a few weeks during the winter, and afterwards matched with other birds, the two when brought together again, rarely, if ever, recognise each other.

Birds sometimes exhibit benevolent feelings; they will feed the deserted young ones even of distinct species, but this perhaps ought to be considered as a mistaken instinct. They will feed, as shewn in an earlier part of this work, adult birds of their own species

which have become blind. Mr. Buxton gives a curious account of a parrot which took care of a frostbitten and crippled bird of a distinct species, cleansed her feathers, and defended her from the attacks of the other parrots which roamed freely about his garden. It is a still more curious fact that these birds apparently evince some sympathy for the pleasures of their fellows. When a pair of cockatoos made a nest in an acacia tree, "it was ridiculous to see the extravagant interest taken in the matter by the others of the same species." These parrots, also, evinced unbounded curiosity, and clearly had "the idea of property and possession." (. 'Acclimatization of Parrots,' by C. Buxton, M.P., 'Annals and Mag. of Nat. Hist.' Nov. , .) They have good memories, for in the Zoological Gardens they have plainly recognised their former masters after an interval of some months.

Birds possess acute powers of observation. Every mated bird, of course, recognises its fellow. Audubon states that a certain number of mocking thrushes (*Mimus polyglottus*) remain all the year round in Louisiana, whilst others migrate to the Eastern States; these latter, on their return, are instantly recognised, and always attacked, by their southern brethren. Birds under confinement distinguish different persons, as is proved by the strong and permanent antipathy or affection which they shew, without any apparent cause, towards certain individuals. I have heard of numerous instances with jays, partridges, canaries, and especially bullfinches. Mr. Hussey has described in how extraordinary a manner a tamed partridge recognised everybody: and its likes and dislikes were very strong. This bird seemed "fond of gay colours, and no new gown or cap could be put on without catching his attention." (. The 'Zoologist,' , .) Mr. Hewitt has described the habits of some ducks (recently descended from wild birds), which, at the approach of a strange dog or cat, would rush headlong into the water, and exhaust themselves in their attempts to escape; but they knew Mr. Hewitt's own dogs and cats so well that they would lie down and bask in the sun close to them. They always moved away from a strange man, and so they would from the lady who attended them if she made any great change in her dress. Audubon relates that he reared and tamed a wild turkey which always ran away from any strange dog; this bird escaped into the woods, and some days afterwards Audubon saw, as he thought, a wild turkey, and made his dog chase it; but, to his astonishment, the bird did not run away, and the dog, when he came udid not attack the bird, for they mutually recognised each other as old friends. (. Hewitt on wild ducks, 'Journal of Horticulture,' Jan. , , . Audubon on the wild turkey, 'Ornithological Biography,' vol. i. . On the mockingthrush, *ibid.* vol. i. .)

Mr. Jenner Weir is convinced that birds pay particular attention to the colours of other birds, sometimes out of jealousy, and sometimes as a sign of kinshiThus he turned a reedbunting (*Emberiza schoeniculus*), which had acquired its black headdress, into his aviary, and the newcomer was not noticed by any bird, except by a bullfinch, which is likewise black headed. This bullfinch was a very quiet bird, and had never before

quarrelled with any of its comrades, including another reedbunting, which had not as yet become blackheaded: but the reedbunting with a black head was so unmercifully treated that it had to be removed. *Spiza cyanea*, during the breedingseason, is of a bright blue colour; and though generally peaceable, it attacked *S. ciris*, which has only the head blue, and completely scalped the unfortunate bird. Mr. Weir was also obliged to turn out a robin, as it fiercely attacked all the birds in his aviary with any red in their plumage, but no other kinds; it actually killed a red breasted crossbill, and nearly killed a goldfinch. On the other hand, he has observed that some birds, when first introduced, fly towards the species which resemble them most in colour, and settle by their sides.

As male birds display their fine plumage and other ornaments with so much care before the females, it is obviously probable that these appreciate the beauty of their suitors. It is, however, difficult to obtain direct evidence of their capacity to appreciate beauty. When birds gaze at themselves in a lookingglass (of which many instances have been recorded) we cannot feel sure that it is not from jealousy of a supposed rival, though this is not the conclusion of some observers. In other cases it is difficult to distinguish between mere curiosity and admiration. It is perhaps the former feeling which, as stated by Lord Lilford (. *The 'Ibis,'* vol. ii. , .), attracts the ruff towards any bright object, so that, in the Ionian Islands, "it will dart down to a bright coloured handkerchief, regardless of repeated shots." The common lark is drawn down from the sky, and is caught in large numbers, by a small mirror made to move and glitter in the sun. Is it admiration or curiosity which leads the magpie, raven, and some other birds to steal and secrete bright objects, such as silver articles or jewels?

Mr. Gould states that certain hummingbirds decorate the outsides of their nests "with the utmost taste; they instinctively fasten thereon beautiful pieces of flat lichen, the larger pieces in the middle, and the smaller on the part attached to the branch. Now and then a pretty feather is intertwined or fastened to the outer sides, the stem being always so placed that the feather stands out beyond the surface." The best evidence, however, of a taste for the beautiful is afforded by the three genera of Australian bowerbirds already mentioned. Their bowers , where the sexes congregate and play strange antics, are variously constructed, but what most concerns us is, that they are decorated by the several species in a different manner. The Satin bowerbird collects gaily coloured articles, such as the blue tailfeathers of parrakeets, bleached bones and shells, which it sticks between the twigs or arranges at the entrance. Mr. Gould found in one bower a neatlyworked stone tomahawk and a slip of blue cotton, evidently procured from a native encampment. These objects are continually rearranged, and carried about by the birds whilst at play. The bower of the Spotted bowerbird "is beautifully lined with tall grasses, so disposed that the heads nearly meet, and the decorations are very profuse." Round stones are used to keep the grasstems in their proper places, and to make divergent paths leading to the bower. The stones and shells are often brought from a

great distance. The Regent bird, as described by Mr. Ramsay, ornaments its short bower with bleached landshells belonging to five or six species, and with "berries of various colours, blue, red, and black, which give it when fresh a very pretty appearance. Besides these there were several newly-picked leaves and young shoots of a pinkish colour, the whole showing a decided taste for the beautiful." Well may Mr. Gould say that "these highly decorated halls of assembly must be regarded as the most wonderful instances of bird architecture yet discovered;" and the taste, as we see, of the several species certainly differs. (. On the ornamented nests of hummingbirds, Gould, 'Introduction to the Trochilidae,' , . On the bowerbirds, Gould, 'Handbook to the Birds of Australia,' , vol. i. p. Ramsay, in the 'Ibis,' , .)

PREFERENCE FOR PARTICULAR MALES BY THE FEMALES.

Having made these preliminary remarks on the discrimination and taste of birds, I will give all the facts known to me which bear on the preference shewn by the female for particular males. It is certain that distinct species of birds occasionally pair in a state of nature and produce hybrids. Many instances could be given: thus Macgillivray relates how a male blackbird and female thrush "fell in love with each other," and produced offspring. (. 'History of Brit. Birds,' vol. ii. .) Several years ago eighteen cases had been recorded of the occurrence in Great Britain of hybrids between the black grouse and pheasant (. 'Zoologist,' , .); but most of these cases may perhaps be accounted for by solitary birds not finding one of their own species to pair with. With other birds, as Mr. Jenner Weir has reason to believe, hybrids are sometimes the result of the casual intercourse of birds building in close proximity. But these remarks do not apply to the many recorded instances of tamed or domestic birds, belonging to distinct species, which have become absolutely fascinated with each other, although living with their own species. Thus Waterton (. Waterton, 'Essays on Nat. Hist.' nd series, p and . For the following statements see on the wigeon, 'Loudon's Mag. of Nat. Hist.' vol. ix. ; L. Lloyd, 'Scandinavian Adventures,' vol. i. , . Dixon, 'Ornamental and Domestic Poultry,' ; Hewitt, in 'Journal of Horticulture,' Jan. , , ; Bechstein, 'Stubenvögel,' , s. . Mr. J. Jenner Weir has lately given me an analogous case with ducks of two species.) states that out of a flock of twentythree Canada geese, a female paired with a solitary Bernicle gander, although so different in appearance and size; and they produced hybrid offspring. A male wigeon (*Mareca penelope*), living with females of the same species, has been known to pair with a pintail duck, *Querquedula acuta*. Lloyd describes the remarkable attachment between a shieldrake (*Tadorna vulpanser*) and a common duck. Many additional instances could be given; and the Rev. E.S. Dixon remarks that "those who have kept many different species of geese together well know what unaccountable attachments they are frequently forming, and that they are quite as likely to pair and rear young with individuals of a race (species) apparently the most alien to themselves as with their own stock."

The Rev. W.D. Fox informs me that he possessed at the same time a pair of Chinese geese (*Anser cygnoides*), and a common gander with three geese. The two lots kept quite separate, until the Chinese gander seduced one of the common geese to live with him. Moreover, of the young birds hatched from the eggs of the common geese, only four were pure, the other eighteen proving hybrids; so that the Chinese gander seems to have had prepotent charms over the common gander. I will give only one other case; Mr. Hewitt states that a wild duck, reared in captivity, "after breeding a couple of seasons with her own mallard, at once shook him off on my placing a male Pintail on the water. It was evidently a case of love at first sight, for she swam about the newcomer caressingly, though he appeared evidently alarmed and averse to her overtures of affection. From that hour she forgot her old partner. Winter passed by, and the next spring the pintail seemed to have become a convert to her blandishments, for they nested and produced seven or eight young ones."

What the charm may have been in these several cases, beyond mere novelty, we cannot even conjecture. Colour, however, sometimes comes into play; for in order to raise hybrids from the siskin (*Fringilla spinus*) and the canary, it is much the best plan, according to Bechstein, to place birds of the same tint together. Mr. Jenner Weir turned a female canary into his aviary, where there were male linnets, goldfinches, siskins, greenfinches, chaffinches, and other birds, in order to see which she would choose; but there never was any doubt, and the greenfinch carried the day. They paired and produced hybrid offspring.

The fact of the female preferring to pair with one male rather than with another of the same species is not so likely to excite attention, as when this occurs, as we have just seen, between distinct species. The former cases can best be observed with domesticated or confined birds; but these are often pampered by high feeding, and sometimes have their instincts vitiated to an extreme degree. Of this latter fact I could give sufficient proofs with pigeons, and especially with fowls, but they cannot be here related. Vitiating instincts may also account for some of the hybrid unions above mentioned; but in many of these cases the birds were allowed to range freely over large ponds, and there is no reason to suppose that they were unnaturally stimulated by high feeding.

With respect to birds in a state of nature, the first and most obvious supposition which will occur to every one is that the female at the proper season accepts the first male whom she may encounter; but she has at least the opportunity for exerting a choice, as she is almost invariably pursued by many males. Audubon and we must remember that he spent a long life in prowling about the forests of the United States and observing the birds does not doubt that the female deliberately chooses her mate; thus, speaking of a woodpecker, he says the hen is followed by halfadozen gay suitors, who continue

performing strange antics, "until a marked preference is shewn for one." The female of the redwinged starling (*Agelaius phoeniceus*) is likewise pursued by several males, "until, becoming fatigued, she alights, receives their addresses, and soon makes a choice." He describes also how several male nightjars repeatedly plunge through the air with astonishing rapidity, suddenly turning, and thus making a singular noise; "but no sooner has the female made her choice than the other males are driven away." With one of the vultures (*Cathartes aura*) of the United States, parties of eight, ten, or more males and females assemble on fallen logs, "exhibiting the strongest desire to please mutually," and after many caresses, each male leads off his partner on the wing. Audubon likewise carefully observed the wild flocks of Canada geese (*Anser canadensis*), and gives a graphic description of their loveantics; he says that the birds which had been previously mated "renewed their courtship as early as the month of January, while the others would be contending or coquetting for hours every day, until all seemed satisfied with the choice they had made, after which, although they remained together, any person could easily perceive that they were careful to keep in pairs. I have observed also that the older the birds the shorter were the preliminaries of their courtshiThe bachelors and old maids whether in regret, or not caring to be disturbed by the bustle, quietly moved aside and lay down at some distance from the rest." (. Audubon, 'Ornithological Biography,' vol. i. ; vol. ii. ; vol. iii. .) Many similar statements with respect to other birds could be cited from this same observer.

Turning now to domesticated and confined birds, I will commence by giving what little I have learnt respecting the courtship of fowls. I have received long letters on this subject from Messrs. Hewitt and Tegetmeier, and almost an essay from the late Mr. Brent. It will be admitted by every one that these gentlemen, so well known from their published works, are careful and experienced observers. They do not believe that the females prefer certain males on account of the beauty of their plumage; but some allowance must be made for the artificial state under which these birds have long been kept. Mr. Tegetmeier is convinced that a gamecock, though disured by being dubbed and with his hackles trimmed, would be accepted as readily as a male retaining all his natural ornaments. Mr. Brent, however, admits that the beauty of the male probably aids in exciting the female; and her acquiescence is necessary. Mr. Hewitt is convinced that the union is by no means left to mere chance, for the female almost invariably prefers the most vigorous, defiant, and mettlesome male; hence it is almost useless, as he remarks, "to attempt true breeding if a game cock in good health and condition runs the locality, for almost every hen on leaving the roostingplace will resort to the gamecock, even though that bird may not actually drive away the male of her own variety." Under ordinary circumstances the males and females of the fowl seem to come to a mutual understanding by means of certain gestures, described to me by Mr. Brent. But hens will often avoid the officious attentions of young males. Old hens, and hens of a pugnacious disposition, as the same writer informs me, dislike strange males, and will not yield until

well beaten into compliance. Ferguson, however, describes how a quarrelsome hen was subdued by the gentle courtship of a Shanghai cock. ('Rare and Prize Poultry,' , .)

There is reason to believe that pigeons of both sexes prefer pairing with birds of the same breed; and dovecot pigeons dislike all the highly improved breeds. ('Variation of Animals and Plants under Domestication,' vol. ii. .) Mr. Harrison Weir has lately heard from a trustworthy observer, who keeps blue pigeons, that these drive away all other coloured varieties, such as white, red, and yellow; and from another observer, that a female dun carrier could not, after repeated trials, be matched with a black male, but immediately paired with a dun. Again, Mr. Tegetmeier had a female blue turbit that obstinately refused to pair with two males of the same breed, which were successively shut up with her for weeks; but on being let out she would have immediately accepted the first blue dragon that offered. As she was a valuable bird, she was then shut up for many weeks with a silver (i.e., very pale blue) male, and at last mated with him. Nevertheless, as a general rule, colour appears to have little influence on the pairing of pigeons. Mr. Tegetmeier, at my request, stained some of his birds with magenta, but they were not much noticed by the others.

Female pigeons occasionally feel a strong antipathy towards certain males, without any assignable cause. Thus MM. Boitard and Corbie, whose experience extended over fortyfive years, state: "Quand une femelle éprouve de l'antipathie pour un mâle avec lequel on veut l'accoupler, malgré tous les feux de l'amour, malgré l'alpiste et le chenevis dont on la nourrit pour augmenter son ardeur, malgré un emprisonnement de six mois et même d'un an, elle refuse constamment ses caresses; les avances empressées, les agaceries, les tournoiemens, les tendres roucoulemens, rien ne peut lui plaire ni l'émouvoir; gonflée, boudeuse, blottie dans un coin de sa prison, elle n'en sort que pour boire et manger, ou pour repousser avec une espèce de rage des caresses devenues trop pressantes." (Boitard and Corbie, 'Les Pigeons,' etc., , . Prosper Lucas ('Traité de l'Héréd. Nat.' tom. ii. ,) has himself observed nearly similar facts with pigeons.) On the other hand, Mr. Harrison Weir has himself observed, and has heard from several breeders, that a female pigeon will occasionally take a strong fancy for a particular male, and will desert her own mate for him. Some females, according to another experienced observer, Riedel (. Die Taubenzucht, , s. .), are of a profligate disposition, and prefer almost any stranger to their own mate. Some amorous males, called by our English fanciers "gay birds," are so successful in their gallantries, that, as Mr. H. Weir informs me, they must be shut up on account of the mischief which they cause.

Wild turkeys in the United States, according to Audubon, "sometimes pay their addresses to the domesticated females, and are generally received by them with great pleasure." So that these females apparently prefer the wild to their own males. (

'Ornithological Biography,' vol. i. . See to the same effect, Dr. Bryant, in Allen's 'Mammals and Birds of Florida,' .)

Here is a more curious case. Sir R. Heron during many years kept an account of the habits of the peafowl, which he bred in large numbers. He states that "the hens have frequently great preference to a particular peafowl. They were all so fond of an old pied cock, that one year, when he was confined, though still in view, they were constantly assembled close to the trellisewalls of his prison, and would not suffer a japanned peacock to touch them. On his being let out in the autumn, the oldest of the hens instantly courted him and was successful in her courtshiThe next year he was shut up in a stable, and then the hens all courted his rival." (. 'Proceedings, Zoological Society,' , . The japanned peacock is considered by Mr. Sclater as a distinct species, and has been named *Pavo nigripennis*; but the evidence seems to me to show that it is only a variety.) This rival was a japanned or blackwinged peacock, to our eyes a more beautiful bird than the common kind.

Lichtenstein, who was a good observer and had excellent opportunities of observation at the Cape of Good Hope, assured Rudolphi that the female widowbird (*Chera progne*) disowns the male when robbed of the long tail feathers with which he is ornamented during the breedingseason. I presume that this observation must have been made on birds under confinement. (. Rudolphi, 'Beiträge zur Anthropologie,' , s. .) Here is an analogous case; Dr. Jaeger (. 'Die Darwin'sche Theorie, und ihre Stellung zu Moral und Religion,' , s. .), director of the Zoological Gardens of Vienna, states that a male silverpheasant, who had been triumphant over all other males and was the accepted lover of the females, had his ornamental plumage spoiled. He was then immediately superseded by a rival, who got the upper hand and afterwards led the flock.

It is a remarkable fact, as shewing how important colour is in the courtship of birds, that Mr. Boardman, a wellknown collector and observer of birds for many years in the Northern United States, has never in his large experience seen an albino paired with another bird; yet he has had opportunities of observing many albinos belonging to several species. (. This statement is given by Mr. A. Leith Adams, in his 'Field and Forest Rambles,' , , and accords with his own experience.) It can hardly be maintained that albinos in a state of nature are incapable of breeding, as they can be raised with the greatest facility under confinement. It appears, therefore, that we must attribute the fact that they do not pair to their rejection by their normally coloured comrades.

Female birds not only exert a choice, but in some few cases they court the male, or even ht together for his possession. Sir R. Heron states that with peafowl, the first advances are always made by the female; something of the same kind takes place, according to Audubon, with the older females of the wild turkey. With the capercailzie, the females

flit round the male whilst he is parading at one of the places of assemblage, and solicit his attention. (. In regard to peafowl, see Sir R. Heron, 'Proc. Zoolog. Soc.' , , and the Rev. E.S. Dixon, 'Ornamental Poultry,' , . For the turkey, Audubon, *ibid.* . For the capercailzie, Lloyd, 'Game Birds of Sweden,' , .) We have seen that a tame wildduck seduced an unwilling pintail drake after a long courtshiMr. Bartlett believes that the Lophophorus, like many other gallinaceous birds, is naturally polygamous, but two females cannot be placed in the same cage with a male, as they ht so much together. The following instance of rivalry is more surprising as it relates to bullfinches, which usually pair for life. Mr. Jenner Weir introduced a dullcoloured and ugly female into his aviary, and she immediately attacked another mated female so unmercifully that the latter had to be separated. The new female did all the courtshiand was at last successful, for she paired with the male; but after a time she met with a just retribution, for, ceasing to be pugnacious, she was replaced by the old female, and the male then deserted his new and returned to his old love.

In all ordinary cases the male is so eager that he will accept any female, and does not, as far as we can judge, prefer one to the other; but, as we shall hereafter see, exceptions to this rule apparently occur in some few groups. With domesticated birds, I have heard of only one case of males shewing any preference for certain females, namely, that of the domestic cock, who, according to the high authority of Mr. Hewitt, prefers the younger to the older hens. On the other hand, in effecting hybrid unions between the male pheasant and common hens, Mr. Hewitt is convinced that the pheasant invariably prefers the older birds. He does not appear to be in the least influenced by their colour; but "is most capricious in his attachments" (. Mr. Hewitt, quoted in Tegetmeier's 'Poultry Book,' , .): from some inexplicable cause he shews the most determined aversion to certain hens, which no care on the part of the breeder can overcome. Mr. Hewitt informs me that some hens are quite unattractive even to the males of their own species, so that they may be kept with several cocks during a whole season, and not one egg out of forty or fifty will prove fertile. On the other hand, with the longtailed duck (*Harelda glacialis*), "it has been remarked," says M. Ekstrom, "that certain females are much more courted than the rest. Frequently, indeed, one sees an individual surrounded by six or eight amorous males." Whether this statement is credible, I know not; but the native sportsmen shoot these females in order to stuff them as decoys. (. Quoted in Lloyd's 'Game Birds of Sweden,' .)

With respect to female birds feeling a preference for particular males, we must bear in mind that we can judge of choice being exerted only by analogy. If an inhabitant of another planet were to behold a number of young rustics at a fair courting a pretty girl, and quarrelling about her like birds at one of their places of assemblage, he would, by the eagerness of the wooers to please her and to display their finery, infer that she had the power of choice. Now with birds the evidence stands thus: they have acute powers of

observation, and they seem to have some taste for the beautiful both in colour and sound. It is certain that the females occasionally exhibit, from unknown causes, the strongest antipathies and preferences for particular males. When the sexes differ in colour or in other ornaments the males with rare exceptions are the more decorated, either permanently or temporarily during the breedingseason. They sedulously display their various ornaments, exert their voices, and perform strange antics in the presence of the females. Even wellarmed males, who, it might be thought, would altogether depend for success on the law of battle, are in most cases highly ornamented; and their ornaments have been acquired at the expense of some loss of power. In other cases ornaments have been acquired, at the cost of increased risk from birds and beasts of prey. With various species many individuals of both sexes congregate at the same spot, and their courtship is a prolonged affair. There is even reason to suspect that the males and females within the same district do not always succeed in pleasing each other and pairing.

What then are we to conclude from these facts and considerations? Does the male parade his charms with so much pomp and rivalry for no purpose? Are we not justified in believing that the female exerts a choice, and that she receives the addresses of the male who pleases her most? It is not probable that she consciously deliberates; but she is most excited or attracted by the most beautiful, or melodious, or gallant males. Nor need it be supposed that the female studies each stripe or spot of colour; that the peahen, for instance, admires each detail in the gorgeous train of the peacockshe is probably struck only by the general effect. Nevertheless, after hearing how carefully the male Argus pheasant displays his elegant primary wingfeathers, and erects his ocellated plumes in the right position for their full effect; or again, how the male goldfinch alternately displays his goldbespangled wings, we ought not to feel too sure that the female does not attend to each detail of beauty. We can judge, as already remarked, of choice being exerted, only from analogy; and the mental powers of birds do not differ fundamentally from ours. From these various considerations we may conclude that the pairing of birds is not left to chance; but that those males, which are best able by their various charms to please or excite the female, are under ordinary circumstances accepted. If this be admitted, there is not much difficulty in understanding how male birds have gradually acquired their ornamental characters. All animals present individual differences, and as man can modify his domesticated birds by selecting the individuals which appear to him the most beautiful, so the habitual or even occasional preference by the female of the more attractive males would almost certainly lead to their modification; and such modifications might in the course of time be augmented to almost any extent, compatible with the existence of the species.

VARIABILITY OF BIRDS, AND ESPECIALLY OF THEIR SECONDARY SEXUAL CHARACTERS.

Variability and inheritance are the foundations for the work of selection. That domesticated birds have varied greatly, their variations being inherited, is certain. That birds in a state of nature have been modified into distinct races is now universally admitted. (According to Dr. Blasius ('Ibis,' vol. ii.), there are indubitable species of birds which breed in Europe, besides sixty forms, which are frequently regarded as distinct species. Of the latter, Blasius thinks that only ten are really doubtful, and that the other fifty ought to be united with their nearest allies; but this shews that there must be a considerable amount of variation with some of our European birds. It is also an unsettled point with naturalists, whether several North American birds ought to be ranked as specifically distinct from the corresponding European species. So again many North American forms which until lately were named as distinct species, are now considered to be local races.) Variations may be divided into two classes; those which appear to our ignorance to arise spontaneously, and those which are directly related to the surrounding conditions, so that all or nearly all the individuals of the same species are similarly modified. Cases of the latter kind have recently been observed with care by Mr. J.A. Allen ('Mammals and Birds of East Florida,' also an 'Ornithological Reconnaissance of Kansas,' etc. Notwithstanding the influence of climate on the colours of birds, it is difficult to account for the dull or dark tints of almost all the species inhabiting certain countries, for instance, the Galapagos Islands under the equator, the wide temperate plains of Patagonia, and, as it appears, Egypt (see Mr. Hartshorne in the 'American Naturalist,'). These countries are open, and afford little shelter to birds; but it seems doubtful whether the absence of brightly coloured species can be explained on the principle of protection, for on the Pampas, which are equally open, though covered by green grass, and where the birds would be equally exposed to danger, many brilliant and conspicuously coloured species are common. I have sometimes speculated whether the prevailing dull tints of the scenery in the above named countries may not have affected the appreciation of bright colours by the birds inhabiting them.), who shews that in the United States many species of birds gradually become more strongly coloured in proceeding southward, and more lightly coloured in proceeding westward to the arid plains of the interior. Both sexes seem generally to be affected in a like manner, but sometimes one sex more than the other. This result is not incompatible with the belief that the colours of birds are mainly due to the accumulation of successive variations through sexual selection; for even after the sexes have been greatly differentiated, climate might produce an equal effect on both sexes, or a greater effect on one sex than on the other, owing to some constitutional difference.

Individual differences between the members of the same species are admitted by every one to occur under a state of nature. Sudden and strongly marked variations are rare; it is also doubtful whether if beneficial they would often be preserved through selection and transmitted to succeeding generations. ('Origin of Species' fifth edit. , p. I had

always perceived, that rare and strongly marked deviations of structure, deserving to be called monstrosities, could seldom be preserved through natural selection, and that the preservation of even highly beneficial variations would depend to a certain extent on chance. I had also fully appreciated the importance of mere individual differences, and this led me to insist so strongly on the importance of that unconscious form of selection by man, which follows from the preservation of the most valued individuals of each breed, without any intention on his part to modify the characters of the breed. But until I read an able article in the 'North British Review' (March , , et seq.), which has been of more use to me than any other Review, I did not see how great the chances were against the preservation of variations, whether slight or strongly pronounced, occurring only in single individuals.) Nevertheless, it may be worth while to give the few cases which I have been able to collect, relating chiefly to colour, simple albinism and melanism being excluded. Mr. Gould is well known to admit the existence of few varieties, for he esteems very slight differences as specific; yet he states (. 'Introduction to the Trochilidae,' .) that near Bogota certain hummingbirds belonging to the genus *Cyananthus* are divided into two or three races or varieties, which differ from each other in the colouring of the tail "some having the whole of the feathers blue, while others have the eight central ones tipped with beautiful green." It does not appear that intermediate gradations have been observed in this or the following cases. In the males alone of one of the Australian parrakeets "the thighs in some are scarlet, in others grassgreen." In another parrakeet of the same country "some individuals have the band across the wingcoverts brightly yellow, while in others the same part is tinged with red." (. Gould, 'Handbook to Birds of Australia,' vol. ii. p and .) In the United States some few of the males of the scarlet tanager (*Tanagra rubra*) have "a beautiful transverse band of glowing red on the smaller wing coverts" (. Audubon, 'Ornithological Biography,' , vol. iv. .); but this variation seems to be somewhat rare, so that its preservation through sexual selection would follow only under usually favourable circumstances. In Bengal the Honey buzzard (*Pernis cristata*) has either a small rudimental crest on its head, or none at all: so slight a difference, however, would not have been worth notice, had not this same species possessed in Southern India a wellmarked occipital crest formed of several graduated feathers." (. Jerdon, 'Birds of India,' vol. i. ; and Mr. Blyth, in 'Land and Water,' , .)

The following case is in some respects more interesting. A pied variety of the raven, with the head, breast, abdomen, and parts of the wings and tail feathers white, is confined to the Feroe Islands. It is not very rare there, for Graba saw during his visit from eight to ten living specimens. Although the characters of this variety are not quite constant, yet it has been named by several distinguished ornithologists as a distinct species. The fact of the pied birds being pursued and persecuted with much clamour by the other ravens of the island was the chief cause which led Brunnich to conclude that they were specifically distinct; but this is now known to be an error. (. Graba, 'Tagebuch Reise nach Faro,' , ss. . Macgillivray, 'History of British Birds,' vol. iii. , 'Ibis,' vol. v. , .) This case seems

analogous to that lately given of albino birds not pairing from being rejected by their comrades.

In various parts of the northern seas a remarkable variety of the common Guillemot (*Uria troile*) is found; and in Feroe, one out of every five birds, according to Graba's estimation, presents this variation. It is characterised (. Graba, *ibid.* s. . Macgillivray, *ibid.* vol. v. .) by a pure white ring round the eye, with a curved narrow white line, an inch and a half in length, extending back from the ring. This conspicuous character has caused the bird to be ranked by several ornithologists as a distinct species under the name of *U. lacrymans*, but it is now known to be merely a variety. It often pairs with the common kind, yet intermediate gradations have never been seen; nor is this surprising, for variations which appear suddenly, are often, as I have elsewhere shewn (. 'Variation of Animals and Plants under Domestication,' vol. ii. .), transmitted either unaltered or not at all. We thus see that two distinct forms of the same species may coexist in the same district, and we cannot doubt that if the one had possessed any advantage over the other, it would soon have been multiplied to the exclusion of the latter. If, for instance, the male pied ravens, instead of being persecuted by their comrades, had been highly attractive (like the above pied peacock) to the black female ravens their numbers would have rapidly increased. And this would have been a case of sexual selection.

With respect to the slight individual differences which are common, in a greater or less degree, to all the members of the same species, we have every reason to believe that they are by far the most important for the work of selection. Secondary sexual characters are eminently liable to vary, both with animals in a state of nature and under domestication. (. On these points see also 'Variation of Animals and Plants under Domestication,' vol. i. ; vol. ii. .) There is also reason to believe, as we have seen in our eighth chapter, that variations are more apt to occur in the male than in the female sex. All these contingencies are highly favourable for sexual selection. Whether characters thus acquired are transmitted to one sex or to both sexes, depends, as we shall see in the following chapter, on the form of inheritance which prevails.

It is sometimes difficult to form an opinion whether certain slight differences between the sexes of birds are simply the result of variability with sexually limited inheritance, without the aid of sexual selection, or whether they have been augmented through this latter process. I do not here refer to the many instances where the male displays splendid colours or other ornaments, of which the female partakes to a slight degree; for these are almost certainly due to characters primarily acquired by the male having been more or less transferred to the female. But what are we to conclude with respect to certain birds in which, for instance, the eyes differ slightly in colour in the two sexes? (. See, for instance, on the irides of a *Podica* and *Gallixrex* in 'Ibis,' vol. ii. , ; and vol. v. , .) In some cases the eyes differ conspicuously; thus with the storks of the genus

Xenorhynchus, those of the male are blackish hazel, whilst those of the females are gambogeyellow; with many hornbills (*Buceros*), as I hear from Mr. Blyth (. See also Jerdon, 'Birds of India,' vol. i. p.), the males have intense crimson eyes, and those of the females are white. In the *Buceros bicornis*, the hind margin of the casque and a stripe on the crest of the beak are black in the male, but not so in the female. Are we to suppose that these black marks and the crimson colour of the eyes have been preserved or augmented through sexual selection in the males? This is very doubtful; for Mr. Bartlett shewed me in the Zoological Gardens that the inside of the mouth of this *Buceros* is black in the male and fleshcoloured in the female; and their external appearance or beauty would not be thus affected. I observed in Chile (. 'Zoology of the Voyage of H.M.S. "Beagle," , .) that the iris in the condor, when about a year old, is darkbrown, but changes at maturity into yellowishbrown in the male, and into bright red in the female. The male has also a small, longitudinal, leadencoloured, fleshy crest or comb. The comb of many gallinaceous birds is highly ornamental, and assumes vivid colours during the act of courtship; but what are we to think of the dull coloured comb of the condor, which does not appear to us in the least ornamental? The same question may be asked in regard to various other characters, such as the knob on the base of the beak of the Chinese goose (*Anser cygnoides*), which is much larger in the male than in the female. No certain answer can be given to these questions; but we ought to be cautious in assuming that knobs and various fleshy appendages cannot be attractive to the female, when we remember that with savage races of man various hideous deformitiesdeep scars on the face with the flesh raised into protuberances, the septum of the nose pierced by sticks or bones, holes in the ears and lips stretched widely openare all admired as ornamental.

Whether or not unimportant differences between the sexes, such as those just specified, have been preserved through sexual selection, these differences, as well as all others, must primarily depend on the laws of variation. On the principle of correlated development, the plumage often varies on different parts of the body, or over the whole body, in the same manner. We see this well illustrated in certain breeds of the fowl. In all the breeds the feathers on the neck and loins of the males are elongated, and are called hackles; now when both sexes acquire a topknot, which is a new character in the genus, the feathers on the head of the male become hackleshaped, evidently on the principle of correlation; whilst those on the head of the female are of the ordinary shape. The colour also of the hackles forming the topknot of the male, is often correlated with that of the hackles on the neck and loins, as may be seen by comparing these feathers in the golden and silverspangled Polish, the Houdans, and Crevecoeur breeds. In some natural species we may observe exactly the same correlation in the colours of these same feathers, as in the males of the splendid Gold and Amherst pheasants.

The structure of each individual feather generally causes any change in its colouring to be symmetrical; we see this in the various laced, spangled, and pencilled breeds of the fowl; and on the principle of correlation the feathers over the whole body are often coloured in the same manner. We are thus enabled without much trouble to rear breeds with their plumage marked almost as symmetrically as in natural species. In laced and spangled fowls the coloured margins of the feathers are abruptly defined; but in a mongrel raised by me from a black Spanish cock glossed with green, and a white gamehen, all the feathers were greenishblack, excepting towards their extremities, which were yellowishwhite; but between the white extremities and the black bases, there was on each feather a symmetrical, curved zone of darkbrown. In some instances the shaft of the feather determines the distribution of the tints; thus with the bodyfeathers of a mongrel from the same black Spanish cock and a silverspangled Polish hen, the shaft, together with a narrow space on each side, was greenishblack, and this was surrounded by a regular zone of darkbrown, edged with brownishwhite. In these cases we have feathers symmetrically shaded, like those which give so much elegance to the plumage of many natural species. I have also noticed a variety of the common pigeon with the wingbars symmetrically zoned with three bright shades, instead of being simply black on a slatyblue ground, as in the parentspecies.

In many groups of birds the plumage is differently coloured in the several species, yet certain spots, marks, or stripes are retained by all. Analogous cases occur with the breeds of the pigeon, which usually retain the two wingbars, though they may be coloured red, yellow, white, black, or blue, the rest of the plumage being of some wholly different tint. Here is a more curious case, in which certain marks are retained, though coloured in a manner almost exactly the opposite of what is natural; the aboriginal pigeon has a blue tail, with the terminal halves of the outer webs of the two outer tail feathers white; now there is a subvariety having a white instead of a blue tail, with precisely that part black which is white in the parentspecies. (. Bechstein, 'Naturgeschichte Deutschlands,' B. iv. , s. , on a subvariety of the Monck pigeon.)

FORMATION AND VARIABILITY OF THE OCELLI OR EYELIKE SPOTS ON THE PLUMAGE OF BIRDS.

[. . Cyllo leda, Linn., from a drawing by Mr. Trimen, shewing the extreme range of variation in the ocelli.

A. Specimen, from Mauritius, upper surface of forewing.

A. Specimen, from Natal, ditto.

B. Specimen, from Java, upper surface of hindwing.

B. Specimen, from Mauritius, ditto.]

As no ornaments are more beautiful than the ocelli on the feathers of various birds, on the hairy coats of some mammals, on the scales of reptiles and fishes, on the skin of

amphibians, on the wings of many Lepidoptera and other insects, they deserve to be especially noticed. An ocellus consists of a spot within a ring of another colour, like the pupil within the iris, but the central spot is often surrounded by additional concentric zones. The ocelli on the tailcoverts of the peacock offer a familiar example, as well as those on the wings of the peacockbutterfly (*Vanessa*). Mr. Trimen has given me a description of a S. African moth (*Gynanisa isis*), allied to our Emperor moth, in which a magnificent ocellus occupies nearly the whole surface of each hinder wing; it consists of a black centre, including a semitransparent crescentshaped mark, surrounded by successive, ochreyellow, black, ochreyellow, pink, white, pink, brown, and whitish zones. Although we do not know the steps by which these wonderfully beautiful and complex ornaments have been developed, the process has probably been a simple one, at least with insects; for, as Mr. Trimen writes to me, "no characters of mere marking or coloration are so unstable in the Lepidoptera as the ocelli, both in number and size." Mr. Wallace, who first called my attention to this subject, shewed me a series of specimens of our common meadowbrown butterfly (*Hipparchia janira*) exhibiting numerous gradations from a simple minute black spot to an elegantlyshaded ocellus. In a S. African butterfly (*Cylo leda*, Linn.), belonging to the same family, the ocelli are even still more variable. In some specimens (A, .) large spaces on the upper surface of the wings are coloured black, and include irregular white marks; and from this state a complete gradation can be traced into a tolerably perfect ocellus (A), and this results from the contraction of the irregular blotches of colour. In another series of specimens a gradation can be followed from excessively minute white dots, surrounded by a scarcely visible black line (B), into perfectly symmetrical and large ocelli (B). (. This woodcut has been engraved from a beautiful drawing, most kindly made for me by Mr. Trimen; see also his description of the wonderful amount of variation in the coloration and shape of the wings of this butterfly, in his '*Rhopalocera Africae Australis*,' .) In cases like these, the development of a perfect ocellus does not require a long course of variation and selection.

With birds and many other animals, it seems to follow from the comparison of allied species that circular spots are often generated by the breaking up and contraction of stripes. In the Tragopan pheasant faint white lines in the female represent the beautiful white spots in the male (. Jerdon, '*Birds of India*,' vol. iii. .); and something of the same kind may be observed in the two sexes of the Argus pheasant. However this may be, appearances strongly favour the belief that on the one hand, a dark spot is often formed by the colouring matter being drawn towards a central point from a surrounding zone, which latter is thus rendered lighter; and, on the other hand, that a white spot is often formed by the colour being driven away from a central point, so that it accumulates in a surrounding darker zone. In either case an ocellus is the result. The colouring matter seems to be a nearly constant quantity, but is redistributed, either centripetally or centrifugally. The feathers of the common guineafowl offer a good instance of white

spots surrounded by darker zones; and wherever the white spots are large and stand near each other, the surrounding dark zones become confluent. In the same wingfeather of the Argus pheasant dark spots may be seen surrounded by a pale zone, and white spots by a dark zone. Thus the formation of an ocellus in its most elementary state appears to be a simple affair. By what further steps the more complex ocelli, which are surrounded by many successive zones of colour, have been generated, I will not pretend to say. But the zoned feathers of the mongrels from differently coloured fowls, and the extraordinary variability of the ocelli on many Lepidoptera, lead us to conclude that their formation is not a complex process, but depends on some slight and graduated change in the nature of the adjoining tissues.

GRADATION OF SECONDARY SEXUAL CHARACTERS.

[. . Feather of Peacock, about twothirds of natural size, drawn by Mr. Ford. The transparent zone is represented by the outermost white zone, confined to the upper end of the disc.]

Cases of gradation are important, as shewing us that highly complex ornaments may be acquired by small successive steps. In order to discover the actual steps by which the male of any existing bird has acquired his magnificent colours or other ornaments, we ought to behold the long line of his extinct progenitors; but this is obviously impossible. We may, however, generally gain a clue by comparing all the species of the same group if it be a large one; for some of them will probably retain, at least partially, traces of their former characters. Instead of entering on tedious details respecting various groups, in which striking instances of gradation could be given, it seems the best plan to take one or two strongly marked cases, for instance that of the peacock, in order to see if light can be thrown on the steps by which this bird has become so splendidly decorated. The peacock is chiefly remarkable from the extraordinary length of his tailcoverts; the tail itself not being much elongated. The barbs along nearly the whole length of these feathers stand separate or are decomposed; but this is the case with the feathers of many species, and with some varieties of the domestic fowl and pigeon. The barbs coalesce towards the extremity of the shaft forming the oval disc or ocellus, which is certainly one of the most beautiful objects in the world. It consists of an iridescent, intensely blue, indented centre, surrounded by a rich green zone, this by a broad copperybrown zone, and this by five other narrow zones of slightly different iridescent shades. A trifling character in the disc deserves notice; the barbs, for a space along one of the concentric zones are more or less destitute of their barbules, so that a part of the disc is surrounded by an almost transparent zone, which gives it a highly finished aspect. But I have elsewhere described (. 'Variation of Animals and Plants under Domestication,' vol. i. .) an exactly analogous variation in the hackles of a subvariety of the game cock, in which the tips, having a metallic lustre, "are separated from the lower part of the feather by a

symmetrically shaped transparent zone, composed of the naked portions of the barbs." The lower margin or base of the darkblue centre of the ocellus is deeply indented on the line of the shaft. The surrounding zones likewise shew traces, as may be seen in the drawing , of indentations, or rather breaks. These indentations are common to the Indian and Javan peacocks (*Pavo cristatus* and *muticus*); and they seem to deserve particular attention, as probably connected with the development of the ocellus; but for a long time I could not conjecture their meaning.

If we admit the principle of gradual evolution, there must formerly have existed many species which presented every successive step between the wonderfully elongated tailcoverts of the peacock and the short tail coverts of all ordinary birds; and again between the magnificent ocelli of the former, and the simpler ocelli or mere coloured spots on other birds; and so with all the other characters of the peacock. Let us look to the allied Gallinaceae for any stillexisting gradations. The species and sub species of *Polyplectron* inhabit countries adjacent to the native land of the peacock; and they so far resemble this bird that they are sometimes called peacockpheasants. I am also informed by Mr. Bartlett that they resemble the peacock in their voice and in some of their habits. During the spring the males, as previously described, strut about before the comparatively plaincoloured females, expanding and erecting their tail and wingfeathers, which are ornamented with numerous ocelli. I request the reader to turn back to the drawing of a *Polyplectron*; In *napoleonis* the ocelli are confined to the tail, and the back is of a rich metallic blue; in which respects this species approaches the Java peacock. *hardwickii* possesses a peculiar topknot, which is also somewhat like that of the Java peacock. In all the species the ocelli on the wings and tail are either circular or oval, and consist of a beautiful, iridescent, greenishblue or greenishpurple disc, with a black border. This border in *chinquis* shades into brown, edged with cream colour, so that the ocellus is here surrounded with variously shaded, though not bright, concentric zones. The unusual length of the tailcoverts is another remarkable character in *Polyplectron*; for in some of the species they are half, and in others twothirds as long as the true tailfeathers. The tailcoverts are ocellated as in the peacock. Thus the several species of *Polyplectron* manifestly make a graduated approach to the peacock in the length of their tailcoverts, in the zoning of the ocelli, and in some other characters.

[. . Part of a tailcovert of *Polyplectron chinquis*, with the two ocelli of natural size.

. . Part of a tailcovert of *Polyplectron malaccense*, with the two ocelli, partially confluent, of natural size.]

Notwithstanding this approach, the first species of *Polyplectron* which I examined almost made me give up the search; for I found not only that the true tailfeathers, which in the peacock are quite plain, were ornamented with ocelli, but that the ocelli on all the

feathers differed fundamentally from those of the peacock, in there being two on the same feather, one on each side of the shaft. Hence I concluded that the early progenitors of the peacock could not have resembled a Polyplectron. But on continuing my search, I observed that in some of the species the two ocelli stood very near each other; that in the tailfeathers of *hardwickii* they touched each other; and, finally, that on the tailcoverts of this same species as well as of *malaccense* they were actually confluent. As the central part alone is confluent, an indentation is left at both the upper and lower ends; and the surrounding coloured zones are likewise indented. A single ocellus is thus formed on each tailcovert, though still plainly betraying its double origin. These confluent ocelli differ from the single ocelli of the peacock in having an indentation at both ends, instead of only at the lower or basal end. The explanation, however, of this difference is not difficult; in some species of Polyplectron the two oval ocelli on the same feather stand parallel to each other; in other species (as in *chinquis*) they converge towards one end; now the partial confluence of two convergent ocelli would manifestly leave a much deeper indentation at the divergent than at the convergent end. It is also manifest that if the convergence were strongly pronounced and the confluence complete, the indentation at the convergent end would tend to disappear.

The tailfeathers in both species of the peacock are entirely destitute of ocelli, and this apparently is related to their being covered up and concealed by the long tailcoverts. In this respect they differ remarkably from the tailfeathers of Polyplectron, which in most of the species are ornamented with larger ocelli than those on the tailcoverts. Hence I was led carefully to examine the tailfeathers of the several species, in order to discover whether their ocelli shewed any tendency to disappear; and to my great satisfaction, this appeared to be so. The central tailfeathers of *napoleonis* have the two ocelli on each side of the shaft perfectly developed; but the inner ocellus becomes less and less conspicuous on the more exterior tailfeathers, until a mere shadow or rudiment is left on the inner side of the outermost feather. Again, in *malaccense*, the ocelli on the tailcoverts are, as we have seen, confluent; and these feathers are of unusual length, being twothirds of the length of the tailfeathers, so that in both these respects they approach the tailcoverts of the peacock. Now in *malaccense*, the two central tailfeathers alone are ornamented, each with two brightlycoloured ocelli, the inner ocellus having completely disappeared from all the other tailfeathers. Consequently the tailcoverts and tailfeathers of this species of Polyplectron make a near approach in structure and ornamentation to the corresponding feathers of the peacock.

As far, then, as gradation throws light on the steps by which the magnificent train of the peacock has been acquired, hardly anything more is needed. If we picture to ourselves a progenitor of the peacock in an almost exactly intermediate condition between the existing peacock, with his enormously elongated tailcoverts, ornamented with single

ocelli, and an ordinary gallinaceous bird with short tailcoverts, merely spotted with some colour, we shall see a bird allied to Polyplectron that is, with tailcoverts, capable of erection and expansion, ornamented with two partially confluent ocelli, and long enough almost to conceal the tail feathers, the latter having already partially lost their ocelli. The indentation of the central disc and of the surrounding zones of the ocellus, in both species of peacock, speaks plainly in favour of this view, and is otherwise inexplicable. The males of Polyplectron are no doubt beautiful birds, but their beauty, when viewed from a little distance, cannot be compared with that of the peacock. Many female progenitors of the peacock must, during a long line of descent, have appreciated this superiority; for they have unconsciously, by the continued preference for the most beautiful males, rendered the peacock the most splendid of living birds.

ARGUS PHEASANT.

Another excellent case for investigation is offered by the ocelli on the wingfeathers of the Argus pheasant, which are shaded in so wonderful a manner as to resemble balls lying loose within sockets, and consequently differ from ordinary ocelli. No one, I presume, will attribute the shading, which has excited the admiration of many experienced artists, to chance or to the fortuitous concourse of atoms of colouring matter. That these ornaments should have been formed through the selection of many successive variations, not one of which was originally intended to produce the ballandsocket effect, seems as incredible as that one of Raphael's Madonnas should have been formed by the selection of chance daubs of paint made by a long succession of young artists, not one of whom intended at first to draw the human ure. In order to discover how the ocelli have been developed, we cannot look to a long line of progenitors, nor to many closely allied forms, for such do not now exist. But fortunately the several feathers on the wing suffice to give us a clue to the problem, and they prove to demonstration that a gradation is at least possible from a mere spot to a finished ballandsocket ocellus.

[. . Part of secondary wingfeather of Argus pheasant, shewing two perfect ocelli, a and b. A, B, C, D, etc., are dark stripes running obliquely down, each to an ocellus. [Much of the web on both sides, especially to the left of the shaft, has been cut off.]

.. Portion of one of the secondary wingfeathers near to the body, shewing the so-called elliptic ornaments. The righthand ure is given merely as a diagram for the sake of the letters of reference. A, B, C, D, etc. Rows of spots running down to and forming the elliptic ornaments. b. Lowest spot or mark in row B. c. The next succeeding spot or mark in the same row. d. Apparently a broken prolongation of the spot c. in the same row B.]

The wingfeathers, bearing the ocelli, are covered with dark stripes or with rows of dark spots, each stripe or row of spots running obliquely down the outer side of the shaft to

one of the ocelli. The spots are generally elongated in a line transverse to the row in which they stand. They often become confluent either in the line of the row and then they form a longitudinal stripe or transversely, that is, with the spots in the adjoining rows, and then they form transverse stripes. A spot sometimes breaks up into smaller spots, which still stand in their proper places.

It will be convenient first to describe a perfect ball and socket ocellus. This consists of an intensely black circular ring, surrounding a space shaded so as exactly to resemble a ball. The ure here given has been admirably drawn by Mr. Ford and well engraved, but a woodcut cannot exhibit the exquisite shading of the original. The ring is almost always slightly broken or interrupted at a point in the upper half, a little to the right of and above the white shade on the enclosed ball; it is also sometimes broken towards the base on the right hand. These little breaks have an important meaning. The ring is always much thickened, with the edges ill defined towards the lefthand upper corner, the feather being held erect, in the position in which it is here drawn. Beneath this thickened part there is on the surface of the ball an oblique almost pure white mark, which shades off downwards into a pale leaden hue, and this into yellowish and brown tints, which insensibly become darker and darker towards the lower part of the ball. It is this shading which gives so admirably the effect of light shining on a convex surface. If one of the balls be examined, it will be seen that the lower part is of a brown tint and is indistinctly separated by a curved oblique line from the upper part, which is yellower and more leaden; this curved oblique line runs at right angles to the longer axis of the white patch of light, and indeed of all the shading; but this difference in colour, which cannot of course be shewn in the woodcut, does not in the least interfere with the perfect shading of the ball. It should be particularly observed that each ocellus stands in obvious connection either with a dark stripe, or with a longitudinal row of dark spots, for both occur indifferently on the same feather. Thus in . stripe A runs to ocellus a; B runs to ocellus b; stripe C is broken in the upper part, and runs down to the next succeeding ocellus, not represented in the woodcut; D to the next lower one, and so with the stripes E and F. Lastly, the several ocelli are separated from each other by a pale surface bearing irregular black marks.

[. . Basal part of the secondary wing feather, nearest to the body.]

I will next describe the other extreme of the series, namely, the first trace of an ocellus. The short secondary wing feather, nearest to the body, is marked like the other feathers, with oblique, longitudinal, rather irregular, rows of very dark spots. The basal spot, or that nearest the shaft, in the five lower rows (excluding the lowest one) is a little larger than the other spots of the same row, and a little more elongated in a transverse direction. It differs also from the other spots by being bordered on its upper side with some dull fulvous shading. But this spot is not in any way more remarkable than those

on the plumage of many birds, and might easily be overlooked. The next higher spot does not differ at all from the upper ones in the same row. The larger basal spots occupy exactly the same relative position on these feathers as do the perfect ocelli on the longer wingfeathers.

By looking to the next two or three succeeding wingfeathers, an absolutely insensible gradation can be traced from one of the lastdescribed basal spots, together with the next higher one in the same row, to a curious ornament, which cannot be called an ocellus, and which I will name, from the want of a better term, an "elliptic ornament." These are shewn in the accompanying ure . We here see several oblique rows, A, B, C, D, etc. (see the lettered diagram on the right hand), of dark spots of the usual character. Each row of spots runs down to and is connected with one of the elliptic ornaments, in exactly the same manner as each stripe in . runs down to and is connected with one of the ballandsocket ocelli. Looking to any one row, for instance, B, in . , the lowest mark (b) is thicker and considerably longer than the upper spots, and has its left extremity pointed and curved upwards. This black mark is abruptly bordered on its upper side by a rather broad space of richly shaded tints, beginning with a narrow brown zone, which passes into orange, and this into a pale leaden tint, with the end towards the shaft much paler. These shaded tints together fill up the whole inner space of the elliptic ornament. The mark (b) corresponds in every respect with the basal shaded spot of the simple feather described in the last paragraph , but is more highly developed and more brightly coloured. Above and to the right of this spot (b, .), with its bright shading, there is a long narrow, black mark (c), belonging to the same row, and which is arched a little downwards so as to face (b). This mark is sometimes broken into two portions. It is also narrowly edged on the lower side with a fulvous tint. To the left of and above c, in the same oblique direction, but always more or less distinct from it, there is another black mark (d). This mark is generally subtriangular and irregular in shape, but in the one lettered in the diagram it is unusually narrow, elongated, and regular. It apparently consists of a lateral and broken prolongation of the mark (c), together with its confluence with a broken and prolonged part of the next spot above; but I do not feel sure of this. These three marks, b, c, and d, with the intervening bright shades, form together the so-called elliptic ornament. These ornaments placed parallel to the shaft, manifestly correspond in position with the ballandsocket ocelli. Their extremely elegant appearance cannot be appreciated in the drawing, as the orange and leaden tints, contrasting so well with the black marks, cannot be shewn.

[. . An ocellus in an intermediate condition between the elliptic ornament and the perfect ballandsocket ocellus.]

Between one of the elliptic ornaments and a perfect ballandsocket ocellus, the gradation is so perfect that it is scarcely possible to decide when the latter term ought to be used.

The passage from the one into the other is effected by the elongation and greater curvature in opposite directions of the lower black mark (b, .), and more especially of the upper one (c), together with the contraction of the elongated sub triangular or narrow mark (d), so that at last these three marks become confluent, forming an irregular elliptic ring. This ring is gradually rendered more and more circular and regular, increasing at the same time in diameter. I have here given a drawing of the natural size of an ocellus not as yet quite perfect. The lower part of the black ring is much more curved than is the lower mark in the elliptic ornament (b, .). The upper part of the ring consists of two or three separate portions; and there is only a trace of the thickening of the portion which forms the black mark above the white shade. This white shade itself is not as yet much concentrated; and beneath it the surface is brighter coloured than in a perfect ballandsocket ocellus. Even in the most perfect ocelli traces of the junction of three or four elongated black marks, by which the ring has been formed, may often be detected. The irregular subtriangular or narrow mark (d, .), manifestly forms, by its contraction and equalisation, the thickened portion of the ring above the white shade on a perfect ballandsocket ocellus. The lower part of the ring is invariably a little thicker than the other parts , and this follows from the lower black mark of the elliptic ornament (b, .) having originally been thicker than the upper mark (c). Every step can be followed in the process of confluence and modification; and the black ring which surrounds the ball of the ocellus is unquestionably formed by the union and modification of the three black marks, b, c, d, of the elliptic ornament. The irregular zigzag black marks between the successive ocelli are plainly due to the breaking up of the somewhat more regular but similar marks between the elliptic ornaments.

The successive steps in the shading of the ballandsocket ocelli can be followed out with equal clearness. The brown, orange, and paleleadened narrow zones, which border the lower black mark of the elliptic ornament, can be seen gradually to become more and more softened and shaded into each other, with the upper lighter part towards the lefthand corner rendered still lighter, so as to become almost white, and at the same time more contracted. But even in the most perfect ballandsocket ocelli a slight difference in the tints, though not in the shading, between the upper and lower parts of the ball can be perceived, as before noticed; and the line of separation is oblique, in the same direction as the bright coloured shades of the elliptic ornaments. Thus almost every minute detail in the shape and colouring of the ballandsocket ocelli can be shewn to follow from gradual changes in the elliptic ornaments; and the development of the latter can be traced by equally small steps from the union of two almost simple spots, the lower one having some dull fulvous shading on its upper side.

[. . Portion near summit of one of the secondary wingfeathers, bearing perfect ballandsocket ocelli. a. Ornamented upper part. b. Uppermost, imperfect ballandsocket

ocellus. (The shading above the white mark on the summit of the ocellus is here a little too dark.) c. Perfect ocellus.]

The extremities of the longer secondary feathers which bear the perfect ballandsocket ocelli, are peculiarly ornamented . The oblique longitudinal stripes suddenly cease upwards and become confused; and above this limit the whole upper end of the feather (a) is covered with white dots, surrounded by little black rings, standing on a dark ground. The oblique stripe belonging to the uppermost ocellus (b) is barely represented by a very short irregular black mark with the usual, curved, transverse base. As this stripe is thus abruptly cut off, we can perhaps understand from what has gone before, how it is that the upper thickened part of the ring is here absent; for, as before stated, this thickened part apparently stands in some relation with a broken prolongation from the next higher spot. From the absence of the upper and thickened part of the ring, the uppermost ocellus, though perfect in all other respects, appears as if its top had been obliquely sliced off. It would, I think, perplex any one, who believes that the plumage of the Argus pheasant was created as we now see it, to account for the imperfect condition of the uppermost ocellus. I should add that on the secondary wingfeather farthest from the body all the ocelli are smaller and less perfect than on the other feathers, and have the upper part of the ring deficient, as in the case just mentioned. The imperfection here seems to be connected with the fact that the spots on this feather shew less tendency than usual to become confluent into stripes; they are, on the contrary, often broken up into smaller spots, so that two or three rows run down to the same ocellus.

There still remains another very curious point, first observed by Mr. T.W. Wood (. The 'Field,' May , .), which deserves attention. In a photograph, given me by Mr. Ward, of a specimen mounted as in the act of display, it may be seen that on the feathers which are held perpendicularly, the white marks on the ocelli, representing light reflected from a convex surface, are at the upper or further end, that is, are directed upwards; and the bird whilst displaying himself on the ground would naturally be illuminated from above. But here comes the curious point; the outer feathers are held almost horizontally, and their ocelli ought likewise to appear as if illuminated from above, and consequently the white marks ought to be placed on the upper sides of the ocelli; and, wonderful as is the fact, they are thus placed! Hence the ocelli on the several feathers, though occupying very different positions with respect to the light, all appear as if illuminated from above, just as an artist would have shaded them. Nevertheless they are not illuminated from strictly the same point as they ought to be; for the white marks on the ocelli of the feathers which are held almost horizontally, are placed rather too much towards the further end; that is, they are not sufficiently lateral. We have, however, no right to expect absolute perfection in a part rendered ornamental through sexual selection, any more than we have in a part modified through natural selection for real use; for instance, in that wondrous organ the human eye. And we know what Helmholtz, the

highest authority in Europe on the subject, has said about the human eye; that if an optician had sold him an instrument so carelessly made, he would have thought himself fully justified in returning it. (. 'Popular Lectures on Scientific Subjects,' Eng. trans. , , , .)

We have now seen that a perfect series can be followed, from simple spots to the wonderful ballandsocket ornaments. Mr. Gould, who kindly gave me some of these feathers, fully agrees with me in the completeness of the gradation. It is obvious that the stages in development exhibited by the feathers on the same bird do not at all necessarily shew us the steps passed through by the extinct progenitors of the species; but they probably give us the clue to the actual steps, and they at least prove to demonstration that a gradation is possible. Bearing in mind how carefully the male Argus pheasant displays his plumes before the female, as well as the many facts rendering it probable that female birds prefer the more attractive males, no one who admits the agency of sexual selection in any case will deny that a simple dark spot with some fulvous shading might be converted, through the approximation and modification of two adjoining spots, together with some slight increase of colour, into one of the so called elliptic ornaments. These latter ornaments have been shewn to many persons, and all have admitted that they are beautiful, some thinking them even more so than the ballandsocket ocelli. As the secondary plumes became lengthened through sexual selection, and as the elliptic ornaments increased in diameter, their colours apparently became less bright; and then the ornamentation of the plumes had to be gained by an improvement in the pattern and shading; and this process was carried on until the wonderful ballandsocket ocelli were finally developed. Thus we can understand in no other way as it seems to me the present condition and origin of the ornaments on the wingfeathers of the Argus pheasant.

From the light afforded by the principle of gradation from what we know of the laws of variation from the changes which have taken place in many of our domesticated birds and, lastly, from the character (as we shall hereafter see more clearly) of the immature plumage of young birds we can sometimes indicate, with a certain amount of confidence, the probable steps by which the males have acquired their brilliant plumage and various ornaments; yet in many cases we are involved in complete darkness. Mr. Gould several years ago pointed out to me a hummingbird, the *Urosticte benjamini*, remarkable for the curious differences between the sexes. The male, besides a splendid gorget, has greenishblack tailfeathers, with the four CENTRAL ones tipped with white; in the female, as with most of the allied species, the three OUTER tailfeathers on each side are tipped with white, so that the male has the four central, whilst the female has the six exterior feathers ornamented with white tips. What makes the case more curious is that, although the colouring of the tail differs remarkably in both sexes of many kinds

of hummingbirds, Mr. Gould does not know a single species, besides the *Urosticte*, in which the male has the four central feathers tipped with white.

The Duke of Argyll, in commenting on this case (. 'The Reign of Law,' , .), passes over sexual selection, and asks, "What explanation does the law of natural selection give of such specific varieties as these?" He answers "none whatever"; and I quite agree with him. But can this be so confidently said of sexual selection? Seeing in how many ways the tailfeathers of hummingbirds differ, why should not the four central feathers have varied in this one species alone, so as to have acquired white tips? The variations may have been gradual, or somewhat abrupt as in the case recently given of the hummingbirds near Bogota, in which certain individuals alone have the "central tailfeathers tipped with beautiful green." In the female of the *Urosticte* I noticed extremely minute or rudimental white tips to the two outer of the four central black tail feathers; so that here we have an indication of change of some kind in the plumage of this species. If we grant the possibility of the central tail feathers of the male varying in whiteness, there is nothing strange in such variations having been sexually selected. The white tips, together with the small white eartufts, certainly add, as the Duke of Argyll admits, to the beauty of the male; and whiteness is apparently appreciated by other birds, as may be inferred from such cases as the snowwhite male of the Bellbird. The statement made by Sir R. Heron should not be forgotten, namely, that his peahens, when debarred from access to the pied peacock, would not unite with any other male, and during that season produced no offspring. Nor is it strange that variations in the tailfeathers of the *Urosticte* should have been specially selected for the sake of ornament, for the next succeeding genus in the family takes its name of *Metallura* from the splendour of these feathers. We have, moreover, good evidence that hummingbirds take especial pains in displaying their tailfeathers; Mr. Belt (. 'The Naturalist in Nicaragua,' , .), after describing the beauty of the *Florisuga mellivora*, says, "I have seen the female sitting on a branch, and two males displaying their charms in front of her. One would shoot up like a rocket, then suddenly expanding the snowwhite tail, like an inverted parachute, slowly descend in front of her, turning round gradually to shew off back and front. The expanded white tail covered more space than all the rest of the bird, and was evidently the grand feature in the performance. Whilst one male was descending, the other would shoot up and come slowly down expanded. The entertainment would end in a fight between the two performers; but whether the most beautiful or the most pugnacious was the accepted suitor, I know not." Mr. Gould, after describing the peculiar plumage of the *Urosticte*, adds, "that ornament and variety is the sole object, I have myself but little doubt." (. 'Introduction to the Trochilidae,' , .) If this be admitted, we can perceive that the males which during former times were decked in the most elegant and novel manner would have gained an advantage, not in the ordinary struggle for life, but in rivalry with other males, and would have left a larger number of offspring to inherit their newly acquired beauty.

CHAPTER XV.

Birdscontinued.

Discussion as to why the males alone of some species, and both sexes of others, are brightly colouredOn sexuallylimited inheritance, as applied to various structures and to

brightly coloured plumage
Nidification in relation to colour
Loss of nuptial plumage during the winter.

We have in this chapter to consider why the females of many birds have not acquired the same ornaments as the male; and why, on the other hand, both sexes of many other birds are equally, or almost equally, ornamented? In the following chapter we shall consider the few cases in which the female is more conspicuously coloured than the male.

In my 'Origin of Species' (Fourth edition,) I briefly suggested that the long tail of the peacock would be inconvenient and the conspicuous black colour of the male capercaillie dangerous, to the female during the period of incubation: and consequently that the transmission of these characters from the male to the female offspring had been checked through natural selection. I still think that this may have occurred in some few instances: but after mature reflection on all the facts which I have been able to collect, I am now inclined to believe that when the sexes differ, the successive variations have generally been from the first limited in their transmission to the same sex in which they first arose. Since my remarks appeared, the subject of sexual coloration has been discussed in some very interesting papers by Mr. Wallace ('Westminster Review,' July . 'Journal of Travel,' vol. i. , .), who believes that in almost all cases the successive variations tended at first to be transmitted equally to both sexes; but that the female was saved, through natural selection, from acquiring the conspicuous colours of the male, owing to the danger which she would thus have incurred during incubation.

This view necessitates a tedious discussion on a difficult point, namely, whether the transmission of a character, which is at first inherited by both sexes can be subsequently limited in its transmission to one sex alone by means of natural selection. We must bear in mind, as shewn in the preliminary chapter on sexual selection, that characters which are limited in their development to one sex are always latent in the other. An imaginary illustration will best aid us in seeing the difficulty of the case; we may suppose that a fancier wished to make a breed of pigeons, in which the males alone should be coloured of a pale blue, whilst the females retained their former slaty tint. As with pigeons characters of all kinds are usually transmitted to both sexes equally, the fancier would have to try to convert this latter form of inheritance into sexually limited transmission. All that he could do would be to persevere in selecting every male pigeon which was in the least degree of a paler blue; and the natural result of this process, if steadily carried on for a long time, and if the pale variations were strongly inherited or often recurred, would be to make his whole stock of a lighter blue. But our fancier would be compelled to match, generation after generation, his pale blue males with slaty females, for he wishes to keep the latter of this colour. The result would generally be the production either of a mongrel piebald lot, or more probably the speedy and complete loss of the

paleblue tint; for the primordial slaty colour would be transmitted with prepotent force. Supposing, however, that some paleblue males and slaty females were produced during each successive generation, and were always crossed together, then the slaty females would have, if I may use the expression, much blue blood in their veins, for their fathers, grandfathers, etc., will all have been blue birds. Under these circumstances it is conceivable (though I know of no distinct facts rendering it probable) that the slaty females might acquire so strong a latent tendency to paleblueness, that they would not destroy this colour in their male offspring, their female offspring still inheriting the slaty tint. If so, the desired end of making a breed with the two sexes permanently different in colour might be gained.

The extreme importance, or rather necessity in the above case of the desired character, namely, paleblueness, being present though in a latent state in the female, so that the male offspring should not be deteriorated, will be best appreciated as follows: the male of Soemmerring's pheasant has a tail thirtyseven inches in length, whilst that of the female is only eight inches; the tail of the male common pheasant is about twenty inches, and that of the female twelve inches long. Now if the female Soemmerring pheasant with her SHORT tail were crossed with the male common pheasant, there can be no doubt that the male hybrid offspring would have a much LONGER tail than that of the pure offspring of the common pheasant. On the other hand, if the female common pheasant, with a tail much longer than that of the female Soemmerring pheasant, were crossed with the male of the latter, the male hybrid offspring would have a much SHORTER tail than that of the pure offspring of Soemmerring's pheasant. (. Temminck says that the tail of the female Phasianus Soemmerringii is only six inches long, 'Planches coloriees,' vol. v. , p and : the measurements above given were made for me by Mr. Sclater. For the common pheasant, see Macgillivray, 'History of British Birds,' vol. i. p.)

Our fancier, in order to make his new breed with the males of a paleblue tint, and the females unchanged, would have to continue selecting the males during many generations; and each stage of paleness would have to be fixed in the males, and rendered latent in the females. The task would be an extremely difficult one, and has never been tried, but might possibly be successfully carried out. The chief obstacle would be the early and complete loss of the paleblue tint, from the necessity of reiterated crosses with the slaty female, the latter not having at first any LATENT tendency to produce paleblue offspring.

On the other hand, if one or two males were to vary ever so slightly in paleness, and the variations were from the first limited in their transmission to the male sex, the task of making a new breed of the desired kind would be easy, for such males would simply have to be selected and matched with ordinary females. An analogous case has actually

occurred, for there are breeds of the pigeon in Belgium (. Dr. Chapuis, 'Le Pigeon Voyageur Belge,' , .) in which the males alone are marked with black striae. So again Mr. Tegetmeier has recently shewn (. The 'Field,' Sept. .) that dragons not rarely produce silvercoloured birds, which are almost always hens; and he himself has bred ten such females. It is on the other hand a very unusual event when a silver male is produced; so that nothing would be easier, if desired, than to make a breed of dragons with blue males and silver females. This tendency is indeed so strong that when Mr. Tegetmeier at last got a silver male and matched him with one of the silver females, he expected to get a breed with both sexes thus coloured; he was however disappointed, for the young male reverted to the blue colour of his grandfather, the young female alone being silver. No doubt with patience this tendency to reversion in the males, reared from an occasional silver male matched with a silver hen, might be eliminated, and then both sexes would be coloured alike; and this very process has been followed with success by Mr. Esquilant in the case of silver turbits.

With fowls, variations of colour, limited in their transmission to the male sex, habitually occur. When this form of inheritance prevails, it might well happen that some of the successive variations would be transferred to the female, who would then slightly resemble the male, as actually occurs in some breeds. Or again, the greater number, but not all, of the successive steps might be transferred to both sexes, and the female would then closely resemble the male. There can hardly be a doubt that this is the cause of the male pouter pigeon having a somewhat larger croand of the male carrier pigeon having somewhat larger wattles, than their respective females; for fanciers have not selected one sex more than the other, and have had no wish that these characters should be more strongly displayed in the male than in the female, yet this is the case with both breeds.

The same process would have to be followed, and the same difficulties encountered, if it were desired to make a breed with the females alone of some new colour.

Lastly, our fancier might wish to make a breed with the two sexes differing from each other, and both from the parent species. Here the difficulty would be extreme, unless the successive variations were from the first sexually limited on both sides, and then there would be no difficulty. We see this with the fowl; thus the two sexes of the pencilled Hamburgs differ greatly from each other, and from the two sexes of the aboriginal *Gallus bankiva*; and both are now kept constant to their standard of excellence by continued selection, which would be impossible unless the distinctive characters of both were limited in their transmission.

The Spanish fowl offers a more curious case; the male has an immense comb, but some of the successive variations, by the accumulation of which it was acquired, appear to have been transferred to the female; for she has a comb many times larger than that of

the females of the parent species. But the comb of the female differs in one respect from that of the male, for it is apt to lop over; and within a recent period it has been ordered by the fancy that this should always be the case, and success has quickly followed the order. Now the lopping of the comb must be sexually limited in its transmission, otherwise it would prevent the comb of the male from being perfectly upright, which would be abhorrent to every fancier. On the other hand, the uprightness of the comb in the male must likewise be a sexually limited character, otherwise it would prevent the comb of the female from lopping over.

From the foregoing illustrations, we see that even with almost unlimited time at command, it would be an extremely difficult and complex, perhaps an impossible process, to change one form of transmission into the other through selection. Therefore, without distinct evidence in each case, I am unwilling to admit that this has been effected in natural species. On the other hand, by means of successive variations, which were from the first

sexually limited in their transmission, there would not be the least difficulty in rendering a male bird widely different in colour or in any other character from the female; the latter being left unaltered, or slightly altered, or specially modified for the sake of protection.

As bright colours are of service to the males in their rivalry with other males, such colours would be selected whether or not they were transmitted exclusively to the same sex. Consequently the females might be expected often to partake of the brightness of the males to a greater or less degree; and this occurs with a host of species. If all the successive variations were transmitted equally to both sexes, the females would be indistinguishable from the males; and this likewise occurs with many birds. If, however, dull colours were of high importance for the safety of the female during incubation, as with many ground birds, the females which varied in brightness, or which received through inheritance from the males any marked accession of brightness, would sooner or later be destroyed. But the tendency in the males to continue for an indefinite period transmitting to their female offspring their own brightness, would have to be eliminated by a change in the form of inheritance; and this, as shewn by our previous illustration, would be extremely difficult. The more probable result of the longcontinued destruction of the more brightlycoloured females, supposing the equal form of transmission to prevail, would be the lessening or annihilation of the bright colours of the males, owing to their continual crossing with the duller females. It would be tedious to follow out all the other possible results; but I may remind the reader that if sexuallylimited variations in brightness occurred in the females, even if they were not in the least injurious to them and consequently were not eliminated, yet they would not be favoured or selected, for the male usually accepts any female, and does not select the more attractive individuals;

consequently these variations would be liable to be lost, and would have little influence on the character of the race; and this will aid in accounting for the females being commonly duller coloured than the males.

In the eighth chapter instances were given, to which many might here be added, of variations occurring at various ages, and inherited at the corresponding age. It was also shewn that variations which occur late in life are commonly transmitted to the same sex in which they first appear; whilst variations occurring early in life are apt to be transmitted to both sexes; not that all the cases of sexually limited transmission can thus be accounted for. It was further shewn that if a male bird varied by becoming brighter whilst young, such variations would be of no service until the age for reproduction had arrived, and there was competition between rival males. But in the case of birds living on the ground and commonly in need of the protection of dull colours, bright tints would be far more dangerous to the young and inexperienced than to the adult males. Consequently the males which varied in brightness whilst young would suffer much destruction and be eliminated through natural selection; on the other hand, the males which varied in this manner when nearly mature, notwithstanding that they were exposed to some additional danger, might survive, and from being favoured through sexual selection, would procreate their kind. As a relation often exists between the period of variation and the form of transmission, if the bright coloured young males were destroyed and the mature ones were successful in their courtship the males alone would acquire brilliant colours and would transmit them exclusively to their male offspring. But I by no means wish to maintain that the influence of age on the form of transmission, is the sole cause of the great difference in brilliancy between the sexes of many birds.

When the sexes of birds differ in colour, it is interesting to determine whether the males alone have been modified by sexual selection, the females having been left unchanged, or only partially and indirectly thus changed; or whether the females have been specially modified through natural selection for the sake of protection. I will therefore discuss this question at some length, even more fully than its intrinsic importance deserves; for various curious collateral points may thus be conveniently considered.

Before we enter on the subject of colour, more especially in reference to Mr. Wallace's conclusions, it may be useful to discuss some other sexual differences under a similar point of view. A breed of fowls formerly existed in Germany (. Bechstein, 'Naturgeschichte Deutschlands,' , B. iii. .) in which the hens were furnished with spurs; they were good layers, but they so greatly disturbed their nests with their spurs that they could not be allowed to sit on their own eggs. Hence at one time it appeared to me probable that with the females of the wild Gallinaceae the development of spurs had been checked through natural selection, from the injury thus caused to their nests. This

seemed all the more probable, as wingspurs, which would not be injurious during incubation, are often as well developed in the female as in the male; though in not a few cases they are rather larger in the male. When the male is furnished with legspurs the female almost always exhibits rudiments of them, the rudiment sometimes consisting of a mere scale, as in Gallus. Hence it might be argued that the females had aboriginally been furnished with well developed spurs, but that these had subsequently been lost through disuse or natural selection. But if this view be admitted, it would have to be extended to innumerable other cases; and it implies that the female progenitors of the existing spur-bearing species were once encumbered with an injurious appendage.

In some few genera and species, as in Galloperdix, Acomus, and the Javan peacock (*Pavo muticus*), the females, as well as the males, possess well developed legspurs. Are we to infer from this fact that they construct a different sort of nest from that made by their nearest allies, and not liable to be injured by their spurs; so that the spurs have not been removed? Or are we to suppose that the females of these several species especially require spurs for their defence? It is a more probable conclusion that both the presence and absence of spurs in the females result from different laws of inheritance having prevailed, independently of natural selection. With the many females in which spurs appear as rudiments, we may conclude that some few of the successive variations, through which they were developed in the males, occurred very early in life, and were consequently transferred to the females. In the other and much rarer cases, in which the females possess fully developed spurs, we may conclude that all the successive variations were transferred to them; and that they gradually acquired and inherited the habit of not disturbing their nests.

The vocal organs and the feathers variously modified for producing sound, as well as the proper instincts for using them, often differ in the two sexes, but are sometimes the same in both. Can such differences be accounted for by the males having acquired these organs and instincts, whilst the females have been saved from inheriting them, on account of the danger to which they would have been exposed by attracting the attention of birds or beasts of prey? This does not seem to me probable, when we think of the multitude of birds which with impunity gladden the country with their voices during the spring. (Daines Barrington, however, thought it probable ('Philosophical Transactions,' ,) that few female birds sing, because the talent would have been dangerous to them during incubation. He adds, that a similar view may possibly account for the inferiority of the female to the male in plumage.) It is a safer conclusion that, as vocal and instrumental organs are of special service only to the males during their courtship these organs were developed through sexual selection and their constant use in that sex alone the successive variations and the effects of use having been from the first more or less limited in transmission to the male offspring.

Many analogous cases could be adduced; those for instance of the plumes on the head being generally longer in the male than in the female, sometimes of equal length in both sexes, and occasionally absent in the female, these several cases occurring in the same group of birds. It would be difficult to account for such a difference between the sexes by the female having been benefited by possessing a slightly shorter crest than the male, and its consequent diminution or complete suppression through natural selection. But I will take a more favourable case, namely the length of the tail. The long train of the peacock would have been not only inconvenient but dangerous to the peahen during the period of incubation and whilst accompanying her young. Hence there is not the least a priori improbability in the development of her tail having been checked through natural selection. But the females of various pheasants, which apparently are exposed on their open nests to as much danger as the peahen, have tails of considerable length. The females as well as the males of the *Menura superba* have long tails, and they build a domed nest, which is a great anomaly in so large a bird. Naturalists have wondered how the female *Menura* could manage her tail during incubation; but it is now known (Mr. Ramsay, in 'Proc. Zoolog. Soc.', .) that she "enters the nest head first, and then turns round with her tail sometimes over her back, but more often bent round by her side. Thus in time the tail becomes quite askew, and is a tolerable guide to the length of time the bird has been sitting." Both sexes of an Australian kingfisher (*Tanysiptera sylvia*) have the middle tailfeathers greatly lengthened, and the female makes her nest in a hole; and as I am informed by Mr. R.B. Sharpe these feathers become much crumpled during incubation.

In these two latter cases the great length of the tailfeathers must be in some degree inconvenient to the female; and as in both species the tail feathers of the female are somewhat shorter than those of the male, it might be argued that their full development had been prevented through natural selection. But if the development of the tail of the peahen had been checked only when it became inconveniently or dangerously great, she would have retained a much longer tail than she actually possesses; for her tail is not nearly so long, relatively to the size of her body, as that of many female pheasants, nor longer than that of the female turkey. It must also be borne in mind that, in accordance with this view, as soon as the tail of the peahen became dangerously long, and its development was consequently checked, she would have continually reacted on her male progeny, and thus have prevented the peacock from acquiring his present magnificent train. We may therefore infer that the length of the tail in the peacock and its shortness in the peahen are the result of the requisite variations in the male having been from the first transmitted to the male offspring alone.

We are led to a nearly similar conclusion with respect to the length of the tail in the various species of pheasants. In the Eared pheasant (*Crossoptilon auritum*) the tail is of equal length in both sexes, namely sixteen or seventeen inches; in the common pheasant

it is about twenty inches long in the male and twelve in the female; in Soemmerring's pheasant, thirtyseven inches in the male and only eight in the female; and lastly in Reeve's pheasant it is sometimes actually seventytwo inches long in the male and sixteen in the female. Thus in the several species, the tail of the female differs much in length, irrespectively of that of the male; and this can be accounted for, as it seems to me, with much more probability, by the laws of inheritance, that is by the successive variations having been from the first more or less closely limited in their transmission to the male sex than by the agency of natural selection, resulting from the length of tail being more or less injurious to the females of these several allied species.

We may now consider Mr. Wallace's arguments in regard to the sexual coloration of birds. He believes that the bright tints originally acquired through sexual selection by the males would in all, or almost all cases, have been transmitted to the females, unless the transference had been checked through natural selection. I may here remind the reader that various facts opposed to this view have already been given under reptiles, amphibians, fishes and lepidoptera. Mr. Wallace rests his belief chiefly, but not exclusively, as we shall see in the next chapter, on the following statement (. 'Journal of Travel,' edited by A. Murray, vol. i. , .), that when both sexes are coloured in a very conspicuous manner, the nest is of such a nature as to conceal the sitting bird; but when there is a marked contrast of colour between the sexes, the male being gay and the female dullcoloured, the nest is open and exposes the sitting bird to view. This coincidence, as far as it goes, certainly seems to favour the belief that the females which sit on open nests have been specially modified for the sake of protection; but we shall presently see that there is another and more probable explanation, namely, that conspicuous females have acquired the instinct of building domed nests oftener than dull coloured birds. Mr. Wallace admits that there are, as might have been expected, some exceptions to his two rules, but it is a question whether the exceptions are not so numerous as seriously to invalidate them.

There is in the first place much truth in the Duke of Argyll's remark (. 'Journal of Travel,' edited by A. Murray, vol. i. , .) that a large domed nest is more conspicuous to an enemy, especially to all tree haunting carnivorous animals, than a smaller open nest. Nor must we forget that with many birds which build open nests, the male sits on the eggs and aids the female in feeding the young: this is the case, for instance, with *Pyranga aestiva* (. Audubon, 'Ornithological Biography,' vol. i. .), one of the most splendid birds in the United States, the male being vermilion, and the female light brownishgreen. Now if brilliant colours had been extremely dangerous to birds whilst sitting on their open nests, the males in these cases would have suffered greatly. It might, however, be of such paramount importance to the male to be brilliantly coloured, in order to beat his rivals, that this may have more than compensated some additional danger.

Mr. Wallace admits that with the Kingcrows (*Dicrurus*), Orioles, and Pittidae, the females are conspicuously coloured, yet build open nests; but he urges that the birds of the first group are highly pugnacious and could defend themselves; that those of the second group take extreme care in concealing their open nests, but this does not invariably hold good (. Jerdon, 'Birds of India,' vol. ii. . Gould's 'Handbook of the Birds of Australia,' vol. i. .); and that with the birds of the third group the females are brightly coloured chiefly on the under surface. Besides these cases, pigeons which are sometimes brightly, and almost always conspicuously coloured, and which are notoriously liable to the attacks of birds of prey, offer a serious exception to the rule, for they almost always build open and exposed nests. In another large family, that of the hummingbirds, all the species build open nests, yet with some of the most gorgeous species the sexes are alike; and in the majority, the females, though less brilliant than the males, are brightly coloured. Nor can it be maintained that all female hummingbirds, which are brightly coloured, escape detection by their tints being green, for some display on their upper surfaces red, blue, and other colours. (. For instance, the female *Eupetomena macroura* has the head and tail dark blue with reddish loins; the female *Lampornis porphyurus* is blackishgreen on the upper surface, with the lores and sides of the throat crimson; the female *Eulampis jugularis* has the top of the head and back green, but the loins and the tail are crimson. Many other instances of highly conspicuous females could be given. See Mr. Gould's magnificent work on this family.)

In regard to birds which build in holes or construct domed nests, other advantages, as Mr. Wallace remarks, besides concealment are gained, such as shelter from the rain, greater warmth, and in hot countries protection from the sun (. Mr. Salvin noticed in Guatemala ('Ibis,' ,) that hummingbirds were much more unwilling to leave their nests during very hot weather, when the sun was shining brightly, as if their eggs would be thus injured, than during cool, cloudy, or rainy weather.); so that it is no valid objection to his view that many birds having both sexes obscurely coloured build concealed nests. (. I may specify, as instances of dull coloured birds building concealed nests, the species belonging to eight Australian genera described in Gould's 'Handbook of the Birds of Australia,' vol. i. , , , , , .) The female Hornbill (*Buceros*), for instance, of India and Africa is protected during incubation with extraordinary care, for she plasters up with her own excrement the orifice of the hole in which she sits on her eggs, leaving only a small orifice through which the male feeds her; she is thus kept a close prisoner during the whole period of incubation (. Mr. C. Horne, 'Proc. Zoolog. Soc.' . .); yet female hornbills are not more conspicuously coloured than many other birds of equal size which build open nests. It is a more serious objection to Mr. Wallace's view, as is admitted by him, that in some few groups the males are brilliantly coloured and the females obscure, and yet the latter hatch their eggs in domed nests. This is the case with the Grallinae of Australia, the Superb Warblers (*Maluridae*) of the same country, the Sunbirds (*Nectarinae*), and with several of the Australian Honeysuckers or

Meliphagidae. (. On the nidification and colours of these latter species, see Gould's 'Handbook to the Birds of Australia,' vol. i. .)

If we look to the birds of England we shall see that there is no close and general relation between the colours of the female and the nature of the nest which is constructed. About forty of our British birds (excluding those of large size which could defend themselves) build in holes in banks, rocks, or trees, or construct domed nests. If we take the colours of the female goldfinch, bullfinch, or blackbird, as a standard of the degree of conspicuousness, which is not highly dangerous to the sitting female, then out of the above forty birds the females of only twelve can be considered as conspicuous to a dangerous degree, the remaining twentyeight being inconspicuous. (. I have consulted, on this subject, Macgillivray's 'British Birds,' and though doubts may be entertained in some cases in regard to the degree of concealment of the nest, and to the degree of conspicuousness of the female, yet the following birds, which all lay their eggs in holes or in domed nests, can hardly be considered, by the above standard, as conspicuous: Passer, species; Sturnus, of which the female is considerably less brilliant than the male; Cinclus; Motacilla boarula (?); Erithacus (?); Fruticola, sp.; Saxicola; Ruticilla, sp.; Sylvia, sp.; Parus, sp.; Mecistura; Anorthura; Certhia; Sitta; Yunx; Muscicapa, sp.; Hirundo, sp.; and Cypselus. The females of the following birds may be considered as conspicuous according to the same standard, viz., Pastor, Motacilla alba, Parus major and caeruleus, Upupa, Picus, sp., Coracias, Alcedo, and Merops.) Nor is there any close relation within the same genus between a wellpronounced difference in colour between the sexes, and the nature of the nest constructed. Thus the male house sparrow (*Passer domesticus*) differs much from the female, the male treesparrow (*montanus*) hardly at all, and yet both build wellconcealed nests. The two sexes of the common flycatcher (*Muscicapa grisola*) can hardly be distinguished, whilst the sexes of the pied flycatcher (*M. luctuosa*) differ considerably, and both species build in holes or conceal their nests. The female blackbird (*Turdus merula*) differs much, the female ring ouzel (*T. torquatus*) differs less, and the female common thrush (*T. musicus*) hardly at all from their respective males; yet all build open nests. On the other hand, the not very distantlyallied waterouzel (*Cinclus aquaticus*) builds a domed nest, and the sexes differ about as much as in the ringouzel. The black and red grouse (*Tetrao tetrix* and *T. scoticus*) build open nests in equally wellconcealed spots, but in the one species the sexes differ greatly, and in the other very little.

Notwithstanding the foregoing objections, I cannot doubt, after reading Mr. Wallace's excellent essay, that looking to the birds of the world, a large majority of the species in which the females are conspicuously coloured (and in this case the males with rare exceptions are equally conspicuous), build concealed nests for the sake of protection. Mr. Wallace enumerates (. 'Journal of Travel,' edited by A. Murray, vol. i. .) a long series of groups in which this rule holds good; but it will suffice here to give, as instances, the

more familiar groups of kingfishers, toucans, trogons, puffbirds (Capitonidae), plantain-eaters (Musophagae, woodpeckers, and parrots. Mr. Wallace believes that in these groups, as the males gradually acquired through sexual selection their brilliant colours, these were transferred to the females and were not eliminated by natural selection, owing to the protection which they already enjoyed from their manner of nidification. According to this view, their present manner of nesting was acquired before their present colours. But it seems to me much more probable that in most cases, as the females were gradually rendered more and more brilliant from partaking of the colours of the male, they were gradually led to change their instincts (supposing that they originally built open nests), and to seek protection by building domed or concealed nests. No one who studies, for instance, Audubon's account of the differences in the nests of the same species in the Northern and Southern United States (See many statements in the 'Ornithological Biography.' See also some curious observations on the nests of Italian birds by Eugenio Bettoni, in the 'Atti della Società Italiana,' vol. xi. , .), will feel any great difficulty in admitting that birds, either by a change (in the strict sense of the word) of their habits, or through the natural selection of so-called spontaneous variations of instinct, might readily be led to modify their manner of nesting.

This way of viewing the relation, as far as it holds good, between the bright colours of female birds and their manner of nesting, receives some support from certain cases occurring in the Sahara Desert. Here, as in most other deserts, various birds, and many other animals, have had their colours adapted in a wonderful manner to the tints of the surrounding surface. Nevertheless there are, as I am informed by the Rev. Mr. Tristram, some curious exceptions to the rule; thus the male of the *Monticola cyanea* is conspicuous from his bright blue colour, and the female almost equally conspicuous from her mottled brown and white plumage; both sexes of two species of *Dromolaea* are of a lustrous black; so that these three species are far from receiving protection from their colours, yet they are able to survive, for they have acquired the habit of taking refuge from danger in holes or crevices in the rocks.

With respect to the above groups in which the females are conspicuously coloured and build concealed nests, it is not necessary to suppose that each separate species had its nidifying instinct specially modified; but only that the early progenitors of each group were gradually led to build domed or concealed nests, and afterwards transmitted this instinct, together with their bright colours, to their modified descendants. As far as it can be trusted, the conclusion is interesting, that sexual selection together with equal or nearly equal inheritance by both sexes, have indirectly determined the manner of nidification of whole groups of birds.

According to Mr. Wallace, even in the groups in which the females, from being protected in domed nests during incubation, have not had their bright colours eliminated through natural selection, the males often differ in a slight, and occasionally in a considerable degree from the females. This is a significant fact, for such differences in colour must be accounted for by some of the variations in the males having been from the first limited in transmission to the same sex; as it can hardly be maintained that these differences, especially when very slight, serve as a protection to the female. Thus all the species in the splendid group of the Trogons build in holes; and Mr. Gould gives us (. See his Monograph of the Trogonidae, 2nd edition.) of both sexes of twenty-five species, in all of which, with one partial exception, the sexes differ sometimes slightly, sometimes conspicuously, in colour, the males being always finer than the females, though the latter are likewise beautiful. All the species of kingfishers build in holes, and with most of the species the sexes are equally brilliant, and thus far Mr. Wallace's rule holds good; but in some of the Australian species the colours of the females are rather less vivid than those of the male; and in one splendidly coloured species, the sexes differ so much that they were at first thought to be specifically distinct. (. Namely, *Cyanalcyon*, Gould's 'Handbook to the Birds of Australia,' vol. i. ; see, also, .) Mr. R.B. Sharpe, who has especially studied this group, has shewn me some American species (*Ceryle*) in which the breast of the male is belted with black. Again, in *Carcineutes*, the difference between the sexes is conspicuous: in the male the upper surface is dull blue banded with black, the lower surface being partly fawn coloured, and there is much red about the head; in the female the upper surface is reddish brown banded with black, and the lower surface white with black markings. It is an interesting fact, as shewing how the same peculiar style of sexual colouring often characterises allied forms, that in three species of *Dacelo* the male differs from the female only in the tail being dull blue banded with black, whilst that of the female is brown with blackish bars; so that here the tail differs in colour in the two sexes in exactly the same manner as the whole upper surface in the two sexes of *Carcineutes*.

With parrots, which likewise build in holes, we find analogous cases: in most of the species, both sexes are brilliantly coloured and indistinguishable, but in not a few species the males are coloured rather more vividly than the females, or even very differently from them. Thus, besides other strongly marked differences, the whole under surface of the male King Lory (*Aprosmictus scapulatus*) is scarlet, whilst the throat and chest of the female is green tinged with red: in the *Euphema splendida* there is a similar difference, the face and wing coverts moreover of the female being of a paler blue than in the male. (. Every gradation of difference between the sexes may be followed in the parrots of Australia. See Gould's 'Handbook,' etc., vol. ii. p.) In the family of the tits (*Parinae*), which build concealed nests, the female of our common blue tomtit (*Parus caeruleus*), is "much less brightly coloured" than the male: and in the magnificent Sultan

yellow tit of India the difference is greater. (. Macgillivray's 'British Birds,' vol. ii. . Jerdon, 'Birds of India,' vol. ii. .)

Again, in the great group of the woodpeckers (. All the following facts are taken from M. Malherbe's magnificent 'Monographie des Picidees,' .), the sexes are generally nearly alike, but in the *Megapicus validus* all those parts of the head, neck, and breast, which are crimson in the male are pale brown in the female. As in several woodpeckers the head of the male is bright crimson, whilst that of the female is plain, it occurred to me that this colour might possibly make the female dangerously conspicuous, whenever she put her head out of the hole containing her nest, and consequently that this colour, in accordance with Mr. Wallace's belief, had been eliminated. This view is strengthened by what Malherbe states with respect to *Indopicus carlotta*; namely, that the young females, like the young males, have some crimson about their heads, but that this colour disappears in the adult female, whilst it is intensified in the adult male. Nevertheless the following considerations render this view extremely doubtful: the male takes a fair share in incubation (. Audubon's 'Ornithological Biography,' vol. ii. ; see also the 'Ibis,' vol. i. .), and would be thus almost equally exposed to danger; both sexes of many species have their heads of an equally bright crimson; in other species the difference between the sexes in the amount of scarlet is so slight that it can hardly make any appreciable difference in the danger incurred; and lastly, the colouring of the head in the two sexes often differs slightly in other ways.

The cases, as yet given, of slight and graduated differences in colour between the males and females in the groups, in which as a general rule the sexes resemble each other, all relate to species which build domed or concealed nests. But similar gradations may likewise be observed in groups in which the sexes as a general rule resemble each other, but which build open nests.

As I have before instanced the Australian parrots, so I may here instance, without giving any details, the Australian pigeons. (. Gould's 'Handbook to the Birds of Australia,' vol. ii. p.) It deserves especial notice that in all these cases the slight differences in plumage between the sexes are of the same general nature as the occasionally greater differences. A good illustration of this fact has already been afforded by those kingfishers in which either the tail alone or the whole upper surface of the plumage differs in the same manner in the two sexes. Similar cases may be observed with parrots and pigeons. The differences in colour between the sexes of the same species are, also, of the same general nature as the differences in colour between the distinct species of the same group. For when in a group in which the sexes are usually alike, the male differs considerably from the female, he is not coloured in a quite new style. Hence we may infer that within the same group the special colours of both sexes when they are alike, and the colours of the

male, when he differs slightly or even considerably from the female, have been in most cases determined by the same general cause; this being sexual selection.

It is not probable, as has already been remarked, that differences in colour between the sexes, when very slight, can be of service to the female as a protection. Assuming, however, that they are of service, they might be thought to be cases of transition; but we have no reason to believe that many species at any one time are undergoing change. Therefore we can hardly admit that the numerous females which differ very slightly in colour from their males are now all commencing to become obscure for the sake of protection. Even if we consider somewhat more marked sexual differences, is it probable, for instance, that the head of the female chaffinch, the crimson on the breast of the female bullfinch, the green of the female greenfinch, the crest of the female goldencrested wren, have all been rendered less bright by the slow process of selection for the sake of protection? I cannot think so; and still less with the slight differences between the sexes of those birds which build concealed nests. On the other hand, the differences in colour between the sexes, whether great or small, may to a large extent be explained on the principle of the successive variations, acquired by the males through sexual selection, having been from the first more or less limited in their transmission to the females. That the degree of limitation should differ in different species of the same group will not surprise any one who has studied the laws of inheritance, for they are so complex that they appear to us in our ignorance to be capricious in their action. (. See remarks to this effect in 'Variation of Animals and Plants under Domestication,' vol. ii. chaxii.)

As far as I can discover there are few large groups of birds in which all the species have both sexes alike and brilliantly coloured, but I hear from Mr. Sclater, that this appears to be the case with the Musophagae or plantain eaters. Nor do I believe that any large group exists in which the sexes of all the species are widely dissimilar in colour: Mr. Wallace informs me that the chattering of S. America (Cotingidae) offer one of the best instances; but with some of the species, in which the male has a splendid red breast, the female exhibits some red on her breast; and the females of other species shew traces of the green and other colours of the males. Nevertheless we have a near approach to close sexual similarity or dissimilarity throughout several groups: and this, from what has just been said of the fluctuating nature of inheritance, is a somewhat surprising circumstance. But that the same laws should largely prevail with allied animals is not surprising. The domestic fowl has produced a great number of breeds and subbreeds, and in these the sexes generally differ in plumage; so that it has been noticed as an unusual circumstance when in certain subbreeds they resemble each other. On the other hand, the domestic pigeon has likewise produced a vast number of distinct breeds and subbreeds, and in these, with rare exceptions, the two sexes are identically alike.

Therefore if other species of *Gallus* and *Columba* were domesticated and varied, it would not be rash to predict that similar rules of sexual similarity and dissimilarity, depending on the form of transmission, would hold good in both cases. In like manner the same form of transmission has generally prevailed under nature throughout the same groups, although marked exceptions to this rule occur. Thus within the same family or even genus, the sexes may be identically alike, or very different in colour. Instances have already been given in the same genus, as with sparrows, fly catchers, thrushes and grouse. In the family of pheasants the sexes of almost all the species are wonderfully dissimilar, but are quite alike in the eared pheasant or *Crossoptilon auritum*. In two species of *Chloephaga*, a genus of geese, the male cannot be distinguished from the females, except by size; whilst in two others, the sexes are so unlike that they might easily be mistaken for distinct species. (. The 'Ibis,' vol. vi. , .)

The laws of inheritance can alone account for the following cases, in which the female acquires, late in life, certain characters proper to the male, and ultimately comes to resemble him more or less completely. Here protection can hardly have come into play. Mr. Blyth informs me that the females of *Oriolus melanocephalus* and of some allied species, when sufficiently mature to breed, differ considerably in plumage from the adult males; but after the second or third moults they differ only in their beaks having a slight greenish tinge. In the dwarf bitterns (*Ardetta*), according to the same authority, "the male acquires his final livery at the first moult, the female not before the third or fourth moult; in the meanwhile she presents an intermediate garb, which is ultimately exchanged for the same livery as that of the male." So again the female *Falco peregrinus* acquires her blue plumage more slowly than the male. Mr. Swinhoe states that with one of the Drongo shrikes (*Dicrurus macrocercus*) the male, whilst almost a nestling, moults his soft brown plumage and becomes of a uniform glossy greenishblack; but the female retains for a long time the white striae and spots on the axillary feathers; and does not completely assume the uniform black colour of the male for three years. The same excellent observer remarks that in the spring of the second year the female spoon bill (*Platalea*) of China resembles the male of the first year, and that apparently it is not until the third spring that she acquires the same adult plumage as that possessed by the male at a much earlier age. The female *Bombycilla carolinensis* differs very little from the male, but the appendages, which like beads of red sealingwax ornament the wingfeathers (. When the male courts the female, these ornaments are vibrated, and "are shewn off to great advantage," on the outstretched wings: A. Leith Adams, 'Field and Forest Rambles,' , .), are not developed in her so early in life as in the male. In the male of an Indian parrakeet (*Palaeornis javanicus*) the upper mandible is coralred from his earliest youth, but in the female, as Mr. Blyth has observed with caged and wild birds, it is at first black and does not become red until the bird is at least a year old, at which age the sexes resemble each other in all respects. Both sexes of the wild turkey are ultimately furnished with a tuft of bristles on the breast, but in twoyearold birds the tuft is about

four inches long in the male and hardly apparent in the female; when, however, the latter has reached her fourth year, it is from four to five inches in length. (. On Ardetta, Translation of Cuvier's 'Regne Animal,' by Mr. Blyth, footnote, . On the Peregrine Falcon, Mr. Blyth, in Charlesworth's 'Mag. of Nat. Hist.' vol. i. , . On *Dicrurus*, 'Ibis,' , . On the *Platalea*, 'Ibis,' vol. vi. , . On the *Bombycilla*, Audubon's 'Ornitholog. Biography,' vol. i. . On the *Palaeornis*, see, also, Jerdon, 'Birds of India,' vol. i. . On the wild turkey, Audubon, *ibid.* vol. i. ; but I hear from Judge Caton that in Illinois the female very rarely acquires a tuft. Analogous cases with the females of *Petrocossyphus* are given by Mr. R. Sharpe, 'Proceedings of the Zoological Society,' , .)

These cases must not be confounded with those where diseased or old females abnormally assume masculine characters, nor with those where fertile females, whilst young, acquire the characters of the male, through variation or some unknown cause. (. Of these latter cases Mr. Blyth has recorded (Translation of Cuvier's 'Regne Animal,') various instances with *Lanius*, *Ruticilla*, *Linaria*, and *Anas*. Audubon has also recorded a similar case ('Ornitholog. Biography,' vol. v.) with *Pyranga aestiva*.) But all these cases have so much in common that they depend, according to the hypothesis of pangenesis, on gemmules derived from each part of the male being present, though latent, in the female; their development following on some slight change in the elective affinities of her constituent tissues.

A few words must be added on changes of plumage in relation to the season of the year. From reasons formerly assigned there can be little doubt that the elegant plumes, long pendant feathers, crests, etc., of egrets, herons, and many other birds, which are developed and retained only during the summer, serve for ornamental and nuptial purposes, though common to both sexes. The female is thus rendered more conspicuous during the period of incubation than during the winter; but such birds as herons and egrets would be able to defend themselves. As, however, plumes would probably be inconvenient and certainly of no use during the winter, it is possible that the habit of moulting twice in the year may have been gradually acquired through natural selection for the sake of casting off inconvenient ornaments during the winter. But this view cannot be extended to the many waders, whose summer and winter plumages differ very little in colour. With defenceless species, in which both sexes, or the males alone, become extremely conspicuous during the breeding season, or when the males acquire at this season such long wing or tailfeathers as to impede their flight, as with *Cosmetornis* and *Vidua*, it certainly at first appears highly probable that the second moult has been gained for the special purpose of throwing off these ornaments. We must, however, remember that many birds, such as some of the Birds of Paradise, the Argus pheasant and peacock, do not cast their plumes during the winter; and it can hardly be maintained that the constitution of these birds, at least of the Gallinaceae, renders a double moult impossible, for the ptarmigan moults thrice in the year. (. See Gould's

'Birds of Great Britain.') Hence it must be considered as doubtful whether the many species which moult their ornamental plumes or lose their bright colours during the winter, have acquired this habit on account of the inconvenience or danger which they would otherwise have suffered.

I conclude, therefore, that the habit of moulting twice in the year was in most or all cases first acquired for some distinct purpose, perhaps for gaining a warmer winter covering; and that variations in the plumage occurring during the summer were accumulated through sexual selection, and transmitted to the offspring at the same season of the year; that such variations were inherited either by both sexes or by the males alone, according to the form of inheritance which prevailed. This appears more probable than that the species in all cases originally tended to retain their ornamental plumage during the winter, but were saved from this through natural selection, resulting from the inconvenience or danger thus caused.

I have endeavoured in this chapter to shew that the arguments are not trustworthy in favour of the view that weapons, bright colours, and various ornaments, are now confined to the males owing to the conversion, by natural selection, of the equal transmission of characters to both sexes, into transmission to the male sex alone. It is also doubtful whether the colours of many female birds are due to the preservation, for the sake of protection, of variations which were from the first limited in their transmission to the female sex. But it will be convenient to defer any further discussion on this subject until I treat, in the following chapter, of the differences in plumage between the young and old.

CHAPTER XVI.

BIRDS concluded.

The immature plumage in relation to the character of the plumage in both sexes when adult
Six classes of cases
Sexual differences between the males of closely allied or representative species
The female assuming the characters of the male
Plumage of the

young in relation to the summer and winter plumage of the adults On the increase of beauty in the birds of the world Protective colouring Conspicuously coloured birds Novelty appreciated Summary of the four chapters on Birds.

We must now consider the transmission of characters, as limited by age, in reference to sexual selection. The truth and importance of the principle of inheritance at corresponding ages need not here be discussed, as enough has already been said on the subject. Before giving the several rather complex rules or classes of cases, under which the differences in plumage between the young and the old, as far as known to me, may be included, it will be well to make a few preliminary remarks.

With animals of all kinds when the adults differ in colour from the young, and the colours of the latter are not, as far as we can see, of any special service, they may generally be attributed, like various embryological structures, to the retention of a former character. But this view can be maintained with confidence, only when the young of several species resemble each other closely, and likewise resemble other adult species belonging to the same group; for the latter are the living proofs that such a state of things was formerly possible. Young lions and pumas are marked with feeble stripes or rows of spots, and as many allied species both young and old are similarly marked, no believer in evolution will doubt that the progenitor of the lion and puma was a striped animal, and that the young have retained vestiges of the stripes, like the kittens of black cats, which are not in the least striped when grown up. Many species of deer, which when mature are not spotted, are whilst young covered with white spots, as are likewise some few species in the adult state. So again the young in the whole family of pigs (Suidae), and in certain rather distantly allied animals, such as the tapir, are marked with dark longitudinal stripes; but here we have a character apparently derived from an extinct progenitor, and now preserved by the young alone. In all such cases the old have had their colours changed in the course of time, whilst the young have remained but little altered, and this has been effected through the principle of inheritance at corresponding ages.

This same principle applies to many birds belonging to various groups, in which the young closely resemble each other, and differ much from their respective adult parents. The young of almost all the Gallinaceae, and of some distantly allied birds such as ostriches, are covered with longitudinally striped down; but this character points back to a state of things so remote that it hardly concerns us. Young crossbills (*Loxia*) have at first straight beaks like those of other finches, and in their immature striated plumage they resemble the mature redpole and female siskin, as well as the young of the goldfinch, greenfinch, and some other allied species. The young of many kinds of buntings (*Emberiza*) resemble one another, and likewise the adult state of the common bunting, *E. miliaria*. In almost the whole large group of thrushes the young have their

breasts spotted character which is retained throughout life by many species, but is quite lost by others, as by the *Turdus migratorius*. So again with many thrushes, the feathers on the back are mottled before they are moulted for the first time, and this character is retained for life by certain eastern species. The young of many species of shrikes (*Lanius*), of some woodpeckers, and of an Indian pigeon (*Chalcophaps indicus*), are transversely striped on the under surface; and certain allied species or whole genera are similarly marked when adult. In some closely allied and resplendent Indian cuckoos (*Chrysococcyx*), the mature species differ considerably from one another in colour, but the young cannot be distinguished. The young of an Indian goose (*Sarkidiornis melanonotus*) closely resemble in plumage an allied genus, *Dendrocygna*, when mature. (In regard to thrushes, shrikes, and woodpeckers, see Mr. Blyth, in Charlesworth's 'Mag. of Nat. Hist.' vol. i. , ; also footnote to his translation of Cuvier's 'Regne Animal,' . I give the case of *Loxia* on Mr. Blyth's information. On thrushes, see also Audubon, 'Ornith. Biog.' vol. ii. . On *Chrysococcyx* and *Chalcophaps*, Blyth, as quoted in Jerdon's 'Birds of India,' vol. iii. . On *Sarkidiornis*, Blyth, in 'Ibis,' , .) Similar facts will hereafter be given in regard to certain herons. Young blackgrouse (*Tetrao tetrix*) resemble the young as well as the old of certain other species, for instance the redgrouse or *T. scoticus*. Finally, as Mr. Blyth, who has attended closely to this subject, has well remarked, the natural affinities of many species are best exhibited in their immature plumage; and as the true affinities of all organic beings depend on their descent from a common progenitor, this remark strongly confirms the belief that the immature plumage approximately shews us the former or ancestral condition of the species.

Although many young birds, belonging to various families, thus give us a glimpse of the plumage of their remote progenitors, yet there are many other birds, both dullcoloured and brightcoloured, in which the young closely resemble their parents. In such cases the young of the different species cannot resemble each other more closely than do the parents; nor can they strikingly resemble allied forms when adult. They give us but little insight into the plumage of their progenitors, excepting in so far that, when the young and the old are coloured in the same general manner throughout a whole group of species, it is probable that their progenitors were similarly coloured.

We may now consider the classes of cases, under which the differences and resemblances between the plumage of the young and the old, in both sexes or in one sex alone, may be grouped. Rules of this kind were first enounced by Cuvier; but with the progress of knowledge they require some modification and amplification. This I have attempted to do, as far as the extreme complexity of the subject permits, from information derived from various sources; but a full essay on this subject by some competent ornithologist is much needed. In order to ascertain to what extent each rule prevails, I have tabulated the facts given in four great works, namely, by Macgillivray on the birds of Britain, Audubon on those of North America, Jerdon on those of India, and

Gould on those of Australia. I may here premise, first, that the several cases or rules graduate into each other; and secondly, that when the young are said to resemble their parents, it is not meant that they are identically alike, for their colours are almost always less vivid, and the feathers are softer and often of a different shape.

RULES OR CLASSES OF CASES.

I. When the adult male is more beautiful or conspicuous than the adult female, the young of both sexes in their first plumage closely resemble the adult female, as with the common fowl and peacock; or, as occasionally occurs, they resemble her much more closely than they do the adult male.

II. When the adult female is more conspicuous than the adult male, as sometimes though rarely occurs, the young of both sexes in their first plumage resemble the adult male.

III. When the adult male resembles the adult female, the young of both sexes have a peculiar first plumage of their own, as with the robin.

IV. When the adult male resembles the adult female, the young of both sexes in their first plumage resemble the adults, as with the kingfisher, many parrots, crows, hedgewarblers.

V. When the adults of both sexes have a distinct winter and summer plumage, whether or not the male differs from the female, the young resemble the adults of both sexes in their winter dress, or much more rarely in their summer dress, or they resemble the females alone. Or the young may have an intermediate character; or again they may differ greatly from the adults in both their seasonal plumages.

VI. In some few cases the young in their first plumage differ from each other according to sex; the young males resembling more or less closely the adult males, and the young females more or less closely the adult females.

CLASS I.

In this class, the young of both sexes more or less closely resemble the adult female, whilst the adult male differs from the adult female, often in the most conspicuous manner. Innumerable instances in all Orders could be given; it will suffice to call to mind the common pheasant, duck, and housesparrow. The cases under this class graduate into others. Thus the two sexes when adult may differ so slightly, and the young so slightly from the adults, that it is doubtful whether such cases ought to come

under the present, or under the third or fourth classes. So again the young of the two sexes, instead of being quite alike, may differ in a slight degree from each other, as in our sixth class. These transitional cases, however, are few, or at least are not strongly pronounced, in comparison with those which come strictly under the present class.

The force of the present law is well shewn in those groups, in which, as a general rule, the two sexes and the young are all alike; for when in these groups the male does differ from the female, as with certain parrots, kingfishers, pigeons, etc., the young of both sexes resemble the adult female. (See, for instance, Mr. Gould's account ('Handbook to the Birds of Australia,' vol. i.) of *Cyanalcyon* (one of the Kingfishers), in which, however, the young male, though resembling the adult female, is less brilliantly coloured. In some species of *Dacelo* the males have blue tails, and the females brown ones; and Mr. R.B. Sharpe informs me that the tail of the young male of *D. gaudichaudi* is at first brown. Mr. Gould has described (ibid. vol. ii. ,) the sexes and the young of certain black Cockatoos and of the King Lory, with which the same rule prevails. Also Jerdon ('Birds of India,' vol. i.) on the *Palaeornis rosa*, in which the young are more like the female than the male. See Audubon ('Ornithological Biography,' vol. ii.) on the two sexes and the young of *Columba passerina*.) We see the same fact exhibited still more clearly in certain anomalous cases; thus the male of *Heliothrix auriculata* (one of the hummingbirds) differs conspicuously from the female in having a splendid gorget and fine eartufts, but the female is remarkable from having a much longer tail than that of the male; now the young of both sexes resemble (with the exception of the breast being spotted with bronze) the adult female in all other respects, including the length of her tail, so that the tail of the male actually becomes shorter as he reaches maturity, which is a most unusual circumstance. (I owe this information to Mr. Gould, who shewed me the specimens; see also his 'Introduction to the Trochilidae,' , .) Again, the plumage of the male goosander (*Mergus merganser*) is more conspicuously coloured than that of the female, with the scapular and secondary wingfeathers much longer; but differently from what occurs, as far as I know, in any other bird, the crest of the adult male, though broader than that of the female, is considerably shorter, being only a little above an inch in length; the crest of the female being two and a half inches long. Now the young of both sexes entirely resemble the adult female, so that their crests are actually of greater length, though narrower, than in the adult male. (Macgillivray, 'Hist. Brit. Birds,' vol. v. p.)

When the young and the females closely resemble each other and both differ from the males, the most obvious conclusion is that the males alone have been modified. Even in the anomalous cases of the *Heliothrix* and *Mergus*, it is probable that originally both adult sexes were furnished the one species with a much elongated tail, and the other with a much elongated crest these characters having since been partially lost by the adult males from some unexplained cause, and transmitted in their diminished state to their

male offspring alone, when arrived at the corresponding age of maturity. The belief that in the present class the male alone has been modified, as far as the differences between the male and the female together with her young are concerned, is strongly supported by some remarkable facts recorded by Mr. Blyth (. See his admirable paper in the 'Journal of the Asiatic Soc. of Bengal,' vol. xix. , ; see also Jerdon, 'Birds of India,' vol. i. introduction, xxix. In regard to Tanysiptera, Prof. Schlegel told Mr. Blyth that he could distinguish several distinct races, solely by comparing the adult males.), with respect to closelyallied species which represent each other in distinct countries. For with several of these representative species the adult males have undergone a certain amount of change and can be distinguished; the females and the young from the distinct countries being indistinguishable, and therefore absolutely unchanged. This is the case with certain Indian chats (*Thamnobia*), with certain honeysuckers (*Nectarinia*), shrikes (*Tephrodornis*), certain kingfishers (*Tanysiptera*), Kalij pheasants (*Gallophasis*), and treepartridges (*Arboricola*).

In some analogous cases, namely with birds having a different summer and winter plumage, but with the two sexes nearly alike, certain closelyallied species can easily be distinguished in their summer or nuptial plumage, yet are indistinguishable in their winter as well as in their immature plumage. This is the case with some of the closelyallied Indian wagtails or *Motacillae*. Mr. Swinhoe (. See also Mr. Swinhoe, in 'Ibis,' July , ; and a previous paper, with an extract from a note by Mr. Blyth, in 'Ibis,' January, , .) informs me that three species of *Ardeola*, a genus of herons, which represent one another on separate continents, are "most strikingly different" when ornamented with their summer plumes, but are hardly, if at all, distinguishable during the winter. The young also of these three species in their immature plumage closely resemble the adults in their winter dress. This case is all the more interesting, because with two other species of *Ardeola* both sexes retain, during the winter and summer, nearly the same plumage as that possessed by the three first species during the winter and in their immature state; and this plumage, which is common to several distinct species at different ages and seasons, probably shews us how the progenitors of the genus were coloured. In all these cases, the nuptial plumage which we may assume was originally acquired by the adult males during the breedingseason, and transmitted to the adults of both sexes at the corresponding season, has been modified, whilst the winter and immature plumages have been left unchanged.

The question naturally arises, how is it that in these latter cases the winter plumage of both sexes, and in the former cases the plumage of the adult females, as well as the immature plumage of the young, have not been at all affected? The species which represent each other in distinct countries will almost always have been exposed to somewhat different conditions, but we can hardly attribute to this action the modification of the plumage in the males alone, seeing that the females and the young,

though similarly exposed, have not been affected. Hardly any fact shews us more clearly how subordinate in importance is the direct action of the conditions of life, in comparison with the accumulation through selection of indefinite variations, than the surprising difference between the sexes of many birds; for both will have consumed the same food, and have been exposed to the same climate. Nevertheless we are not precluded from believing that in the course of time new conditions may produce some direct effect either on both sexes, or from their constitutional differences chiefly on one sex. We see only that this is subordinate in importance to the accumulated results of selection. Judging, however, from a widespread analogy, when a species migrates into a new country (and this must precede the formation of representative species), the changed conditions to which they will almost always have been exposed will cause them to undergo a certain amount of fluctuating variability. In this case sexual selection, which depends on an element liable to change the taste or admiration of the female will have had new shades of colour or other differences to act on and accumulate; and as sexual selection is always at work, it would (from what we know of the results on domestic animals of man's unintentional selection), be surprising if animals inhabiting separate districts, which can never cross and thus blend their newlyacquired characters, were not, after a sufficient lapse of time, differently modified. These remarks likewise apply to the nuptial or summer plumage, whether confined to the males, or common to both sexes.

Although the females of the above closelyallied or representative species, together with their young, differ hardly at all from one another, so that the males alone can be distinguished, yet the females of most species within the same genus obviously differ from each other. The differences, however, are rarely as great as between the males. We see this clearly in the whole family of the Gallinaceae: the females, for instance, of the common and Japan pheasant, and especially of the gold and Amherst pheasant of the silver pheasant and the wild fowl resemble one another very closely in colour, whilst the males differ to an extraordinary degree. So it is with the females of most of the Cotingidae, Fringillidae, and many other families. There can indeed be no doubt that, as a general rule, the females have been less modified than the males. Some few birds, however, offer a singular and inexplicable exception; thus the females of Paradisea apoda and papuana differ from each other more than do their respective males (. Wallace, 'The Malay Archipelago,' vol. ii. , .); the female of the latter species having the under surface pure white, whilst the female apoda is deep brown beneath. So, again, as I hear from Professor Newton, the males of two species of Oxynotus (shrikes), which represent each other in the islands of Mauritius and Bourbon (. These species are described with coloured ures, by M. F. Pollen, in 'Ibis,' , .), differ but little in colour, whilst the females differ much. In the Bourbon species the female appears to have partially retained an immature condition of plumage, for at first sight she "might be taken for the young of the Mauritian species." These differences may be compared with

those inexplicable ones, which occur independently of man's selection in certain subbreeds of the gamefowl, in which the females are very different, whilst the males can hardly be distinguished. (. 'Variation of Animals,' etc., vol. i. .)

As I account so largely by sexual selection for the differences between the males of allied species, how can the differences between the females be accounted for in all ordinary cases? We need not here consider the species which belong to distinct genera; for with these, adaptation to different habits of life, and other agencies, will have come into play. In regard to the differences between the females within the same genus, it appears to me almost certain, after looking through various large groups, that the chief agent has been the greater or less transference to the female of the characters acquired by the males through sexual selection. In the several British finches, the two sexes differ either very slightly or considerably; and if we compare the females of the greenfinch, chaffinch, goldfinch, bullfinch, crossbill, sparrow, etc., we shall see that they differ from one another chiefly in the points in which they partially resemble their respective males; and the colours of the males may safely be attributed to sexual selection. With many gallinaceous species the sexes differ to an extreme degree, as with the peacock, pheasant, and fowl, whilst with other species there has been a partial or even complete transference of character from the male to the female. The females of the several species of *Polyplectron* exhibit in a dim condition, and chiefly on the tail, the splendid ocelli of their males. The female partridge differs from the male only in the red mark on her breast being smaller; and the female wild turkey only in her colours being much duller. In the guineafowl the two sexes are indistinguishable. There is no improbability in the plain, though peculiarly spotted plumage of this latter bird having been acquired through sexual selection by the males, and then transmitted to both sexes; for it is not essentially different from the much more beautifully spotted plumage, characteristic of the males alone of the Tragopan pheasants.

It should be observed that, in some instances, the transference of characters from the male to the female has been effected apparently at a remote period, the male having subsequently undergone great changes, without transferring to the female any of his latergained characters. For instance, the female and the young of the blackgrouse (*Tetrao tetrix*) resemble pretty closely both sexes and the young of the redgrouse (*T. scoticus*); and we may consequently infer that the blackgrouse is descended from some ancient species, of which both sexes were coloured in nearly the same manner as the redgrouse. As both sexes of this latter species are more distinctly barred during the breedingseason than at any other time, and as the male differs slightly from the female in his more strongly pronounced red and brown tints (. Macgillivray, 'History of British Birds,' vol. i. p.), we may conclude that his plumage has been influenced by sexual selection, at least to a certain extent. If so, we may further infer that nearly similar plumage of the female blackgrouse was similarly produced at some former period. But

since this period the male blackgrouse has acquired his fine black plumage, with his forked and outwardlycurled tailfeathers; but of these characters there has hardly been any transference to the female, excepting that she shews in her tail a trace of the curved fork.

We may therefore conclude that the females of distinct though allied species have often had their plumage rendered more or less different by the transference in various degrees of characters acquired by the males through sexual selection, both during former and recent times. But it deserves especial attention that brilliant colours have been transferred much more rarely than other tints. For instance, the male of the redthroated blue breast (*Cyanecula suecica*) has a rich blue breast, including a sub triangular red mark; now marks of nearly the same shape have been transferred to the female, but the central space is fulvous instead of red, and is surrounded by mottled instead of blue feathers. The Gallinaceae offer many analogous cases; for none of the species, such as partridges, quails, guineafowls, etc., in which the colours of the plumage have been largely transferred from the male to the female, are brilliantly coloured. This is well exemplified with the pheasants, in which the male is generally so much more brilliant than the female; but with the Eared and Cheer pheasants (*Crossoptilon auritum* and *Phasianus wallichii*) the sexes closely resemble each other and their colours are dull. We may go so far as to believe that if any part of the plumage in the males of these two pheasants had been brilliantly coloured, it would not have been transferred to the females. These facts strongly support Mr. Wallace's view that with birds which are exposed to much danger during incubation, the transference of bright colours from the male to the female has been checked through natural selection. We must not, however, forget that another explanation, before given, is possible; namely, that the males which varied and became bright, whilst they were young and inexperienced, would have been exposed to much danger, and would generally have been destroyed; the older and more cautious males, on the other hand, if they varied in a like manner, would not only have been able to survive, but would have been favoured in their rivalry with other males. Now variations occurring late in life tend to be transmitted exclusively to the same sex, so that in this case extremely bright tints would not have been transmitted to the females. On the other hand, ornaments of a less conspicuous kind, such as those possessed by the Eared and Cheer pheasants, would not have been dangerous, and if they appeared during early youth, would generally have been transmitted to both sexes.

In addition to the effects of the partial transference of characters from the males to the females, some of the differences between the females of closely allied species may be attributed to the direct or definite action of the conditions of life. (. See, on this subject, chaxxiii. in the 'Variation of Animals and Plants under Domestication.') With the males, any such action would generally have been masked by the brilliant colours gained through sexual selection; but not so with the females. Each of the endless diversities in

plumage which we see in our domesticated birds is, of course, the result of some definite cause; and under natural and more uniform conditions, some one tint, assuming that it was in no way injurious, would almost certainly sooner or later prevail. The free intercrossing of the many individuals belonging to the same species would ultimately tend to make any change of colour, thus induced, uniform in character.

No one doubts that both sexes of many birds have had their colours adapted for the sake of protection; and it is possible that the females alone of some species may have been modified for this end. Although it would be a difficult, perhaps an impossible process, as shewn in the last chapter, to convert one form of transmission into another through selection, there would not be the least difficulty in adapting the colours of the female, independently of those of the male, to surrounding objects, through the accumulation of variations which were from the first limited in their transmission to the female sex. If the variations were not thus limited, the bright tints of the male would be deteriorated or destroyed. Whether the females alone of many species have been thus specially modified, is at present very doubtful. I wish I could follow Mr. Wallace to the full extent; for the admission would remove some difficulties. Any variations which were of no service to the female as a protection would be at once obliterated, instead of being lost simply by not being selected, or from free intercrossing, or from being eliminated when transferred to the male and in any way injurious to him. Thus the plumage of the female would be kept constant in character. It would also be a relief if we could admit that the obscure tints of both sexes of many birds had been acquired and preserved for the sake of protection, for example, of the hedgewarbler or kittiwren (*Accentor modularis* and *Troglodytes vulgaris*), with respect to which we have no sufficient evidence of the action of sexual selection. We ought, however, to be cautious in concluding that colours which appear to us dull, are not attractive to the females of certain species; we should bear in mind such cases as that of the common housesparrow, in which the male differs much from the female, but does not exhibit any bright tints. No one probably will dispute that many gallinaceous birds which live on the open ground, have acquired their present colours, at least in part, for the sake of protection. We know how well they are thus concealed; we know that ptarmigans, whilst changing from their winter to their summer plumage, both of which are protective, suffer greatly from birds of prey. But can we believe that the very slight differences in tints and markings between, for instance, the female blackgrouse and redgrouse serve as a protection? Are partridges, as they are now coloured, better protected than if they had resembled quails? Do the slight differences between the females of the common pheasant, the Japan and gold pheasants, serve as a protection, or might not their plumages have been interchanged with impunity? From what Mr. Wallace has observed of the habits of certain gallinaceous birds in the East, he thinks that such slight differences are beneficial. For myself, I will only say that I am not convinced.

Formerly when I was inclined to lay much stress on protection as accounting for the duller colours of female birds, it occurred to me that possibly both sexes and the young might aboriginally have been equally bright coloured; but that subsequently, the females from the danger incurred during incubation, and the young from being inexperienced, had been rendered dull as a protection. But this view is not supported by any evidence, and is not probable; for we thus in imagination expose during past times the females and the young to danger, from which it has subsequently been necessary to shield their modified descendants. We have, also, to reduce, through a gradual process of selection, the females and the young to almost exactly the same tints and markings, and to transmit them to the corresponding sex and period of life. On the supposition that the females and the young have partaken during each stage of the process of modification of a tendency to be as brightly coloured as the males, it is also a somewhat strange fact that the females have never been rendered dullcoloured without the young participating in the same change; for there are no instances, as far as I can discover, of species with the females dull and the young bright coloured. A partial exception, however, is offered by the young of certain woodpeckers, for they have "the whole upper part of the head tinged with red," which afterwards either decreases into a mere circular red line in the adults of both sexes, or quite disappears in the adult females. (. Audubon, 'Ornith. Biography,' vol. i. . Macgillivray, 'History of British Birds,' vol. iii. . See also the case before given of *Indopicus carlotta*.)

Finally, with respect to our present class of cases, the most probable view appears to be that successive variations in brightness or in other ornamental characters, occurring in the males at a rather late period of life have alone been preserved; and that most or all of these variations, owing to the late period of life at which they appeared, have been from the first transmitted only to the adult male offspring. Any variations in brightness occurring in the females or in the young, would have been of no service to them, and would not have been selected; and moreover, if dangerous, would have been eliminated. Thus the females and the young will either have been left unmodified, or (as is much more common) will have been partially modified by receiving through transference from the males some of his successive variations. Both sexes have perhaps been directly acted on by the conditions of life to which they have long been exposed: but the females from not being otherwise much modified, will best exhibit any such effects. These changes and all others will have been kept uniform by the free intercrossing of many individuals. In some cases, especially with ground birds, the females and the young may possibly have been modified, independently of the males, for the sake of protection, so as to have acquired the same dullcoloured plumage.

CLASS II.

**WHEN THE ADULT FEMALE IS MORE CONSPICUOUS THAN THE ADULT
MALE, THE YOUNG OF BOTH SEXES IN THEIR FIRST PLUMAGE
RESEMBLE THE ADULT MALE.**

This class is exactly the reverse of the last, for the females are here brighter coloured or more conspicuous than the males; and the young, as far as they are known, resemble the adult males instead of the adult females. But the difference between the sexes is never nearly so great as with many birds in the first class, and the cases are comparatively rare. Mr. Wallace, who first called attention to the singular relation which exists between the less bright colours of the males and their performing the duties of incubation, lays great stress on this point (. 'Westminster Review,' July , and A. Murray, 'Journal of Travel,' , .), as a crucial test that obscure colours have been acquired for the sake of protection during the period of nesting. A different view seems to me more probable. As the cases are curious and not numerous, I will briefly give all that I have been able to find.

In one section of the genus Turnix, quail-like birds, the female is invariably larger than the male (being nearly twice as large in one of the Australian species), and this is an unusual circumstance with the Gallinaceae. In most of the species the female is more distinctly coloured and brighter than the male (. For the Australian species, see Gould's 'Handbook,' etc., vol. ii. , , and . In the British Museum specimens of the Australian Plainwanderer (*Pedionomus torquatus*) may be seen, shewing similar sexual differences.), but in some few species the sexes are alike. In Turnix taigoor of India the male "wants the black on the throat and neck, and the whole tone of the plumage is lighter and less pronounced than that of the female." The female appears to be noisier, and is certainly much more pugnacious than the male; so that the females and not the males are often kept by the natives for hting, like gamecocks. As male birds are exposed by the English birdcatchers for a decoy near a train order to catch other males by exciting their rivalry, so the females of this Turnix are employed in India. When thus exposed the females soon begin their "loud purring call, which can be heard a long way off, and any females within earshot run rapidly to the spot, and commence hting with the caged bird." In this way from twelve to twenty birds, all breeding females, may be caught in the course of a single day. The natives assert that the females after laying their eggs associate in flocks, and leave the males to sit on them. There is no reason to doubt the truth of this assertion, which is supported by some observations made in China by Mr. Swinhoe. (. Jerdon, 'Birds of India,' vol. iii. . Mr. Swinhoe, in 'Ibis,' , ; , .) Mr. Blyth believes, that the young of both sexes resemble the adult male.

[. . *Rhynchaea capensis* (from Brehm).]

The females of the three species of Painted Snipes (*Rhynchaea*, .) "are not only larger but much more richly coloured than the males." (. Jerdon, 'Birds of India,' vol. iii. .) With all other birds in which the trachea differs in structure in the two sexes it is more developed and complex in the male than in the female; but in the *Rhynchaea australis* it is simple in the male, whilst in the female it makes four distinct convolutions before entering the lungs. (. Gould's 'Handbook to the Birds of Australia,' vol. ii. .) The female therefore of this species has acquired an eminently masculine character. Mr. Blyth ascertained, by examining many specimens, that the trachea is not convoluted in either sex of *R. bengalensis*, which species resembles *R. australis* so closely, that it can hardly be distinguished except by its shorter toes. This fact is another striking instance of the law that secondary sexual characters are often widely different in closely allied forms, though it is a very rare circumstance when such differences relate to the female sex. The young of both sexes of *R. bengalensis* in their first plumage are said to resemble the mature male. (. 'The Indian Field,' Sept. , .) There is also reason to believe that the male undertakes the duty of incubation, for Mr. Swinhoe (. 'Ibis,' , .) found the females before the close of the summer associated in flocks, as occurs with the females of the Turnix.

The females of *Phalaropus fulicarius* and *hyperboreus* are larger, and in their summer plumage "more gaily attired than the males." But the difference in colour between the sexes is far from conspicuous. According to Professor Steenstrupe the male alone of *fulicarius* undertakes the duty of incubation; this is likewise shewn by the state of his breast feathers during the breeding season. The female of the dotterel plover (*Eudromias morinellus*) is larger than the male, and has the red and black tints on the lower surface, the white crescent on the breast, and the stripes over the eyes, more strongly pronounced. The male also takes at least a share in hatching the eggs; but the female likewise attends to the young. (. For these several statements, see Mr. Gould's 'Birds of Great Britain.' Prof. Newton informs me that he has long been convinced, from his own observations and from those of others, that the males of the above named species take either the whole or a large share of the duties of incubation, and that they "shew much greater devotion towards their young, when in danger, than do the females." So it is, as he informs me, with *Limosa lapponica* and some few other Waders, in which the females are larger and have more strongly contrasted colours than the males.) I have not been able to discover whether with these species the young resemble the adult males more closely than the adult females; for the comparison is somewhat difficult to make on account of the double moult.

Turning now to the ostrich Order: the male of the common cassowary (*Casuarius galeatus*) would be thought by any one to be the female, from his smaller size and from the appendages and naked skin about his head being much less brightly coloured; and I am informed by Mr. Bartlett that in the Zoological Gardens, it is certainly the male alone who sits on the eggs and takes care of the young. (. The natives of Ceram (Wallace,

'Malay Archipelago,' vol. ii.) assert that the male and female sit alternately on the eggs; but this assertion, as Mr. Bartlett thinks, may be accounted for by the female visiting the nest to lay her eggs.) The female is said by Mr. T.W. Wood (. The 'Student,' April , .) to exhibit during the breedingseason a most pugnacious disposition; and her wattles then become enlarged and more brilliantly coloured. So again the female of one of the emus (*Dromoeus irroratus*) is considerably larger than the male, and she possesses a slight topknot, but is otherwise indistinguishable in plumage. She appears, however, "to have greater power, when angry or otherwise excited, of erecting, like a turkeycock, the feathers of her neck and breast. She is usually the more courageous and pugilistic. She makes a deep hollow guttural boom especially at night, sounding like a small gong. The male has a slenderer frame and is more docile, with no voice beyond a suppressed hiss when angry, or a croak." He not only performs the whole duty of incubation, but has to defend the young from their mother; "for as soon as she catches sight of her progeny she becomes violently agitated, and notwithstanding the resistance of the father appears to use her utmost endeavours to destroy them. For months afterwards it is unsafe to put the parents together, violent quarrels being the inevitable result, in which the female generally comes off conqueror." (. See the excellent account of the habits of this bird under confinement, by Mr. A.W. Bennett, in 'Land and Water,' May , .) So that with this emu we have a complete reversal not only of the parental and incubating instincts, but of the usual moral qualities of the two sexes; the females being savage, quarrelsome, and noisy, the males gentle and good. The case is very different with the African ostrich, for the male is somewhat larger than the female and has finer plumes with more strongly contrasted colours; nevertheless he undertakes the whole duty of incubation. (. Mr. Sclater, on the incubation of the Struthionides, 'Proc. Zool. Soc.' June , . So it is with the *Rhea darwinii*: Captain Musters says ('At Home with the Patagonians,' ,), that the male is larger, stronger and swifter than the female, and of slightly darker colours; yet he takes sole charge of the eggs and of the young, just as does the male of the common species of *Rhea*.)

I will specify the few other cases known to me, in which the female is more conspicuously coloured than the male, although nothing is known about the manner of incubation. With the carrionhawk of the Falkland Islands (*Milvago leucurus*) I was much surprised to find by dissection that the individuals, which had all their tints strongly pronounced, with the cere and legs orangecoloured, were the adult females; whilst those with duller plumage and grey legs were the males or the young. In an Australian tree creeper (*Climacteris erythroptera*) the female differs from the male in "being adorned with beautiful, radiated, rufous markings on the throat, the male having this part quite plain." Lastly, in an Australian nightjar "the female always exceeds the male in size and in the brilliance of her tints; the males, on the other hand, have two white spots on the primaries more conspicuous than in the female." (. For the *Milvago*, see 'Zoology of the Voyage of the "Beagle," Birds,' , . For the *Climacteris* and nightjar

(Eurostopodus), see Gould's 'Handbook to the Birds of Australia,' vol. i. p and . The New Zealand shieldrake (*Tadorna variegata*) offers a quite anomalous case; the head of the female is pure white, and her back is redder than that of the male; the head of the male is of a rich dark bronzed colour, and his back is clothed with finely pencilled slate coloured feathers, so that altogether he may be considered as the more beautiful of the two. He is larger and more pugnacious than the female, and does not sit on the eggs. So that in all these respects this species comes under our first class of cases; but Mr. Sclater ('Proceedings of the Zoological Society,' ,) was much surprised to observe that the young of both sexes, when about three months old, resembled in their dark heads and necks the adult males, instead of the adult females; so that it would appear in this case that the females have been modified, whilst the males and the young have retained a former state of plumage.)

We thus see that the cases in which female birds are more conspicuously coloured than the males, with the young in their immature plumage resembling the adult males instead of the adult females, as in the previous class, are not numerous, though they are distributed in various Orders. The amount of difference, also, between the sexes is incomparably less than that which frequently occurs in the last class; so that the cause of the difference, whatever it may have been, has here acted on the females either less energetically or less persistently than on the males in the last class. Mr. Wallace believes that the males have had their colours rendered less conspicuous for the sake of protection during the period of incubation; but the difference between the sexes in hardly any of the foregoing cases appears sufficiently great for this view to be safely accepted. In some of the cases, the brighter tints of the female are almost confined to the lower surface, and the males, if thus coloured, would not have been exposed to danger whilst sitting on the eggs. It should also be borne in mind that the males are not only in a slight degree less conspicuously coloured than the females, but are smaller and weaker. They have, moreover, not only acquired the maternal instinct of incubation, but are less pugnacious and vociferous than the females, and in one instance have simpler vocal organs. Thus an almost complete transposition of the instincts, habits, disposition, colour, size, and of some points of structure, has been effected between the two sexes.

Now if we might assume that the males in the present class have lost some of that ardour which is usual to their sex, so that they no longer search eagerly for the females; or, if we might assume that the females have become much more numerous than the males and in the case of one Indian Turnix the females are said to be "much more commonly met with than the males" (. Jerdon, 'Birds of India,' vol. iii. .) then it is not improbable that the females would have been led to court the males, instead of being courted by them. This indeed is the case to a certain extent with some birds, as we have seen with the peahen, wild turkey, and certain kinds of grouse. Taking as our guide the habits of most male birds, the greater size and strength as well as the extraordinary

pugnacity of the females of the Turnix and emu, must mean that they endeavour to drive away rival females, in order to gain possession of the male; and on this view all the facts become clear; for the males would probably be most charmed or excited by the females which were the most attractive to them by their bright colours, other ornaments, or vocal powers. Sexual selection would then do its work, steadily adding to the attractions of the females; the males and the young being left not at all, or but little modified.

CLASS III.

WHEN THE ADULT MALE RESEMBLES THE ADULT FEMALE, THE YOUNG OF BOTH SEXES HAVE A PECULIAR FIRST PLUMAGE OF THEIR OWN.

In this class the sexes when adult resemble each other, and differ from the young. This occurs with many birds of many kinds. The male robin can hardly be distinguished from the female, but the young are widely different, with their mottled duskyolive and brown plumage. The male and female of the splendid scarlet ibis are alike, whilst the young are brown; and the scarlet colour, though common to both sexes, is apparently a sexual character, for it is not well developed in either sex under confinement; and a loss of colour often occurs with brilliant males when they are confined. With many species of herons the young differ greatly from the adults; and the summer plumage of the latter, though common to both sexes, clearly has a nuptial character. Young swans are slatecoloured, whilst the mature birds are pure white; but it would be superfluous to give additional instances. These differences between the young and the old apparently depend, as in the last two classes, on the young having retained a former or ancient state of plumage, whilst the old of both sexes have acquired a new one. When the adults are bright coloured, we may conclude from the remarks just made in relation to the scarlet ibis and to many herons, and from the analogy of the species in the first class, that such colours have been acquired through sexual selection by the nearly mature males; but that, differently from what occurs in the first two classes, the transmission, though limited to the same age, has not been limited to the same sex. Consequently, the sexes when mature resemble each other and differ from the young.

CLASS IV.

WHEN THE ADULT MALE RESEMBLES THE ADULT FEMALE, THE YOUNG OF BOTH SEXES IN THEIR FIRST PLUMAGE RESEMBLE THE ADULTS.

In this class the young and the adults of both sexes, whether brilliantly or obscurely coloured, resemble each other. Such cases are, I think, more common than those in the last class. We have in England instances in the kingfisher, some woodpeckers, the jay, magpie, crow, and many small dull coloured birds, such as the hedgewarbler or kittywren. But the similarity in plumage between the young and the old is never complete, and graduates away into dissimilarity. Thus the young of some members of the kingfisher family are not only less vividly coloured than the adults, but many of the feathers on the lower surface are edged with brown (. Jerdon, 'Birds of India,' vol. i. . Gould's 'Handbook to the Birds of Australia,' vol. i. .), a vestige probably of a former state of the plumage. Frequently in the same group of birds, even within the same genus, for instance in an Australian genus of parrakeets (*Platycercus*), the young of some species closely resemble, whilst the young of other species differ considerably, from their parents of both sexes, which are alike. (. Gould, *ibid.* vol. ii. , .) Both sexes and the young of the common jay are closely similar; but in the Canada jay (*Perisoreus canadensis*) the young differ so much from their parents that they were formerly described as distinct species. (. Audubon, 'Ornith. Biography,' vol. ii. .)

I may remark before proceeding that, under the present and next two classes of cases, the facts are so complex and the conclusions so doubtful, that any one who feels no especial interest in the subject had better pass them over.

The brilliant or conspicuous colours which characterise many birds in the present class, can rarely or never be of service to them as a protection; so that they have probably been gained by the males through sexual selection, and then transferred to the females and the young. It is, however, possible that the males may have selected the more attractive females; and if these transmitted their characters to their offspring of both sexes, the same results would follow as from the selection of the more attractive males by the females. But there is evidence that this contingency has rarely, if ever, occurred in any of those groups of birds in which the sexes are generally alike; for, if even a few of the successive variations had failed to be transmitted to both sexes, the females would have slightly exceeded the males in beauty. Exactly the reverse occurs under nature; for, in almost every large group in which the sexes generally resemble each other, the males of some few species are in a slight degree more brightly coloured than the females. It is again possible that the females may have selected the more beautiful males, these males having reciprocally selected the more beautiful females; but it is doubtful whether this double process of selection would be likely to occur, owing to the greater eagerness of one sex than the other, and whether it would be more efficient than selection on one side alone. It is, therefore, the most probable view that sexual selection has acted, in the present class, as far as ornamental characters are concerned, in accordance with the general rule throughout the animal kingdom, that is, on the males; and that these have

transmitted their graduallyacquired colours, either equally or almost equally, to their offspring of both sexes.

Another point is more doubtful, namely, whether the successive variations first appeared in the males after they had become nearly mature, or whilst quite young. In either case sexual selection must have acted on the male when he had to compete with rivals for the possession of the female; and in both cases the characters thus acquired have been transmitted to both sexes and all ages. But these characters if acquired by the males when adult, may have been transmitted at first to the adults alone, and at some subsequent period transferred to the young. For it is known that, when the law of inheritance at corresponding ages fails, the offspring often inherit characters at an earlier age than that at which they first appeared in their parents. (. 'Variation of Animals and Plants under Domestication,' vol. ii. .) Cases apparently of this kind have been observed with birds in a state of nature. For instance Mr. Blyth has seen specimens of *Lanius rufus* and of *Colymbus glacialis* which had assumed whilst young, in a quite anomalous manner, the adult plumage of their parents. (. 'Charlesworth's Magazine of Natural History,' vol. i. , .) Again, the young of the common swan (*Cygnus olor*) do not cast off their dark feathers and become white until eighteen months or two years old; but Dr. F. Forel has described the case of three vigorous young birds, out of a brood of four, which were born pure white. These young birds were not albinos, as shewn by the colour of their beaks and legs, which nearly resembled the same parts in the adults. (. 'Bulletin de la Soc. Vaudoise des Sc. Nat.' vol. x. , . The young of the Polish swan, *Cygnus immutabilis* of Yarrell, are always white; but this species, as Mr. Sclater informs me, is believed to be nothing more than a variety of the domestic swan (*Cygnus olor*.)

It may be worth while to illustrate the above three modes by which, in the present class, the two sexes and the young may have come to resemble each other, by the curious case of the genus *Passer*. (. I am indebted to Mr. Blyth for information in regard to this genus. The sparrow of Palestine belongs to the subgenus *Petronia*.) In the housesparrow (*domesticus*) the male differs much from the female and from the young. The young and the females are alike, and resemble to a large extent both sexes and the young of the sparrow of Palestine (*brachydactylus*), as well as of some allied species. We may therefore assume that the female and young of the housesparrow approximately shew us the plumage of the progenitor of the genus. Now with the treesparrow (*montanus*) both sexes and the young closely resemble the male of the housesparrow; so that they have all been modified in the same manner, and all depart from the typical colouring of their early progenitor. This may have been effected by a male ancestor of the treesparrow having varied, firstly, when nearly mature; or, secondly, whilst quite young, and by having in either case transmitted his modified plumage to the females and the young; or, thirdly, he may have varied when adult and transmitted his plumage to both adult sexes,

and, owing to the failure of the law of inheritance at corresponding ages, at some subsequent period to his young.

It is impossible to decide which of these three modes has generally prevailed throughout the present class of cases. That the males varied whilst young, and transmitted their variations to their offspring of both sexes, is the most probable. I may here add that I have, with little success, endeavoured, by consulting various works, to decide how far the period of variation in birds has generally determined the transmission of characters to one sex or to both. The two rules, often referred to (namely, that variations occurring late in life are transmitted to one and the same sex, whilst those which occur early in life are transmitted to both sexes), apparently hold good in the first (. For instance, the males of *Tanagra aestiva* and *Fringilla cyanea* require three years, the male of *Fringilla ciris* four years, to complete their beautiful plumage. (See Audubon, 'Ornith. Biography,' vol. i. ,). The Harlequin duck takes three years (*ibid.* vol. iii.). The male of the Gold pheasant, as I hear from Mr. Jenner Weir, can be distinguished from the female when about three months old, but he does not acquire his full splendour until the end of the September in the following year.), second, and fourth classes of cases; but they fail in the third, often in the fifth (. Thus the *Ibis tantalus* and *Grus americanus* take four years, the Flamingo several years, and the *Ardea ludovicana* two years, before they acquire their perfect plumage. See Audubon, *ibid.* vol. i. ; vol. iii. , .), and in the sixth small class. They apply, however, as far as I can judge, to a considerable majority of the species; and we must not forget the striking generalisation by Dr. W. Marshall with respect to the protuberances on the heads of birds. Whether or not the two rules generally hold good, we may conclude from the facts given in the eighth chapter, that the period of variation is one important element in determining the form of transmission.

With birds it is difficult to decide by what standard we ought to judge of the earliness or lateness of the period of variation, whether by the age in reference to the duration of life, or to the power of reproduction, or to the number of moults through which the species passes. The moulting of birds, even within the same family, sometimes differs much without any assignable cause. Some birds moult so early, that nearly all the body feathers are cast off before the first wingfeathers are fully grown; and we cannot believe that this was the primordial state of things. When the period of moulting has been accelerated, the age at which the colours of the adult plumage are first developed will falsely appear to us to be earlier than it really is. This may be illustrated by the practice followed by some birdfanciers, who pull out a few feathers from the breast of nestling bullfinches, and from the head or neck of young goldpheasants, in order to ascertain their sex; for in the males, these feathers are immediately replaced by coloured ones. (. Mr. Blyth, in Charlesworth's 'Magazine of Natural History,' vol. i. , . Mr. Bartlett has informed me in regard to gold pheasants.) The actual duration of life is known in but few birds, so that we can hardly judge by this standard. And, with reference to the

period at which the power of reproduction is gained, it is a remarkable fact that various birds occasionally breed whilst retaining their immature plumage. (. I have noticed the following cases in Audubon's 'Ornith. Biography.' The redstart of America (*Muscapica ruticilla*, vol. i.). The Ibis *tantalus* takes four years to come to full maturity, but sometimes breeds in the second year (vol. iii.). The *Grus americanus* takes the same time, but breeds before acquiring its full plumage (vol. iii.). The adults of *Ardea caerulea* are blue, and the young white; and white, mottled, and mature blue birds may all be seen breeding together (vol. iv.): but Mr. Blyth informs me that certain herons apparently are dimorphic, for white and coloured individuals of the same age may be observed. The Harlequin duck (*Anas histrionica*, Linn.) takes three years to acquire its full plumage, though many birds breed in the second year (vol. iii.). The Whiteheaded Eagle (*Falco leucocephalus*, vol. iii.) is likewise known to breed in its immature state. Some species of *Oriolus* (according to Mr. Blyth and Mr. Swinhoe, in 'Ibis,' July ,) likewise breed before they attain their full plumage.)

The fact of birds breeding in their immature plumage seems opposed to the belief that sexual selection has played as important a part, as I believe it has, in giving ornamental colours, plumes, etc., to the males, and, by means of equal transmission, to the females of many species. The objection would be a valid one, if the younger and less ornamented males were as successful in winning females and propagating their kind, as the older and more beautiful males. But we have no reason to suppose that this is the case. Audubon speaks of the breeding of the immature males of *Ibis tantalus* as a rare event, as does Mr. Swinhoe, in regard to the immature males of *Oriolus*. (. See footnote above.) If the young of any species in their immature plumage were more successful in winning partners than the adults, the adult plumage would probably soon be lost, as the males would prevail, which retained their immature dress for the longest period, and thus the character of the species would ultimately be modified. (. Other animals, belonging to quite distinct classes, are either habitually or occasionally capable of breeding before they have fully acquired their adult characters. This is the case with the young males of the salmon. Several amphibians have been known to breed whilst retaining their larval structure. Fritz Müller has shewn ('Facts and arguments for Darwin,' Eng. trans. ,) that the males of several amphipod crustaceans become sexually mature whilst young; and I infer that this is a case of premature breeding, because they have not as yet acquired their fullydeveloped claspers. All such facts are highly interesting, as bearing on one means by which species may undergo great modifications of character.) If, on the other hand, the young never succeeded in obtaining a female, the habit of early reproduction would perhaps be sooner or later eliminated, from being superfluous and entailing waste of power.

The plumage of certain birds goes on increasing in beauty during many years after they are fully mature; this is the case with the train of the peacock, with some of the birds of

paradise, and with the crest and plumes of certain herons, for instance, the *Ardea ludovicana*. (. Jerdon, 'Birds of India,' vol. iii. , on the peacock. Dr. Marshall thinks that the older and more brilliant males of birds of paradise, have an advantage over the younger males; see 'Archives Neerlandaises,' tom. vi. .On *Ardea*, Audubon, *ibid.* vol. iii. .) But it is doubtful whether the continued development of such feathers is the result of the selection of successive beneficial variations (though this is the most probable view with birds of paradise) or merely of continuous growth. Most fishes continue increasing in size, as long as they are in good health and have plenty of food; and a somewhat similar law may prevail with the plumes of birds.

CLASS V.

WHEN THE ADULTS OF BOTH SEXES HAVE A DISTINCT WINTER AND SUMMER PLUMAGE, WHETHER OR NOT THE MALE DIFFERS FROM THE FEMALE, THE YOUNG RESEMBLE THE ADULTS OF BOTH SEXES IN THEIR WINTER DRESS, OR MUCH MORE RARELY IN THEIR SUMMER DRESS, OR THEY RESEMBLE THE FEMALES ALONE. OR THE YOUNG MAY HAVE AN INTERMEDIATE CHARACTER; OR, AGAIN, THEY MAY DIFFER GREATLY FROM THE ADULTS IN BOTH THEIR SEASONAL PLUMAGES.

The cases in this class are singularly complex; nor is this surprising, as they depend on inheritance, limited in a greater or less degree in three different ways, namely, by sex, age, and the season of the year. In some cases the individuals of the same species pass through at least five distinct states of plumage. With the species, in which the male differs from the female during the summer season alone, or, which is rarer, during both seasons (. For illustrative cases, see vol. iv. of Macgillivray's 'History of British Birds;' on *Tringa*, etc., ; on the *Machetes*, ; on the *Charadrius hiaticula*, ; on the *Charadrius pluvialis*, .), the young generally resemble the females, as with the so-called goldfinch of North America, and apparently with the splendid Maluri of Australia. (. For the goldfinch of N. America, *Fringilla tristis*, Linn., see Audubon, 'Ornithological Biography,' vol. i. . For the Maluri, Gould's 'Handbook of the Birds of Australia,' vol. i. .) With those species, the sexes of which are alike during both the summer and winter, the young may resemble the adults, firstly, in their winter dress; secondly, and this is of much rarer occurrence, in their summer dress; thirdly, they may be intermediate between these two states; and, fourthly, they may differ greatly from the adults at all seasons. We have an instance of the first of these four cases in one of the egrets of India (*Buphus coromandus*), in which the young and the adults of both sexes are white during the winter, the adults becoming goldenbuff during the summer.

With the gaper (*Anastomus oscitans*) of India we have a similar case, but the colours are reversed: for the young and the adults of both sexes are grey and black during the winter, the adults becoming white during the summer. (. I am indebted to Mr. Blyth for information as to the Buphus; see also Jerdon, 'Birds of India,' vol. iii. . On the *Anastomus*, see Blyth, in 'Ibis,' , .) As an instance of the second case, the young of the razorbill (*Alca torda*, Linn.), in an early state of plumage, are coloured like the adults during the summer; and the young of the white crowned sparrow of North America (*Fringilla leucophrys*), as soon as fledged, have elegant white stripes on their heads, which are lost by the young and the old during the winter. (. On the *Alca*, see Macgillivray, 'Hist. Brit. Birds,' vol. v. . On the *Fringilla leucophrys*, Audubon, *ibid.* vol. ii. . I shall have hereafter to refer to the young of certain herons and egrets being white.) With respect to the third case, namely, that of the young having an intermediate character between the summer and winter adult plumages, Yarrell (. 'History of British Birds,' vol. i. , .) insists that this occurs with many waders. Lastly, in regard to the young differing greatly from both sexes in their adult summer and winter plumages, this occurs with some herons and egrets of North America and India, the young alone being white.

I will make only a few remarks on these complicated cases. When the young resemble the females in their summer dress, or the adults of both sexes in their winter dress, the cases differ from those given under Classes I. and III. only in the characters originally acquired by the males during the breeding season, having been limited in their transmission to the corresponding season. When the adults have a distinct summer and winter plumage, and the young differ from both, the case is more difficult to understand. We may admit as probable that the young have retained an ancient state of plumage; we can account by sexual selection for the summer or nuptial plumage of the adults, but how are we to account for their distinct winter plumage? If we could admit that this plumage serves in all cases as a protection, its acquirement would be a simple affair; but there seems no good reason for this admission. It may be suggested that the widely different conditions of life during the winter and summer have acted in a direct manner on the plumage; this may have had some effect, but I have not much confidence in so great a difference as we sometimes see between the two plumages, having been thus caused. A more probable explanation is, that an ancient style of plumage, partially modified through the transference of some characters from the summer plumage, has been retained by the adults during the winter. Finally, all the cases in our present class apparently depend on characters acquired by the adult males, having been variously limited in their transmission according to age, season, and sex; but it would not be worth while to attempt to follow out these complex relations.

CLASS VI.

**THE YOUNG IN THEIR FIRST PLUMAGE DIFFER FROM EACH OTHER
ACCORDING TO SEX; THE YOUNG MALES RESEMBLING MORE OR LESS
CLOSELY THE ADULT MALES, AND THE YOUNG FEMALES MORE OR
LESS CLOSELY THE ADULT FEMALES.**

The cases in the present class, though occurring in various groups, are not numerous; yet it seems the most natural thing that the young should at first somewhat resemble the adults of the same sex, and gradually become more and more like them. The adult male blackcap (*Sylvia atricapilla*) has a black head, that of the female being reddishbrown; and I am informed by Mr. Blyth, that the young of both sexes can be distinguished by this character even as nestlings. In the family of thrushes an unusual number of similar cases have been noticed; thus, the male blackbird (*Turdus merula*) can be distinguished in the nest from the female. The two sexes of the mocking bird (*Turdus polyglottus*, Linn.) differ very little from each other, yet the males can easily be distinguished at a very early age from the females by showing more pure white. (. Audubon, 'Ornith. Biography,' vol. i. .) The males of a forestthrush and of a rock thrush (*Orocetes erythrogastra* and *Petrocincla cyanea*) have much of their plumage of a fine blue, whilst the females are brown; and the nestling males of both species have their main wing and tailfeathers edged with blue whilst those of the female are edged with brown. (. Mr. C.A. Wright, in 'Ibis,' vol. vi. , . Jerdon, 'Birds of India,' vol. i. . See also on the blackbird, Blyth in Charlesworth's 'Magazine of Natural History,' vol. i. , .) In the young blackbird the wing feathers assume their mature character and become black after the others; on the other hand, in the two species just named the wingfeathers become blue before the others. The most probable view with reference to the cases in the present class is that the males, differently from what occurs in Class I., have transmitted their colours to their male offspring at an earlier age than that at which they were first acquired; for, if the males had varied whilst quite young, their characters would probably have been transmitted to both sexes. (. The following additional cases may be mentioned; the young males of *Tanagra rubra* can be distinguished from the young females (Audubon, 'Ornith. Biography,' vol. iv.), and so it is within the nestlings of a blue nuthatch, *Dendrophila frontalis* of India (Jerdon, 'Birds of India,' vol. i.). Mr. Blyth also informs me that the sexes of the stonechat, *Saxicola rubicola*, are distinguishable at a very early age. Mr. Salvin gives ('Proc. Zoolog. Soc.' ,) the case of a hummingbird, like the following one of *Eustephanus*.)

In *Aithurus polytmus*, a hummingbird, the male is splendidly coloured black and green, and two of the tailfeathers are immensely lengthened; the female has an ordinary tail and inconspicuous colours; now the young males, instead of resembling the adult female, in accordance with the common rule, begin from the first to assume the colours proper to their sex, and their tailfeathers soon become elongated. I owe this information to Mr. Gould, who has given me the following more striking and as yet unpublished

case. Two hummingbirds belonging to the genus *Eustephanus*, both beautifully coloured, inhabit the small island of Juan Fernandez, and have always been ranked as specifically distinct. But it has lately been ascertained that the one which is of a rich chestnutbrown colour with a goldenred head, is the male, whilst the other which is elegantly variegated with green and white with a metallic green head is the female. Now the young from the first somewhat resemble the adults of the corresponding sex, the resemblance gradually becoming more and more complete.

In considering this last case, if as before we take the plumage of the young as our guide, it would appear that both sexes have been rendered beautiful independently; and not that one sex has partially transferred its beauty to the other. The male apparently has acquired his bright colours through sexual selection in the same manner as, for instance, the peacock or pheasant in our first class of cases; and the female in the same manner as the female *Rhynchaea* or *Turnix* in our second class of cases. But there is much difficulty in understanding how this could have been effected at the same time with the two sexes of the same species. Mr. Salvin states, as we have seen in the eighth chapter, that with certain hummingbirds the males greatly exceed the females in number, whilst with other species inhabiting the same country the females greatly exceed the males. If, then, we might assume that during some former lengthened period the males of the Juan Fernandez species had greatly exceeded the females in number, but that during another lengthened period the females had far exceeded the males, we could understand how the males at one time, and the females at another, might have been rendered beautiful by the selection of the brighter coloured individuals of either sex; both sexes transmitting their characters to their young at a rather earlier age than usual. Whether this is the true explanation I will not pretend to say; but the case is too remarkable to be passed over without notice.

We have now seen in all six classes, that an intimate relation exists between the plumage of the young and the adults, either of one sex or both. These relations are fairly well explained on the principle that one sex this being in the great majority of cases the male first acquired through variation and sexual selection bright colours or other ornaments, and transmitted them in various ways, in accordance with the recognised laws of inheritance. Why variations have occurred at different periods of life, even sometimes with species of the same group we do not know, but with respect to the form of transmission, one important determining cause seems to be the age at which the variations first appear.

From the principle of inheritance at corresponding ages, and from any variations in colour which occurred in the males at an early age not being then selected on the contrary being often eliminated as dangerous whilst similar variations occurring at or near the period of reproduction have been preserved, it follows that the plumage of the

young will often have been left unmodified, or but little modified. We thus get some insight into the colouring of the progenitors of our existing species. In a vast number of species in five out of our six classes of cases, the adults of one sex or of both are bright coloured, at least during the breeding season, whilst the young are invariably less brightly coloured than the adults, or are quite dull coloured; for no instance is known, as far as I can discover, of the young of dullcoloured species displaying bright colours, or of the young of brightcoloured species being more brilliant than their parents. In the fourth class, however, in which the young and the old resemble each other, there are many species (though by no means all), of which the young are brightcoloured, and as these form old groups, we may infer that their early progenitors were likewise bright. With this exception, if we look to the birds of the world, it appears that their beauty has been much increased since that period, of which their immature plumage gives us a partial record.

ON THE COLOUR OF THE PLUMAGE IN RELATION TO PROTECTION.

It will have been seen that I cannot follow Mr. Wallace in the belief that dull colours, when confined to the females, have been in most cases specially gained for the sake of protection. There can, however, be no doubt, as formerly remarked, that both sexes of many birds have had their colours modified, so as to escape the notice of their enemies; or in some instances, so as to approach their prey unobserved, just as owls have had their plumage rendered soft, that their flight may not be overheard. Mr. Wallace remarks (. 'Westminster Review,' July , .) that "it is only in the tropics, among forests which never lose their foliage, that we find whole groups of birds, whose chief colour is green." It will be admitted by every one, who has ever tried, how difficult it is to distinguish parrots in a leafcovered tree. Nevertheless, we must remember that many parrots are ornamented with crimson, blue, and orange tints, which can hardly be protective. Woodpeckers are eminently arboreal, but besides green species, there are many black, and blackandwhite kinds all the species being apparently exposed to nearly the same dangers. It is therefore probable that with treehaunting birds, stronglypronounced colours have been acquired through sexual selection, but that a green tint has been acquired oftener than any other, from the additional advantage of protection.

In regard to birds which live on the ground, every one admits that they are coloured so as to imitate the surrounding surface. How difficult it is to see a partridge, snipe, woodcock, certain plovers, larks, and nightjars when crouched on ground. Animals inhabiting deserts offer the most striking cases, for the bare surface affords no concealment, and nearly all the smaller quadrupeds, reptiles, and birds depend for safety on their colours. Mr. Tristram has remarked in regard to the inhabitants of the Sahara, that all are protected by their "isabelline or sandcolour." (. 'Ibis,' , vol. i. , et seq.

Dr. Rohlf, however, remarks to me in a letter that according to his experience of the Sahara, this statement is too strong.) Calling to my recollection the desertbirds of South America, as well as most of the groundbirds of Great Britain, it appeared to me that both sexes in such cases are generally coloured nearly alike. Accordingly, I applied to Mr. Tristram with respect to the birds of the Sahara, and he has kindly given me the following information. There are twenty-six species belonging to fifteen genera, which manifestly have their plumage coloured in a protective manner; and this colouring is all the more striking, as with most of these birds it differs from that of their congeners. Both sexes of thirteen out of the twenty-six species are coloured in the same manner; but these belong to genera in which this rule commonly prevails, so that they tell us nothing about the protective colours being the same in both sexes of desertbirds. Of the other thirteen species, three belong to genera in which the sexes usually differ from each other, yet here they have the sexes alike. In the remaining ten species, the male differs from the female; but the difference is confined chiefly to the under surface of the plumage, which is concealed when the bird crouches on the ground; the head and back being of the same sand coloured hue in the two sexes. So that in these ten species the upper surfaces of both sexes have been acted on and rendered alike, through natural selection, for the sake of protection; whilst the lower surfaces of the males alone have been diversified, through sexual selection, for the sake of ornament. Here, as both sexes are equally well protected, we clearly see that the females have not been prevented by natural selection from inheriting the colours of their male parents; so that we must look to the law of sexually limited transmission.

In all parts of the world both sexes of many softbilled birds, especially those which frequent reeds or sedges, are obscurely coloured. No doubt if their colours had been brilliant, they would have been much more conspicuous to their enemies; but whether their dull tints have been specially gained for the sake of protection seems, as far as I can judge, rather doubtful. It is still more doubtful whether such dull tints can have been gained for the sake of ornament. We must, however, bear in mind that male birds, though dull coloured, often differ much from their females (as with the common sparrow), and this leads to the belief that such colours have been gained through sexual selection, from being attractive. Many of the softbilled birds are songsters; and a discussion in a former chapter should not be forgotten, in which it was shewn that the best songsters are rarely ornamented with bright tints. It would appear that female birds, as a general rule, have selected their mates either for their sweet voices or gay colours, but not for both charms combined. Some species, which are manifestly coloured for the sake of protection, such as the jacksnipe, woodcock, and nightjar, are likewise marked and shaded, according to our standard of taste, with extreme elegance. In such cases we may conclude that both natural and sexual selection have acted conjointly for protection and ornament. Whether any bird exists which does not possess some special attraction, by which to charm the opposite sex, may be doubted. When both sexes are so

obscurely coloured that it would be rash to assume the agency of sexual selection, and when no direct evidence can be advanced shewing that such colours serve as a protection, it is best to own complete ignorance of the cause, or, which comes to nearly the same thing, to attribute the result to the direct action of the conditions of life.

Both sexes of many birds are conspicuously, though not brilliantly coloured, such as the numerous black, white, or piebald species; and these colours are probably the result of sexual selection. With the common blackbird, capercailzie, blackcock, black scoterduck (*Oidemia*), and even with one of the birds of paradise (*Lophorina atra*), the males alone are black, whilst the females are brown or mottled; and there can hardly be a doubt that blackness in these cases has been a sexually selected character. Therefore it is in some degree probable that the complete or partial blackness of both sexes in such birds as crows, certain cockatoos, storks, and swans, and many marine birds, is likewise the result of sexual selection, accompanied by equal transmission to both sexes; for blackness can hardly serve in any case as a protection. With several birds, in which the male alone is black, and in others in which both sexes are black, the beak or skin about the head is brightly coloured, and the contrast thus afforded adds much to their beauty; we see this in the bright yellow beak of the male blackbird, in the crimson skin over the eyes of the blackcock and capercailzie, in the brightly and variously coloured beak of the scoterdrake (*Oidemia*), in the red beak of the chough (*Corvus graculus*, Linn.), of the black swan, and the black stork. This leads me to remark that it is not incredible that toucans may owe the enormous size of their beaks to sexual selection, for the sake of displaying the diversified and vivid stripes of colour, with which these organs are ornamented. (No satisfactory explanation has ever been offered of the immense size, and still less of the bright colours, of the toucan's beak. Mr. Bates ('The Naturalist on the Amazons,' vol. ii. ,) states that they use their beaks for reaching fruit at the extreme tips of the branches; and likewise, as stated by other authors, for extracting eggs and young birds from the nests of other birds. But, as Mr. Bates admits, the beak "can scarcely be considered a very perfectlyformed instrument for the end to which it is applied." The great bulk of the beak, as shewn by its breadth, depth, as well as length, is not intelligible on the view, that it serves merely as an organ of prehension. Mr. Belt believes ('The Naturalist in Nicaragua,') that the principal use of the beak is as a defence against enemies, especially to the female whilst nesting in a hole in a tree.) The naked skin, also, at the base of the beak and round the eyes is likewise often brilliantly coloured; and Mr. Gould, in speaking of one species (*Rhamphastos carinatus*, Gould's 'Monograph of Ramphastidae.'), says that the colours of the beak "are doubtless in the finest and most brilliant state during the time of pairing." There is no greater improbability that toucans should be encumbered with immense beaks, though rendered as light as possible by their cancellated structure, for the display of fine colours (an object falsely appearing to us unimportant), than that the male Argus pheasant and some other birds should be encumbered with plumes so long as to impede their flight.

In the same manner, as the males alone of various species are black, the females being dullcoloured; so in a few cases the males alone are either wholly or partially white, as with the several bellbirds of South America (*Chasmorhynchus*), the Antarctic goose (*Bernicla antarctica*), the silver pheasant, etc., whilst the females are brown or obscurely mottled. Therefore, on the same principle as before, it is probable that both sexes of many birds, such as white cockatoos, several egrets with their beautiful plumes, certain ibises, gulls, terns, etc., have acquired their more or less completely white plumage through sexual selection. In some of these cases the plumage becomes white only at maturity. This is the case with certain gannets, tropicbirds, etc., and with the snowgoose (*Anser hyperboreus*). As the latter breeds on the "barren grounds," when not covered with snow, and as it migrates southward during the winter, there is no reason to suppose that its snowwhite adult plumage serves as a protection. In the *Anastomus oscitans*, we have still better evidence that the white plumage is a nuptial character, for it is developed only during the summer; the young in their immature state, and the adults in their winter dress, being grey and black. With many kinds of gulls (*Larus*), the head and neck become pure white during the summer, being grey or mottled during the winter and in the young state. On the other hand, with the smaller gulls, or seamews (*Gavia*), and with some terns (*Sterna*), exactly the reverse occurs; for the heads of the young birds during the first year, and of the adults during the winter, are either pure white, or much paler coloured than during the breedingseason. These latter cases offer another instance of the capricious manner in which sexual selection appears often to have acted. (. On *Larus*, *Gavia*, and *Sterna*, see Macgillivray, 'History of British Birds,' vol. v. , . On the *Anser hyperboreus*, Audubon, 'Ornithological Biography,' vol. iv. . On the *Anastomus*, Mr. Blyth, in 'Ibis,' , .)

That aquatic birds have acquired a white plumage so much oftener than terrestrial birds, probably depends on their large size and strong powers of flight, so that they can easily defend themselves or escape from birds of prey, to which moreover they are not much exposed. Consequently, sexual selection has not here been interfered with or guided for the sake of protection. No doubt with birds which roam over the open ocean, the males and females could find each other much more easily, when made conspicuous either by being perfectly white or intensely black; so that these colours may possibly serve the same end as the callnotes of many landbirds. (. It may be noticed that with vultures, which roam far and wide high in the air, like marine birds over the ocean, three or four species are almost wholly or largely white, and that many others are black. So that here again conspicuous colours may possibly aid the sexes in finding each other during the breedingseason.) A white or black bird when it discovers and flies down to a carcass floating on the sea or cast up on the beach, will be seen from a great distance, and will guide other birds of the same and other species, to the prey; but as this would be a disadvantage to the first finders, the individuals which were the whitest or blackest

would not thus procure more food than the less strongly coloured individuals. Hence conspicuous colours cannot have been gradually acquired for this purpose through natural selection.

As sexual selection depends on so fluctuating an element as taste, we can understand how it is that, within the same group of birds having nearly the same habits, there should exist white or nearly white, as well as black, or nearly black species, for instance, both white and black cockatoos, storks, ibises, swans, terns, and petrels. Piebald birds likewise sometimes occur in the same groups together with black and white species; for instance, the blacknecked swan, certain terns, and the common magpie. That a strong contrast in colour is agreeable to birds, we may conclude by looking through any large collection, for the sexes often differ from each other in the male having the pale parts of a purer white, and the variously coloured dark parts of still darker tints than the female.

It would even appear that mere novelty, or slight changes for the sake of change, have sometimes acted on female birds as a charm, like changes of fashion with us. Thus the males of some parrots can hardly be said to be more beautiful than the females, at least according to our taste, but they differ in such points, as in having a rosecoloured collar instead of "a bright emeraldine narrow green collar"; or in the male having a black collar instead of "a yellow demicollar in front," with a pale roseate instead of a plumblue head. (. See Jerdon on the genus *Palaeornis*, 'Birds of India,' vol. i. p.) As so many male birds have elongated tailfeathers or elongated crests for their chief ornament, the shortened tail, formerly described in the male of a hummingbird, and the shortened crest of the male goosander, seem like one of the many changes of fashion which we admire in our own dresses.

Some members of the heron family offer a still more curious case of novelty in colouring having, as it appears, been appreciated for the sake of novelty. The young of the *Ardea asha* are white, the adults being dark slatecoloured; and not only the young, but the adults in their winter plumage, of the allied *Buphus coromandus* are white, this colour changing into a rich goldenbuff during the breedingseason. It is incredible that the young of these two species, as well as of some other members of the same family (. The young of *Ardea rufescens* and *A. caerulea* of the United States are likewise white, the adults being coloured in accordance with their specific names. Audubon ('Ornithological Biography,' vol. iii. ; vol. iv.) seems rather pleased at the thought that this remarkable change of plumage will greatly "disconcert the systematists."), should for any special purpose have been rendered pure white and thus made conspicuous to their enemies; or that the adults of one of these two species should have been specially rendered white during the winter in a country which is never covered with snow. On the other hand we have good reason to believe that whiteness has been gained by many birds as a sexual ornament. We may therefore conclude that some early progenitor of the *Ardea asha* and

the Buphus acquired a white plumage for nuptial purposes, and transmitted this colour to their young; so that the young and the old became white like certain existing egrets; and that the whiteness was afterwards retained by the young, whilst it was exchanged by the adults for more strongly pronounced tints. But if we could look still further back to the still earlier progenitors of these two species, we should probably see the adults darkcoloured. I infer that this would be the case, from the analogy of many other birds, which are dark whilst young, and when adult are white; and more especially from the case of the *Ardea gularis*, the colours of which are the reverse of those of *A. asha*, for the young are darkcoloured and the adults white, the young having retained a former state of plumage. It appears therefore that, during a long line of descent, the adult progenitors of the *Ardea asha*, the Buphus, and of some allies, have undergone the following changes of colour: first, a dark shade; secondly, pure white; and thirdly, owing to another change of fashion (if I may so express myself), their present slaty, reddish, or goldenbuff tints. These successive changes are intelligible only on the principle of novelty having been admired by birds for its own sake.

Several writers have objected to the whole theory of sexual selection, by assuming that with animals and savages the taste of the female for certain colours or other ornaments would not remain constant for many generations; that first one colour and then another would be admired, and consequently that no permanent effect could be produced. We may admit that taste is fluctuating, but it is not quite arbitrary. It depends much on habit, as we see in mankind; and we may infer that this would hold good with birds and other animals. Even in our own dress, the general character lasts long, and the changes are to a certain extent graduated. Abundant evidence will be given in two places in a future chapter, that savages of many races have admired for many generations the same cicatrices on the skin, the same hideously perforated lips, nostrils, or ears, distorted heads, etc.; and these deformities present some analogy to the natural ornaments of various animals. Nevertheless, with savages such fashions do not endure for ever, as we may infer from the differences in this respect between allied tribes on the same continent. So again the raisers of fancy animals certainly have admired for many generations and still admire the same breeds; they earnestly desire slight changes, which are considered as improvements, but any great or sudden change is looked at as the greatest blemish. With birds in a state of nature we have no reason to suppose that they would admire an entirely new style of coloration, even if great and sudden variations often occurred, which is far from being the case. We know that dovecot pigeons do not willingly associate with the variously coloured fancy breeds; that albino birds do not commonly get partners in marriage; and that the black ravens of the Feroe Islands chase away their piebald brethren. But this dislike of a sudden change would not preclude their appreciating slight changes, any more than it does in the case of man. Hence with respect to taste, which depends on many elements, but partly on habit and partly on a love of novelty, there seems no improbability in animals admiring for a very

long period the same general style of ornamentation or other attractions, and yet appreciating slight changes in colours, form, or sound.

SUMMARY OF THE FOUR CHAPTERS ON BIRDS.

Most male birds are highly pugnacious during the breedingseason, and some possess weapons adapted for hting with their rivals. But the most pugnacious and the best armed males rarely or never depend for success solely on their power to drive away or kill their rivals, but have special means for charming the female. With some it is the power of song, or of giving forth strange cries, or instrumental music, and the males in consequence differ from the females in their vocal organs, or in the structure of certain feathers. From the curiously diversified means for producing various sounds, we gain a high idea of the importance of this means of courtshiMany birds endeavour to charm the females by love dances or antics, performed on the ground or in the air, and sometimes at prepared places. But ornaments of many kinds, the most brilliant tints, combs and wattles, beautiful plumes, elongated feathers, topknots, and so forth, are by far the commonest means. In some cases mere novelty appears to have acted as a charm. The ornaments of the males must be highly important to them, for they have been acquired in not a few cases at the cost of increased danger from enemies, and even at some loss of power in hting with their rivals. The males of very many species do not assume their ornamental dress until they arrive at maturity, or they assume it only during the breedingseason, or the tints then become more vivid. Certain ornamental appendages become enlarged, turgid, and brightly coloured during the act of courtshiThe males display their charms with elaborate care and to the best effect; and this is done in the presence of the females. The courtship is sometimes a prolonged affair, and many males and females congregate at an appointed place. To suppose that the females do not appreciate the beauty of the males, is to admit that their splendid decorations, all their pomp and display, are useless; and this is incredible. Birds have fine powers of discrimination, and in some few instances it can be shewn that they have a taste for the beautiful. The females, moreover, are known occasionally to exhibit a marked preference or antipathy for certain individual males.

If it be admitted that the females prefer, or are unconsciously excited by the more beautiful males, then the males would slowly but surely be rendered more and more attractive through sexual selection. That it is this sex which has been chiefly modified, we may infer from the fact that, in almost every genus where the sexes differ, the males differ much more from one another than do the females; this is well shewn in certain closelyallied representative species, in which the females can hardly be distinguished, whilst the males are quite distinct. Birds in a state of nature offer individual differences which would amply suffice for the work of sexual selection; but we have seen that they occasionally present more strongly marked variations which recur so frequently that

they would immediately be fixed, if they served to allure the female. The laws of variation must determine the nature of the initial changes, and will have largely influenced the final result. The gradations, which may be observed between the males of allied species, indicate the nature of the steps through which they have passed. They explain also in the most interesting manner how certain characters have originated, such as the indented ocelli on the tailfeathers of the peacock, and the ballandsocket ocelli on the wingfeathers of the Argus pheasant. It is evident that the brilliant colours, topknots, fine plumes, etc., of many male birds cannot have been acquired as a protection; indeed, they sometimes lead to danger. That they are not due to the direct and definite action of the conditions of life, we may feel assured, because the females have been exposed to the same conditions, and yet often differ from the males to an extreme degree. Although it is probable that changed conditions acting during a lengthened period have in some cases produced a definite effect on both sexes, or sometimes on one sex alone, the more important result will have been an increased tendency to vary or to present more strongly marked individual differences; and such differences will have afforded an excellent ground work for the action of sexual selection.

The laws of inheritance, irrespectively of selection, appear to have determined whether the characters acquired by the males for the sake of ornament, for producing various sounds, and for hting together, have been transmitted to the males alone or to both sexes, either permanently, or periodically during certain seasons of the year. Why various characters should have been transmitted sometimes in one way and sometimes in another, is not in most cases known; but the period of variability seems often to have been the determining cause. When the two sexes have inherited all characters in common they necessarily resemble each other; but as the successive variations may be differently transmitted, every possible gradation may be found, even within the same genus, from the closest similarity to the widest dissimilarity between the sexes. With many closely allied species, following nearly the same habits of life, the males have come to differ from each other chiefly through the action of sexual selection; whilst the females have come to differ chiefly from partaking more or less of the characters thus acquired by the males. The effects, moreover, of the definite action of the conditions of life, will not have been masked in the females, as in the males, by the accumulation through sexual selection of strongly pronounced colours and other ornaments. The individuals of both sexes, however affected, will have been kept at each successive period nearly uniform by the free intercrossing of many individuals.

With species, in which the sexes differ in colour, it is possible or probable that some of the successive variations often tended to be transmitted equally to both sexes; but that when this occurred the females were prevented from acquiring the bright colours of the males, by the destruction which they suffered during incubation. There is no evidence

that it is possible by natural selection to convert one form of transmission into another. But there would not be the least difficulty in rendering a female dullcoloured, the male being still kept bright coloured, by the selection of successive variations, which were from the first limited in their transmission to the same sex. Whether the females of many species have actually been thus modified, must at present remain doubtful. When, through the law of the equal transmission of characters to both sexes, the females were rendered as conspicuously coloured as the males, their instincts appear often to have been modified so that they were led to build domed or concealed nests.

In one small and curious class of cases the characters and habits of the two sexes have been completely transposed, for the females are larger, stronger, more vociferous and brighter coloured than the males. They have, also, become so quarrelsome that they often fight together for the possession of the males, like the males of other pugnacious species for the possession of the females. If, as seems probable, such females habitually drive away their rivals, and by the display of their bright colours or other charms endeavour to attract the males, we can understand how it is that they have gradually been rendered, by sexual selection and sexually limited transmission, more beautiful than the male the latter being left unmodified or only slightly modified.

Whenever the law of inheritance at corresponding ages prevails but not that of sexually limited transmission, then if the parents vary late in life and we know that this constantly occurs with our poultry, and occasionally with other birds the young will be left unaffected, whilst the adults of both sexes will be modified. If both these laws of inheritance prevail and either sex varies late in life, that sex alone will be modified, the other sex and the young being unaffected. When variations in brightness or in other conspicuous characters occur early in life, as no doubt often happens, they will not be acted on through sexual selection until the period of reproduction arrives; consequently if dangerous to the young, they will be eliminated through natural selection. Thus we can understand how it is that variations arising late in life have so often been preserved for the ornamentation of the males; the females and the young being left almost unaffected, and therefore like each other. With species having a distinct summer and winter plumage, the males of which either resemble or differ from the females during both seasons or during the summer alone, the degrees and kinds of resemblance between the young and the old are exceedingly complex; and this complexity apparently depends on characters, first acquired by the males, being transmitted in various ways and degrees, as limited by age, sex, and season.

As the young of so many species have been but little modified in colour and in other ornaments, we are enabled to form some judgment with respect to the plumage of their early progenitors; and we may infer that the beauty of our existing species, if we look to the whole class, has been largely increased since that period, of which the immature

plumage gives us an indirect record. Many birds, especially those which live much on the ground, have undoubtedly been obscurely coloured for the sake of protection. In some instances the upper exposed surface of the plumage has been thus coloured in both sexes, whilst the lower surface in the males alone has been variously ornamented through sexual selection. Finally, from the facts given in these four chapters, we may conclude that weapons for battle, organs for producing sound, ornaments of many kinds, bright and conspicuous colours, have generally been acquired by the males through variation and sexual selection, and have been transmitted in various ways according to the several laws of inheritance the females and the young being left comparatively but little modified. (I am greatly indebted to the kindness of Mr. Sclater for having looked over these four chapters on birds, and the two following ones on mammals. In this way I have been saved from making mistakes about the names of the species, and from stating anything as a fact which is known to this distinguished naturalist to be erroneous. But, of course, he is not at all answerable for the accuracy of the statements quoted by me from various authorities.)

CHAPTER XVII.

SECONDARY SEXUAL CHARACTERS OF MAMMALS.

The law of battleSpecial weapons, confined to the malesCause of absence of weapons in the femaleWeapons common to both sexes, yet primarily acquired by the maleOther uses of such weaponsTheir high importance Greater size of the maleMeans of defenceOn the preference shown by either sex in the pairing of quadrupeds.

With mammals the male appears to win the female much more through the law of battle than through the display of his charms. The most timid animals, not provided with any special weapons for fighting, engage in desperate conflicts during the season of love. Two male hares have been seen to fight together until one was killed; male moles often fight, and sometimes with fatal results; male squirrels engage in frequent contests, "and often wound each other severely"; as do male beavers, so that "hardly a skin is without scars." (. See Waterton's account of two hares fighting, 'Zoologist,' vol. i. , . On moles, Bell, 'Hist. of British Quadrupeds,' 1st ed., . On squirrels, Audubon and Bachman, 'Viviparous Quadrupeds of N. America,' , . On beavers, Mr. A.H. Green, in 'Journal of Linnean Society, Zoology,' vol. x. , .) I observed the same fact with the hides of the guanaco in Patagonia; and on one occasion several were so absorbed in fighting that they fearlessly rushed close by me. Livingstone speaks of the males of the many animals in Southern Africa as almost invariably showing the scars received in former contests.

The law of battle prevails with aquatic as with terrestrial mammals. It is notorious how desperately male seals fight, both with their teeth and claws, during the breeding season; and their hides are likewise often covered with scars. Male spermwhales are very jealous at this season; and in their battles "they often lock their jaws together, and turn on their sides and twist about"; so that their lower jaws often become distorted. (. On the battles of seals, see Capt. C. Abbott in 'Proc. Zool. Soc.' , ; Mr. R. Brown, *ibid.* , ; also L. Lloyd, 'Game Birds of Sweden,' , ; also Pennant. On the spermwhale see Mr. J.H. Thompson, in 'Proc. Zool. Soc.' , .)

All male animals which are furnished with special weapons for fighting, are well known to engage in fierce battles. The courage and the desperate conflicts of stags have often been described; their skeletons have been found in various parts of the world, with the horns inextricably locked together, showing how miserably the victor and vanquished had perished. (. See Scrope ('Art of Deerstalking,') on the locking of the horns with the *Cervus elaphus*. Richardson, in 'Fauna Bor. Americana,' , , says that the wapiti, moose, and reindeer have been found thus locked together. Sir A. Smith found at the Cape of Good Hope the skeletons of two gnus in the same condition.) No animal in the world is so dangerous as an elephant in must. Lord Tankerville has given me a graphic description of the battles between the wild bulls in Chillingham Park, the descendants, degenerated in size but not in courage, of the gigantic *Bos primigenius*. In several contended for mastery; and it was observed that two of the younger bulls attacked in concert the old leader of the herd, overthrew and disabled him, so that he was believed

by the keepers to be lying mortally wounded in a neighbouring wood. But a few days afterwards one of the young bulls approached the wood alone; and then the "monarch of the chase," who had been lashing himself up for vengeance, came out and, in a short time, killed his antagonist. He then quietly joined the herd, and long held undisputed sway. Admiral Sir B.J. Sullivan informs me that, when he lived in the Falkland Islands, he imported a young English stallion, which frequented the hills near Port William with eight mares. On these hills there were two wild stallions, each with a small troop of mares; "and it is certain that these stallions would never have approached each other without fighting. Both had tried singly to fight the English horse and drive away his mares, but had failed. One day they came in TOGETHER and attacked him. This was seen by the captain who had charge of the horses, and who, on riding to the spot, found one of the two stallions engaged with the English horse, whilst the other was driving away the mares, and had already separated four from the rest. The captain settled the matter by driving the whole party into the corral, for the wild stallions would not leave the mares."

Male animals which are provided with efficient cutting or tearing teeth for the ordinary purposes of life, such as the carnivora, insectivora, and rodents, are seldom furnished with weapons especially adapted for fighting with their rivals. The case is very different with the males of many other animals. We see this in the horns of stags and of certain kinds of antelopes in which the females are hornless. With many animals the canine teeth in the upper or lower jaw, or in both, are much larger in the males than in the females, or are absent in the latter, with the exception sometimes of a hidden rudiment. Certain antelopes, the muskdeer, camel, horse, boar, various apes, seals, and the walrus, offer instances. In the females of the walrus the tusks are sometimes quite absent. (. Mr. Lamont ('Seasons with the SeaHorses,' ,) says that a good tusk of the male walrus weighs pounds, and is longer than that of the female, which weighs about pounds. The males are described as fighting ferociously. On the occasional absence of the tusks in the female, see Mr. R. Brown, 'Proceedings, Zoological Society,' , .) In the male elephant of India and in the male dugong (. Owen, 'Anatomy of Vertebrates,' vol. iii. .) the upper incisors form offensive weapons. In the male narwhal the left canine alone is developed into the wellknown, spirallytwisted, so-called horn, which is sometimes from nine to ten feet in length. It is believed that the males use these horns for fighting together; for "an unbroken one can rarely be got, and occasionally one may be found with the point of another jammed into the broken place." (. Mr. R. Brown, in 'Proc. Zool. Soc.' , . See Prof. Turner, in 'Journal of Anat. and Phys.' , , on the homological nature of these tusks. Also Mr. J.W. Clarke on two tusks being developed in the males, in 'Proceedings of the Zoological Society,' , .) The tooth on the opposite side of the head in the male consists of a rudiment about ten inches in length, which is embedded in the jaw; but sometimes, though rarely, both are equally developed on the two sides. In the female both are always rudimentary. The male cachalot has a larger head than that of the female, and it no doubt aids him in his aquatic battles. Lastly, the adult male ornithorhynchus is

provided with a remarkable apparatus, namely a spur on the foreleg, closely resembling the poisonfang of a venomous snake; but according to Harting, the secretion from the gland is not poisonous; and on the leg of the female there is a hollow, apparently for the reception of the spur. (. Owen on the cachalot and *Ornithorhynchus*, *ibid.* vol. iii. . Harting is quoted by Dr. Zouteveen in the Dutch translation of this work, vol. ii. .)

When the males are provided with weapons which in the females are absent, there can be hardly a doubt that these serve for fighting with other males; and that they were acquired through sexual selection, and were transmitted to the male sex alone. It is not probable, at least in most cases, that the females have been prevented from acquiring such weapons, on account of their being useless, superfluous, or in some way injurious. On the contrary, as they are often used by the males for various purposes, more especially as a defence against their enemies, it is a surprising fact that they are so poorly developed, or quite absent, in the females of so many animals. With female deer the development during each recurrent season of great branching horns, and with female elephants the development of immense tusks, would be a great waste of vital power, supposing that they were of no use to the females. Consequently, they would have tended to be eliminated in the female through natural selection; that is, if the successive variations were limited in their transmission to the female sex, for otherwise the weapons of the males would have been injuriously affected, and this would have been a greater evil. On the whole, and from the consideration of the following facts, it seems probable that when the various weapons differ in the two sexes, this has generally depended on the kind of transmission which has prevailed.

As the reindeer is the one species in the whole family of Deer, in which the female is furnished with horns, though they are somewhat smaller, thinner, and less branched than in the male, it might naturally be thought that, at least in this case, they must be of some special service to her. The female retains her horns from the time when they are fully developed, namely, in September, throughout the winter until April or May, when she brings forth her young. Mr. Crotch made particular enquiries for me in Norway, and it appears that the females at this season conceal themselves for about a fortnight in order to bring forth their young, and then reappear, generally hornless. In Nova Scotia, however, as I hear from Mr. H. Reeks, the female sometimes retains her horns longer. The male on the other hand casts his horns much earlier, towards the end of November. As both sexes have the same requirements and follow the same habits of life, and as the male is destitute of horns during the winter, it is improbable that they can be of any special service to the female during this season, which includes the larger part of the time during which she is horned. Nor is it probable that she can have inherited horns from some ancient progenitor of the family of deer, for, from the fact of the females of so many species in all quarters of the globe not having horns, we may conclude that this was the primordial character of the group. On the structure and shedding of the horns of

the reindeer, Hoffberg, 'Amoenitates Acad.' vol. iv. , . See Richardson, 'Fauna Bor. Americana,' , in regard to the American variety or species: also Major W. Ross King, 'The Sportsman in Canada,' , .

The horns of the reindeer are developed at a most unusually early age; but what the cause of this may be is not known. The effect has apparently been the transference of the horns to both sexes. We should bear in mind that horns are always transmitted through the female, and that she has a latent capacity for their development, as we see in old or diseased females. (. Isidore Geoffroy St.Hilaire, 'Essais de Zoolog. Générale,' , . Other masculine characters, besides the horns, are sometimes similarly transferred to the female; thus Mr. Boner, in speaking of an old female chamois ('Chamois Hunting in the Mountains of Bavaria,' , nd ed.,), says, "not only was the head very malelooking, but along the back there was a ridge of long hair, usually to be found only in bucks.") Moreover the females of some other species of deer exhibit, either normally or occasionally, rudiments of horns; thus the female of *Cervulus moschatus* has "bristly tufts, ending in a knob, instead of a horn"; and "in most specimens of the female wapiti (*Cervus canadensis*) there is a sharp bony protuberance in the place of the horn." (. On the *Cervulus*, Dr. Gray, 'Catalogue of Mammalia in the British Museum,' part iii. . On the *Cervus canadensis* or wapiti, see Hon. J.D. Caton, 'Ottawa Academy of Nat. Sciences,' May , .) From these several considerations we may conclude that the possession of fairly welldeveloped horns by the female reindeer, is due to the males having first acquired them as weapons for hting with other males; and secondarily to their development from some unknown cause at an unusually early age in the males, and their consequent transference to both sexes.

Turning to the sheathhorned ruminants: with antelopes a graduated series can be formed, beginning with species, the females of which are completely destitute of horns passing on to those which have horns so small as to be almost rudimentary (as with the *Antilocapra americana*, in which species they are present in only one out of four or five females (. I am indebted to Dr. Canfield for this information; see also his paper in the 'Proceedings of the Zoological Society,' , .))to those which have fairly developed horns, but manifestly smaller and thinner than in the male and sometimes of a different shape (. For instance the horns of the female *Ant. euchore* resemble those of a distinct species, viz. the *Ant. dorcas* var. *Corine*, see Desmarest, 'Mammalogie,' .),and ending with those in which both sexes have horns of equal size. As with the reindeer, so with antelopes, there exists, as previously shewn, a relation between the period of the development of the horns and their transmission to one or both sexes; it is therefore probable that their presence or absence in the females of some species, and their more or less perfect condition in the females of other species, depends, not on their being of any special use, but simply on inheritance. It accords with this view that even in the same restricted genus both sexes of some species, and the males alone of others, are

thus provided. It is also a remarkable fact that, although the females of *Antilope bezoartica* are normally destitute of horns, Mr. Blyth has seen no less than three females thus furnished; and there was no reason to suppose that they were old or diseased.

In all the wild species of goats and sheep the horns are larger in the male than in the female, and are sometimes quite absent in the latter. (. Gray, 'Catalogue of Mammalia, the British Museum,' part iii. , .) In several domestic breeds of these two animals, the males alone are furnished with horns; and in some breeds, for instance, in the sheep of North Wales, though both sexes are properly horned, the ewes are very liable to be hornless. I have been informed by a trustworthy witness, who purposely inspected a flock of these same sheep during the lambing season, that the horns at birth are generally more fully developed in the male than in the female. Mr. J. Peel crossed his Lonk sheeboth sexes of which always bear horns, with hornless Leicesters and hornless Shropshire Downs; and the result was that the male offspring had their horns considerably reduced, whilst the females were wholly destitute of them. These several facts indicate that, with shee the horns are a much less firmly fixed character in the females than in the males; and this leads us to look at the horns as properly of masculine origin.

With the adult muskox (*Ovibos moschatus*) the horns of the male are larger than those of the female, and in the latter the bases do not touch. (. Richardson, 'Fauna Bor. Americana,' .) In regard to ordinary cattle Mr. Blyth remarks: "In most of the wild bovine animals the horns are both longer and thicker in the bull than in the cow, and in the cowbanteng (*Bos sondaicus*) the horns are remarkably small, and inclined much backwards. In the domestic races of cattle, both of the humped and humpless types, the horns are short and thick in the bull, longer and more slender in the cow and ox; and in the Indian buffalo, they are shorter and thicker in the bull, longer and more slender in the cow. In the wild gaour (*B. gaurus*) the horns are mostly both longer and thicker in the bull than in the cow." (. 'Land and Water,' , .) Dr. Forsyth Major also informs me that a fossil skull, believed to be that of the female *Bos etruscus*, has been found in Val d'Arno, which is wholly without horns. In the *Rhinoceros simus*, as I may add, the horns of the female are generally longer but less powerful than in the male; and in some other species of rhinoceros they are said to be shorter in the female. (. Sir Andrew Smith, 'Zoology of S. Africa,' pl. xix. Owen, 'Anatomy of Vertebrates,' vol. iii. .) From these various facts we may infer as probable that horns of all kinds, even when they are equally developed in the two sexes, were primarily acquired by the male in order to conquer other males, and have been transferred more or less completely to the female.

The effects of castration deserve notice, as throwing light on this same point. Stags after the operation never renew their horns. The male reindeer, however, must be excepted, as after castration he does renew them. This fact, as well as the possession of horns by

both sexes, seems at first to prove that the horns in this species do not constitute a sexual character (. This is the conclusion of Seidlitz, 'Die Darwinsche Theorie,' , .); but as they are developed at a very early age, before the sexes differ in constitution, it is not surprising that they should be unaffected by castration, even if they were aboriginally acquired by the male. With sheep both sexes properly bear horns; and I am informed that with Welch sheep the horns of the males are considerably reduced by castration; but the degree depends much on the age at which the operation is performed, as is likewise the case with other animals. Merino rams have large horns, whilst the ewes "generally speaking are without horns"; and in this breed castration seems to produce a somewhat greater effect, so that if performed at an early age the horns "remain almost undeveloped." (. I am much obliged to Prof. Victor Carus, for having made enquiries for me in Saxony on this subject. H. von Nathusius ('Viehzucht,' ,) says that the horns of sheep castrated at an early period, either altogether disappear or remain as mere rudiments; but I do not know whether he refers to merinos or to ordinary breeds.) On the Guinea coast there is a breed in which the females never bear horns, and, as Mr. Winwood Reade informs me, the rams after castration are quite destitute of them. With cattle, the horns of the males are much altered by castration; for instead of being short and thick, they become longer than those of the cow, but otherwise resemble them. The Antelope bezoartica offers a somewhat analogous case: the males have long straight spiral horns, nearly parallel to each other, and directed backwards; the females occasionally bear horns, but these when present are of a very different shape, for they are not spiral, and spreading widely, bend round with the points forwards. Now it

is a remarkable fact that, in the castrated male, as Mr. Blyth informs me, the horns are of the same peculiar shape as in the female, but longer and thicker. If we may judge from analogy, the female probably shews us, in these two cases of cattle and the antelope, the former condition of the horns in some early progenitor of each species. But why castration should lead to the reappearance of an early condition of the horns cannot be explained with any certainty. Nevertheless, it seems probable, that in nearly the same manner as the constitutional disturbance in the offspring, caused by a cross between two distinct species or races, often leads to the reappearance of longlost characters (. I have given various experiments and other evidence proving that this is the case, in my 'Variation of Animals and Plants under Domestication,' vol. ii. , p.); so here, the disturbance in the constitution of the individual, resulting from castration, produces the same effect.

The tusks of the elephant, in the different species or races, differ according to sex, nearly as do the horns of ruminants. In India and Malacca the males alone are provided with welldeveloped tusks. The elephant of Ceylon is considered by most naturalists as a distinct race, but by some as a distinct species, and here "not one in a hundred is found with tusks, the few that possess them being exclusively males." (. Sir J. Emerson

Tennent, 'Ceylon,' , vol. ii. . For Malacca, 'Journal of Indian Archipelago,' vol. iv. .) The African elephant is undoubtedly distinct, and the female has large welldeveloped tusks, though not so large as those of the male.

These differences in the tusks of the several races and species of elephants the great variability of the horns of deer, as notably in the wild reindeer the occasional presence of horns in the female Antelope Bezoartica, and their frequent absence in the female of Antilocapra americanathe presence of two tusks in some few male narwhalsthe complete absence of tusks in some female walrusesare all instances of the extreme variability of secondary sexual characters, and of their liability to differ in closelyallied forms.

Although tusks and horns appear in all cases to have been primarily developed as sexual weapons, they often serve other purposes. The elephant uses his tusks in attacking the tiger; according to Bruce, he scores the trunks of trees until they can be thrown down easily, and he likewise thus extracts the farinaceous cores of palms; in Africa he often uses one tusk, always the same, to probe the ground and thus ascertain whether it will bear his weight. The common bull defends the herd with his horns; and the elk in Sweden has been known, according to Lloyd, to strike a wolf dead with a single blow of his great horns. Many similar facts could be given. One of the most curious secondary uses to which the horns of an animal may be occasionally put is that observed by Captain Hutton (. 'Calcutta Journal of Natural History,' vol. ii, , .) with the wild goat (*Capra aegagrus*) of the Himalayas and, as it is also said with the ibex, namely that when the male accidentally falls from a height he bends inwards his head, and by alighting on his massive horns, breaks the shock. The female cannot thus use her horns, which are smaller, but from her more quiet disposition she does not need this strange kind of shield so much.

Each male animal uses his weapons in his own peculiar fashion. The common ram makes a charge and butts with such force with the bases of his horns, that I have seen a powerful man knocked over like a child. Goats and certain species of shee for instance the *Ovis cycloceros* of Afghanistan (. Mr. Blyth, in 'Land and Water,' March, , , on the authority of Capt. Hutton and others. For the wild Pembrokeshire goats, see the 'Field,' , .), rear on their hind legs, and then not only butt, but "make a cut down and a jerk uwith the ribbed front of their scimitarshaped horn, as with a sabre. When the *O. cycloceros* attacked a large domestic ram, who was a noted bruiser, he conquered him by the sheer novelty of his mode of hting, always closing at once with his adversary, and catching him across the face and nose with a sharp drawing jerk of the head, and then bounding out of the way before the blow could be returned." In Pembrokeshire a male goat, the master of a flock which during several generations had run wild, was known to have killed several males in single combat; this goat possessed enormous horns, measuring thirtynine inches in a straight line from tip to tiThe common bull, as every one knows, gores and

tosses his opponent; but the Italian buffalo is said never to use his horns: he gives a tremendous blow with his convex forehead, and then tramples on his fallen enemy with his kneesan instinct which the common bull does not possess. (. M. E.M. Bailly, "Sur l'usage des cornes," etc., .Annal des Sciences Nat.' tom. ii. , .) Hence a dog who pins a buffalo by the nose is immediately crushed. We must, however, remember that the Italian buffalo has been long domesticated, and it is by no means certain that the wild parentform had similar horns. Mr. Bartlett informs me that when a female Cape buffalo (*Bubalus caffer*) was turned into an enclosure with a bull of the same species, she attacked him, and he in return pushed her about with great violence. But it was manifest to Mr. Bartlett that, had not the bull shewn dignified forbearance, he could easily have killed her by a single lateral thrust with his immense horns. The giraffe uses his short, haircovered horns, which are rather longer in the male than in the female, in a curious manner; for, with his long neck, he swings his head to either side, almost upside down, with such force that I have seen a hard plank deeply indented by a single blow.

[. . *Oryx leucoryx*, male (from the Knowsley Menagerie).]

With antelopes it is sometimes difficult to imagine how they can possibly use their curiouslyshaped horns; thus the springboc (*Ant. euchore*) has rather short upright horns, with the sharp points bent inwards almost at right angles, so as to face each other; Mr. Bartlett does not know how they are used, but suggests that they would inflict a fearful wound down each side of the face of an antagonist. The slightlycurved horns of the *Oryx leucoryx* are directed backwards, and are of such length that their points reach beyond the middle of the back, over which they extend in almost parallel lines. Thus they seem singularly illfitted for hting; but Mr. Bartlett informs me that when two of these animals prepare for battle, they kneel down, with their heads between their fore legs, and in this attitude the horns stand nearly parallel and close to the ground, with the points directed forwards and a little upwards. The combatants then gradually approach each other, and each endeavours to get the upturned points under the body of the other; if one succeeds in doing this, he suddenly springs uthrowing up his head at the same time, and can thus wound or perhaps even transfix his antagonist. Both animals always kneel down, so as to guard as far as possible against this manoeuvre. It has been recorded that one of these antelopes has used his horn with effect even against a lion; yet from being forced to place his head between the forelegs in order to bring the points of the horns forward, he would generally be under a great disadvantage when attacked by any other animal. It is, therefore, not probable that the horns have been modified into their present great length and peculiar position, as a protection against beasts of prey. We can however see that, as soon as some ancient male progenitor of the *Oryx* acquired moderately long horns, directed a little backwards, he would be compelled, in his battles with rival males, to bend his head somewhat inwards or downwards, as is now done by certain stags; and it is not improbable that he might have

acquired the habit of at first occasionally and afterwards of regularly kneeling down. In this case it is almost certain that the males which possessed the longest horns would have had a great advantage over others with shorter horns; and then the horns would gradually have been rendered longer and longer, through sexual selection, until they acquired their present extraordinary length and position.

With stags of many kinds the branches of the horns offer a curious case of difficulty; for certainly a single straight point would inflict a much more serious wound than several diverging ones. In Sir Philip Egerton's museum there is a horn of the reddeer (*Cervus elaphus*), thirty inches in length, with "not fewer than fifteen snags or branches"; and at Moritzburg there is still preserved a pair of antlers of a reddeer, shot in by Frederick I., one of which bears the astonishing number of thirtythree branches and the other twentyseven, making altogether sixty branches. Richardson uses a pair of antlers of the wild reindeer with twentynine points. (On the horns of reddeer, Owen, 'British Fossil Mammals,' , ; Richardson on the horns of the reindeer, 'Fauna Bor. Americana,' , . I am indebted to Prof. Victor Carus, for the Moritzburg case.) From the manner in which the horns are branched, and more especially from deer being known occasionally to hit together by kicking with their fore feet (Hon. J.D. Caton ('Ottawa Acad. of Nat. Science,' May ,) says that the American deer hit with their forefeet, after "the question of superiority has been once settled and acknowledged in the herd." Bailly, 'Sur l'Usage des cornes,' 'Annales des Sciences Nat.' tom. ii. , .), M. Bailly actually comes to the conclusion that their horns are more injurious than useful to them. But this author overlooks the pitched battles between rival males. As I felt much perplexed about the use or advantage of the branches, I applied to Mr. McNeill of Colonsay, who has long and carefully observed the habits of reddeer, and he informs me that he has never seen some of the branches brought into use, but that the brow antlers, from inclining downwards, are a great protection to the forehead, and their points are likewise used in attack. Sir Philip Egerton also informs me both as to reddeer and fallowdeer that, in fighting, they suddenly dash together, and getting their horns fixed against each other's bodies, a desperate struggle ensues. When one is at last forced to yield and turn round, the victor endeavours to plunge his brow antlers into his defeated foe. It thus appears that the upper branches are used chiefly or exclusively for pushing and fencing. Nevertheless in some species the upper branches are used as weapons of offence; when a man was attacked by a wapiti deer (*Cervus canadensis*) in Judge Caton's park in Ottawa, and several men tried to rescue him, the stag "never raised his head from the ground; in fact he kept his face almost flat on the ground, with his nose nearly between his fore feet, except when he rolled his head to one side to take a new observation preparatory to a plunge." In this position the ends of the horns were directed against his adversaries. "In rolling his head he necessarily raised it somewhat, because his antlers were so long that he could not roll his head without raising them on one side, while, on the other side they touched the ground." The stag by this procedure gradually drove the party of rescuers

backwards to a distance of or feet; and the attacked man was killed. (. See a most interesting account in the Appendix to Hon. J.D. Caton's paper, as above quoted.)

[. . Strepsiceros Kudu (from Sir Andrew Smith's 'Zoology of South Africa.')

Although the horns of stags are efficient weapons, there can, I think, be no doubt that a single point would have been much more dangerous than a branched antler; and Judge Caton, who has had large experience with deer, fully concurs in this conclusion. Nor do the branching horns, though highly important as a means of defence against rival stags, appear perfectly well adapted for this purpose, as they are liable to become interlocked. The suspicion has therefore crossed my mind that they may serve in part as ornaments. That the branched antlers of stags as well as the elegant lyrated horns of certain antelopes, with their graceful double curvature, are ornamental in our eyes, no one will dispute. If, then, the horns, like the splendid accoutrements of the knights of old, add to the noble appearance of stags and antelopes, they may have been modified partly for this purpose, though mainly for actual service in battle; but I have no evidence in favour of this belief.

An interesting case has lately been published, from which it appears that the horns of a deer in one district in the United States are now being modified through sexual and natural selection. A writer in an excellent American Journal (. The 'American Naturalist,' Dec. , .) says, that he has hunted for the last twentyone years in the Adirondacks, where the *Cervus virginianus* abounds. About fourteen years ago he first heard of SPIKEHORN BUCKS. These became from year to year more common; about five years ago he shot one, and afterwards another, and now they are frequently killed. "The spikehorn differs greatly from the common antler of the *C. virginianus*. It consists of a single spike, more slender than the antler, and scarcely half so long, projecting forward from the brow, and terminating in a very sharp point. It gives a considerable advantage to its possessor over the common buck. Besides enabling him to run more swiftly through the thick woods and underbrush (every hunter knows that does and yearling bucks run much more rapidly than the large bucks when armed with their cumbrous antlers), the spikehorn is a more effective weapon than the common antler. With this advantage the spikehorn bucks are gaining upon the common bucks, and may, in time, entirely supersede them in the Adirondacks. Undoubtedly, the first spikehorn buck was merely an accidental freak of nature. But his spikehorns gave him an advantage, and enabled him to propagate his peculiarity. His descendants having a like advantage, have propagated the peculiarity in a constantly increasing ratio, till they are slowly crowding the antlered deer from the region they inhabit." A critic has well objected to this account by asking, why, if the simple horns are now so advantageous, were the branched antlers of the parentform ever developed? To this I can only answer by remarking, that a new mode of attack with new weapons might be a great advantage,

as shewn by the case of the *Ovis cycloceros*, who thus conquered a domestic ram famous for his fighting power. Though the branched antlers of a stag are well adapted for fighting with his rivals, and though it might be an advantage to the pronghorned variety slowly to acquire long and branched horns, if he had to fight only with others of the same kind, yet it by no means follows that branched horns would be the best fitted for conquering a foe differently armed. In the foregoing case of the *Oryx leucoryx*, it is almost certain that the victory would rest with an antelope having short horns, and who therefore did not need to kneel down, though an oryx might profit by having still longer horns, if he fought only with his proper rivals.

Male quadrupeds, which are furnished with tusks, use them in various ways, as in the case of horns. The boar strikes laterally and upwards; the musk deer downwards with serious effect. (. Pallas, 'Spicilegia Zoologica,' fasc. xiii. , .) The walrus, though having so short a neck and so unwieldy a body, "can strike either upwards, or downwards, or sideways, with equal dexterity." (. Lamont, 'Seasons with the SeaHorses,' , .) I was informed by the late Dr. Falconer, that the Indian elephant fights in a different manner according to the position and curvature of his tusks. When they are directed forwards and upwards he is able to fling a tiger to a great distance it is said to even thirty feet; when they are short and turned downwards he endeavours suddenly to pin the tiger to the ground and, in consequence, is dangerous to the rider, who is liable to be jerked off the howdah. (. See also Corse ('Philosophical Transactions,' ,) on the manner in which the short-tusked Mooknah variety attacks other elephants.)

Very few male quadrupeds possess weapons of two distinct kinds specially adapted for fighting with rival males. The male muntjac deer (*Cervulus*), however, offers an exception, as he is provided with horns and exerted canine teeth. But we may infer from what follows that one form of weapon has often been replaced in the course of ages by another. With ruminants the development of horns generally stands in an inverse relation with that of even moderately developed canine teeth. Thus camels, guanacoës, chevrotains, and muskdeer, are hornless, and they have efficient canines; these teeth being "always of smaller size in the females than in the males." The Camelidae have, in addition to their true canines, a pair of canine-shaped incisors in their upper jaws. (. Owen, 'Anatomy of Vertebrates,' vol. iii. .) Male deer and antelopes, on the other hand, possess horns, and they rarely have canine teeth; and these, when present, are always of small size, so that it is doubtful whether they are of any service in their battles. In *Antelope montana* they exist only as rudiments in the young male, disappearing as he grows old; and they are absent in the female at all ages; but the females of certain other antelopes and of certain deer have been known occasionally to exhibit rudiments of these teeth. (. See Ruppell (in 'Proc. Zoolog. Soc.' Jan. , ,) on the canines in deer and antelopes, with a note by Mr. Martin on a female American deer. See also Falconer ('Palaeont. Memoirs and Notes,' vol. i. ,) on canines in an adult female deer. In old

males of the muskdeer the canines (Pallas, 'Spic. Zoolog.' fasc. xiii. ,) sometimes grow to the length of three inches, whilst in old females a rudiment projects scarcely half an inch above the gums.) Stallions have small canine teeth, which are either quite absent or rudimentary in the mare; but they do not appear to be used in fighting, for stallions bite with their incisors, and do not open their mouths wide like camels and guanacoës. Whenever the adult male possesses canines, now inefficient, whilst the female has either none or mere rudiments, we may conclude that the early male progenitor of the species was provided with efficient canines, which have been partially transferred to the females. The reduction of these teeth in the males seems to have followed from some change in their manner of fighting, often (but not in the horse) caused by the development of new weapons.

Tusks and horns are manifestly of high importance to their possessors, for their development consumes much organised matter. A single tusk of the Asiatic elephant and of the extinct woolly species and of the African elephant, have been known to weigh respectively , , and pounds; and even greater weights have been given by some authors. (Emerson Tennent, 'Ceylon,' , vol. ii. ; Owen, 'British Fossil Mammals,' , .) With deer, in which the horns are periodically renewed, the drain on the constitution must be greater; the horns, for instance, of the moose weigh from fifty to sixty pounds, and those of the extinct Irish elk from sixty to seventy pounds the skull of the latter weighing on an average only five pounds and a quarter. Although the horns are not periodically renewed in sheep yet their development, in the opinion of many agriculturists, entails a sensible loss to the breeder. Stags, moreover, in escaping from beasts of prey are loaded with an additional weight for the race, and are greatly retarded in passing through a woody country. The moose, for instance, with horns extending five and a half feet from tip to tip although so skilful in their use that he will not touch or break a twig when walking quietly, cannot act so dexterously whilst rushing away from a pack of wolves. "During his progress he holds his nose up so as to lay the horns horizontally back; and in this attitude cannot see the ground distinctly." (Richardson, 'Fauna Bor. Americana,' on the moose, *Alces palmata*, ; on the expanse of the horns, 'Land and Water,' , . See also Owen, 'British Fossil Mammals,' on the Irish elk, .) The tips of the horns of the great Irish elk were actually eight feet apart! Whilst the horns are covered with velvet, which lasts with red deer for about twelve weeks, they are extremely sensitive to a blow; so that in Germany the stags at this time somewhat change their habits, and avoiding dense forests, frequent young woods and low thickets. ('Forest Creatures,' by C. Boner, , .) These facts remind us that male birds have acquired ornamental plumes at the cost of retarded flight, and other ornaments at the cost of some loss of power in their battles with rival males.

With mammals, when, as is often the case, the sexes differ in size, the males are almost always larger and stronger. I am informed by Mr. Gould that this holds good in a

marked manner with the marsupials of Australia, the males of which appear to continue growing until an unusually late age. But the most extraordinary case is that of one of the seals (*Callorhinus ursinus*), a fullgrown female weighing less than onesixth of a fullgrown male. (. See the very interesting paper by Mr. J.A. Allen in 'Bull. Mus. ComZoology of Cambridge, United States,' vol. ii. , . The weights were ascertained by a careful observer, Capt. Bryant. Dr. Gill in 'The American Naturalist,' January, , Prof. Shaler on the relative size of the sexes of whales, 'American Naturalist,' January, .) Dr. Gill remarks that it is with the polygamous seals, the males of which are well known to ht savagely together, that the sexes differ much in size; the monogamous species differing but little. Whales also afford evidence of the relation existing between the pugnacity of the males and their large size compared with that of the female; the males of the rightwhales do not ht together, and they are not larger, but rather smaller, than their females; on the other hand, male spermwhales ht much together, and their bodies are "often found scarred with the imprint of their rival's teeth," and they are double the size of the females. The greater strength of the male, as Hunter long ago remarked (. 'Animal Economy,' .), is invariably displayed in those parts of the body which are brought into action in hting with rival malesfor instance, in the massive neck of the bull. Male quadrupeds are also more courageous and pugnacious than the females. There can be little doubt that these characters have been gained, partly through sexual selection, owing to a long series of victories, by the stronger and more courageous males over the weaker, and partly through the inherited effects of use. It is probable that the successive variations in strength, size, and courage, whether due to mere variability or to the effects of use, by the accumulation of which male quadrupeds have acquired these characteristic qualities, occurred rather late in life, and were consequently to a large extent limited in their transmission to the same sex.

From these considerations I was anxious to obtain information as to the Scotch deerhound, the sexes of which differ more in size than those of any other breed (though bloodhounds differ considerably), or than in any wild canine species known to me. Accordingly, I applied to Mr. Cupples, well known for his success with this breed, who has weighed and measured many of his own dogs, and who has with great kindness collected for me the following facts from various sources. Fine male dogs, measured at the shoulder, range from inches, which is low, to or even inches in height; and in weight from pounds, which is light, to pounds, or even more. The females range in height from to , or even to inches; and in weight from to , or even pounds. (. See also Richardson's 'Manual on the Dog,' . Much valuable information on the Scottish deerhound is given by Mr. McNeill, who first called attention to the inequality in size between the sexes, in Scrope's 'Art of Deer Stalking.' I hope that Mr. Cupples will keep to his intention of publishing a full account and history of this famous breed.) Mr. Cupples concludes that from to pounds for the male, and for the female, would be a safe average; but there is reason to believe that formerly both sexes attained a greater weight.

Mr. Cupples has weighed puppies when a fortnight old; in one litter the average weight of four males exceeded that of two females by six and a half ounces; in another litter the average weight of four males exceeded that of one female by less than one ounce; the same males when three weeks old, exceeded the female by seven and a half ounces, and at the age of six weeks by nearly fourteen ounces. Mr. Wright of Yeldersley House, in a letter to Mr. Cupples, says: "I have taken notes on the sizes and weights of puppies of many litters, and as far as my experience goes, dogpuppies as a rule differ very little from bitches till they arrive at about five or six months old; and then the dogs begin to increase, gaining upon the bitches both in weight and size. At birth, and for several weeks afterwards, a bitchpuppy will occasionally be larger than any of the dogs, but they are invariably beaten by them later." Mr. McNeill, of Colonsay, concludes that "the males do not attain their full growth till over two years old, though the females attain it sooner." According to Mr. Cupples' experience, male dogs go on growing in stature till they are from twelve to eighteen months old, and in weight till from eighteen to twentyfour months old; whilst the females cease increasing in stature at the age of from nine to fourteen or fifteen months, and in weight at the age of from twelve to fifteen months. From these various statements it is clear that the full difference in size between the male and female Scotch deerhound is not acquired until rather late in life. The males almost exclusively are used for coursing, for, as Mr. McNeill informs me, the females have not sufficient strength and weight to pull down a fullgrown deer. From the names used in old legends, it appears, as I hear from Mr. Cupples, that, at a very ancient period, the males were the most celebrated, the females being mentioned only as the mothers of famous dogs. Hence, during many generations, it is the male which has been chiefly tested for strength, size, speed, and courage, and the best will have been bred from. As, however, the males do not attain their full dimensions until rather late in life, they will have tended, in accordance with the law often indicated, to transmit their characters to their male offspring alone; and thus the great inequality in size between the sexes of the Scotch deerhound may probably be accounted for.

[. . Head of Common wild boar, in prime of life (from Brehm).]

The males of some few quadrupeds possess organs or parts developed solely as a means of defence against the attacks of other males. Some kinds of deer use, as we have seen, the upper branches of their horns chiefly or exclusively for defending themselves; and the Oryx antelope, as I am informed by Mr. Bartlett, fences most skilfully with his long, gently curved horns; but these are likewise used as organs of offence. The same observer remarks that rhinoceroses in fighting, parry each other's sidelong blows with their horns, which clatter loudly together, as do the tusks of boars. Although wild boars hit desperately, they seldom, according to Brehm, receive fatal wounds, as the blows fall on each other's tusks, or on the layer of gristly skin covering the shoulder, called by the German hunters, the shield; and here we have a part specially modified for defence.

With boars in the prime of life the tusks in the lower jaw are used for hting, but they become in old age, as Brehm states, so much curved inwards and upwards over the snout that they can no longer be used in this way. They may, however, still serve, and even more effectively, as a means of defence. In compensation for the loss of the lower tusks as weapons of offence, those in the upper jaw, which always project a little laterally, increase in old age so much in length and curve so much upwards that they can be used for attack. Nevertheless, an old boar is not so dangerous to man as one at the age of six or seven years. (. Brehm, 'Thierleben,' B. ii. ss. .)

[. . Skull of the Babirusa Pig (from Wallace's 'Malay Archipelago').]

In the fullgrown male Babirusa pig of Celebes , the lower tusks are formidable weapons, like those of the European boar in the prime of life, whilst the upper tusks are so long and have their points so much curled inwards, sometimes even touching the forehead, that they are utterly useless as weapons of attack. They more nearly resemble horns than teeth, and are so manifestly useless as teeth that the animal was formerly supposed to rest his head by hooking them on to a branch! Their convex surfaces, however, if the head were held a little laterally, would serve as an excellent guard; and hence, perhaps, it is that in old animals they "are generally broken off, as if by hting." (. See Mr. Wallace's interesting account of this animal, 'The Malay Archipelago,' , vol. i. .) Here, then, we have the curious case of the upper tusks of the Babirusa regularly assuming during the prime of life a structure which apparently renders them fitted only for defence; whilst in the European boar the lower tusks assume in a less degree and only during old age nearly the same form, and then serve in like manner solely for defence.

[. . Head of female Aethiopian warthog, from 'Proc. Zool. Soc.' , shewing the same characters as the male, though on a reduced scale. N.B. When the engraving was first made, I was under the impression that it represented the male.]

In the warthog (see *Phacochoerus aethiopicus*, .) the tusks in the upper jaw of the male curve upwards during the prime of life, and from being pointed serve as formidable weapons. The tusks in the lower jaw are sharper than those in the upper, but from their shortness it seems hardly possible that they can be used as weapons of attack. They must, however, greatly strengthen those in the upper jaw, from being ground so as to fit closely against their bases. Neither the upper nor the lower tusks appear to have been specially modified to act as guards, though no doubt they are to a certain extent used for this purpose. But the warthog is not destitute of other special means of protection, for it has, on each side of the face, beneath the eyes, a rather stiff, yet flexible, cartilaginous, oblong pad , which projects two or three inches outwards; and it appeared to Mr. Bartlett and myself, when viewing the living animal, that these pads, when struck from beneath by the tusks of an opponent, would be turned upwards, and would thus

admirably protect the somewhat prominent eyes. I may add, on the authority of Mr. Bartlett, that these boars when fighting stand directly face to face.

Lastly, the African riverhog (*Potamochoerus penicillatus*) has a hard cartilaginous knob on each side of the face beneath the eyes, which answers to the flexible pad of the warthog; it has also two bony prominences on the upper jaw above the nostrils. A boar of this species in the Zoological Gardens recently broke into the cage of the warthog. They fought all night long, and were found in the morning much exhausted, but not seriously wounded. It is a significant fact, as shewing the purposes of the above described projections and excrescences, that these were covered with blood, and were scored and abraded in an extraordinary manner.

Although the males of so many members of the pig family are provided with weapons, and as we have just seen with means of defence, these weapons seem to have been acquired within a rather late geological period. Dr. Forsyth Major specifies (. 'Atti della Soc. Italiana di Sc. Nat.' , vol. xv. fasc. iv.) several miocene species, in none of which do the tusks appear to have been largely developed in the males; and Professor Rutimeyer was formerly struck with this same fact.

The mane of the lion forms a good defence against the attacks of rival lions, the one danger to which he is liable; for the males, as Sir A. Smith informs me, engage in terrible battles, and a young lion dares not approach an old one. In a tiger at Bromwich broke into the cage of a lion and a fearful scene ensued: "the lion's mane saved his neck and head from being much injured, but the tiger at last succeeded in ripping up his belly, and in a few minutes he was dead." (. 'The Times,' Nov. , . In regard to the Canada lynx, see Audubon and Bachman, 'Quadrupeds of North America,' , .) The broad ruff round the throat and chin of the Canadian lynx (*Felis canadensis*) is much longer in the male than in the female; but whether it serves as a defence I do not know. Male seals are well known to fight desperately together, and the males of certain kinds (*Otaria jubata*) (. Dr. Murie, on *Otaria*, 'Proc. Zoolog. Soc.' , . Mr. J.A. Allen, in the paper above quoted), doubts whether the hair, which is longer on the neck in the male than in the female, deserves to be called a mane.) have great manes, whilst the females have small ones or none. The male baboon of the Cape of Good Hope (*Cynocephalus porcarius*) has a much longer mane and larger canine teeth than the female; and the mane probably serves as a protection, for, on asking the keepers in the Zoological Gardens, without giving them any clue to my object, whether any of the monkeys especially attacked each other by the nape of the neck, I was answered that this was not the case, except with the above baboon. In the Hamadryas baboon, Ehrenberg compares the mane of the adult male to that of a young lion, whilst in the young of both sexes and in the female the mane is almost absent.

It appeared to me probable that the immense woolly mane of the male American bison, which reaches almost to the ground, and is much more developed in the males than in the females, served as a protection to them in their terrible battles; but an experienced hunter told Judge Caton that he had never observed anything which favoured this belief. The stallion has a thicker and fuller mane than the mare; and I have made particular inquiries of two great trainers and breeders, who have had charge of many entire horses, and am assured that they "invariably endeavour to seize one another by the neck." It does not, however, follow from the foregoing statements, that when the hair on the neck serves as a defence, that it was originally developed for this purpose, though this is probable in some cases, as in that of the lion. I am informed by Mr. McNeill that the long hairs on the throat of the stag (*Cervus elaphus*) serve as a great protection to him when hunted, for the dogs generally endeavour to seize him by the throat; but it is not probable that these hairs were specially developed for this purpose; otherwise the young and the females would have been equally protected.

CHOICE IN PAIRING BY EITHER SEX OF QUADRUPEDS.

Before describing in the next chapter, the differences between the sexes in voice, odours emitted, and ornaments, it will be convenient here to consider whether the sexes exert any choice in their unions. Does the female prefer any particular male, either before or after the males may have fought together for supremacy; or does the male, when not a polygamist, select any particular female? The general impression amongst breeders seems to be that the male accepts any female; and this owing to his eagerness, is, in most cases, probably the truth. Whether the female as a general rule indifferently accepts any male is much more doubtful. In the fourteenth chapter, on Birds, a considerable body of direct and indirect evidence was advanced, shewing that the female selects her partner; and it would be a strange anomaly if female quadrupeds, which stand higher in the scale and have higher mental powers, did not generally, or at least often, exert some choice. The female could in most cases escape, if wooed by a male that did not please or excite her; and when pursued by several males, as commonly occurs, she would often have the opportunity, whilst they were hting together, of escaping with some one male, or at least of temporarily pairing with him. This latter contingency has often been observed in Scotland with female reddeer, as I am informed by Sir Philip Egerton and others. (. Mr. Boner, in his excellent description of the habits of the reddeer in Germany ('Forest Creatures,' ,) says, "while the stag is defending his rights against one intruder, another invades the sanctuary of his harem, and carries off trophy after trophy." Exactly the same thing occurs with seals; see Mr. J.A. Allen, *ibid.* .)

It is scarcely possible that much should be known about female quadrupeds in a state of nature making any choice in their marriage unions. The following curious details on the courtship of one of the eared seals (*Callorhinus ursinus*) are given (. Mr. J.A. Allen in

'Bull. Mus. ComZool. of Cambridge, United States,' vol. ii. , .) on the authority of Capt. Bryant, who had ample opportunities for observation. He says, "Many of the females on their arrival at the island where they breed appear desirous of returning to some particular male, and frequently climb the outlying rocks to overlook the rookeries, calling out and listening as if for a familiar voice. Then changing to another place they do the same again. As soon as a female reaches the shore, the nearest male goes down to meet her, making meanwhile a noise like the clucking of a hen to her chickens. He bows to her and coaxes her until he gets between her and the water so that she cannot escape him. Then his manner changes, and with a harsh growl he drives her to a place in his harem. This continues until the lower row of harems is nearly full. Then the males higher up select the time when their more fortunate neighbours are off their guard to steal their wives. This they do by taking them in their mouths and lifting them over the heads of the other females, and carefully placing them in their own harem, carrying them as cats do their kittens. Those still higher up pursue the same method until the whole space is occupied. Frequently a struggle ensues between two males for the possession of the same female, and both seizing her at once pull her in two or terribly lacerate her with their teeth. When the space is all filled, the old male walks around complacently reviewing his family, scolding those who crowd or disturb the others, and fiercely driving off all intruders. This surveillance always keeps him actively occupied."

As so little is known about the courtship of animals in a state of nature, I have endeavoured to discover how far our domesticated quadrupeds evince any choice in their unions. Dogs offer the best opportunity for observation, as they are carefully attended to and well understood. Many breeders have expressed a strong opinion on this head. Thus, Mr. Mayhew remarks, "The females are able to bestow their affections; and tender recollections are as potent over them as they are known to be in other cases, where higher animals are concerned. Bitches are not always prudent in their loves, but are apt to fling themselves away on curs of low degree. If reared with a companion of vulgar appearance, there often springs up between the pair a devotion which no time can afterwards subdue. The passion, for such it really is, becomes of a more than romantic endurance." Mr. Mayhew, who attended chiefly to the smaller breeds, is convinced that the females are strongly attracted by males of a large size. (. 'Dogs: their Management,' by E. Mayhew, M.R.C.V.S., nd ed., , p.) The wellknown veterinary Blaine states (. Quoted by Alex. Walker, 'On Intermarriage,' , ; see also .) that his own female pug dog became so attached to a spaniel, and a female setter to a cur, that in neither case would they pair with a dog of their own breed until several weeks had elapsed. Two similar and trustworthy accounts have been given me in regard to a female retriever and a spaniel, both of which became enamoured with terrier dogs.

Mr. Cupples informs me that he can personally vouch for the accuracy of the following more remarkable case, in which a valuable and wonderfully intelligent female terrier

loved a retriever belonging to a neighbour to such a degree, that she had often to be dragged away from him. After their permanent separation, although repeatedly shewing milk in her teats, she would never acknowledge the courtship of any other dog, and to the regret of her owner never bore puppies. Mr. Cupples also states, that in , a female deerhound in his kennel thrice produced puppies, and on each occasion shewed a marked preference for one of the largest and handsomest, but not the most eager, of four deerhounds living with her, all in the prime of life. Mr. Cupples has observed that the female generally favours a dog whom she has associated with and knows; her shyness and timidity at first incline her against a strange dog. The male, on the contrary, seems rather inclined towards strange females. It appears to be rare when the male refuses any particular female, but Mr. Wright, of Yeldersley House, a great breeder of dogs, informs me that he has known some instances; he cites the case of one of his own deerhounds, who would not take any notice of a particular female mastiff, so that another deerhound had to be employed. It would be superfluous to give, as I could, other instances, and I will only add that Mr. Barr, who has carefully bred many bloodhounds, states that in almost every instance particular individuals of opposite sexes shew a decided preference for each other. Finally, Mr. Cupples, after attending to this subject for another year, has written to me, "I have had full confirmation of my former statement, that dogs in breeding form decided preferences for each other, being often influenced by size, bright colour, and individual characters, as well as by the degree of their previous familiarity."

In regard to horses, Mr. Blenkiron, the greatest breeder of racehorses in the world, informs me that stallions are so frequently capricious in their choice, rejecting one mare and without any apparent cause taking to another, that various artifices have to be habitually used. The famous Monarque, for instance, would never consciously look at the dam of Gladiateur, and a trick had to be practised. We can partly see the reason why valuable racehorse stallions, which are in such demand as to be exhausted, should be so particular in their choice. Mr. Blenkiron has never known a mare reject a horse; but this has occurred in Mr. Wright's stable, so that the mare had to be cheated. Prosper Lucas (. 'Traité de l'Héréd. Nat.' tom. ii. , .) quotes various statements from French authorities, and remarks, "On voit des étalons qui s'eprennent d'une jument, et negligent toutes les autres." He gives, on the authority of Baelen, similar facts in regard to bulls; and Mr. H. Reeks assures me that a famous shorthorn bull belonging to his father "invariably refused to be matched with a black cow." Hoffberg, in describing the domesticated reindeer of Lapland says, "Foeminae majores et fortiores mares prae caeteris admittunt, ad eos confugiunt, a junioribus agitatae, qui hos in fugam conjiciunt." (. 'Amoenitates Acad.' vol. iv. , .) A clergyman, who has bred many pigs, asserts that sows often reject one boar and immediately accept another.

From these facts there can be no doubt that, with most of our domesticated quadrupeds, strong individual antipathies and preferences are frequently exhibited, and much more commonly by the female than by the male. This being the case, it is improbable that the unions of quadrupeds in a state of nature should be left to mere chance. It is much more probable that the females are allured or excited by particular males, who possess certain characters in a higher degree than other males; but what these characters are, we can seldom or never discover with certainty.

CHAPTER XVIII.

SECONDARY SEXUAL CHARACTERS OF MAMMALScontinued.

Voice Remarkable sexual peculiarities in seals
Odour Development of the hair
Colour of the hair and skin
Anomalous case of the female being more ornamented than the male
Colour and ornaments due to sexual selection
Colour acquired for the sake of protection
Colour, though common to both sexes, often due to sexual selection
On the disappearance of spots and stripes in adult quadrupeds
On the colours and ornaments of the Quadrumana
Summary.

Quadrupeds use their voices for various purposes, as a signal of danger, as a call from one member of a troop to another, or from the mother to her lost offspring, or from the latter for protection to their mother; but such uses need not here be considered. We are concerned only with the difference between the voices of the sexes, for instance between that of the lion and lioness, or of the bull and cow. Almost all male animals use their voices much more during the rutting season than at any other time; and some, as the giraffe and porcupine (. Owen, 'Anatomy of Vertebrates,' vol. iii. .), are said to be completely mute excepting at this season. As the throats (i.e. the larynx and thyroid bodies (. Ibid. .)) of stags periodically become enlarged at the beginning of the breeding season, it might be thought that their powerful voices must be somehow of high importance to them; but this is very doubtful. From information given to me by two experienced observers, Mr. McNeill and Sir Egerton, it seems that young stags under three years old do not roar or bellow; and that the old ones begin bellowing at the commencement of the breeding season, at first only occasionally and moderately, whilst they restlessly wander about in search of the females. Their battles are prefaced by loud and prolonged bellowing, but during the actual conflict they are silent. Animals of all kinds which habitually use their voices utter various noises under any strong emotion, as when enraged and preparing to fight; but this may merely be the result of nervous excitement, which leads to the spasmodic contraction of almost all the muscles of the body, as when a man grinds his teeth and clenches his fists in rage or agony. No doubt stags challenge each other to mortal combat by bellowing; but those with the more powerful voices, unless at the same time the stronger, better armed, and more courageous, would not gain any advantage over their rivals.

It is possible that the roaring of the lion may be of some service to him by striking terror into his adversary; for when enraged he likewise erects his mane and thus instinctively tries to make himself appear as terrible as possible. But it can hardly be supposed that the bellowing of the stag, even if it be of service to him in this way, can have been important enough to have led to the periodical enlargement of the throat. Some writers suggest that the bellowing serves as a call to the female; but the experienced observers above quoted inform me that female deer do not search for the male, though the males search eagerly for the females, as indeed might be expected from what we know of the habits of other male quadrupeds. The voice of the female, on the other hand, quickly brings to her one or more stags (. See, for instance, Major W. Ross King ('The

Sportsman in Canada,' ,) on the habits of the moose and wild reindeer.), as is well known to the hunters who in wild countries imitate her cry. If we could believe that the male had the power to excite or allure the female by his voice, the periodical enlargement of his vocal organs would be intelligible on the principle of sexual selection, together with inheritance limited to the same sex and season; but we have no evidence in favour of this view. As the case stands, the loud voice of the stag during the breedingseason does not seem to be of any special service to him, either during his courtship or battles, or in any other way. But may we not believe that the frequent use of the voice, under the strong excitement of love, jealousy, and rage, continued during many generations, may at last have produced an inherited effect on the vocal organs of the stag, as well as of other male animals? This appears to me, in our present state of knowledge, the most probable view.

The voice of the adult male gorilla is tremendous, and he is furnished with a laryngeal sack, as is the adult male orang. (. Owen 'Anatomy of Vertebrates,' vol. iii. .) The gibbons rank among the noisiest of monkeys, and the Sumatra species (*Hylobates syndactylus*) is also furnished with an air sack; but Mr. Blyth, who has had opportunities for observation, does not believe that the male is noisier than the female. Hence, these latter monkeys probably use their voices as a mutual call; and this is certainly the case with some quadrupeds, for instance the beaver. (. Mr. Green, in 'Journal of Linnean Society,' vol. x. 'Zoology,' , note .) Another gibbon, the *H. agilis*, is remarkable, from having the power of giving a complete and correct octave of musical notes (. C.L. Martin, 'General Introduction to the Natural History of Mamm. Animals,' , .), which we may reasonably suspect serves as a sexual charm; but I shall have to recur to this subject in the next chapter. The vocal organs of the American *Mycetes caraya* are onethird larger in the male than in the female, and are wonderfully powerful. These monkeys in warm weather make the forests resound at morning and evening with their overwhelming voices. The males begin the dreadful concert, and often continue it during many hours, the females sometimes joining in with their less powerful voices. An excellent observer, Rengger (. 'Naturgeschichte der Säugethiere von Paraguay,' , ss. , .), could not perceive that they were excited to begin by any special cause; he thinks that, like many birds, they delight in their own music, and try to excel each other. Whether most of the foregoing monkeys have acquired their powerful voices in order to beat their rivals and charm the females or whether the vocal organs have been strengthened and enlarged through the inherited effects of longcontinued use without any particular good being thus gained I will not pretend to say; but the former view, at least in the case of the *Hylobates agilis*, seems the most probable.

I may here mention two very curious sexual peculiarities occurring in seals, because they have been supposed by some writers to affect the voice. The nose of the male seaelephant (*Macrorhinus proboscideus*) becomes greatly elongated during the

breedingseason, and can then be erected. In this state it is sometimes a foot in length. The female is not thus provided at any period of life. The male makes a wild, hoarse, gurgling noise, which is audible at a great distance and is believed to be strengthened by the proboscis; the voice of the female being different. Lesson compares the erection of the proboscis, with the swelling of the wattles of male gallinaceous birds whilst courting the females. In another allied kind of seal, the bladdernose (*Cystophora cristata*), the head is covered by a great hood or bladder. This is supported by the septum of the nose, which is produced far backwards and rises into an internal crest seven inches in height. The hood is clothed with short hair, and is muscular; can be inflated until it more than equals the whole head in size! The males when rutting, hit furiously on the ice, and their roaring "is said to be sometimes so loud as to be heard four miles off." When attacked they likewise roar or bellow; and whenever irritated the bladder is inflated and quivers. Some naturalists believe that the voice is thus strengthened, but various other uses have been assigned to this extraordinary structure. Mr. R. Brown thinks that it serves as a protection against accidents of all kinds; but this is not probable, for, as I am assured by Mr. Lamont who killed of these animals, the hood is rudimentary in the females, and it is not developed in the males during youth. (. On the seaelephant, see an article by Lesson, in 'Dict. Class. Hist. Nat.' tom. xiii. . For the *Cystophora*, or *Stemmatopus*, see Dr. Dekay, 'Annals of Lyceum of Nat. Hist.' New York, vol. i. , . Pennant has also collected information from the sealers on this animal. The fullest account is given by Mr. Brown, in 'Proc. Zoolog. Soc.' , .)

ODOUR.

With some animals, as with the notorious skunk of America, the overwhelming odour which they emit appears to serve exclusively as a defence. With shrewmice (*Sorex*) both sexes possess abdominal scentglands, and there can be little doubt, from the rejection of their bodies by birds and beasts of prey, that the odour is protective; nevertheless, the glands become enlarged in the males during the breedingseason. In many other quadrupeds the glands are of the same size in both sexes (. As with the castoreum of the beaver, see Mr. L.H. Morgan's most interesting work, 'The American Beaver,' , . Pallas ('Spic. Zoolog.' fasc. viii. ,) has well discussed the odoriferous glands of mammals. Owen ('Anat. of Vertebrates,' vol. iii.) also gives an account of these glands, including those of the elephant, and () those of shrewmice. On bats, Mr. Dobson in 'Proceedings of the Zoological Society' , .), but their uses are not known. In other species the glands are confined to the males, or are more developed than in the females; and they almost always become more active during the ruttingseason. At this period the glands on the sides of the face of the male elephant enlarge, and emit a secretion having a strong musky odour. The males, and rarely the females, of many kinds of bats have glands and protrudable sacks situated in various parts; and it is believed that these are odoriferous.

The rank effluvia of the male goat is well known, and that of certain male deer is wonderfully strong and persistent. On the banks of the Plata I perceived the air tainted with the odour of the male *Cervus campestris*, at half a mile to leeward of a herd; and a silk handkerchief, in which I carried home a skin, though often used and washed, retained, when first unfolded, traces of the odour for one year and seven months. This animal does not emit its strong odour until more than a year old, and if castrated whilst young never emits it. (. Rengger, 'Naturgeschichte der Säugethiere von Paraguay,' , s. . This observer also gives some curious particulars in regard to the odour.) Besides the general odour, permeating the whole body of certain ruminants (for instance, *Bos moschatus*) in the breedingseason, many deer, antelopes, sheeand goats possess odoriferous glands in various situations, more especially on their faces. The so-called tearsacks, or suborbital pits, come under this head. These glands secrete a semifluid fetid matter which is sometimes so copious as to stain the whole face, as I have myself seen in an antelope. They are "usually larger in the male than in the female, and their development is checked by castration." (. Owen, 'Anatomy of Vertebrates,' vol. iii. . See also Dr. Murie's observations on those glands in the 'Proc. Zoolog. Soc.' , . Desmarest, 'On the Antilope subgutturosa, 'Mammalogie,' , .) According to Desmarest they are altogether absent in the female of *Antilope subgutturosa*. Hence, there can be no doubt that they stand in close relation with the reproductive functions. They are also sometimes present, and sometimes absent, in nearly allied forms. In the adult male muskdeer (*Moschus moschiferus*), a naked space round the tail is bedewed with an odoriferous fluid, whilst in the adult female, and in the male until two years old, this space is covered with hair and is not odoriferous. The proper musk sack of this deer is from its position necessarily confined to the male, and forms an additional scentorgan. It is a singular fact that the matter secreted by this latter gland, does not, according to Pallas, change in consistence, or increase in quantity, during the ruttingseason; nevertheless this naturalist admits that its presence is in some way connected with the act of reproduction. He gives, however, only a conjectural and unsatisfactory explanation of its use. (. Pallas, 'Spicilegia Zoolog.' fasc. xiii. , ; Desmoulins, 'Dict. Class. d'Hist. Nat.' tom. iii. .)

In most cases, when only the male emits a strong odour during the breeding season, it probably serves to excite or allure the female. We must not judge on this head by our own taste, for it is well known that rats are enticed by certain essential oils, and cats by valerian, substances far from agreeable to us; and that dogs, though they will not eat carrion, sniff and roll on it. From the reasons given when discussing the voice of the stag, we may reject the idea that the odour serves to bring the females from a distance to the males. Active and longcontinued use cannot here have come into play, as in the case of the vocal organs. The odour emitted must be of considerable importance to the male, inasmuch as large and complex glands, furnished with muscles for everting the sack, and for closing or opening the orifice, have in some cases been developed. The

development of these organs is intelligible through sexual selection, if the most odoriferous males are the most successful in winning the females, and in leaving offspring to inherit their gradually perfected glands and odours.

DEVELOPMENT OF THE HAIR.

We have seen that male quadrupeds often have the hair on their necks and shoulders much more developed than the females; and many additional instances could be given. This sometimes serves as a defence to the male during his battles; but whether the hair in most cases has been specially developed for this purpose, is very doubtful. We may feel almost certain that this is not the case, when only a thin and narrow crest runs along the back; for a crest of this kind would afford scarcely any protection, and the ridge of the back is not a place likely to be injured; nevertheless such crests are sometimes confined to the males, or are much more developed in them than in the females. Two antelopes, the *Tragelaphus scriptus* (. Dr. Gray, 'Gleanings from the Menagerie at Knowsley,' pl. .) and *Portax picta* may be given as instances. When stags, and the males of the wild goat, are enraged or terrified, these crests stand erect (. Judge Caton on the Wapiti, 'Transact. Ottawa Acad. Nat. Sciences,' , ; Blyth, 'Land and Water,' on *Capra aegagrus* , .); but it cannot be supposed that they have been developed merely for the sake of exciting fear in their enemies. One of the abovenamed antelopes, the *Portax picta*, has a large welldefined brush of black hair on the throat, and this is much larger in the male than in the female. In the *Ammotragus tragelaphus* of North Africa, a member of the sheepfamily, the forelegs are almost concealed by an extraordinary growth of hair, which depends from the neck and upper halves of the legs; but Mr. Bartlett does not believe that this mantle is of the least use to the male, in whom it is much more developed than in the female.

[. . *Pithecia satanas*, male (from Brehm).]

Male quadrupeds of many kinds differ from the females in having more hair, or hair of a different character, on certain parts of their faces. Thus the bull alone has curled hair on the forehead. (. Hunter's 'Essays and Observations,' edited by Owen, . vol. i. .) In three closely allied subgenera of the goat family, only the males possess beards, sometimes of large size; in two other subgenera both sexes have a beard, but it disappears in some of the domestic breeds of the common goat; and neither sex of the *Hemitragus* has a beard. In the ibex the beard is not developed during the summer, and is so small at other times that it may be called rudimentary. (. See Dr. Gray's 'Catalogue of Mammalia in the British Museum,' part iii. , .) With some monkeys the beard is confined to the male, as in the orang; or is much larger in the male than in the female, as in the *Mycetes caraya* and *Pithecia satanas* . So it is with the whiskers of some species of *Macacus* (. Rengger, 'Säugethiere,' etc., s. ; Desmarest, 'Mammalogie,' .), and, as we have seen, with the

manes of some species of baboons. But with most kinds of monkeys the various tufts of hair about the face and head are alike in both sexes.

The males of various members of the ox family (Bovidae), and of certain antelopes, are furnished with a dewlap or great fold of skin on the neck, which is much less developed in the female.

Now, what must we conclude with respect to such sexual differences as these? No one will pretend that the beards of certain male goats, or the dewlaps of the bull, or the crests of hair along the backs of certain male antelopes, are of any use to them in their ordinary habits. It is possible that the immense beard of the male *Pithecia*, and the large beard of the male orang, may protect their throats when fighting; for the keepers in the Zoological Gardens inform me that many monkeys attack each other by the throat; but it is not probable that the beard has been developed for a distinct purpose from that served by the whiskers, moustache, and other tufts of hair on the face; and no one will suppose that these are useful as a protection. Must we attribute all these appendages of hair or skin to mere purposeless variability in the male? It cannot be denied that this is possible; for in many domesticated quadrupeds, certain characters, apparently not derived through reversion from any wild parent form, are confined to the males, or are more developed in them than in the females for instance, the hump on the male zebu cattle of India, the tail of fat tailed rams, the arched outline of the forehead in the males of several breeds of sheep and lastly, the mane, the long hairs on the hind legs, and the dewlap of the male of the Barbura goat. (See the chapters on these several animals in vol. i. of my 'Variation of Animals under Domestication;' also vol. ii. ; also chaxx. on the practice of selection by semicivilised people. For the Barbura goat, see Dr. Gray, 'Catalogue,' *ibid.* .) The mane, which occurs only in the rams of an African breed of sheep is a true secondary sexual character, for, as I hear from Mr. Winwood Reade, it is not developed if the animal be castrated. Although we ought to be extremely cautious, as shewn in my work on 'Variation under Domestication,' in concluding that any character, even with animals kept by semicivilised people, has not been subjected to selection by man, and thus augmented, yet in the cases just specified this is improbable; more especially as the characters are confined to the males, or are more strongly developed in them than in the females. If it were positively known that the above African ram is a descendant of the same primitive stock as the other breeds of sheep and if the Barbura male goat with his mane, dewlap etc., is descended from the same stock as other goats, then, assuming that selection has not been applied to these characters, they must be due to simple variability, together with sexually limited inheritance.

Hence it appears reasonable to extend this same view to all analogous cases with animals in a state of nature. Nevertheless I cannot persuade myself that it generally holds good, as in the case of the extraordinary development of hair on the throat and

forelegs of the male *Ammotragus*, or in that of the immense beard of the male *Pithecia*. Such study as I have been able to give to nature makes me believe that parts or organs which are highly developed, were acquired at some period for a special purpose. With those antelopes in which the adult male is more strongly coloured than the female, and with those monkeys in which the hair on the face is elegantly arranged and coloured in a diversified manner, it seems probable that the crests and tufts of hair were gained as ornaments; and this I know is the opinion of some naturalists. If this be correct, there can be little doubt that they were gained or at least modified through sexual selection; but how far the same view may be extended to other mammals is doubtful.

COLOUR OF THE HAIR AND OF THE NAKED SKIN.

I will first give briefly all the cases known to me of male quadrupeds differing in colour from the females. With Marsupials, as I am informed by Mr. Gould, the sexes rarely differ in this respect; but the great red kangaroo offers a striking exception, "delicate blue being the prevailing tint in those parts of the female which in the male are red." (. *Osphranter rufus*, Gould, 'Mammals of Australia,' , vol. ii. On the *Didelphis*, Desmarest, 'Mammalogie,' .) In the *Didelphis* opossum of Cayenne the female is said to be a little more red than the male. Of the Rodents, Dr. Gray remarks: "African squirrels, especially those found in the tropical regions, have the fur much brighter and more vivid at some seasons of the year than at others, and the fur of the male is generally brighter than that of the female." (. 'Annals and Magazine of Natural History,' Nov. , . On the *Mus minutus*, Desmarest, 'Mammalogie,' .) Dr. Gray informs me that he specified the African squirrels, because, from their unusually bright colours, they best exhibit this difference. The female of the *Mus minutus* of Russia is of a paler and dirtier tint than the male. In a large number of bats the fur of the male is lighter than in the female. (. J.A. Allen, in 'Bulletin of Mus. ComZoolog. of Cambridge, United States,' , . Mr. Dobson on sexual characters in the Chiroptera, 'Proceedings of the Zoological Society,' , . Dr. Gray on Sloths, *ibid.* , .) Mr. Dobson also remarks, with respect to these animals: "Differences, depending partly or entirely on the possession by the male of fur of a much more brilliant hue, or distinguished by different markings or by the greater length of certain portions, are met only, to any appreciable extent, in the frugivorous bats in which the sense of sight is well developed." This last remark deserves attention, as bearing on the question whether bright colours are serviceable to male animals from being ornamental. In one genus of sloths, it is now established, as Dr. Gray states, "that the males are ornamented differently from the females that is to say, that they have a patch of soft short hair between the shoulders, which is generally of a more or less orange colour, and in one species pure white. The females, on the contrary, are destitute of this mark."

The terrestrial Carnivora and Insectivora rarely exhibit sexual differences of any kind, including colour. The ocelot (*Felis pardalis*), however, is exceptional, for the colours of

the female, compared with those of the male, are "moins apparentes, le fauve, étant plus terne, le blanc moins pur, les raies ayant moins de largeur et les taches moins de diamètre." (. Desmarest, 'Mammalogie,' , . On *Felis mitis*, Rengger, *ibid.* s. .) The sexes of the allied *Felis mitis* also differ, but in a less degree; the general hues of the female being rather paler than in the male, with the spots less black. The marine Carnivora or seals, on the other hand, sometimes differ considerably in colour, and they present, as we have already seen, other remarkable sexual differences. Thus the male of the *Otaria nigrescens* of the southern hemisphere is of a rich brown shade above; whilst the female, who acquires her adult tints earlier in life than the male, is darkgrey above, the young of both sexes being of a deep chocolate colour. The male of the northern *Phoca groenlandica* is tawny grey, with a curious saddleshaped dark mark on the back; the female is much smaller, and has a very different appearance, being "dull white or yellowish strawcolour, with a tawny hue on the back"; the young at first are pure white, and can "hardly be distinguished among the icy hummocks and snow, their colour thus acting as a protection." (. Dr. Murie on the *Otaria*, 'Proceedings Zoological Society,' , . Mr. R. Brown on the *groenlandica*, *ibid.* , . See also on the colours of seals, Desmarest, *ibid.* .)

With Ruminants sexual differences of colour occur more commonly than in any other order. A difference of this kind is general in the *Strepsicerene* antelopes; thus the male nilghau (*Portax picta*) is bluishgrey and much darker than the female, with the square white patch on the throat, the white marks on the fetlocks, and the black spots on the ears all much more distinct. We have seen that in this species the crests and tufts of hair are likewise more developed in the male than in the hornless female. I am informed by Mr. Blyth that the male, without shedding his hair, periodically becomes darker during the breedingseason. Young males cannot be distinguished from young females until about twelve months old; and if the male is emasculated before this period, he never, according to the same authority, changes colour. The importance of this latter fact, as evidence that the colouring of the *Portax* is of sexual origin, becomes obvious, when we hear (. Judge Caton, in 'Transactions of the Ottawa Academy of Natural Sciences,' , .) that neither the red summercoat nor the blue wintercoat of the Virginian deer is at all affected by emasculation. With most or all of the highlyornamented species of *Tragelaphus* the males are darker than the hornless females, and their crests of hair are more fully developed. In the male of that magnificent antelope, the Derbyan eland, the body is redder, the whole neck much blacker, and the white band which separates these colours broader than in the female. In the Cape eland, also, the male is slightly darker than the female. (. Dr. Gray, 'Cat. of Mamm. in Brit. Mus.' part iii. , p; also Dr. Gray, 'Gleanings from the Menagerie of Knowsley,' in which there is a splendid drawing of the *Oreas derbianus*: see the text on *Tragelaphus*. For the Cape eland (*Oreas canna*), see Andrew Smith, 'Zoology of S. Africa,' pl. and . There are also many of these Antelopes in the Zoological Gardens.)

In the Indian blackbuck (*A. bezoartica*), which belongs to another tribe of antelopes, the male is very dark, almost black; whilst the hornless female is fawn-coloured. We meet in this species, as Mr. Blyth informs me, with an exactly similar series of facts, as in the *Portax picta*, namely, in the male periodically changing colour during the breeding season, in the effects of emasculation on this change, and in the young of both sexes being indistinguishable from each other. In the *Antilope niger* the male is black, the female, as well as the young of both sexes, being brown; in *A. singsing* the male is much brighter coloured than the hornless female, and his chest and belly are blacker; in the male *A. caama*, the marks and lines which occur on various parts of the body are black, instead of brown as in the female; in the brindled gnu (*A. gorgon*) "the colours of the male are nearly the same as those of the female, only deeper and of a brighter hue." (. On the *Ant. niger*, see 'Proc. Zool. Soc.' , . With respect to an allied species, in which there is an equal sexual difference in colour, see Sir S. Baker, 'The Albert Nyanza,' , vol. ii. . For the *A. singsing*, Gray, 'Cat. B. Mus.' . Desmarest, 'Mammalogie,' , on the *A. caama*. Andrew Smith, 'Zoology of S. Africa,' on the Gnu.) Other analogous cases could be added.

The Banteng bull (*Bos sondaicus*) of the Malayan Archipelago is almost black, with white legs and buttocks; the cow is of a bright dun, as are the young males until about the age of three years, when they rapidly change colour. The emasculated bull reverts to the colour of the female. The female Kemas goat is paler, and both it and the female *Capra aegagrus* are said to be more uniformly tinted than their males. Deer rarely present any sexual differences in colour. Judge Caton, however, informs me that in the males of the wapiti deer (*Cervus canadensis*) the neck, belly, and legs are much darker than in the female; but during the winter the darker tints gradually fade away and disappear. I may here mention that Judge Caton has in his park three races of the Virginian deer, which differ slightly in colour, but the differences are almost exclusively confined to the blue winter or breeding coat; so that this case may be compared with those given in a previous chapter of closely allied or representative species of birds, which differ from each other only in their breeding plumage. (. 'Ottawa Academy of Sciences,' May , , .) The females of *Cervus paludosus* of S. America, as well as the young of both sexes, do not possess the black stripes on the nose and the blackish brown line on the breast, which are characteristic of the adult males. (. S. Muller, on the Banteng, 'Zoog. Indischen Archipel.' , tab. ; see also Raffles, as quoted by Mr. Blyth, in 'Land and Water,' , . On goats, Dr. Gray, 'Catalogue of the British Museum,' ; Desmarest, 'Mammalogie,' . On the *Cervus paludosus*, Rengger, *ibid.* s. .) Lastly, as I am informed by Mr. Blyth, the mature male of the beautifully coloured and spotted axis deer is considerably darker than the female: and this hue the castrated male never acquires.

The last Order which we need consider is that of the Primates. The male of the Lemur macaco is generally coalblack, whilst the female is brown. (. Sclater, 'Proc. Zool. Soc.' , i. The same fact has also been fully ascertained by MM. Pollen and van Dam. See, also, Dr. Gray in 'Annals and Magazine of Natural History,' May , .) Of the Quadrumana of the New World, the females and young of *Mycetes caraya* are greyishyellow and like each other; in the second year the young male becomes reddishbrown; in the third, black, excepting the stomach, which, however, becomes quite black in the fourth or fifth year. There is also a stronglymarked difference in colour between the sexes of *Mycetes seniculus* and *Cebus capucinus*; the young of the former, and I believe of the latter species, resembling the females. With *Pithecia leucocephala* the young likewise resemble the females, which are brownishblack above and light rustyred beneath, the adult males being black. The ruff of hair round the face of *Ateles marginatus* is tinted yellow in the male and white in the female. Turning to the Old World, the males of *Hylobates hoolock* are always black, with the exception of a white band over the brows; the females vary from whitybrown to a dark tint mixed with black, but are never wholly black. (. On *Mycetes*, Rengger, *ibid.* s. ; and Brehm, 'Thierleben,' B. i. s. , . On *Ateles Desmarest*, 'Mammalogie,' . On *Hylobates*, Blyth, 'Land and Water,' , . On the *Semnopithecus*, S. Muller, 'Zoog. Indischen Archipel.' tab. x.) In the beautiful *Cercopithecus diana*, the head of the adult male is of an intense black, whilst that of the female is dark grey; in the former the fur between the thighs is of an elegant fawn colour, in the latter it is paler. In the beautiful and curious moustache monkey (*Cercopithecus cephus*) the only difference between the sexes is that the tail of the male is chestnut and that of the female grey; but Mr. Bartlett informs me that all the hues become more pronounced in the male when adult, whilst in the female they remain as they were during youth. According to the coloured ures given by Solomon Muller, the male of *Semnopithecus chrysomelas* is nearly black, the female being pale brown. In the *Cercopithecus cynosurus* and *griseoviridis* one part of the body, which is confined to the male sex, is of the most brilliant blue or green, and contrasts strikingly with the naked skin on the hinder part of the body, which is vivid red.

[. . Head of male Mandrill (from Gervais, 'Hist. Nat. des Mammifères').]

Lastly, in the baboon family, the adult male of *Cynocephalus hamadryas* differs from the female not only by his immense mane, but slightly in the colour of the hair and of the naked callosities. In the drill (*C. leucophaeus*) the females and young are much palercoloured, with less green, than the adult males. No other member in the whole class of mammals is coloured in so extraordinary a manner as the adult male mandrill (*C. mormon*). The face at this age becomes of a fine blue, with the ridge and tip of the nose of the most brilliant red. According to some authors, the face is also marked with whitish stripes, and is shaded in parts with black, but the colours appear to be variable. On the forehead there is a crest of hair, and on the chin a yellow beard. "Toutes les

parties supérieures de leurs cuisses et le grand espace nu de leurs fesses sont également colorés du rouge le plus vif, avec un mélange de bleu qui ne manque réellement pas d'élégance." (. Gervais, 'Hist. Nat. des Mammifères,' , . ures are given of the skull of the male. Also Desmarest, 'Mammalogie,' . Geoffroy St.Hilaire and F. Cuvier, 'Hist. Nat. des Mammifères,' , tom. i.) When the animal is excited all the naked parts become much more vividly tinted. Several authors have used the strongest expressions in describing these resplendent colours, which they compare with those of the most brilliant birds. Another remarkable peculiarity is that when the great canine teeth are fully developed, immense protuberances of bone are formed on each cheek, which are deeply furrowed longitudinally, and the naked skin over them is brilliantly coloured, as just described. (. .) In the adult females and in the young of both sexes these protuberances are scarcely perceptible; and the naked parts are much less bright coloured, the face being almost black, tinged with blue. In the adult female, however, the nose at certain regular intervals of time becomes tinted with red.

In all the cases hitherto given the male is more strongly or brighter coloured than the female, and differs from the young of both sexes. But as with some few birds it is the female which is brighter coloured than the male, so with the Rhesus monkey (*Macacus rhesus*), the female has a large surface of naked skin round the tail, of a brilliant carmine red, which, as I was assured by the keepers in the Zoological Gardens, periodically becomes even yet more vivid, and her face also is pale red. On the other hand, in the adult male and in the young of both sexes (as I saw in the Gardens), neither the naked skin at the posterior end of the body, nor the face, shew a trace of red. It appears, however, from some published accounts, that the male does occasionally, or during certain seasons, exhibit some traces of the red. Although he is thus less ornamented than the female, yet in the larger size of his body, larger canine teeth, more developed whiskers, more prominent superciliary ridges, he follows the common rule of the male excelling the female.

I have now given all the cases known to me of a difference in colour between the sexes of mammals. Some of these may be the result of variations confined to one sex and transmitted to the same sex, without any good being gained, and therefore without the aid of selection. We have instances of this with our domesticated animals, as in the males of certain cats being rusty red, whilst the females are tortoiseshell coloured. Analogous cases occur in nature: Mr. Bartlett has seen many black varieties of the jaguar, leopard, vulpine phalanger, and wombat; and he is certain that all, or nearly all these animals, were males. On the other hand, with wolves, foxes, and apparently American squirrels, both sexes are occasionally born black. Hence it is quite possible that with some mammals a difference in colour between the sexes, especially when this is congenital, may simply be the result, without the aid of selection, of the occurrence of one or more variations, which from the first were sexually limited in their transmission.

Nevertheless it is improbable that the diversified, vivid, and contrasted colours of certain quadrupeds, for instance, of the above monkeys and antelopes, can thus be accounted for. We should bear in mind that these colours do not appear in the male at birth, but only at or near maturity; and that unlike ordinary variations, they are lost if the male be emasculated. It is on the whole probable that the strongly marked colours and other ornamental characters of male quadrupeds are beneficial to them in their rivalry with other males, and have consequently been acquired through sexual selection. This view is strengthened by the differences in colour between the sexes occurring almost exclusively, as may be collected from the previous details, in those groups and subgroups of mammals which present other and strongly marked secondary sexual characters; these being likewise due to sexual selection.

Quadrupeds manifestly take notice of colour. Sir S. Baker repeatedly observed that the African elephant and rhinoceros attacked white or grey horses with special fury. I have elsewhere shewn (. The 'Variation of Animals and Plants under Domestication,' , vol. ii. .) that halfwild horses apparently prefer to pair with those of the same colour, and that herds of fallowdeer of different colours, though living together, have long kept distinct. It is a more significant fact that a female zebra would not admit the advances of a male ass until he was painted so as to resemble a zebra, and then, as John Hunter remarks, "she received him very readily. In this curious fact, we have instinct excited by mere colour, which had so strong an effect as to get the better of everything else. But the male did not require this, the female being an animal somewhat similar to himself, was sufficient to rouse him." (. 'Essays and Observations,' by J. Hunter, edited by Owen, , vol. i. .)

In an earlier chapter we have seen that the mental powers of the higher animals do not differ in kind, though greatly in degree, from the corresponding powers of man, especially of the lower and barbarous races; and it would appear that even their taste for the beautiful is not widely different from that of the Quadrumana. As the negro of Africa raises the flesh on his face into parallel ridges "or cicatrices, high above the natural surface, which unsightly deformities are considered great personal attractions" (. Sir S. Baker, 'The Nile Tributaries of Abyssinia,' .); as negroes and savages in many parts of the world paint their faces with red, blue, white, or black bars, so the male mandrill of Africa appears to have acquired his deeply furrowed and gaudily coloured face from having been thus rendered attractive to the female. No doubt it is to us a most grotesque notion that the posterior end of the body should be coloured for the sake of ornament even more brilliantly than the face; but this is not more strange than that the tails of many birds should be especially decorated.

With mammals we do not at present possess any evidence that the males take pains to display their charms before the female; and the elaborate manner in which this is

performed by male birds and other animals is the strongest argument in favour of the belief that the females admire, or are excited by, the ornaments and colours displayed before them. There is, however, a striking parallelism between mammals and birds in all their secondary sexual characters, namely in their weapons for fighting with rival males, in their ornamental appendages, and in their colours. In both classes, when the male differs from the female, the young of both sexes almost always resemble each other, and in a large majority of cases resemble the adult female. In both classes the male assumes the characters proper to his sex shortly before the age of reproduction; and if emasculated at an early period, loses them. In both classes the change of colour is sometimes seasonal, and the tints of the naked parts sometimes become more vivid during the act of courtship. In both classes the male is almost always more vividly or strongly coloured than the female, and is ornamented with larger crests of hair or feathers, or other such appendages. In a few exceptional cases the female in both classes is more highly ornamented than the male. With many mammals, and at least in the case of one bird, the male is more odoriferous than the female. In both classes the voice of the male is more powerful than that of the female. Considering this parallelism, there can be little doubt that the same cause, whatever it may be, has acted on mammals and birds; and the result, as far as ornamental characters are concerned, may be attributed, as it appears to me, to the long continued preference of the individuals of one sex for certain individuals of the opposite sex, combined with their success in leaving a larger number of offspring to inherit their superior attractions.

EQUAL TRANSMISSION OF ORNAMENTAL CHARACTERS TO BOTH SEXES.

With many birds, ornaments, which analogy leads us to believe were primarily acquired by the males, have been transmitted equally, or almost equally, to both sexes; and we may now enquire how far this view applies to mammals. With a considerable number of species, especially of the smaller kinds, both sexes have been coloured, independently of sexual selection, for the sake of protection; but not, as far as I can judge, in so many cases, nor in so striking a manner, as in most of the lower classes. Audubon remarks that he often mistook the muskrat (*Fiber zibethicus*, Audubon and Bachman, 'The Quadrupeds of North America,' .), whilst sitting on the banks of a muddy stream, for a clod of earth, so complete was the resemblance. The hare on her form is a familiar instance of concealment through colour; yet this principle partly fails in a closely allied species, the rabbit, for when running to its burrow, it is made conspicuous to the sportsman, and no doubt to all beasts of prey, by its upturned white tail. No one doubts that the quadrupeds inhabiting snowclad regions have been rendered white to protect them from their enemies, or to favour their stealing on their prey. In regions where snow never lies for long, a white coat would be injurious; consequently, species of this colour are extremely rare in the hotter parts of the world. It deserves notice that many

quadrupeds inhabiting moderately cold regions, although they do not assume a white winter dress, become paler during this season; and this apparently is the direct result of the conditions to which they have long been exposed. Pallas (. 'Novae species Quadrupedum e Glirium ordine,' , . What I have called the roe is the *Capreolus sibiricus subcaudatus* of Pallas.) states that in Siberia a change of this nature occurs with the wolf, two species of *Mustela*, the domestic horse, the *Equus hemionus*, the domestic cow, two species of antelopes, the musk deer, the roe, elk, and reindeer. The roe, for instance, has a red summer and a greyishwhite winter coat; and the latter may perhaps serve as a protection to the animal whilst wandering through the leafless thickets, sprinkled with snow and hoarfrost. If the abovenamed animals were gradually to extend their range into regions perpetually covered with snow, their pale wintercoats would probably be rendered through natural selection, whiter and whiter, until they became as white as snow.

Mr. Reeks has given me a curious instance of an animal profiting by being peculiarly coloured. He raised from fifty to sixty white and brown piebald rabbits in a large walled orchard; and he had at the same time some similarly coloured cats in his house. Such cats, as I have often noticed, are very conspicuous during day; but as they used to lie in watch during the dusk at the mouths of the burrows, the rabbits apparently did not distinguish them from their particoloured brethren. The result was that, within eighteen months, every one of these particoloured rabbits was destroyed; and there was evidence that this was effected by the cats. Colour seems to be advantageous to another animal, the skunk, in a manner of which we have had many instances in other classes. No animal will voluntarily attack one of these creatures on account of the dreadful odour which it emits when irritated; but during the dusk it would not easily be recognised and might be attacked by a beast of prey. Hence it is, as Mr. Belt believes (. 'The Naturalist in Nicaragua,' .), that the skunk is provided with a great white bushy tail, which serves as a conspicuous warning.

[. . *Tragelaphus scriptus*, male (from the Knowsley Menagerie).

. . *Damalis pygarga*, male (from the Knowsley Menagerie).]

Although we must admit that many quadrupeds have received their present tints either as a protection, or as an aid in procuring prey, yet with a host of species, the colours are far too conspicuous and too singularly arranged to allow us to suppose that they serve for these purposes. We may take as an illustration certain antelopes; when we see the square white patch on the throat, the white marks on the fetlocks, and the round black spots on the ears, all more distinct in the male of the *Portax picta*, than in the female; when we see that the colours are more vivid, that the narrow white lines on the flank and the broad white bar on the shoulder are more distinct in the male *Oreas*

derbyanus than in the female; when we see a similar difference between the sexes of the curiously ornamented *Tragelaphus scriptus*, we cannot believe that differences of this kind are of any service to either sex in their daily habits of life. It seems a much more probable conclusion that the various marks were first acquired by the males and their colours intensified through sexual selection, and then partially transferred to the females. If this view be admitted, there can be little doubt that the equally singular colours and marks of many other antelopes, though common to both sexes, have been gained and transmitted in a like manner. Both sexes, for instance, of the koodoo (*Strepsiceros kudu*) have narrow white vertical lines on their hind flanks, and an elegant angular white mark on their foreheads. Both sexes in the genus *Damalis* are very oddly coloured; in *D. pygarga* the back and neck are purplish red, shading on the flanks into black; and these colours are abruptly separated from the white belly and from a large white space on the buttocks; the head is still more oddly coloured, a large oblong white mask, narrowly edged with black, covers the face up to the eyes; there are three white stripes on the forehead, and the ears are marked with white. The fawns of this species are of a uniform pale yellowish brown. In *Damalis albifrons* the colouring of the head differs from that in the last species in a single white stripe replacing the three stripes, and in the ears being almost wholly white. (See the fine plates in A. Smith's 'Zoology of South Africa,' and Dr. Gray's 'Gleanings from the Menagerie of Knowsley.') After having studied to the best of my ability the sexual differences of animals belonging to all classes, I cannot avoid the conclusion that the curiously arranged colours of many antelopes, though common to both sexes, are the result of sexual selection primarily applied to the male.

The same conclusion may perhaps be extended to the tiger, one of the most beautiful animals in the world, the sexes of which cannot be distinguished by colour, even by the dealers in wild beasts. Mr. Wallace believes ('Westminster Review,' July , , .) that the striped coat of the tiger "so assimilates with the vertical stems of the bamboo, as to assist greatly in concealing him from his approaching prey." But this view does not appear to me satisfactory. We have some slight evidence that his beauty may be due to sexual selection, for in two species of *Felis* the analogous marks and colours are rather brighter in the male than in the female. The zebra is conspicuously striped, and stripes cannot afford any protection in the open plains of South Africa. Burchell ('Travels in South Africa,' , vol. ii. .) in describing a herd says, "their sleek ribs glistened in the sun, and the brightness and regularity of their striped coats presented a picture of extraordinary beauty, in which probably they are not surpassed by any other quadruped." But as throughout the whole group of the *Equidae* the sexes are identical in colour, we have here no evidence of sexual selection. Nevertheless he who attributes the white and dark vertical stripes on the flanks of various antelopes to this process, will probably extend the same view to the Royal Tiger and beautiful Zebra.

We have seen in a former chapter that when young animals belonging to any class follow nearly the same habits of life as their parents, and yet are coloured in a different manner, it may be inferred that they have retained the colouring of some ancient and extinct progenitor. In the family of pigs, and in the tapirs, the young are marked with longitudinal stripes, and thus differ from all the existing adult species in these two groups. With many kinds of deer the young are marked with elegant white spots, of which their parents exhibit not a trace. A graduated series can be followed from the axis deer, both sexes of which at all ages and during all seasons are beautifully spotted (the male being rather more strongly coloured than the female), to species in which neither the old nor the young are spotted. I will specify some of the steps in this series. The Mantchurian deer (*Cervus mantchuricus*) is spotted during the whole year, but, as I have seen in the Zoological Gardens, the spots are much plainer during the summer, when the general colour of the coat is lighter, than during the winter, when the general colour is darker and the horns are fully developed. In the hogdeer (*Hyelaphus porcinus*) the spots are extremely conspicuous during the summer when the coat is reddishbrown, but quite disappear during the winter when the coat is brown. (. Dr. Gray, 'Gleanings from the Menagerie of Knowsley,' . Mr. Blyth, in speaking ('Land and Water,' ,) of the hogdeer of Ceylon, says it is more brightly spotted with white than the common hogdeer, at the season when it renews its horns.) In both these species the young are spotted. In the Virginian deer the young are likewise spotted, and about five per cent. of the adult animals living in Judge Caton's park, as I am informed by him, temporarily exhibit at the period when the red summer coat is being replaced by the bluish winter coat, a row of spots on each flank, which are always the same in number, though very variable in distinctness. From this condition there is but a very small step to the complete absence of spots in the adults at all seasons; and, lastly, to their absence at all ages and seasons, as occurs with certain species. From the existence of this perfect series, and more especially from the fawns of so many species being spotted, we may conclude that the now living members of the deer family are the descendants of some ancient species which, like the axis deer, was spotted at all ages and seasons. A still more ancient progenitor probably somewhat resembled the *Hyomoschus aquaticus* for this animal is spotted, and the hornless males have large exerted canine teeth, of which some few true deer still retain rudiments. *Hyomoschus*, also, offers one of those interesting cases of a form linking together two groups, for it is intermediate in certain osteological characters between the pachyderms and ruminants, which were formerly thought to be quite distinct. (. Falconer and Cautley, 'Proc. Geolog. Soc.' ; and Falconer's 'Pal. Memoirs,' vol. i. .)

A curious difficulty here arises. If we admit that coloured spots and stripes were first acquired as ornaments, how comes it that so many existing deer, the descendants of an aboriginally spotted animal, and all the species of pigs and tapirs, the descendants of an aboriginally striped animal, have lost in their adult state their former ornaments? I

cannot satisfactorily answer this question. We may feel almost sure that the spots and stripes disappeared at or near maturity in the progenitors of our existing species, so that they were still retained by the young; and, owing to the law of inheritance at corresponding ages, were transmitted to the young of all succeeding generations. It may have been a great advantage to the lion and puma, from the open nature of their usual haunts, to have lost their stripes, and to have been thus rendered less conspicuous to their prey; and if the successive variations, by which this end was gained, occurred rather late in life, the young would have retained their stripes, as is now the case. As to deer, pigs, and tapirs, Fritz Müller has suggested to me that these animals, by the removal of their spots or stripes through natural selection, would have been less easily seen by their enemies; and that they would have especially required this protection, as soon as the carnivora increased in size and number during the tertiary periods. This may be the true explanation, but it is rather strange that the young should not have been thus protected, and still more so that the adults of some species should have retained their spots, either partially or completely, during part of the year. We know that, when the domestic ass varies and becomes reddishbrown, grey, or black, the stripes on the shoulders and even on the spine frequently disappear, though we cannot explain the cause. Very few horses, except duncoloured kinds, have stripes on any part of their bodies, yet we have good reason to believe that the aboriginal horse was striped on the legs and spine, and probably on the shoulders. (. The 'Variation of Animals and Plants under Domestication,' , vol. i. p.) Hence the disappearance of the spots and stripes in our adult existing deer, pigs, and tapirs, may be due to a change in the general colour of their coats; but whether this change was effected through sexual or natural selection, or was due to the direct action of the conditions of life, or to some other unknown cause, it is impossible to decide. An observation made by Mr. Sclater well illustrates our ignorance of the laws which regulate the appearance and disappearance of stripes; the species of *Asinus* which inhabit the Asiatic continent are destitute of stripes, not having even the cross shoulderstripe, whilst those which inhabit Africa are conspicuously striped, with the partial exception of *A. taeniopus*, which has only the cross shoulderstripe and generally some faint bars on the legs; and this species inhabits the almost intermediate region of Upper Egypt and Abyssinia. (. 'Proc. Zool. Soc.' , . See, also, Dr. Hartmann, 'Ann. d. Landw.' Bd. xliiii. s. .)

QUADRUMANA.

[. . Head of *Semnopithecus rubicundus*. This and the following ones (from Prof. Gervais) are given to shew the odd arrangement and development of the hair on the head.

. . Head of *Semnopithecus comatus*.

. . Head of *Cebus capucinus*.

. . Head of *Ateles marginatus*.

. . Head of *Cebus vellerosus*.]

Before we conclude, it will be well to add a few remarks on the ornaments of monkeys. In most of the species the sexes resemble each other in colour, but in some, as we have seen, the males differ from the females, especially in the colour of the naked parts of the skin, in the development of the beard, whiskers, and mane. Many species are coloured either in so extraordinary or so beautiful a manner, and are furnished with such curious and elegant crests of hair, that we can hardly avoid looking at these characters as having been gained for the sake of ornament. The accompanying ures (s. to) serve to shew the arrangement of the hair on the face and head in several species. It is scarcely conceivable that these crests of hair, and the strongly contrasted colours of the fur and skin, can be the result of mere variability without the aid of selection; and it is inconceivable that they can be of use in any ordinary way to these animals. If so, they have probably been gained through sexual selection, though transmitted equally, or almost equally, to both sexes. With many of the *Quadrumana*, we have additional evidence of the action of sexual selection in the greater size and strength of the males, and in the greater development of their canine teeth, in comparison with the females.

[. . *Cercopithecus petaurista* (from Brehm).]

A few instances will suffice of the strange manner in which both sexes of some species are coloured, and of the beauty of others. The face of the *Cercopithecus petaurista* is black, the whiskers and beard being white, with a defined, round, white spot on the nose, covered with short white hair, which gives to the animal an almost ludicrous aspect. The *Semnopithecus frontatus* likewise has a blackish face with a long black beard, and a large naked spot on the forehead of a bluishwhite colour. The face of *Macacus lasiotus* is dirty fleshcoloured, with a defined red spot on each cheek. The appearance of *Cercocebus aethiops* is grotesque, with its black face, white whiskers and collar, chestnut head, and a large naked white spot over each eyelid. In very many species, the beard, whiskers, and crests of hair round the face are of a different colour from the rest of the head, and when different, are always of a lighter tint (. I observed this fact in the Zoological Gardens; and many cases may be seen in the coloured plates in Geoffroy St.Hilaire and F. Cuvier, 'Histoire Nat. des Mammifères,' tom. i. .), being often pure white, sometimes bright yellow, or reddish. The whole face of the South American *Brachyurus calvus* is of a "glowing scarlet hue"; but this colour does not appear until the animal is nearly mature. (. Bates, 'The Naturalist on the Amazons,' , vol. ii. .) The naked skin of the face differs wonderfully in colour in the various species. It is often brown or fleshcolour, with parts perfectly white, and often as black as that of the

most sooty negro. In the *Brachyurus* the scarlet tint is brighter than that of the most blushing Caucasian damsel. It is sometimes more distinctly orange than in any Mongolian, and in several species it is blue, passing into violet or grey. In all the species known to Mr. Bartlett, in which the adults of both sexes have strongly coloured faces, the colours are dull or absent during early youth. This likewise holds good with the mandrill and Rhesus, in which the face and the posterior parts of the body are brilliantly coloured in one sex alone. In these latter cases we have reason to believe that the colours were acquired through sexual selection; and we are naturally led to extend the same view to the foregoing species, though both sexes when adult have their faces coloured in the same manner.

[. . *Cercopithecus diana* (from Brehm).]

Although many kinds of monkeys are far from beautiful according to our taste, other species are universally admired for their elegant appearance and bright colours. The *Semnopithecus nemeus*, though peculiarly coloured, is described as extremely pretty; the orangetinted face is surrounded by long whiskers of glossy whiteness, with a line of chestnutred over the eyebrows; the fur on the back is of a delicate grey, with a square patch on the loins, the tail and the forearms being of a pure white; a gorget of chestnut surmounts the chest; the thighs are black, with the legs chestnut red. I will mention only two other monkeys for their beauty; and I have selected these as presenting slight sexual differences in colour, which renders it in some degree probable that both sexes owe their elegant appearance to sexual selection. In the moustachemonkey (*Cercopithecus cephus*) the general colour of the fur is mottledgreenish with the throat white; in the male the end of the tail is chestnut, but the face is the most ornamented part, the skin being chiefly bluishgrey, shading into a blackish tint beneath the eyes, with the upper lip of a delicate blue, clothed on the lower edge with a thin black moustache; the whiskers are orangecoloured, with the upper part black, forming a band which extends backwards to the ears, the latter being clothed with whitish hairs. In the Zoological Society's Gardens I have often overheard visitors admiring the beauty of another monkey, deservedly called *Cercopithecus diana* ; the general colour of the fur is grey; the chest and inner surface of the forelegs are white; a large triangular defined space on the hinder part of the back is rich chestnut; in the male the inner sides of the thighs and the abdomen are delicate fawn coloured, and the top of the head is black; the face and ears are intensely black, contrasting finely with a white transverse crest over the eyebrows and a long white peaked beard, of which the basal portion is black. (. I have seen most of the above monkeys in the Zoological Society's Gardens. The description of the *Semnopithecus nemeus* is taken from Mr. W.C. Martin's 'Natural History of Mammalia,' ; see also .)

In these and many other monkeys, the beauty and singular arrangement of their colours, and still more the diversified and elegant arrangement of the crests and tufts of hair on their heads, force the conviction on my mind that these characters have been acquired through sexual selection exclusively as ornaments.

SUMMARY.

The law of battle for the possession of the female appears to prevail throughout the whole great class of mammals. Most naturalists will admit that the greater size, strength, courage, and pugnacity of the male, his special weapons of offence, as well as his special means of defence, have been acquired or modified through that form of selection which I have called sexual. This does not depend on any superiority in the general struggle for life, but on certain individuals of one sex, generally the male, being successful in conquering other males, and leaving a larger number of offspring to inherit their superiority than do the less successful males.

There is another and more peaceful kind of contest, in which the males endeavour to excite or allure the females by various charms. This is probably carried on in some cases by the powerful odours emitted by the males during the breedingseason; the odoriferous glands having been acquired through sexual selection. Whether the same view can be extended to the voice is doubtful, for the vocal organs of the males must have been strengthened by use during maturity, under the powerful excitements of love, jealousy or rage, and will consequently have been transmitted to the same sex. Various crests, tufts, and mantles of hair, which are either confined to the male, or are more developed in this sex than in the female, seem in most cases to be merely ornamental, though they sometimes serve as a defence against rival males. There is even reason to suspect that the branching horns of stags, and the elegant horns of certain antelopes, though properly serving as weapons of offence or defence, have been partly modified for ornament.

When the male differs in colour from the female, he generally exhibits darker and more stronglycontrasted tints. We do not in this class meet with the splendid red, blue, yellow, and green tints, so common with male birds and many other animals. The naked parts, however, of certain *Quadrumana* must be excepted; for such parts, often oddly situated, are brilliantly coloured in some species. The colours of the male in other cases may be due to simple variation, without the aid of selection. But when the colours are diversified and strongly pronounced, when they are not developed until near maturity, and when they are lost after emasculation, we can hardly avoid the conclusion that they have been acquired through sexual selection for the sake of ornament, and have been transmitted exclusively, or almost exclusively, to the same sex. When both sexes are coloured in the same manner, and the colours are conspicuous or curiously arranged, without being of the least apparent use as a protection, and especially when they are associated with various other ornamental appendages, we are led by analogy to the same conclusion, namely, that they have been acquired through sexual selection, although transmitted to both sexes. That conspicuous and diversified colours, whether confined to the males or common to both sexes, are as a general rule associated in the same groups and

subgroups with other secondary sexual characters serving for war or for ornament, will be found to hold good, if we look back to the various cases given in this and the last chapter.

The law of the equal transmission of characters to both sexes, as far as colour and other ornaments are concerned, has prevailed far more extensively with mammals than with birds; but weapons, such as horns and tusks, have often been transmitted either exclusively or much more perfectly to the males than to the females. This is surprising, for, as the males generally use their weapons for defence against enemies of all kinds, their weapons would have been of service to the females. As far as we can see, their absence in this sex can be accounted for only by the form of inheritance which has prevailed. Finally, with quadrupeds the contest between the individuals of the same sex, whether peaceful or bloody, has, with the rarest exceptions, been confined to the males; so that the latter have been modified through sexual selection, far more commonly than the females, either for fighting with each other or for alluring the opposite sex.