CHAPTER V.

ON THE OPINION THAT EACH SEX MAY TRANSMIT ANY CHARACTERISTIC WHATEVER.

The argument from hybrids—This argument is inconclusive—The argument from the homology between the ovum and the male cell—Homology does not involve functional similarity—The argument from the dual personality of each individual; from reversion; and from polymorphism—These phenomena admit of a simpler explanation—Summary of chapter.

The Argument from Hybrids.

According to the view to be presented in this work, the functions of the two sexual elements, in inheritance, are not alike.

The proof of this will be presented further on, when the subject is reached in the logical course of the development of our argument.

Some of the very highest authorities have been led to a view which is directly opposite, and have held that either parent may transmit to the offspring any characteristic whatever. Lest any reader should assume, at the beginning of this book, that the work involves an absurdity, and that my conclusion is already disproved, it seems best to at once examine the reasons for the opposite view. If I can show that these reasons are inconclusive, and that there is and can be no proof for the statement that each sexual element transmits to the offspring every characteristic of the parent, we can then enter into the subject without prejudice, and can wait

for the proper time to present the proof of the opposite view, that the two sexual elements play different parts in heredity.

If the authority of great names counted for anything whatever in science, the case against me would be very strong, but where an appeal to nature is possible, authority counts for nothing.

Darwin's place among the students of heredity is certainly the highest, and he takes very strong ground indeed upon this subject.

Thus he says (*Variation of Animals and Plants*, Vol. ii. p. 88): "I am aware that such cases (of prepotency) have been ascribed by various authors to such rules as that the father influences the external characters, and the mother the internal characters.

"But the great diversity of the rules given by various authors almost proves their falseness. Dr. Prosper Lucas has fully discussed this point, and has shown that none of the rules (and I could add others to those quoted by him) apply to all animals. Similar rules have been announced for plants and have been proved by Gärtner to be all erroneous."

In the *Anatomy of Invertebrated Animals*, p. 30, Huxley states that "no structural modification is so slight, and no functional peculiarity is so insignificant *in either parent*, that it may not make its appearance in the offspring."

Darwin, in many parts of his writings, is still more explicit. Thus he says (*Variation of Animals and Plants*, Vol. ii. p. 431): "Ovules and the male element, before they become united, have, like buds, an independent existence. *Both have* the power of transmitting *every single character* possessed by the parent form. We see this clearly when hybrids are paired *inter se*, for

the characters of either grandparent often reappear, either perfectly or by segments, in the progeny. *It is an error to suppose that the male transmits certain characters and the female other characters.*"

I think a little examination will show clearly the impossibility of proving this statement from the phenomena of crossing. In order to breed together animals must be closely related; they must belong to the same species or to two closely allied species. Since the individuals which belong to two closely related species are the descendants of a common, and not very remote, ancestral species, it is clear that almost the whole course of their evolution has been shared by them in common; all their generic characteristics being inherited from this ancestor. Only the slight differences in minor points, which distinguish one species of a genus from another, have been acquired since the two diverged, and not even all of these slight differences, for a difference between two allied species may be due to the fact that while one has been modified the other has retained, unmodified, certain resemblances to their common ancestor. We know that the duration of even the most persistent species is only an infinitesimal part of the whole history of their evolution, and it is clear that the common characteristics of two allied species must outnumber, thousands of times, the differences between them. It follows that the parents of any possible hybrid must be alike in thousands of features for one in which they differ. It is therefore out of the question to attempt to prove, from the phenomena of crossing, that each parent can transmit to the child all its characteristics. Crossing simply results in the formation of a germ by the union of a male and a female element derived from two essentially similar parents, with at most only a few secondary

and comparatively slight differences, all of which have been recently acquired.

If a perfect animal could be developed from the spermatozoon of a male parent, as it can be, in cases of parthenogenesis, from the ovum of a female parent, we should have a means of proving that each sex transmits its entire organization to its offspring.

The phenomena of parthenogenesis prove that the female does actually thus transmit its entire organization, but there is nothing to show that the male parent does also, for it is clear that, from the nature of the case, the phenomena of crossing are incompetent to prove it.

The Argument from the Homology of the Male and Female Sexual Elements.

Many authors have gone much further than the statement that any characteristic whatever may be transmitted by either parent, and have held that the offspring is actually a dual personality, made up of a complete organization or individuality inherited from the father, and another, equally complete, inherited from the mother. This view has found favor with a number of modern writers, and frequently makes its appearance in the literature of the subject.

Thus Huxley says (*Encyclop. Brit., Art. Evolution*), "It is conceivable, and indeed *probable*, that every part of the adult contains molecules derived from the male and from the female parent; and that, regarded as a mass of molecules, the entire organism may be compared to a web, of which the warp is derived from the female, and the woof from the male. And each of these may constitute an individuality in the same sense as the whole organism is one individual, although the matter of the organism has been continually changing."

It will be found, on examination, that there is much to be said in support of this view, although I believe that there is a much simpler explanation of the facts which seem to favor it.

The only reason given by Huxley, in the article above quoted, is the homology between the ovum and the spermatozoon; the fact that in all the higher animals and plants the germ is formed by the union of one nucleated cell, the ovum, with another more or less modified nucleated cell, the male cell, and that the structural components of the body of the embryo are all derived, by a process of division, from the coalesced male and female germs.

In answer to this we may point out that while the hypothesis requires that a wasp born from a fertilized egg should differ essentially from one born from a parthenogenetic egg, the one being a dual person and the other a unit, we do not find any obvious difference corresponding to the supposed molecular difference. We should not expect a wasp with a dual personality to be, to all appearances, exactly like one with a single personality.

A fatal objection to Huxley's argument, above given, is that, at bottom, it is simply an assumption that the homology or morphological equivalence of the ovum and male cell proves their functional equivalence. The fallacy of this assumption hardly needs notice, since it is well known that homology is no evidence whatever of functional resemblance. The quill feathers which fit a bird's wing for flight are homologous with the scales which cover and protect the arms and fingers of a crocodile, but we could hardly name two structures which serve more different purposes. The homology between them simply indicates that, at some time in their his-

tory, both scales and feathers have had a common origin in an epidermic structure, which has gradually become specialized into these organs.

While the homology between the ovum and the male cell is no reason for assuming that their functions are now alike, the constant differences between them, *throughout almost all of the organic world, seem to* afford a very convincing reason for believing that their functions have been specialized in two divergent directions.

If we can show that good might have resulted to the organism from such specialization, and from the restriction of certain parts of the reproductive function to one element, and the restriction of others to the other, we may feel confident that, provided variations in these directions have at any time arisen, natural selection would have seized upon and perpetuated them.

I hope to show the great usefulness of a specialization of this sort, and if I can do so, it is clear that the known differences between the ovum and the spermatozoon are reasons for a belief in its existence, while the only conclusion which can be drawn from the homology between them is, that at one time their functions were alike.

The Arguments from the Transmission of Latent Sexual Characteristics; from Reversion, and from Alternation of Generations.

In addition to the reason given by Huxley for a belief in the dual nature of each organism, he might have adduced the fact that the characteristics of each sex are potential and latent in the organism of the opposite sex, *as is proved by the transmission by a father to his daughter* of characteristics inherited from his grandmother.

The fact that the characteristics of one sex are latent

in the organism of the other is proved by countless well-known illustrations, and it seems, at first sight, to afford evidence of the dual personality of each animal.

The fact in itself is so interesting that, while I believe in the possibility of a much simpler and more satisfactory explanation, it will not be out of place to devote a little space to the subject.

"In every female all the secondary male characters, and in every male all the secondary female characters, apparently exist in a latent state, ready to be evolved under certain conditions" (Darwin, *Variation. Vol.* ii. p. 68).

A perfect beard often begins to grow upon the face of a woman after the power of reproduction is lost by age or disease. Such women are often alluded to by Roman authors under the name of "viragines," and Hippocrates (*De Morb. Vulg., Lib.* vi. 55–56) has left us the description of two well-marked instances.

Aristotle (*Hist. Animal*, ix. cap. 36) gives an account of a hen which had ceased laying, and assumed the characteristics of the male bird, and similar change in female birds has been recorded by many writers. It has been observed in the hen, common pheasant, golden pheasant, silver pheasant, turkey, pea-hen, partridge, bustard, pelican, various ducks, cuckoo, cotinga, chaffinch, bunting, and other birds. The change may be produced by age, by disease of the ovaries, removal of the ovaries, and even (*Yarrel, Phil. Trans.* 1827, ii. p. 268) by removal of part of the oviduct.

Old hens which have stopped laying often acquire a comb, wattles, spurs, the brightly-colored plumage and long tail-feathers of the cock, assume the habits of the male, and even learn to crow. The bad character, as layers, of crowing hens, has even given rise to a proverb.

According to Darwin, Waterton gives a curious case of a hen which had ceased laying, and had assumed the plumage, voice, spurs and warlike disposition of the cock: when opposed to an enemy she would erect her hackels and show fight.

Female deer often acquire the horns, peculiar hair, ears, odor, and sexual desire of the males.

On the other hand, it is well known that the secondary sexual characteristics of male animals are more or less completely lost when they are subjected to castration.

Darwin states, on the authority of Yarrell, that if the operation be performed on a young cock, he never crows again; the comb, wattles and spurs do not grow to their full size, and the hackels assume an intermediate appearance between the true hackels and the feathers of the hen. Similar results are said to be produced by confinement.

Buffon states (*Hist. Nat., Tom.* vi. p. 80) that the horns of a stag castrated during the rutting season become permanent, but that new horns do not usually appear if it is castrated when out of heat.

Simpson says (*Cyc. of Anat., Vol.* ii. p. 717), "From the frequency with which castration is performed, the effect of the testes in evolving the general sexual peculiarities of the male have been more accurately ascertained than that of the ovaries upon the female constitution. These effects vary according to the age at which the removal takes place. When an animal is castrated some time before it reaches the term of puberty, the distinctive characteristics of the male are in general never developed; and the total absence of these characters, together with the softness of their tissues, the contour of their form, the tone of their voice, and their want of energy and vigor, assimilate them more in appearance and

habits to the female than to the male type. If the testicles are removed nearer the period of puberty, or at any time after that term has occurred, and when the various male sexual peculiarities have been already developed, the effect is seldom so striking: the sexual instinct of the animals, and the energy of character which these instincts impart, are certainly more or less completely destroyed, and the tone of the voice is sometimes changed to that of puberty, but the general male character of form, such as the beard in man, and the horns of ruminants, generally continue to grow."

Darwin, after reviewing these facts, concludes as follows:

". . . We thus see that in many, probably in all cases, the secondary sexual characters of each sex lie dormant or latent in the opposite sex, ready to be evolved under peculiar circumstances.

"We can thus understand how, for instance, it is possible for a good milking cow to transmit her good milking qualities through her male offspring to future generations, for we may confidently believe that these qualities are present, though latent, in the males of each generation. So it is with the game-cock, who can transmit his superiority in courage and vigor through his female to his male offspring; and with man it is known that diseases necessarily confined to the male sex can be transmitted through the female to the grandson. Such cases are intelligible on the belief that characters common to the grandparent and the grandchild of the same sex are present, though latent, in the intermediate parent of the opposite sex."

Facts of this sort certainly seem, at first sight, to show the existence in each individual of two complete individualities, one from each parent; and the presence in each

sex, in a latent condition, of the organization of the other sex; but it is not difficult to show that the phenomena in question admit of a much simpler explanation.

In most cases when the sexes differ from each other in what are known as secondary sexual characteristics, that is, features which are not directly concerned in the reproductive function, the mature male is more different than the mature female from the young. I shall discuss this subject more fully in another place, so I shall give only a few illustrations at present. It will be sufficient to call attention to the resemblance between the smooth face of a woman and the face of either a boy or a girl, as contrasted with the bearded face of a man. The voice of a woman, the voice of a girl, and that of a boy, all resemble each other, and all differ from the voice of a man in the same, or nearly the same, respects.

In fowls the young of both sexes are much like the adult female in form and color.

These familiar instances are enough for our present purpose, and they show that, so far as the secondary sexual characteristics are concerned, the female is, as a rule, distinguished from the male by her failure to acquire the fully developed characteristics of the race. In these respects the female is an arrested male, and this is well shown by that fact that while the females and young of two closely related species of wild animals may be so much alike that they can hardly be distinguished, the adult males may be very different from each other.

All we need to assume, then, in order to reach a simple explanation of the secondary sexual differences between the sexes, is that each ovum has the power to develop into an organism with all the characteristics of the species, but that the female function acts, in some

way, to arrest the general organization somewhat short of full perfection.

We can also understand that the power to develop perfectly and to assume the characteristics of the species might remain latent in the female, and might come into action after the loss of reproductive power.

According to this view, the possession of a beard must be regarded as a general characteristic of our race, inherited by all children, girls as well as boys. The development, in the girl, of the female reproductive function, or the lack of the stimulus which comes, in the male, from the development of the male function, arrests the development of the beard, although its power for growth may remain latent, and may come into more or less perfect activity after the period of reproduction is past.

A careful examination of the examples given above will bring out the interesting fact that when a female, from disease or mutilation or old age, assumes a resemblance to the male, the change is an advance, and consists in the acquisition of structures not usually present in the female. When, on the other hand, the male, from castration or confinement, comes to resemble the female, the resemblance is due, in most cases, to arrest, or a failure of the male to acquire the adult male characteristics of the species.

Simpson (*Hermaphroditism, Cyc. of Anat. and Phys.*, Vol. ii. p. 719) gives the following summary of the subject:

"The consideration of the various facts that we have now stated inclines us to the belief that the natural history characteristics of any species of animal are certainly not to be sought for solely either in the system of the male or in that of the female; but as Mr. Hunter pointed out, they are to be found in those properties that are

common to both sexes, and which we have occasionally seen combined together by nature upon the bodies of hermaphrodites, or evolved from the interference of art upon a castrated male or a spayed female.

"In assuming at the age of puberty the distinctive secondary peculiarities of his sex, the male, so far as regards these secondary peculiarities, evidently passes into a higher degree of development than the female, and leaves her more in possession of those characters that are common to the young of both sexes, and which he himself never loses when his testicles are early removed. These and other facts connected with the evolution of both the primary and the secondary peculiarities of the sexes farther appear to us to show that, physiologically at least, we ought to consider the male type of organization to be the more perfect, as respects the individual, and the female as respects the species. Hence we find that, when the female is malformed in the sexual parts so as to resemble the male, the malformation is almost always one of excessive development, and, on the other hand, when the male organs are malformed in such a manner as to simulate the female, the abnormal appearance is generally to be traced to a defect of development. In the same way, when the female assumes the secondary characters of the male it is either, first, when by original malformation its own ovaries and sexual organs are so defective in structure as not to be capable of taking a part in the function of reproduction, and of exercising that influence over the general organization which this faculty imparts to them; or, secondly, when in the course of age the ovaries have ceased to be capable of performing the action allotted to them in the reproductive process. In both of these cases we observe the powers of the female organization, now that its

capabilities for performing its particular office in the continuation of the species are wanting or lost, expend themselves in perfecting its own individual system, and hence the animal gradually assumes more or fewer of the secondary sexual characters that belong to the male."

It is true that, in a few instances, the male has been known to acquire true feminine characteristics, foreign to normal males. Thus, according to Darwin, "characteristics properly confined to the female are likewise acquired: the capon takes to sitting on eggs, and will bring up chickens; and what is more curious, the utterly sterile male hybrids from the pheasant and fowl act in the same manner, their delight being to watch when the hen leaves the nest, and to take on themselves the office of a sitter.

Many male birds normally sit, and hatch the eggs, and there are reasons for believing that the incubating habit was originally shared by both sexes, and I am therefore inclined to attribute such cases as this to reversion to a remote male ancestor, rather than to the acquisition by the male of a female characteristic.

We may conclude, then, that the transmission by one sex, in a latent condition, of the secondary characteristics of the opposite sex, does not compel us to believe in the dual sexual personality of each individual, since we have a much simpler explanation in the view that each embryo inherits the power to develop all the characteristics of the species, but that this power does not fully manifest itself in the female.

It may seem difficult to explain in this way the transmission by a bull of the good milking qualities of his mother, or the capacity occasionally shown by male mammals of yielding milk, but it is surely simpler to assume that each male inherits, like the females, the

power of developing perfect functional mammæ, and that this power is arrested in the male, than to assume that each male animal includes in itself a complete female duplicate.

An illustration may make the subject more clear. Certain embryo bees, when exposed to certain conditions, develop into sterile workers, but when exposed to another set of conditions they become fertile females. The differences between the workers and the queens are not confined to the reproductive organs, but extend to the shape and size of the body, the general organization, and to the instincts of the animals. These differences are not due to the direct action of the conditions to which the young are exposed, but are truly hereditary, as we see from the fact that the workers of different species are as distinct and as characteristic of their species as the male or the fertile females.

Now which is simplest, to assume that each female embryo has a complete worker organization and a complete queen organization, or to hold that it has the power to develop all the characteristics common to both, and also the distinctive characteristics of each; that one set of conditions suppresses the distinctive characteristics of a perfect queen, while another set of conditions arrests those of a perfect worker?

The argument in favor of the multiple personality of individuals which is furnished by polymorphic communities is at least as strong as that furnished by the latent transmission of secondary sexual characteristics.

In the case of the polymorphic hydroids an egg-embryo may give rise, by budding, to certain descendants *with fully developed digestive organs, but with no* organs of locomotion or reproductive organs, to other descendants with organs of locomotion, but without diges-

tive organs or reproductive organs, and to still others with reproductive organs, but with no organs of digestion or locomotion. All these forms are hereditary and are characteristic of the species, so there is no escape from the conclusion that they all are present in some form in the egg-embryo, and it is certainly natural to suspect that the entire organization of each one of them is latent in this embryo, but the explanation which I have proposed to account for the transmission of secondary sexual characteristics, applies to such cases as this just as well.

The hypothesis that the egg-embryo inherits and transmits to each of its descendants, those produced asexually as well as those produced sexually, all the characteristics of the species, and that it also inherits and transmits to each of them a tendency to suppress certain of these characteristics under certain conditions, seems to furnish a simple and satisfactory explanation of all the facts.

According to this view the feeding zooids of a polymorphic Siphonophore are individuals which have inherited in full all the characteristics of the race, but which do not attain to perfect development in all respects. The swimming zooids are similar individuals, with other characteristics suppressed, and so on.

This explanation seems much more satisfactory than the supposition that the egg-embryo contains one complete personality for feeding zooids, one for locomotor zooids and one for reproductive zooids, and I hope that this case will make clearer the lack of necessity for assuming the dual personality of each male or female animal, so long as we have a much simpler explanation in the hypothesis that each embryo has the power to develop all the characteristics of the species, together with a tendency to suppress certain ones in each sex.

A little thought will show that if there were no explanation of the transmission of latent sexual characteristics more simple than the hypothesis of a dual personality, this hypothesis would then be too simple, and would need to be made much more complicated.

The characteristics of the opposite sex are not the only ones which may be latent, and in cases of reversion a parent may transmit to children characteristics which were exhibited by neither parent nor grandparent, and which may have remained latent for many generations.

If we must assume the existence of a dual personality to account for the latent transmission of the characteristics of the grandparent of the opposite sex, we must assume still other personalities to account for reversion to more remote ancestors, and Darwin has not hesitated to carry the hypothesis to this, its logical conclusion.

He says (*Variation*, ii. 65), "Several authors have maintained that hybrids and mongrels include all the characteristics of both parents, not fused together but merely mingled in different proportions in different parts of the body; or, as Naudin has expressed it, a hybrid is a living mosaic work, in which the eye cannot distinguish the discordant elements, so completely are they intermingled. We can hardly doubt that, in a certain sense, this is true, as when we behold in a hybrid the elements of both species segregating themselves into segment in the same flower or fruit—by a process of self-attraction or self-affinity—this segregation taking place either by seminal or by bud propagation. Naudin further believes that the segregation of two specific elements or essences is eminently liable to occur in the male and female reproductive matter, and he thus explains the almost universal tendency to reversion in successive hybrid generations. . . . But it would, I suspect,

be more correct to say that the elements of both parent species exist in every hybrid in a double state, namely, blended together and completely separated."

In another place (*Variation*, ii. p. 80) he says: "On the doctrine of reversion, as given in this chapter, the germ becomes a far more marvellous object, for besides the visible changes to which it is subjected, we must believe that it is crowded with invisible characteristics, proper to both sexes, to both the right and left sides of the body, and to a long line of ancestors, male and female, separated by hundreds or even thousands of generations from the present time, and these characters, like those written on paper with invisible ink, all lie ready to be evolved under certain known or unknown conditions."

I shall discuss the phenomena of reversion somewhat at length in another place, and wish to simply call attention at present to the fact that here, as in the case of secondary sexual characters, we have a much simpler explanation in the hypothesis of arrest, and therefore do not need to call in an unknown factor, such as the multiple personality of each individual.

I think that the phenomena of alternation of generations favor this latter supposition even more than the facts of reversion.

The egg-embryo of a hydro-medusa may give rise by budding to an indefinite number of hydroids like itself, and each of these may give rise to other hydroids, and so on indefinitely.

Each one of these may also, under certain conditions, give rise to medusæ quite different from the hydroids and like the original medusa. As the medusæ which are thus produced inherit through a long series of hydra ancestors all the specific characteristics of the origi-

nal medusa, we are forced to conclude that each hydroid contains, in a latent state, the power to reproduce a definite specific medusa.

As the hydra and its medusa differ from each other very much more than a male and a female mammal, and have little in common except the general plan of their organization, there seems at first to be no escape from the conclusion that the medusa structure exists side by side with the hydra structure, in each hydroid, as a second personality.

I hope to show, in the chapter on asexual reproduction that alternation of generations is a secondary condition of things, and that it has been brought about by a modification of ordinary metamorphosis.

I think there is every reason to believe that at one time the hydra-larva which hatched from a medusa egg became metamorphosed, by a gradual change during growth, into a medusa.

If this were the case now, there would be no more reason for believing in a hydra personality and a medusa personality than there is for believing that a human child contains a distinct adult personality.

Now we can understand that if such a larva should give rise by budding to other hydroids like itself, they also would have the power to grow into mature medusæ. We can also understand that circumstances might arise to cause the later stages in the development of some of these hydra-larvæ to become latent. We should then have two generations—hydroids without a medusa stage, and hydroids with a medusa stage.

The suppression of the hydra features of the latter would then give us a generation of medusæ with no hydra stage, giving birth to a generation of hydroids with no medusa stage, and these in turn producing a

generation of medusæ with no hydra stage. We should then have a case of alternation like that which is presented by ordinary hydro-medusæ.

Summary of Chapter.

A careful review of the reasons which have induced various authors to believe that either sexual element may transmit any characteristic whatever, leads to the conclusion that its truth is not proven.

It is impossible to prove it by the phenomena of crossing, since the only animals which can be made to cross are essentially alike, and differ only in minor points.

The homology between the ovum and the male cell is no reason for supposing that their functions are similar, and the differences between them should lead us to believe that their functions are not alike.

There is no reason for assuming that each sex transmits its entire organization to the offspring, in order to account for the latent transmission of secondary sexual characteristics, since this transmission can be more simply explained by assuming that each embryo inherits but does not necessarily develop all the characteristics of its species.

Reversion and alternation of generations admit of a similar explanation.

We may therefore conclude that there is and can be no proof that each sexual element transmits all the characteristics of the parent, and that there is no *a priori* absurdity in the hypothesis that the male and female reproductive elements are unlike in function, and are specialized in different directions.

We can therefore enter without prejudice into an examination of the evidence for this latter view.