

Andalusian fowl has never bred true—*i.e.*, when a blue pullet was mated with a blue cockerel, half only of the chicks are blue and the other half mongrels, but it has been found that by mating the mongrels, a black one and a splashed white one, in every instance the chicks were blue. This again brings us back to the segregation of the characters in the gametes—the germ cells. Into that I fear I cannot enter.

Some may say all this intense experimenting and observation is very interesting and doubtless fascinating to those who are engaged in it, but it does not appeal to us. I know it does not appeal to everyone any more than the finest works of art do, but its usefulness is undoubted. The laws underlying plant life are applicable in most instances to animal life, and the laws underlying animal life are applicable in most instances to human life. Thus we ascend the scale from the lowest to the highest, and the solution of many social problems may become as much the work of the Scientist as of the Statesman.

ABSTRACT OF PAPER ON THE MENDELIAN LAW AND THE THEORY EXPLANATORY OF IT.

BY DR. A. J. HALL.

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We all know that throughout a large portion of the animal and vegetable kingdoms the new individual comes into being by means of the union of two unicellular bodies called germ cells or gametes.

The fertilised ovum, or zygote as it is called, which results from the coalescence of the two (the male and female) gametes is still a unicellular organism, and is the first stage of the new individual.

If the gametes are typical specimens of the species to which they belong, the new individual is exactly the same as its parents, and in due course will produce gametes exactly the same as those which gave it birth.

All this is true when there is no "variation" in the species under consideration. But we know that in many species there is variation—there are varieties—and this brings us into the region of Mendelism.

We know that most plants are hermaphrodite, bearing male and female organs on the same flower, and that as a rule they are cross-fertilised by means of insects. In the latter

respect the common edible pea is an exception. By the arrangement of its petals it is protected from visits by insects, and it is generally self-fertilised. Mendel and his followers, therefore, found the pea specially suitable for experiments in artificial cross-fertilisation.

There are "tall" varieties of the edible pea, and there are "dwarf" varieties, each of which breed true. Mendel (and many others since his time) artificially cross-fertilised a tall pea and a dwarf one, with the result that the whole of the members of the first filial generation, though hybrids, were all tall, and indistinguishable from the tall parent.

Each hybrid when allowed to self-fertilise produced seeds which, when sown, gave plants in the proportion of 3 tall to 1 dwarf. This is the second filial generation. It was further found that when the seeds of each of the members of F_2 were sown in separate plots, the whole of the dwarfs bred true, and one-third of the tall plants bred true, while the remaining two-thirds of the tall ones produced plants in the proportion of three tall to one dwarf, and so on in all subsequent generations. This, then, is the great law of heredity which Mendel demonstrated to be true, and it, together with the theory advanced to explain it, have excited great interest among all students of Natural History.

The gametes or germ cells which form the connecting links between the successive generations in a pure species have, of course, the power within them of transmitting *all* the characteristics of the species. The gametes of tall peas have, among other characteristics, "tallness" in their nature, those of dwarf peas, "dwarfness." The theory adopted to explain the Mendelian law is that a hybrid produces gametes of two kinds—one kind corresponding to the gametes of its one parent, and the other kind corresponding to those of the other parent; and that these two kinds are produced *in equal numbers*.

This hypothesis satisfies most of the facts which Mendel's

discovery brought to light, and its adoption is associated with two general principles.

I. The doctrine of unit characters or allelomorphic (one or other) pairs of characteristics.

II. The theory of gametic purity.

To illustrate, let us go back to the hybrid pea. The parents of our hybrid had many characteristics in common. The difference between them consisted in that the one parent had "tallness" and the other had "dwarfness." The hybrid itself, no doubt, had "dwarfness" in its being, but this was not manifest in its appearance. It appeared altogether as a tall pea. Of this allelomorphic pair of characteristics "tallness" is said to be the dominant one, and "dwarfness" the recessive one. The "dwarfness" though it recedes or is recessive in this generation, is not altogether lost, for it appears in F_2 in all the purity of the original dwarf parent.

The fact of dominance is indisputable. Its nature and extent is still a matter of uncertainty. Dominance is the one fact in the Mendelian discovery which the Mendelian hypothesis does not quite explain.

Dominance is, as a rule, absolute, but, as we shall see later on, is not always so.

Again, the Mendelian hypothesis involves the idea of gametic purity. You may have a hybrid individual, but you cannot have a hybrid gamete. Tallness and dwarfness may be represented in the same plant or seed, but cannot both be represented in the same gamete.

With the view of clearly demonstrating the facts and theory of Mendelism, Professor Bateman, of Cambridge, hit on the idea of using draughtsmen, black and white, to represent the dominant and recessive gametes respectively. A pure dominant zygote is represented by one black man on the

MENDEL'S LAWS OF HEREDITY.

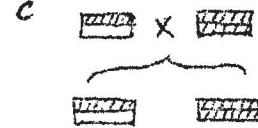
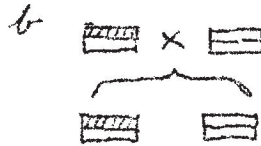
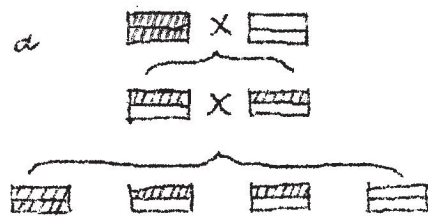
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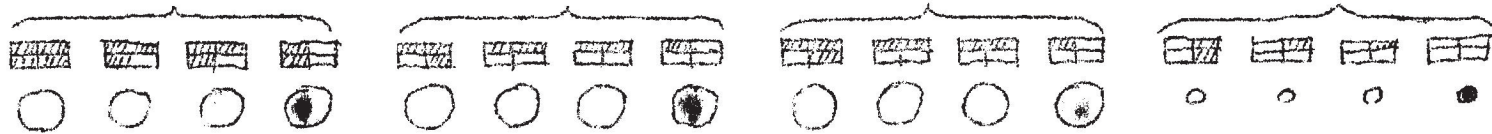
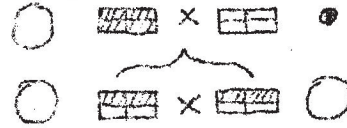
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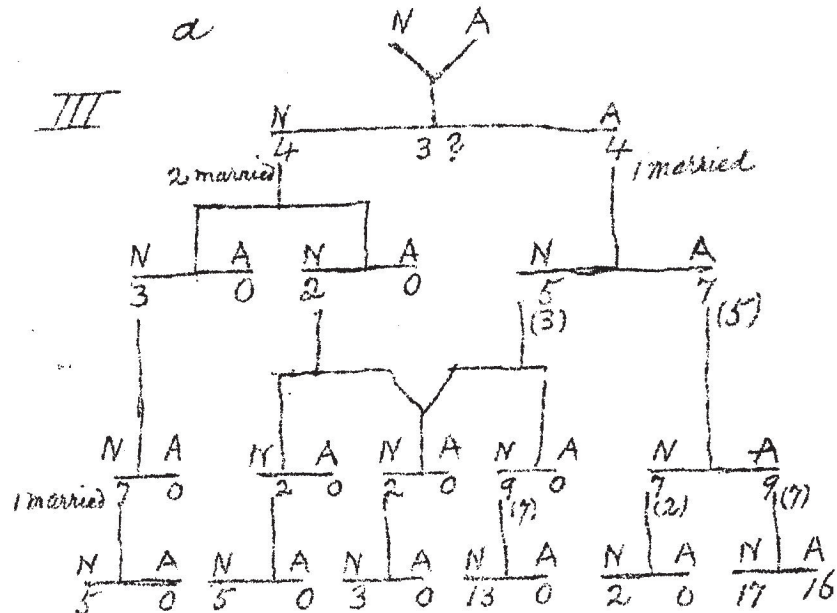
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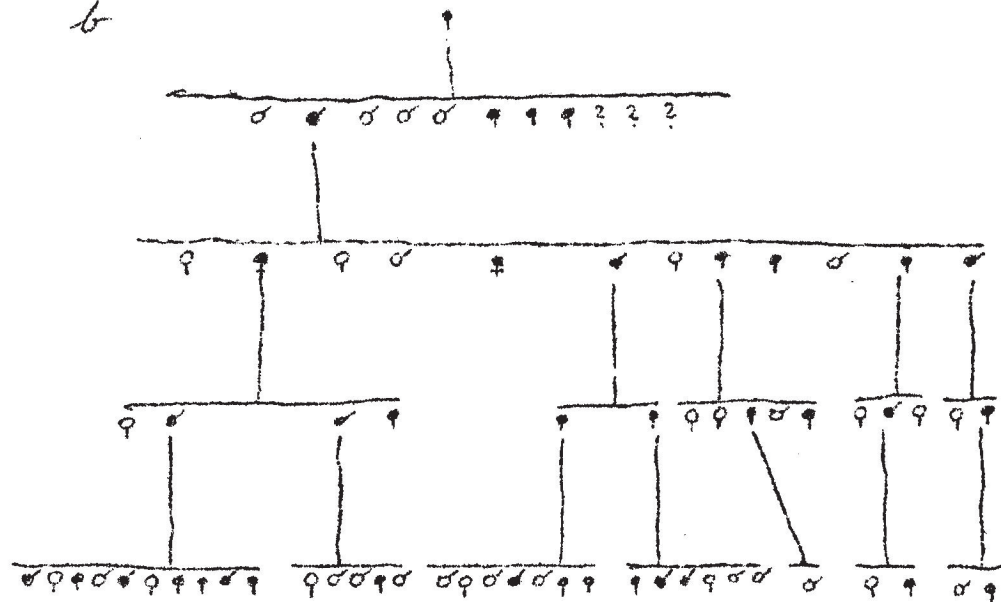
Dihybridism.



III



b



If you care to put it to the test you can do so in this way. Take two bags, each containing two black draughtsmen and two white ones, eight in all. The one bag may be considered to contain pollen grains and the other ovules. Take one man out of each bag and place the two together as a pair. Continue doing this until the four pairs are lying side by side. In the great majority of cases the pairs are found to be in agreement with the law of Mendel. In those cases where they do not come out right the errors correct each other. When once this law regulating the crossing of pure dominant with pure recessive is appreciated, all the others, including that of dihybridism, are readily accepted.

We have seen that this Mendelian principle holds good in the case of peas. As a matter of fact it obtains over a large portion of the animal and vegetable kingdoms—wherever there are well marked varieties in species.

In the case of rabbits and mice albinism has been found to be a recessive characteristic to the natural brown colour. In fowls the high serrated comb of the Spanish breed is recessive towards the “rose” comb of Hamburgs, &c.

In the human family blue eyes are said to be recessive to brown and other eyes not blue. If this last observation be correct we should be unable to point to a child having brown eyes, both parents having their eyes blue. And again, where one parent has brown eyes and the other blue, the children having brown eyes and those having blue are generally about equal in number. *Vide* Diagram I., Table 2.

Sometimes a characteristic which differentiates a variety is an abnormality, and such abnormality is in some cases recessive, in others dominant. The abnormality of the inner ear which is the cause of the “waltzing” in the case of the Japanese waltzing mice is found to be recessive to the normal type of mouse.

Diagram No. III. illustrates an interesting case of an abnormality in the human family, showing itself as a *dominant*

character. It is the case of a family in Pennsylvania, described by Farabee. The abnormality consisted in the affected members having only two instead of three phalanges on each finger and toe. None of the unaffected members of the family transmitted the peculiarity: they were recessive and bred true. The affected members who married all transmitted the peculiarity, and the children of the abnormal parents were nearly equally divided—33 normals and 36 abnormals.

Dominance: its limitations. Dominance is generally perfect, the hybrid being indistinguishable from its dominant parent. There are, however, exceptions in which the hybrid is slightly different from the pure dominant parent and can be easily recognised as a hybrid. Besides these, there is at least one case where the hybrid is very decidedly different from both dominant and recessive parents.

Diagram No. IV. illustrates the case of the blue Andalusian fowl. These fowls, when carefully selected and bred, give as progeny $\frac{1}{4}$ black, $\frac{1}{4}$ white, and $\frac{1}{2}$ blue. The black and white bred together give all blue. The black and white are the pure breeds and the blue is the hybrid. These facts correspond with the theory of gametic purity.

Such cases as this must have been very confusing at first, and show us how much we owe to the pioneers in this branch of knowledge.

Dihybridism: Diagram No. II. shows the law of heredity, which determines the progeny of two parents which differ from each other in respect of two pairs of characteristics. We saw that in the pea, tall varieties are dominant towards dwarf ones. It is also true that yellow seeded varieties are dominant towards green seeded ones. The diagram illustrates the result of crossing a tall yellow seeded pea with a dwarf, green seeded one. In the first filial generation all the individuals, though hybrid, appear like the dominant parent. In the second filial generation, of the 16

groups, nine show both dominants, and one of the nine breeds true; three show one dominant, and one of the three breeds true; three show the other dominant, and one of the three breeds true; while one shows neither dominant: it is therefore pure recessive, and of course breeds true.

We have thus not only individuals exactly the same as the original parents (strengthened no doubt by the cross-breeding), but we have also two new varieties, a tall green seeded pea and a dwarf yellow seeded one, each of which breeds true.

The effect which Mendel's discovery may have on the possibility of holding the older views concerning the origin of species, is a subject of great interest, but time does not permit us at present to enter on it. To us, however, it appears there is nothing in this new knowledge which calls upon us to give up the belief that species may acquire and transmit new characteristics under the stimulating influence of successive changes of environment.