

FRIDAY FORENOON, JANUARY 18—GENERAL SESSION.

The Association met with the Ohio agricultural societies in University Chapel at 10 o'clock, with Hon. A. P. Grout in the Chair. He announced that the first number on the program would be the report of the Committee on Animal Hybridizing, by Prof. W. J. Spillman, of the United States Department of Agriculture.

REPORT OF COMMITTEE ON ANIMAL HYBRIDIZING.

By Prof. W. J. SPILLMAN, *U. S. Department of Agriculture, Washington, D. C.*

The principal lines of work undertaken by this committee are as follows:

(1) The collection of known facts recorded in the literature of the subject relating to hybridization of our domesticated animals. Prof. F. B. Mumford, Columbia, Mo., has been appointed a sub-committee in charge of this work.

(2) Securing records of results of crossing by breeders in this country with a view to determining the laws governing the transmission of breed and other characters. With this end in view, the committee has prepared a set of breeding records which have already been placed in the hands of a number of breeders who are crossing domesticated breeds.

Cross breeding is going on all over the United States. The results, if accurately recorded, would enable us to unravel the inheritance of a large number of characters of greater or less importance. The first cross between two breeds shows which characters are dominant and which recessive, and which character pairs produce mosaics. By breeding the first cross together, and also by breeding the first cross to each of the parent forms, the unit characters are revealed. It is well known that hybrids are, generally speaking, much more vigorous than purebreds. If we understood the inheritance of all strictly breed characters we should have the possibility of the introduction of blood from other breeds without disturbing breed characters, thus securing the tremendous advantage which comes from cross breeding, while at the same time maintaining a breed type.

A number of breeders, whose work is known to the committee, have already secured highly important results. Mr. Q. I. Simpson, of Palmer, Ill., has made numerous crosses between the wild boar of Europe, Tamworths, Yorkshires, Poland Chinas, Duroc-Jerseys, and Chester White swine. These crosses have enabled us to determine a number of unit characters and their behavior in inheritance. Mr. Mossom Boyd, of Bobcaygeon, Canada, is crossing Buffaloes with Hereford and Aberdeen-Angus cattle. He has also crossed the Aberdeen-

Angus and the Hereford with a view to introducing into the Hereford breed the polled character of the Aberdeen-Angus, in which he has been highly successful. The Polled Herefords have proven to be of great vigor, and are highly popular with his patrons on the western ranges. Prof. W. J. Kennedy, of Ames, Iowa, is crossing Galloways with white Shorthorns. The first cross is a blue roan, and Prof. Kennedy has eleven of these animals. He has arranged to breed them to the two parent types, as well as to each other. This will render it possible to work out the laws of inheritance of a number of important breed characters. Some results are already at hand and are of great interest.

The record blanks prepared by this committee have been placed in the hands of these breeders and a number of others. The blanks are of two forms, one for individual animals and the other to be used in cases of crosses between breeds of hogs for litters. They are as follows:

BREEDING RECORD OF INDIVIDUAL ANIMAL.

Herd of..... *P. O.*..... *Herd No.*.....
Name..... *Sire*..... *Dam*.....
Reg. No...... *Reg. No.*..... *Reg. No.*.....
Date of Birth..... *Herd No.*..... *Herd No.*.....
Description.....

Date.	Animal Bred to—		Date of Delivery.	No.		Herd Numbers of Young.	Remarks.
	Name.	Herd No.		M.	F.		
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LITTER RECORD. *Herd of*..... *P. O.*..... *Litter No.*.....
Date of Birth..... *Sire*..... *Dam*.....
No. pigs born..... *Reg. No.*..... *Reg. No.*.....
No. pigs raised..... *Herd No.*..... *Herd No.*.....
Herd numbers of pigs.....

DESCRIPTION OF INDIVIDUALS.

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The work of collecting data of this kind from breeders has only just begun, but has already enabled your committee to work out a number of characters. Data thus far collected is decidedly fragmentary and cannot be regarded as scientifically accurate. Most of it relates to colors, the most obvious breed characters. With the system of records we have instituted we hope to get data on characters other than color.

These records may easily serve as a basis for registration of hybrid animals. Your committee would recommend that it be authorized to issue certificates of registration of hybrids on the basis of the records secured under the usual conditions for securing accuracy of data.

(3) Improvements of breeds by crossing. The study of the improvement of breeds of domestic animals by cross breeding involves a number of important considerations. The most important of all is the effect of the introduction of new blood on constitutional vigor. This committee is giving special attention to this phase of the question. Closely related thereto is the effect of inbreeding and line-breeding in reducing constitutional vigor.

In established breeds in this country it has long since ceased to be the custom to introduce new blood. While we are not ready to propose the introduction of new blood into established breeds in this country, there is no question that superior breeds can be produced in this manner. In this connection it is a matter of importance that we should learn the effect on breed characters of the introduction of new blood from different sources. As soon as we have worked out the inheritance of these characters we shall then know how to avoid serious difficulties of this kind. Already a good deal is known in this direction. For instance, we have learned how to introduce the polled character into horned breeds without otherwise visibly affecting the breeds, except to increase constitutional vigor by the out-cross. Definite rules of procedure in dehorning cattle by cross breeding have been formulated and were published in Volume II of the report of this Association.

Many years ago a few Brahmin cattle were introduced into Southern Texas. The crosses between these cattle and American cattle proved to be immune against the southern cattle tick. These crosses have increased in number, and are at the present time an important factor on the cattle ranges of Southern Texas. Calves with sufficient Brahmin blood to be immune from injury by ticks grow much more rapidly, and at weaning time are worth, on the average, 50 per cent more than other calves. There has been no opportunity to study the inheritance of immunity or other characters in this cross, but sufficient is known to justify the recommendation that other cattle of this kind should be imported.

Another character which could be introduced into some of our breeds of hogs with great advantage is prolificacy. There has been no opportunity to study the inheritance of this character. From what is known concerning other characters there seems to be little doubt that it could be introduced without materially disturbing any other breed character.

Another important result to be attained by knowledge of inheritance of various characters is the elimination of undesirable characters from established breeds. Methods are already worked out for doing this in some cases. A few characters of this kind may be mentioned. In the Aberdeen-Angus there is occasionally produced a red animal; also occasionally one with horns. These characters have been so nearly eliminated that they are of little importance at the present time, but

it is practically established that, whenever these characters outcrop in this breed, both of the parents carry the characters, and neither of them should be used again for breeding purposes.

Horns appear occasionally in practically all polled breeds. When they do appear both parents contain this character in a hidden form, and neither of them should be used for further breeding.

Black sheep appear in flocks in exactly the same manner as horns do in polled breeds, and for the same reason. If it is desired to eliminate them entirely, both parents of a black lamb must be eliminated.

Mottled faces occasionally occur in Herefords, and less often colored faces. The same thing is true in this case as in the two cases just mentioned.

Some Chester White swine have black color hidden in them. This usually gives no trouble, but it quite frequently causes black skin, and occasionally black spots of hair. This character has not yet been studied sufficiently to ascertain the best method of eradicating it. Red breeds of swine occasionally contain black in more or less suppressed condition. The elimination of this black is not yet understood.

Hampshire swine are black with white belts. This breed has recently attracted attention and is working its way into popular favor. At the present time about 10 per cent of the pigs lack the white belt. The reason for this has recently been worked out by a member of this committee, and the manner of eliminating this undesirable character is now understood.

It is an old saying amongst breeders that no new breed was ever formed from a cross between two breeds. There is no scientific basis for this saying, and there is no question that several distinct and fixed new breeds can easily be produced by crossing two breeds. It is true that the type which appears in the first cross between breeds; when this type differs from both of the breeds, can usually not be fixed; but by breeding the cross-breeds together a number of new fixed types are obtained.

A few of the unit characters which have been worked out in domestic breeds may be mentioned. The poll character and horns in cattle form a Mendelian character pair, the poll character being dominant, a portion of the hybrids having imperfect horns, or scurs.

There are two color characters in Tamworth swine, namely, light red and dark red. They act as a character pair; the light being dominant. The light red of Tamworth, when crossed with Chester, makes a red roan; the dark red gives white in the first generation.

The white of the Yorkshire, Chester White, Berkshire, and Poland China seems to be allomorphic with red in Tamworths and Duroc Jerseys, though this is not fully established. Yorkshire White is dominant over Poland China and Berkshire Black. These two characters, however, are independent and do not form a Mendelian character pair. The black of the Aberdeen-Angus is dominant over Hereford red, and these characters appear to form a pair. The white face of the Here-

ford is dominant over the colored face of the Angus. These two last points are deduced from the work of Mr. Mossom Boyd, a member of this committee, while the facts above stated concerning the behavior of color in swine are deduced from the work of Mr. Q. I. Simpson, another member of the committee.

Dr. C. B. Davenport has recently shown that the black character in sheep is recessive to white, and that the two behave as a character pair.

Both black and white in the Hampshire are dominant over red in Durocs. Black and red in swine seem to be independent characters, while white and red seem to form a character pair.

The belt of Hampshire swine appears to be due to the presence of a compound character of two factors which governs the distribution of color in this breed. These two characters are independent, and each is dominant over its opposite, namely, the absence of the character. Both of these factors which determine the distribution of color are transmitted independently of the colors themselves. It has already been stated that about 10 per cent of this breed do not have the belt. With the knowledge we now possess concerning the inheritance of the factors causing the belt, we can rapidly reduce the number of swine in which the belt fails to appear.

The black of the Poland China and Berkshire, when crossed with the red of the Tamworth or Duroc, produces a black and red spotted hog. In other words, this combination produces a mosaic of the two characters. Black and red in swine are not allomorphic, and may, therefore, be transmitted together.

(4) A fourth subject to which this committee is devoting attention is that of the fertility of hybrids, as well as aberrant hybrid forms. Dr. Guyer, of the University of Cincinnati, has shown that lack of fertility in certain hybrid pigeons is due to the inability of the chromosomes to pass through the synaptic stage. Your committee is able to report on the authority of Van Buren & Tufts, Mitchell, Ga., that the cross between Pekin and Muscovy ducks is sterile. This cross should furnish material for cytological study. These gentlemen state that the cross is larger than either breed, that the males and females are uniformly colored, but the two sexes are not of the same color.

Your committee would call attention to the difficulty experienced by breeders who desire to secure domesticated animals from Europe for crossing with American breeds because of importation restrictions. It would seem that these difficulties could be removed by proper action of Government officials, especially by maintaining quarantine stations on this side of the water where imported animals could be held until they were known to be free from disease.

It is hoped that the present interest in breeding will enlist the efforts of wealthy men who maintain farms and breeding establishments for pleasure. This committee would take pleasure in assisting men who are in position to do work of this kind in suggesting desirable crosses.

During the past year your committee has communicated with the

various zoological parks in this country where animals are kept with a view to ascertaining what animals might be available for crossing with domesticated breeds. Appended to this report are lists of animals in the zoological garden at Philadelphia and in the National Zoological Park at Washington, D. C. Attention is called to the difficulty of utilizing these animals in breeding experiments. Most of these animals have been secured at great expense and can hardly be loaned. The park authorities usually do not have facilities for keeping ordinary domestic animals with which the animals under their care could be crossed. Generally speaking, however, the superintendents of these parks, particularly Superintendent Baker of the park at Washington City, express interest in the work, and offer to cooperate as far as possible.

List of Animals at the National Zoological Park, Washington, D. C.

- Swine*.—Wild boar, male and female; and collared peccary, male and female.
Cattle.—American bison, male and female; zebu, male and female; yak, male and female; Philippine buffalo (*Buffelus bubalus*), male, castrated; and anoa, male.
Sheep.—Mouflon, female; Barbary sheep, male and female; blue sheep (*Ovis nahoor*), male.
Horse.—Grevy's zebra, male.

List of Animals at the Philadelphia Zoological Garden.

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| Chapman's Zebra (<i>Equus burchellii</i>). | Barbary Sheep (<i>Ovis tragelaphus</i>). |
| Persian Wild Ass (<i>E. onaga</i>). | Mouflon (<i>Ovis musimon</i>). |
| Wild Boar (<i>Sus scrofa</i>). | Himalayan Thar (<i>Hemitragus jemlaicus</i>). |
| Red River Hog (<i>Potamochoerus porcus</i>). | Doreus Goat (<i>Capra doreus</i>). |
| Wart Hog (<i>Phacochoerus aethiopicus</i>). | White-Lipped Peccary (<i>Dicotyles labiatus</i>). |
| American Bison (<i>B. bison</i>). | Zebu (<i>Bos indicus</i>). |

There is probably not a great deal to be gained in crosses between these animals and our domesticated breeds. It is, however, not possible to say in advance what crosses would be of value, and important results might follow where least expected.

DISCUSSION.

Chairman GROUT. Before we proceed to the next topic, there may be some questions. A question that occurs to me as a practical farmer is this: What good practical thing can be accomplished by this breeding?

Mr. SPILLMAN. I am not sure that there will be any practical results come from it, and yet it seems to me that a knowledge of the laws of inheritance cannot fail ultimately to do some good. I will specify one instance; I found a few men who were trying to breed horns off of Hereford cattle. They had a few polled Hereford cattle.

I got in conversation with one of these gentlemen and found that he had been crossing those Herefords with Polled Durhams. The Hereford white face is a dominant character. By selecting for four or five generations he had an animal which was apparently a pure Hereford except that it was polled. Another man had searched through the whole breed of Hereford cattle and had found fourteen polled animals in the registration book of the Hereford breed. He had bought some of them and gotten them together, so that he had a few polled animals that were registered Herefords. This man went to breeding, and selling the stock. After a while they began to attract some attention, and finally two associations were organized, so that we have now in this country two polled Hereford breeding associations. One is called the Polled Hereford Cattle Club, and the other the Polled Hereford Breeders' Association, I think. Now these men were having a good deal of difficulty in keeping their animals from pairing with other cattle. By the merest accident my attention was called to their work, and I went to study the laws of inheritance governing the transmission of the polled character. It was only a small piece of work to discover that the polled character and the horned character form a Mendelian character pair. We all know how a Mendelian character pair behaves, and we know what the progeny will be. I undertook then to outline the rules of procedure for those breeders for the elimination of the horns from their horned Herefords. I happen to know that at least a dozen of the leading breeders have those rules pinned up in their stables, and that they are using them. Only just a day or two ago before I left home I had a letter from a man who had paid \$500 for a polled calf that I had assured him was a pure polled and not a hybrid polled. He says now that he has had 27 calves from him from horned cows, every one of which is polled. He thinks that this was cheap, although it cost him \$500. That is one instance of the practical application of scientific knowledge in accomplishing a definite purpose in breeding. (Applause.)

Dr. CHAMBERLAIN. Will the gentleman, for the benefit of the agricultural press, please state in the briefest form and in practical language the Mendelian law so often referred to and so well understood by scientific men, so that we can make it plain to our readers just what it is?

Mr. SPILLMAN. You men do not know what you are stirring up when you get me started on that subject.

Dr. CHAMBERLAIN. I said, in the briefest possible language.

Mr. SPILLMAN. The difficulty is in that word "brief." Here is an animal which has horns, which is known, we will say, to be pure horned; and here is another which is polled and known to be pure polled. This polled animal is incapable of transmitting the horned character, and the horned animal is incapable of transmitting the polled character. We cross those two, and the progeny inherits the polled character from this side, and it inherits the horned character from the other side.

It happens in this case that this progeny that has both characters present will be polled in appearance. Of course we may have about 5 to 10 per cent of these crossed animals that have imperfect horns, scurs as they are called, but the remainder look like pure polled. Now the following is the Mendelian law stated in one form, though there are many ways in which I could state it: This hybrid will transmit the polled character to half of its offspring, and the horned character to the other half. Now that is the Mendelian law. It is all built up from this fact, that when two animals or plants differ with respect to one character, which behaves as a Mendelian unit character, if we cross them we get an individual which will usually show one of the characters but will possess both. When that individual produces progeny, it will transmit one of the characters to one-half of its progeny, and the other character to the other half.

But I have gone a little too far already; I have jumped a step. It will not in all cases transmit this character to half of its progeny exactly. That will be true of cattle, but not true of corn, for instance. It will produce two kinds of reproductive cells. One kind will have one character in it, and the other kind will have the other character in it. That is the actual fact of the case.

RESULTS OF HILL SELECTION OF SEED POTATOES.

By C. W. WAID, *Ohio Experiment Station, Wooster, Ohio.*

In the spring of 1903 a set of experiments was begun at the Ohio Experiment Station for the purpose of securing data which would throw more light on the question of the effect of hill selection of seed potatoes upon the resulting product.

These experiments were conducted along two distinct lines. In one case, the seed was selected from high-yielding and low-yielding hills, and in the other, from hills the plants of which were especially vigorous or had the ability to resist disease.

SEED SELECTED FROM HIGH-YIELDING AND FROM LOW-YIELDING HILLS.

In 1903 200 hills of Carman No. 3 were planted, from which the selections were to be made. At digging time the potatoes from each of 100 hills were weighed and counted; 40 of the heaviest yielding hills were scored on the basis of uniform size, regular form, freedom from disease, and yield. The 10 hills which scored the highest were sacked separately and stored for another year. The 20 lowest yielding hills were also sacked separately and stored. The other 100 hills were dug, the potatoes were thrown together and enough seed was selected to plant 100 hills. In making the selection, uniform-sized tubers were chosen but with no reference to individual hills. In the spring of 1904, 10 hills were planted from each of the 10 hills which scored the highest the previous season, making in all 100 hills. Five hills were