Creating New Animals and Plants

Mendelism and the Farm

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IN the practical affairs of life practice usually precedes science frequently by many years. Then the scientist discovers the principles which underlie practice, and thus enables us to improve on former practice. Much improvement in domesticated animals and considerable improvement in farm crops was made before we discovered any of the fundamental principles involved. Important discoveries in this line began about twelve years ago. It is true the most important of all these discoveries was published in 1865, but it was in advance of its time and was forgotten until rediscovered by several men about 1899 to 1901. The art of breeding, both of farm crops and of farm animals, may now be said to be an applied science. The principles which have been discovered will be stated here in the briefest possible form.

SELECTION.

The old method of improving crops and animals was by selecting the best individuals for breeding purposes. It was thought that this produced actual improvement in the individuals selected. We now know, however, that it does not do this, but it does eliminate inferior strains and thus raises the general level of excellence of the breed. Much improvement has been made in varieties of wheat, potatoes, corn, and in all of our improved breeds of farm animals by selection without any attempt at cross breeding of different varieties. But it must be remembered that the improvements thus made can accomplish only the segregation of the best individuals or combinations of characters existing in the population with which we began the selection; it cannot produce any improvement beyond that point.

It frequently occurs that two different varieties or breeds, each possessing excellences and defects, can be crossed and a new variety or breed made combining the excellences and eliminating the defects of the breeds or varieties used in the cross. It is only during the past dozen years that this has been known, and the reason for it understood. It is true that

Gregor Mendel discovered this principle and published it in 1865, so that it is now known as Mendel's law; but no practical use was made of it until it was rediscovered a third of a century later.

There are three important principles involved in Mendel's law. The first is the principle of dominance. Figs. 8 and 6 illustrate this principle. In Fig. 8 a bearded wheat with lax heads, shown at the right, was crossed with a beardless Club wheat, shown at the left. The hybrid, which is shown between its parents, has a Club head and no beards. Characters which show in a hybrid while their opposites do not show are said to be dominant, and the characters which do not show in a hybrid, although present, are said to be recessive. In Fig. 6 a polled, or hornless, animal is shown. One of its parents had horns, the other did not. It is seen that the poll character is dominant and the horn character recessive. This principle is of great importance, especially in producing new varieties of potatoes, fruits, etc., which are propagated by cuttings. A hybrid, when it reproduces from seed, does not reproduce true to type; but when reproduced from cuttings, it reproduces perfectly true to the type of the hybrid.

SECOND GENERATION OF BROWN X BLUE EYES.

Br=Brown; Bl=Blue.

1. Br fr. F. and Br fr. M.=BrBr.
2. Br fr. F. and Bl fr. M.=BrBl.
3. Bl fr. F. and Br fr. M.=BrBl.
4. Bl fr. F. and Bl fr. M.=BlBl.

The second principle is that known as the law of segregation. Referring to the animal shown in Fig. 6, which is a hybrid between a horned and a polled breed, according to the law of segregation, this animal will transmit the horn character to half its offspring and the poll character to the other half.

The third and most important principle which Mendel discovered is known as the law of recombination. It is a result of the law of segregation and the further fact that each pair of characters segregates

without any reference to any other pair. According to the law of recombination, the second generation of a hybrid, if sufficiently numerous, will present every possible combination of the characters of the original parents. The foregoing table shows this law in the case of eye color in human beings. Both parents in this family: (1) Those inheriting brown eyes brown eyes and blue eyes. Brown eyes being dominant over blue eyes, these parents are both brown-eyed. There are four classes of children which may appear in this family: (1) those inheriting brown eyes from both parents; these will be pure brown-eyed; (2) those inheriting brown eyes from the father and blue eyes from the mother; (3) those inheriting blue eyes from the father and brown eyes from the mother; these two classes will be alike and like the parents; (4) those inheriting blue eyes from both parents, and they will be the only blue-eyed children in the family. Thus in such a family, on the average of a large number of cases, one fourth of the children will be blue-eyed.

APPLICATION OF MENDEL'S LAW.

Many important applications of the principles above enunciated have been made in producing new varieties of farm crops and new breeds of animals. Many other applications can be made.

New Varieties of Wheat.—Eastern Washington, eastern Oregon, and northern Idaho is one of the great wheat-growing regions of the world. The farmers in that section in the early day tried every variety of wheat known in order to find varieties adapted to their conditions. In the vicinity of Pullman, Wash., where the State Experiment Station is located, up to 1899 the farmers had found only one variety that was satisfactory, and it had some serious faults. The difficulty with practically all the varieties tried, except this one, was that the straw was weak, and when a rain storm came after the wheat had grown up in the spring it would blow down. Again, except this one variety, when the grain got ripe the chaff would

Fig. 1.—Brahmin bull owned by Georgia experiment station and used in producing immunity to Texas fever in southern cattle.

Fig. 2.—Hybrid steers produced by crossing Short Horns and Herefords. These hybrid animals make better feeders than pure breeds.

ANIMALS AND PLANTS MADE TO ORDER

spread apart and let a great deal of the grain fall out, especially if the weather was windy. But the Little Club variety would stand up and hold its grain for a month or more after it was ripe. It has been found in that country that when wheat is sown in the fall, if it goes through the winter without injury, it will yield 50 per cent more than if sown in the spring. Hence although the Little Club is a spring variety it was nearly always sown in the fall. On an average of about every third year it would freeze out and have to be resown in the spring. The farmers insistently demanded a winter wheat that would stand up and hold its grain. The writer was at that time Agriculturist to the State Experiment Sta-

tion of Washington, and attempted to find a winter wheat of this character. Hundreds of varieties were obtained from all over the world, but none of them would stand up and hold its grain. At that time Mendel's law was not known, but in the hope of producing a combination of the good characters of some of the best winter wheats and the Little Club spring wheat numerous crosses were made. Fig. 3 shows Prof. E. E. Elliott, who was at that time the writer's assistant and who later succeeded him at the Washington Station, making the crosses in the field. He is here transferring the pollen from one variety of wheat to the stigmas of another variety. The first generation hybrids were harvested in the summer of

1900. The seed of each hybrid plant was kept separate and sown by itself in the fall of 1900. While these wheats were heading out the next year, the writer discovered the law of recombination. He found that in every row every possible recombination of the old parent characters was present. For instance, Fig. 10 shows the Valley and Little Club varieties six first generation hybrids of these two varieties, and the types which each of these six hybrids produced in the second generation. At the top of the figure the small head at the left is the Little Club variety, the next is the Valley. The left half of the picture shows the results when pollen

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Fig. 3.—Hybridizing wheat. Transferring pollen of one variety to the stigmas of another.

Fig. 4.—A Holstein bull. Note the characteristic white stripe over the hips and just behind the shoulders, which frequently occurs in this breed.

Fig. 5.—A pure polled animal of the Hereford type produced by the application of Mendel's law of recombination.

Fig. 6.—A cross-bred animal having a horned dam and a polled or hornless sire, illustrating dominance of poll character.

Fig. 7.—A Hampshire pig, showing the white belt which is characteristic of this breed. Breeders have not been able to fix this belt.

Fig. 8.—Hybrid between Valley and Little Club. The Valley type is shown at the right, the Little Club at the left, the hybrid in the middle.

Fig. 9.—Hogget wool, worth three or four times the price of ordinary wool.

Fig. 10.—Parents and first and second generation hybrids of wheat produced at the Washington State experiment station. In this cross valuable new varieties of wheat were produced.

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Longer Piers for the Port of New York

(Continued from page 158.)

that the city of New York seeks no extension which will be unfair to New Jersey interests, and asks that the establishment of the pierhead lines on both sides of the river shall now be given consideration.

As regards the third objection, I would respectfully submit the following points:

1. The fairway opposite the Chelsea district is now 2,750 feet wide between pierhead lines. The extension asked for will reduce this to 2,650 feet, a width greatly in excess of that of the fairway at other important ports; thus, at Antwerp abreast the port the river is 2,000 feet wide, and in some turns of the river only 1,000; at Hamburg the river is 1,200 feet wide, and at Rotterdam 1,200; at Liverpool, 2,000 to 2,400; the Thames at the Tilbury Docks is approximately 1,600 feet wide, and at London, in some parts of the London docks, where large steamers continually go, the width of the river is reduced to 600 feet. It is also to be noted that the Hudson fairway is nearly straight in comparison with the tortuous channels existing at many of the ports noted.

2. Sailing vessels, river boats and lighters have almost disappeared from the harbor waters. Traffic is now generally moved under steam, and is consequently under better control than formerly.

3. Twin screw steamers of modern construction can turn and maneuver in much shorter distances than heretofore.

4. If need be, the movement of traffic can be placed under greater police restriction than at present; although this does not now seem necessary.

5. The Ambrose channel has been dug at great expense by the Federal authorities and should be availed of to bring vessels of a length proportionate to their draught to Manhattan.

6. The Panama Canal locks are being constructed for vessels 1,000 feet in length, and accommodations for this class of vessels should be provided.

7. In the Chelsea district it will be impracticable to secure greater pier lengths by excavation inshore on account of the prohibitive cost of such undertaking, and the fact that a marginal elevated freight railway is being planned, the alignment of which will be prejudiced by the sharp turns made necessary by such a radical change in the city street plan. Again, the city has just finished the construction of the new Chelsea piers, the finest and largest of their kind in the world, at a cost of about \$24,000,000, and any rearrangement at this time will be most unfortunate.

8. The steamship companies occupying the Chelsea piers have leased them for long periods of time, and the city cannot relieve them from these engagements without serious disarrangement to its finances, since it is depending upon the capitalization value of revenues derived from leases for additional waterfront improvements.

9. I would venture the suggestion, subject to the opinion of the New Jersey authorities, that an extension of the pierhead line of Castle Point, opposite the Chelsea district, is not urgent or desirable, since it is the jutting point of the New Jersey shore and better opportunities for extension exist both above and below that point.

10. A slight turn in the river at this point tends to deflect the lines of traffic both up and down stream toward the New Jersey and away from the Manhattan shore.

11. The Department of Docks has prepared and will soon submit its report for a better system of railroad terminals for the west side of Manhattan. In a general way this report recommends that the present system of daily storage of car float terminals along the river front be so changed that railroad cars shall be

loaded and unloaded at terminals on the east side of the marginal way, thus restoring the waterfront to marine commerce. If the policy recommended is to be adopted, it will ultimately be possible to build long piers for long ships at many points, which will be to the advantage of the port's commerce. The greatest sea port of the world should be able to berth the greatest ships to their and its greatest advantage.

I submit herewith:

(a) Cross section of the river opposite the Chelsea piers as modified by inshore excavations on the Manhattan side.

(b) Sketch showing additional length of piers in this vicinity.

(c) General plan of proposed pierhead line extension along the west side of Manhattan from the Battery to 99th Street.

(d) Sketch of Cunard and White Star piers in the Chelsea district, together with models of steamers "Baltic," "Olympic," and of proposed new Cunard ship.

In conclusion, I will again state that New York city submits no partisan plea and desires to reach a decision which shall be fair for New Jersey as for New York interests, and which shall not prejudice the future utility of its harbor.

Creating New Kinds of Animals and Plants

(Continued from page 165.)

from the Little Club was used on stigmas from the Valley. The right half of the picture shows the results when pollen was used from Valley on the stigmas of the Little Club. In each case the results are seen to be the same. The three short heads shown at the extreme left of the picture are three first generation hybrids. It is seen that they are all alike and very much like the Little Club. To the right of each of these three heads are seen the six types, which could be distinguished by inspection, produced by each of these first generation hybrids. One type is seen to be long and bearded; another long and beardless; another of intermediate length and bearded; a fourth of intermediate length without beards; the fifth bearded Club, and the sixth beardless Club. The two intermediate lengths are hybrids between long and short heads. The same types are seen to appear in every case in the second generation. For instance, in the cross between Valley and Little Club there were some plants with lax bearded heads, other plants had lax beardless heads, others bearded Club heads, while still others had beardless Club heads. It was found later that some of all these types were winter wheat, some spring wheat, and some hybrid between winter and spring wheat. In every one of the crosses made, the combination of good characters sought for actually occurred, and several new varieties of wheat were produced which combined the winter hardiness of the winter wheats with the stiff straw and the tightly closed chaff of the spring wheat. In due time the pure types of the kind desired were selected out of these hybrids, tested for yielding power, and finally, in the fall of 1907, distributed to the farmers of eastern Washington. These hardy hybrid wheats are now grown very generally in that region and are producing yields very much larger than the old Little Club produced. Not only that, but the quality of the grain is better, and the hybrid wheats sell for two or three cents a bushel more than the old Club wheat.

I have already referred to the fact that a new breed of cattle has been produced by the deliberate application of Mendel's law of recombination. Fig. 5 is a picture of a very fine animal produced in this way. Originally the Polled Durham was crossed with the Hereford. After several generations pure polled cattle were produced that had the red color and the white face of the Hereford breed, and a registry associa-

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tion—in fact, two of them—has been started for registering Polled Herefords. I have already stated that it is not always possible, by inspection, to distinguish between an animal which is a pure poll and one which is a hybrid between the polled and the horned. Frequently the hybrids have no sign of a horn.

But there is a way of distinguishing these hybrids from pure polls, especially in the case of the males. It is as follows: Breed the male to a dozen horned cows. If he is hybrid, the chances are that he will transmit the horns to half his offspring. These, receiving horns from the dam also, will be pure horned animals. If, however, the animal is pure polled, he will transmit the poll character to all his progeny, but since the hybrid between the polled and horned never has perfect horns, none of these calves will have perfect horns, no matter what his dam is. But since it is an even chance whether a hybrid of this kind will transmit horns or the poll character to a given offspring, it is possible that a hybrid might get twelve polled calves from twelve horned cows. The chance, however, that this will occur is only one in more than four thousand cases. Hence a breeder who has thus tested a young bull is safe in guaranteeing that none of his calves will have perfect horns, no matter what the dam may be. He will have to make good this guarantee once in 4,096 times. Breeders of Polled Herefords now frequently test young bulls in the manner above described, then sell them at high prices under a guarantee that all their calves will be polls, or at least have only scurs.

It is a comparatively easy matter to produce any desired breed of animals or any desired variety of plants when the various characters desired can be found scattered in breeds or varieties that can be cross bred. Application of these principles in producing new breeds and varieties have thus far not been very numerous because the principles are new, but they are being used now more largely than in the past, and will undoubtedly play an important part in the improvements of farm crops and farm animals in the future. In fact, the same principles can be applied in improving the human race, and they are now being applied in a rough way in several States.

VIGOR OF HYBRIDS.

Another important principle which is frequently made use of by farmers is the fact that generally speaking hybrids are more vigorous than pure-bred plants or animals. Fig. 2 is a photograph of some steers which are hybrids between Short Horns and Herefords. They have the characteristics white face of the Hereford, but the spots of red in the face show the hybrid origin. Mr. Wallace Huidekoper, of North Dakota, who furnished this photograph, produces many such hybrids for feeding purposes, and states that they feed better and make better beef animals than the pure breeds. This principle is frequently applied by hog breeders to produce feeders; but on account of the law of recombination of characters, these hybrid animals do not reproduce true to type and hence are not good for breeding purposes.

Our knowledge of the law of recombination enables us to get rid of undesirable characters which occasionally crop out in breeds of animals. For instance, in all of the polled (that is, hornless) breeds occasionally horned individuals are born. We know now that this can occur only when both of the parents of the horned calf are hybrid with reference to horns. This shows that there is still, in all these breeds, a small percentage of animals that have horns latent in them. When two such animals are mated the chances are that one-fourth of the calves will be horned. Knowing the

cause of the appearance of horns in these breeds, we are in position to avoid them by eliminating both the sire and the dam of such calves whenever they occur. In this way the proportion of horned calves born in the polled breeds is gradually decreasing, until now they are very rare indeed in some breeds.

In all black breeds of cattle there are occasionally red calves born. This is due to the fact that there is, in such breeds, a small percentage of animals that are hybrid between red and black. When these are mated, one-fourth of the calves are red. The undesirable red can be eliminated from the breed only by destroying both the sire and the dam of every red calf born.

Dr. Pearl, of the Maine Experiment Station, has recently shown that high egg-laying capacity in hens is transmitted as a Mendelian character. This is a matter of very great importance, and will undoubtedly result in great improvement in all of our breeds of chickens.

Another interesting application of Mendelian principles is seen in the cross between Brahmin cattle and our common cattle which is being made on a large scale in our Southern States, especially Texas. Fig. 1 is the photograph of a Brahmin bull owned by the Georgia Experiment Station. The most important characteristic of these cattle is the fact that the Texas fever tick does not molest them. This immunity from the tick, and consequently from Texas fever, is a dominant character, so that the hybrids between Brahmin cattle and our common cattle are immune to Texas fever.

Mr. A. P. Borden, who is one of the prominent breeders of these hybrid cattle, informs the writer that because of this immunity from ticks the calves of this breed are much larger at weaning time than our ordinary calves, and sell regularly for fifty per cent more on account of their size and thrift. Mr. Borden recently imported from India a large number of these Brahmin cattle, and several breeders are now engaged in distributing this blood among southern cattle.

Fig. 7 illustrates a mistake that breeders of animals sometimes make. This shows a pig of the Hampshire breed, which has a white stripe over its shoulders. This white stripe is an exceedingly variable character, and it is exceedingly difficult to breed these pigs true to type. This white marking is a character which has no economic value, and in order to breed it pure it is necessary sometimes to use animals for breeding purpose that are not of good quality.

Fig. 4 shows a similar mistake with a breed of cattle. It will be noticed that this animal has a white stripe over the hips and another just behind the shoulders. A few breeders insist that their cattle shall have these white stripes. They are of no economic value, and the attempt to establish such a character is certain to react on the economic value of the breed.

Fig. 9 shows a sample of what is known as hogget wool. This sample was taken from one of two fleeces found in a large quantity of wool bought by a country buyer in Michigan. It sold for ninety cents a pound, while the other fleeces sold for about twenty cents. The peculiar wavy character of this sample is the characteristic which makes it so valuable. We have not yet been able to locate the herd of sheep from which this sample came. If we could locate it, and the waviness of the wool should prove to be a Mendelian character, it would be a very easy matter to spread it over any or all the breeds of sheep in this country, since we know now the principles which must be applied to do this.

While Mendelian principles are new and have therefore not yet been widely applied, it is easily seen that there is room for enormous improvement in plants and animals by means of these scientific principles.

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Two weeks' writing with a sure and safe pen without dip, skip, blot or blemish. Think of such convenience!

A perfectly simple pen which is easily filled. All that you need to know about a fountain pen is that it is a Waterman's Ideal. That is our guarantee to both you and your dealer. The Spoon Feed and Clip-Cap are necessary for perfection.

Self-Filling Style

The self-filling Waterman's Ideals are made to fill by suction direct from the ink bottle. This style has become a favorite among many classes of busy writers owing to the convenience of the inner filling device.

To fill this Pen it is necessary only, to draw back the snug fitting collar, dip pen point in ink, press bar, release pressure, and the tube is filled. The entire Pen may be instantly cleaned in the same manner, using cold water. Every style Waterman's Ideal was a success from the start. Write for booklet

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