which there may be some true exceptions) and will be of assistance in predicting dominance.

Finally, one must refer to the cases lately brought forward seeming to show that the germ cells may be directly affected by environment so as permanently to modify the strain. In the experiments of McDougal and Tower the variations produced by external agents affecting the germ cells have been transmitted to following generations. The continuation of such investigations is a great desideratum.

COLOR FACTORS IN MAMMALS.

By Prof. W. J. Spillman, *Washington, D. C.*

The following table displays the color factors in coat coverings of animals that have been demonstrated in different species of mammals arranged in such a way as to indicate their probable relation. These relations are not all definitely made out for all the species, but where they have been made out they indicate relations as shown in the table. This arrangement is merely a suggestion, and is intended to furnish investigators with a suggestion that may help to unravel the inheritance of color characters:

Color factors in Mammals.

Investigator.	Species.	Chromosomes producing black.			Chromosomes producing red or yellow.	Chromosomes producing white.	Chromosomes carrying control factor.	Activating factor.
Castle	Rabbits.	Black.	Dilute black.	Trace of black.	Yellow.	....	Present.	Present or absent.
do.	Guinea pigs	do.	....	....	Yellow and chocolate	....	do.	do.
do.	Mice.	do.	....	....	do.	....	do.	do.
do.	Wild rats.	do.	....	....	Yellow.	....	do.	Present.
Spillman.	Swine.	do.	....	Trace of blk.(?)	Red (dark and light)	Present (?)	do.	do.
do.	Cattle.	do.	....	....	Red or yellow.	do.	do.	do.
Hurst.	Horses.	do.	....	....	do.	do.	do.	Present or absent.
....	Man.	do.	....	....	Red.	....	Absent.	do.

This table indicates four, or possibly five, groups of color characters which may be transmitted independently of each other. It is suggested that the three forms of black found by Castle in rabbits and the two forms found by the writer and Mr. Q. I. Simpson in swine may be the result of the gradual disappearance of the black pigment-producing function, and therefore allelomorphic to each other. It is further suggested that the various shades of red and yellow, which in swine at least are transmitted independently of black and are apparently not allelomorphic to black, may have resulted in a similar manner by gradual change of the red pigment-producing function. In certain species of animals white is a positive character. In swine there is without question two distinct white characters, though whether they are allelomorphic is not yet determined. One of them is dominant to all the colored pigments while the other is not. On the chromosome theory we may explain the relation suggested in the table as follows: A certain group of chromosomes is responsible for the black pigment. When the function is well developed the color is strong. In a part of this set of chromosomes the pigment-producing function is weakened or perhaps entirely lost, thus giving rise to a dilute black and traces of black found by Castle in rabbits, and to the black specks or spots which occasionally occur in all non-black breeds of swine.

Another group of chromosomes is responsible for the production of red pigment. In swine there are two distinct types of this red pigment, viz., dark and light, the light being dominant to the dark. It is suggested that the yellow and chocolate colors may be due to the modification of the red pigment-producing function of certain of these chromosomes. In swine one of the white characters behaves as if it were allelomorphic to red or yellow, thus indicating that the white color in certain breeds of swine may be due to another modification in a portion of the set of chromosomes which determines red pigment.

Another set of chromosomes furnishes the control factor. When black and yellow pigment are both present with this control factor the two pigments are so distributed in the hair as to give the wild gray color which is so common amongst mammals. In some cases it is possible that this control factor is compound, more than one set of chromosomes being concerned in it.

Another set of chromosomes determine the activating factor, and cooperate with the sets producing colored pigment. If this activating function be lost no pigment is produced, and we have albinism. Albinos may therefore carry the black and yellow pigment-producing function, and in fact it has been demonstrated that some albinos do this, the lack of the activating factor rendering the function useless.

The evident similarity in the color factors of different mammals cannot be considered other than striking, and indicates that the functions of the chromosomes concerned have been inherited from very remote ancestors. The control factor is of more than ordinary interest. This seems to correspond to a set of chromosomes which have nothing to do with the production of color pigment, but which control the distribution of pigment in the hair. When both the black and yellow pigment are present together and this control factor is present we get the wild gray color due to the peculiar grouping of the yellow and black pigments in the hair. It is very evident in the wild boar of Europe, in some breeds of cattle (some Jerseys at least are mouse-colored), and occasionally one sees a horse in which this control factor seems to be present, though usually apparently in a weakened condition. In man it seems to have been entirely lost.

If the chromosomes which are responsible for the black pigment fail to function in such manner as to produce the pigment, we then get the yellow or red animal. A black animal may or may not have yellow pigment. If the control factor is absent, then black and yellow are so distributed as to obscure the yellow, resulting in black. Investigation indicates that every one of the sets of chromosomes corresponding to the various columns in the table represents a group in which part of the chromosomes, considering the species as a whole, fail to perform their function properly. When the black fails we have yellow; when the yellow fails we have black. When the control factor fails, wild gray color is converted into black. When the activating factor fails we have albinism.

MENDELIAN PHENOMENA AND DISCONTINUOUS VARIATION.

By PROF. W. J. SPILLMAN, *Washington, D. C.*

Some of our leading investigators of Mendelian phenomena have found in the separation of the members of a character pair what to them seems to be a strong confirmation of the DeVriesian idea of discontinuous variation. A pair of distinct characters are brought together in a hybrid and then separate unaffected by this association; hence they argue, there are no intermediate types between these characters, and one of them must therefore have arisen suddenly from the other.

In these days the fact that types intermediate between two species do not exist is no argument that such types never existed. We look for such intermediate types in the ancestry of the species. Similarly, we should expect to find the forms intermediate between the members of a character pair in the ancestry of the pair; and there is just as much probability of the disappearance of intermediate types between hereditary characters as there is between species, and in exactly the same manner.

Recent investigations render it probable that the so-called discontinuous variation is due, in some cases, to the ordinary phenomena of recombination of hereditary characters occurring in the second and later generations of a hybrid. In other cases it seems to be due to irregularities in cell divison in which chromosomes are lost or gained. If either of these causes is responsible for this phenomenon, then discontinuous variation is only an artifact, and there is no necessity for assuming that the variation, which appears to be discontinuous, is caused by any sudden change in real hereditary characters. It is due rather to new combinations of these characters, and the characters themselves may change either slowly or rapidly, so far as observed phenomena indicate.