Animal Breeding

Thomas Shaw

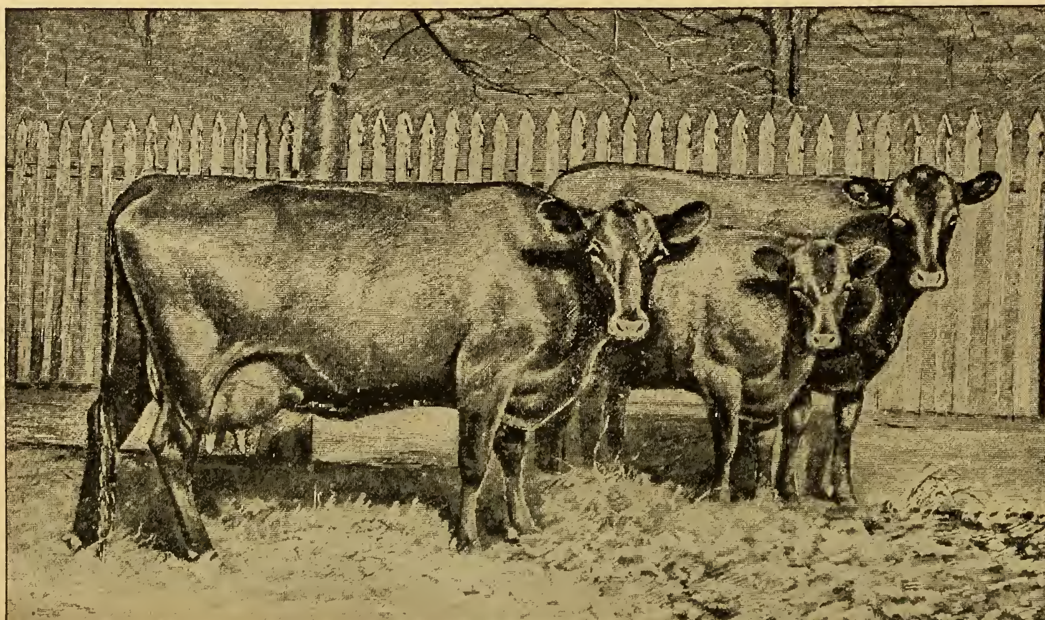

FIG. 1. "LIKE PRODUCES LIKE."
Prettygirl 4294, with heifer calves at 5 and 17 months respectively, by Pando 1254.
The property of Captain V. T. Hills, Delaware, Ohio.

ANIMAL BREEDING

By

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"Public School Agriculture"
"Weeds and How to Eradicate Them"
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"Soiling Crops and the Silo," Etc.

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TO MY BRETHREN THE TEACHERS OF ANIMAL HUSBANDRY, TO THE STUDENTS OF THE AGRICULTURAL COLLEGES, AND TO ALL INTERESTED IN THE GROWING OF LIVE STOCK IN THE UNITED STATES THIS WORK IS MOST RESPECTFULLY DEDICATED BY THE AUTHOR.

TABLE OF CONTENTS.

LIST OF ILLUSTRATIONS.

THE AUTHOR'S PREFACE.

Animal breeding is in many of its phases a most intricate subject. While it has its shallows it has also its great deeps that have never yet been fathomed. They would take an intellectual giant over his head at the very first plunge. The difficulty, therefore, of writing effectively on such a subject will be at once apparent. Several authors have made the attempt, and some of them have written well. It must however be apparent to those who have studied the subject that these books are all more or less wanting, first, in the comprehensive treatment of the subject, or, second, in orderly arrangement and sequence, or, third, in simplicity. This book is written, therefore, in the hope of, in some measure, removing these defects and of giving to the public a more teachable book. How far the author has succeeded is left with an indulgent public to say.

University Experiment Farm,
St. Anthony Park Univ.
1901.

CHAPTER I.

BREEDING LIVE STOCK.

The term live stock is used to denote living animals such as are kept upon the farm. It is more commonly applied to cattle, sheep, and swine, but is also used in a sense so wide as to include all domesticated animals reared upon the farm. It has probably been coined as an easy means of reference to the living animal as distinguished from the same in the dead meat or dressed form.

Definition of Animal Breeding.—Animal breeding is that science which treats of the reproduction and improvement of domestic animals. Some knowledge of the principles which govern successful breeding has been possessed from a very early period, but just how early can never be certainly known. Both ancient and modern writers are almost entirely silent on the subject until within the last two or three centuries. Almost the only reference to the subject, as such, during the first four thousand years of the world's history, is that incidentally narrated in the book of Genesis when speaking of the arts practiced by Jacob to increase his flocks and herds. But, within the past two or three centuries, great advances have been made in this science. The principles which govern it have not only come to be better understood, but the knowledge of these is being diffused as never before. Foremost among the agencies in disseminating such knowledge have been the agricultural press and the agricultural college.

Breeding a Science and an Art.—Animal breeding is at once a science and an art. It is a science in so far as it discovers and systematically arranges the truths and principles which relate to the improvement of live stock. The value of in-and-in breeding, for instance, as a quick means of improvement illustrates such discovery. (See Chapter X.) It does not appear to have been known to the ancients. If it were thus known the knowledge was subsequently lost. The systematic arrangement of the truths and principles which relate to the science is yet far from complete, and it may be added, that many of these truths and principles are not yet understood. It is an art in so far as it successfully uses those principles in effecting improvement. The importance, therefore, of understanding the principles which make improvement possible will be at once apparent, since, until so understood, they cannot be turned to profitable account.

Source of the Rules which Govern Breeding.—The rules which govern breeding are almost entirely empirical in their origin since they have been almost exclusively derived from the practice of the most successful breeders. These rules, so far as known, would seem to have been preserved only in a traditional way until within the last two hundred years. This would militate against the diffusion of such knowledge, and it is partly responsible for the little progress made in the science of breeding until recent centuries.

Robert Bakewell, of Dishley Hall, Leicestershire, England, is usually regarded as the originator of improved breeding as now practiced. The value of selection was no doubt understood previously. The renovating influence from judicious out-crossing was also well known, and the knowledge had been turned to good account. (See p. 129.) Notwithstanding, it remained for Robert Bakewell to make known to the world the short cut to improvement and fixity in type, through in-and-in breeding, accompanied by the most rigorous selection. Previously, improvement had been sought chiefly through crossing, hence the way of improvement was tedious and uncertain.

Nearly all the modern breeds possessed of value have been evolved, or at least improved, on the principles which Bakewell thus introduced and practiced. In this fact the explanation is furnished of the comparatively recent origin of many of the improved breeds that now stand high in the popular estimate. The statement would not be extravagant, it is thought, which would claim that Bakewell's discovery more than anything else is responsible for the rapid advances that have been made in breeding domestic animals since his time.

Live Stock Improvement Neglected.—The improvement of live stock upon the average American farm has not received that attention which its importance demands. This is but another way of saying that animal breeding has not been given the attention that should have been accorded to it. Several reasons may be given by way of explanation. First, the opinion has extensively prevailed among farmers that the growing of live stock is not so remunerative as the growing of grain or other products of the soil, such as are sold directly from the land. This opinion has arisen, first, from an incorrect basis for computing profits. The advocates of growing crops for direct sale usually overlook the value of live stock in preserving fertility. But, the greater prosperity of individuals and communities who give much attention to the production of live stock and live stock products, as milk, butter, cheese, and wool, is more and more arresting attention and paving the way for the more rapid extension of the live stock industry. Second, the present necessities of farmers have retarded investments in live stock, and have thus delayed their more rapid introduction on farms. This accounts, in part at least, for the little attention given to live stock production in more newly settled areas. But third, the shortsighted and incorrect views of farmers too commonly held regarding the value of live stock improvement, more than anything else, has hindered such improvement. This, more than anything else, also accounts for the comparatively unimproved condition of the flocks and herds kept on so many of the farms of the United States and Canada.

Many cling to the idea that improvement is to be brought about chiefly through feeding. Because of the prevalence of this view very many of the growers of live stock do the work in an aimless way; grade sires are used indiscriminately; in-breeding is unconsciously practiced through the continued choice of sires from within the herd or flock; selection is based on false premises, and other injudicious practices, far too numerous to mention here, are followed. As a result the scrub is still in evidence on too many farms. (See p. 271.) In view of these facts, the importance of quickly diffusing light on this question becomes greatly significant, and more especially when it is remembered that in the keeping of live stock correct practice and generous profits go hand in hand.

Live Stock, Machines for Manufacturing Food.—Live stock upon the farm should be regarded as machines for manufacturing agricultural products into forms more concentrated and possessed of a higher value. These products can then be shipped to better advantage than the materials could be from which they are made, since, ordinarily the cost of shipping decreases with the increase in the concentration of the product shipped. The concentration thus secured is usually very marked, as, for instance, when bulky foods are turned into milk and flesh. In addition to the freight thus saved, much coarse and bulky food grown upon the farm, which would otherwise be largely wasted, is given a money value.

The straw of what is termed the small grains, and corn stover, that is corn stalks without the corn, would be turned into money. While the animals are thus employed, so to speak, in manufacturing food into more concentrated products, they give back to the farms the greater part of the fertility contained in the food, where the management is correct. Whenever, therefore, the living animal is used as a machine, it is important that this living machine do its work to the best advantage. If animals of a certain type will make more and better beef than those of another type, those of the first type should be given the preference by the grower of meat, and if cows of a certain type in the dairy will give a better return in dairy products for the food consumed than cows of another type, those of the first should, of course, be chosen by the dairyman.

Animal Breeding Comprehensive.—The breeding of live stock is a question at once comprehensive and many-sided. Notwithstanding that much has been gleaned in regard to the subject, it is likewise true that many of the influences which affect breeding are as yet obscure or but imperfectly understood. Some of those principles are fairly constant in their action as the law that like produces like, discussed in Chapter III., and some are variable and uncertain as the law of variation discussed in Chapter IV. Again, some of the influences that govern transmission act together and in conjunction, while others are apparently antagonistic. It is impossible, therefore, at present to state in regular and orderly sequence, all the different phases of animal breeding and the influences which affect it. Indeed it is highly probable that some of these have not been discovered, and it is quite certain that the degree of influence which each will exert is not known. Yet it will be correct to say, first, that it considers the principles that govern heredity as far as these have been determined. Heredity is the transmission to the offspring of peculiarities possessed by the parents. These peculiarities may relate to form, function, qualities both mental and physical and to habit. The law that like produces like furnishes an illustration of these principles, as does also the law or principle of correlation discussed in Chapter VIII. Second, it considers certain features of transmission not well understood, as, for instance, atavism or reversion discussed in Chapter V. Third, it includes the effect of external influences on transmission and development as contrasted with those which may be termed internal and inherent. Of this very numerous class are the influences of environment and food. And fourth, it includes the application of every known principle of breeding and also every feature of correct practice, to the improvement of animals in form and in all useful qualities.

It would be necessary, therefore, for the breeder who aims at the highest success in his work to have a wide grasp of the subject. He should be familiar with all the principles that govern breeding as far as known. He should understand what is implied in a standard of excellence, and should be able to sit in judgment on the value of pedigree. He should be versed in the effects of environment on development. He ought to be familiar with recorded results in the making of breeds, in cross-breeding, and in improvement through up-grading, and he ought to know approximately the feeding value of the foods available and the ends for which they are adapted, and also the methods of feeding and blending them so as to produce a given result. The last item is in itself a large factor, since it virtually covers the whole ground of feeding domestic animals.

A Problem Advanced and Difficult.—From what has just been stated it will be apparent, that the successful breeding of live stock furnishes one of the most advanced and difficult problems relating to practical agriculture. This arises not alone from the comprehensive character of the subject as above outlined, but also from irregularities in transmission, the causes of which are not well understood. These crop up so unexpectedly and so frequently as to perplex the breeder betimes, and to make improvement less rapid than it would otherwise be. It is not surprising, therefore, that the number of those who have greatly distinguished themselves in breeding is not numerous, not nearly so numerous as that of statesmen, who, by their successes, have graven their names on the records of imperishable history. But the number will increase with the greatly increased attention that is being given to the subject during recent years. Happily, however, the fundamental principles of the science of breeding which are essential to a fair measure of success are not numerous nor are they complex.

Fundamental Principles.—These include: 1. Breeding to a standard of excellence, ideal or real. 2. Breeding only from parents which conform to this standard in a marked degree. 3. Breeding from parents, more especially males, which have long been bred without intermixture of alien blood. 4. Mating animals so as to correct the defects of the parent in the offspring. 5. Practicing a selection at once rigorous and persistent. And 6. Giving due attention to environment, sanitary conditions, and feeding. Breeding to a standard of excellence is considered in Chapter II. The great necessity for breeding only from animals which conform to this standard is based on the first and greatest law of heredity, viz.: that like produces like. The necessity for breeding from parents purely bred is based on the increased certainty in transmission secured from such breeding. It has been noticed that when alien blood of one or more breeds is present in a marked degree, the tendencies to variation in transmission are also marked. This arises from the absence of what may be termed dominant or controlling blood elements. The physiological units of transmission, so to speak, that are similar, are not present in a sufficient number to form a preponderating, controlling factor in transmission.

With the elimination of alien blood there is an increase in dominant or governing properties in the direction desired, according to the end sought. By the time that alien blood is eliminated so as to be an inappreciable factor in ordinary transmission, the animals may be considered pure. But the dominance of the blood elements is further strengthened by carrying on the breeding in the same line. Theoretically, the increase in the dominance of properties would go on as long as the same line of breeding was continued, but practically it would cease after many years of such breeding. It is only theoretically true that the oldest breed is absolutely the most prepotent. The mating of animals is discussed in Chapter XXX., and selection is discussed in Chapter XXIV. The influences of environment are discussed in Chapter XXVIII., and less directly in some other chapters. Sanitary conditions are only incidentally discussed in the book, and the same is true of feeding, since the discussion of these more properly belongs to a work or works on the management and feeding of live stock.

Obscure Features of Breeding.—The features of breeding which are yet somewhat obscure and but imperfectly understood are such as relate to variations in transmission. They include the laws of variation and atavism. The existence of these laws has been deduced from the results which they have produced without being able to ascertain all the influences that have led to the results. But since they are understood in part, their action can also be controlled in part. For instance, it has been noticed that the tendency to variation decreases, as previously stated, with increased intensity in the purity of the breeding, and that the tendency to atavic transmission increases with increase in the admixture of alien blood. Such knowledge can, therefore, be turned to excellent account in decreasing the tendency to variation in transmission and also to atavism. They also include certain influences associated with conception, as the influence of a previous impregnation, intra-uterine influences, and influences that determine the sex, discussed in Chapters XIV., XV., and XVI., respectively. These features of breeding are even less understood than those that relate to variations in transmission, hence they are even less under the control of the breeder. But experience has shown that something may be done to modify the results emanating from these influences. While, therefore, the obscurities which becloud some of the features of breeding tend to hamper the breeder somewhat in his work, the influences that tend to produce uniformity in results are so many and so strong as to furnish a guaranty of at least measurable uniformity in results and in the direction sought.

The Chief Aim in Breeding.—The chief aim in breeding should be the improvement of animals in those qualities which have a definite value as meat, milk, wool, speed, and labor. These qualities are usually associated with more or less of beauty and symmetry of form. It would probably be correct to say, that the strengthening of these is in no way antagonistic to beauty and symmetry, since they are never more markedly present than when they may be said to be the outcome of fitness for the desired end. To illustrate: the draft horse perfectly equipped for his work, is quite as beautiful and symmetrical as the carriage horse perfectly equipped for his, but it is beauty and symmetry of a different character. Useful qualities should never be sacrificed for what may be termed fancy points. For the definition of fancy points see page 21.

Concentration in the Search for Improvement.—The highest success has been achieved when the breeder has sought improvement in but one essential quality. In other words the breeder whose chief aim is to effect improvement in meat production will succeed better if content with a moderate amount of milk production and *vice versa*. The breeder of the draft horse cannot at the same time secure speed in a marked degree, nor can the breeder of the standard bred horse secure strength as in the draft horse. When high development is sought in but one direction the energies of the system may be made to act, as it were, in that one direction. They may be focused, so to speak, in the production of one end. But such concentration should never be carried so far as to react injuriously upon the system as a whole. This result will certainly follow when what may be termed extremest development in one direction is sought. The breeders of the Saxony Merino sheep obtained a finer staple in the wool than the breeders of other types of the Merino, but they did so at the sacrifice of vigor. And those who have secured what may be termed phenomenal yields in milk production have done so in many instances at the sacrifice of the future usefulness of the cow. They drove the animal machine, as it were, at too high a pressure. Nevertheless the fact remains, that high attainment in one direction is not necessarily antagonistic to the maintenance of a high degree of vigor.

While it is true that the highest attainment in production is reached when the energies of the system act in one direction, it is also true that there is no inherent antagonism in the action of the same up to a certain limit in more than one direction. Up to that limit, therefore, it follows, that production may be attained in more than one line. Experience has taught that liberal production may be reached in two lines and even in more than two lines in the same animal. For instance, liberal meat and milk production is frequently found in the same breed. Up to a certain limit development in more than one direction is found mutually helpful. It is when development in one direction becomes very marked that it becomes detrimental to development in the other direction. It is quite possible, therefore, to secure even a high measure of development in more than one line of production in the same animal. Whether marked development should be sought in one direction, or medium development in more than one, will depend upon conditions such as relate to soil, location, food production, markets, and the tastes of the individual. Experience has demonstrated that there is a place, and one of great importance, for the cow that ranks well in meat and milk production, for the horse that can plow in the field and carry loads to the market, for the sheep well up in the production of meat and wool, and for the fowl that lays eggs abundantly when alive and serves well for the table when dead. Such production is frequently spoken of as being dual in character, hence the term dual purpose cow. The large place for the special or one purpose animal, no reasonable person will deny.

The Basis of Value in Animals.—The relative value of animals depends upon their adaptation to one or more particular uses and the returns they make for the food consumed. The best animals are those which convert the largest amount of food into animal products of the best quality and with the least possible waste in the materials fed. But a large consumption of food is not in itself a guaranty of profitable production. The scrub steer is usually a large consumer of food, but in the assimilation of the food he is often faulty, hence, the increase in weight from calfhood to maturity is not what it would be from a pure bred steer of one of the beef breeds, the consumption of food in both instances being the same. Nor would the meat made by the first be nearly as valuable as the meat made by the second. The only profit obtained from the food fed to the animal is from that assimilated beyond what is required for sustenance. Take, for instance, a dairy cow of correct form and with good assimilative powers in digestion. A certain amount of food is required to keep running the machinery of her being. No return is obtained from this. The return comes from the food she consumes in excess of the food of maintenance. It is evident, therefore, that the profit from the cow will increase with the increase in her consumption of food over the food of maintenance. Other things being equal, then, the best returns will be obtained from animals that consume the most food in proportion to their live weight.

CHAPTER II.

A STANDARD OF EXCELLENCE.

It is absolutely impossible to attain marked success in breeding domestic animals without breeding them to a certain standard. The man who makes the attempt to do so is like the mariner who sails the seas without a compass. He, himself, cannot tell whither he is drifting. He is playing at what may be termed a game of chance.

Definition of the Term.—A standard of excellence is an ideal for the guidance of the breeder, and one which he should constantly aim to reach. This standard may be written or unwritten. Written standards are commonly prepared by the individual associations which protect the interests of the respective breeds. Unwritten standards are ideals in breeding which exist only in the minds of individuals engaged in the work. These ideals may be original and exist independently, or they may be based on what may be termed popular opinion; of the former class were the ideals held by the originators and improvers of breeds. These of necessity had to make their own standards. Of the latter class are those held by judges and breeders of stock in the absence of a written standard. The necessity for a written standard is based on the desirability of reaching uniformity and high excellence in the breeding of live stock. In the absence of a standard in one or the other of its forms, such uniformity and high excellence are impossible. Even with the aid of a standard, absolute uniformity can never be attained in breeding, because of the existence of the law of variation. (See Chapter IV.)

But it can certainly be more nearly approximated with than without a standard, and with the aid of a written standard rather than with that of one not written. Standards are also necessary to enable the teachers of the science of animal husbandry to do their work intelligently and with sufficient precision and exactness. The standard points of the living animal must be presented from a standard either written or unwritten. The advantage of the first method over the second will be at once apparent to all fair-minded men. Again, good judges of live stock have gone into the show ring with the boast upon their lips that they did not believe in standards. They claimed they were going to judge the animal on its merits, and not by paper made standards, oblivious of the fact that every award made by them was based on a standard existing in their own minds.

Standards for Purebreds.—In nearly all instances the standards for purebreds are written, but there are some exceptions. Notable among these are the Shorthorn and Hereford breeds of cattle. That these breeds are yet without a written standard is not to be set down to the credit of the associations which guard the interests of the respective breeds. True, they have attained much celebrity without written standards, but that was before the era of standards and in spite of their absence rather than because of the same. The existence of written standards would have made impossible the Jew and Samaritan-like attitude that prevailed so long between the breeders of the Bates and Booth Shorthorns, and it would altogether have prevented the unfortunate controversy between the advocates of the white and mottled faced Herefords toward the close of the last century. It does seem unfortunate there should be any necessity to make a plea for the existence of written standards in this progressive age.

When not written, the standard for judging purebreds is regulated to a considerable extent by the awards made in the show rings by men who are generally recognized as good judges. The type of animal which more commonly gets the prize is recognized for the time being as the standard type. To some extent it is also influenced for a time by popular taste and the demands of the market. Some years ago the popular taste in this country proscribed white animals among Shorthorns and showed a decided preference for those that were red. To so great an extent was this unfortunate prejudice carried, that white Shorthorns became almost unsalable for breeding uses, notwithstanding their individual excellence, and roan Shorthorns were much discriminated against. Again, when the Cruikshank type of Shorthorns first came before the public, many of the breeders of the Bates and Booth types refused to introduce Cruikshank sires into their herds. But the dealers in meat gave the preference to animals low and blocky in type and thickly fleshed, hence, the demands of the market compelled the breeders of the Bates and Booth types to introduce Scotch blood into their herds.

The originators of breeds must make their own standards, as previously intimated. They are seeking what may be termed a creation, that is something different in the line of live stock from anything that has previously existed. In the absence of a standard they must create one, whether it be written or unwritten.

Standard for Grades.—The standard for grades is unwritten, except in so far as it may have been or may be committed to paper from time to time by certain individual breeders. From the very nature of things it must be so in the absence of organization to protect the interest of grades of any class. Because of this, uniformity in the breeding of grades can never be attained as in the breeding of purebreds with a written standard. But whether the standard is written or unwritten, the ideal type must be clearly fixed in the mind of the breeder. His work will not be that success which it ought to be unless his ideal is as clearly present to his mental vision as though it were on canvas or better still, a living presence standing before him.

Such a standard will or should rest upon utility. Fancy points may be tolerated in breeding purebreds since they may so far evidence pure and even high breeding. But there would seem to be no place for them in grades. It will take into account the performance of the animals, as, for instance, in relation to speed, milk, or meat production, and prolificacy, since in all these respects the relation is close between animal form and performance resulting therefrom. It will also take into account the demands of the market. If the market should demand lean pork with much side meat, or fat pork with but little side meat the grower must give heed to such demands and shape his ideal accordingly. This one influence has tended to modify the ideal in certain breeds, as, for instance, in the bacon breeds of swine in Britain.

The same is also true of certain of the types of the American Merino in the United States. Happily those changes in the popular taste are not of frequent occurrence and they are made but slowly. Were it otherwise, the possibility of breeding to a fixed ideal would scarcely be practicable.

The Makers of Standards.—From what has been stated above it will be apparent, that in nearly all instances the makers of standards are the members of the associations formed to protect and promote the interests of the various pure breeds. The work is usually done by a committee appointed by the members of the association. Sometimes it is admirably done, but, in instances not a few, standards are quite defective. The defects include, chiefly, a lack of clearness, definiteness and precision in statement, and a want of comprehensiveness in the points covered. Such phrases, for instance, as, "A head well set on," and "A good back," are well-nigh meaningless to the uninitiated in live stock lore. They arise, not from a want of knowledge on the part of those who frame them with reference to the requisite furnishings of the animal, but rather from a lack of felicity of expression in the use of language. The statement, though clear to the framers of the standards, may be far from clear to the average reader.

Some breeds are represented by several associations. The Poland China breed has a number of these. Usually this multiplication of associations is unfortunate, since it oftentimes results from strife that has sprung up in one or more of the associations previously formed. Happily these associations generally adopt the same standard. When they do not the interests of the breed suffer.

Two Classes of Standards.—Two distinct classes of standards have been drawn up for some of these pure breeds. The first relates to the requisite furnishings of the animal, more especially as to external form, but it includes such evidences of disposition, stamina, and performance as may be gleaned from external form and also color. It is frequently spoken of as a scale of points, although, strictly speaking, a scale of points has reference to the numbers affixed to the various points in the standards. The terms scale of points and standard of excellence have frequently been regarded as synonymous and interchangeable. But, from what has been said, it will be apparent that the second is the more comprehensive term, since it includes all kinds of standards as applied to live stock, not excepting the scale of points. The second class of standards is based upon performance. They are in a sense supplemental to the first, and are usually referred to as advanced registration. They seek to encourage higher achievement in the breeding and management of live stock.

A Scale of Points.—A more extended description of a scale of points will make it to include: 1, size, symmetry, style, and weight; 2, evidences of disposition, digestion, constitution, and capacity; 3, what is termed quality and the amount and kind of bone; 4, the general outline of form as a whole and the development of each part as far as discernible to the eye, and 5, color and fancy points, as, for instance, color markings. Symmetry relates to the harmony, as to form, that exists between the different members of the body. Style or carriage as it may be termed relates to the movement of the different members of the body and to the position of the same when in motion. Weight should always be included in a scale of points though frequently it is not. For the evidences of disposition, digestion, constitution, and capacity, see Chapter XXIII., and for the evidences of quality, see Chapter XVIII.

Advanced Registration.—Advanced registration usually records performance in animal production, absolutely or at different ages, and speed in trotting horses. It may be made to record performance in breeding and possibly in some other lines, as in wool production. Heretofore it has been confined more commonly to dairy cattle and to standard bred horses.

When applied to dairy cows it takes into account performance in the production of milk or butter, or both, for a term of days, weeks, months, or years. Only purebreds have been admitted to advanced registration, among dairy animals, but it would also be possible to establish such registration with unrecorded animals, whatever might be thought of the expediency of such a course of action. When applied to trotting horses it records the time made in speeding on the track. Animals whose performance is recorded in the advanced Registry are also recorded in the ordinary pedigree standards kept for the breed.

Points in Standards.—In drawing up standards, certain numbers are used to designate perfection in the particular part or characteristic considered. These numbers vary with the importance relatively of the part under consideration. For instance, in beef cattle, while but 1 point may be assigned to the ear, 10 or 12 points will probably be assigned to the back, because of its greater relative importance. In some records they also vary with certain features of development peculiar to the sexes. For instance, in dairy cows, many points may be allowed for udder development. In the male this could not be, but with him more stress is put upon other indications, as, for instance, those that relate to the evidences of constitution and other features of a well developed masculinity. In other instances the numbers are affixed not to a single feature of development, but to a group of these considered collectively. For instance, so many marks will be assigned to the head as a whole briefly described, rather than to each part of the head particularized in detail. To affix marks in detail rather than to certain parts grouped furnishes a more complete scale of points. And in yet other standards, objectionable features are stated even with some minuteness in detail, but no points have been affixed to these to discount, as it were, the valuable points. The numbers used in a scale of points are also sometimes called counts, and 100 of these are fixed upon as the standard of perfection.

Fancy Points.—Fancy points are those which have little or no intrinsic value in themselves when viewed from the standpoint of utility. They are such as relate to color and color markings, the size and shape of the ear, wool on the head and legs, and dish in the face of pigs. It would not be correct to say that fancy points are of no value at all, but that they are only or chiefly valuable as indications of purity of breeding. While thus far they are valuable, the fact should not be overlooked that other indications could be made to substitute them in time without necessarily impairing the usefulness of the breed. They should never be sought at the sacrifice of important features of form unless when they are regarded as an essential evidence of purity of breeding. The red color, for instance, would not be admissible in an Aberdeen Angus, since black is the standard color. To select a Shorthorn bull, red in color, but inferior in form and pedigree, in preference to a roan would be carrying a fancy point to an extreme, as would also the choice of a Shropshire ram of but ordinary development in preference to one of superior development because the covering of the head in the first was superior.

Advantages of Standards.—It has already been intimated that standards are necessary to secure uniformity in breeding and to make it practicable to teach correctly the facts relating to form. In the absence of authorized standards, individual breeders set up standards for themselves which may and which do differ materially. The difference in type thus produced tends to confuse. An illustration is found in the Bakewell and Border types of Leicesters and in the Bates, Booth, and Cruikshank types of Shorthorns. Where such differences in type exist, controversy regarding them arises, and the difficulty in placing awards in the show rings is increased, hence, the reputation of the breed suffers proportionately. It does not follow, however, that breed type should never be modified, but when so modified the standard should be made to accompany such modification.

Standards May Change.—Standards may and do change, but when they do the changes are usually slight. They may change with the changing of fashion, with the changed demands of the market or to increase the usefulness of the breed. The favorite standard color in Poland China swine calls for much less white than formerly. The pork market calls for a longer and leaner side to meet the changes in the popular taste, and to maintain sufficient stamina in some of the breeds stronger bone is needed. Modifications in some of the standards for swine have already been made in these directions and possibly further modifications may yet be made. However, after breeds are established, the aim should be to conform type to standard rather than standard to type, hence, the necessity for keeping standards abreast of the needs of the times.

Receiving Benefit from Standards.—The merest tyro in breeding will receive benefit from standards, since they will furnish him with a guide in selection as far as he may be capable of using them. But the highest benefit from standards will come to those who understand best the laws of breeding. In the absence of knowledge regarding these, the information which standards bring cannot be turned to the best account. In the hope of simplifying the study of these laws, the attempt will be made in the chapters which immediately follow to so define and explain them that the essential features thereof may be so grasped by the ordinary intellect that they may be turned to good account by anyone engaged in the breeding of live stock.

CHAPTER III.

THE LAW THAT LIKE PRODUCES LIKE.

Breeding, like everything else in the domain of nature, is governed by laws. How far the action of these is modified by the conditions which precede and accompany such action is not fully known, nor is it likely ever to be. Nor would it be correct to say that all the laws or principles which relate to this great subject have even been discovered. But some of them have, and happily enough may be gleaned regarding them to enable the breeder to prosecute his work with at least a fair measure of certainty and success.

Fundamental Laws.—Of the laws or principles which govern breeding three may be considered as fundamental, viz.: 1. The law that like begets like; 2. The law or principle of variation; and 3. The law or principle known as atavism.

Not Unvarying in their Action.—Much has yet to be learned about these laws. They are only understood in part since no one of them, as now understood, is unvarying or uniform in its action. In practice it can never be known with absolute certainty which of them will dominate in determining the character of the offspring. It sometimes happens that the progeny of two parents will be possessed of high excellence in one instance, while in the next the progeny of the same will be only ordinary if not indeed inferior. The result is doubtless the outcome of the action of law in both instances, but why law should produce results so dissimilar when the conditions are as nearly alike as man can make them, is one of the inscrutable things that man will probably never be able to discover.

It is true, nevertheless, that man is by no means helpless in determining what the results from mating animals will be. Noting results has taught him much and will doubtless teach him more in the future. It has been noticed that the first law is more uniform in its action than the second and the second than the third. Uniformity in the action of the law that like produces like increases with the purity of the breeding, the duration of the period of such breeding, and also up to a certain limit with the closeness of the relationship of the animals so bred. The intensity of action in the second law would seem to increase with the increase in the distance from the conditions just named. And it will probably be correct to say that the law of atavism weakens as the starting point in pure breeding is receded from. By properly utilizing such knowledge the breeder can do much toward securing uniformity in results. An excellent illustration of this is seen in the frontispiece representing the Red Poll cow "Pretty Girl 4292" with heifer calves at 5 and 17 months respectively, by "Pando 1254." The property of Capt. V. T. Hills, Delaware, O.

The First Law Defined.—The law that like produces like implies that the characters of parents will appear in their offspring, or to put it differently, that the offspring will bear a close resemblance to the parents in all important essentials. Because of this it may be said that this law is the great sheet anchor of the breeder. It is the compass without which he could never enter the harbor of success. The law that like produces like pervades all animated nature. It dominates the animal kingdom and it would seem to be but little less potent in the domain of plant life. When the parents are much alike in breeding and in all essential characteristics, this law is sufficiently uniform in its action to justify the breeder in looking for progeny similarly endowed. But where parents unlike in these respects are mated, it would be unreasonable to look for progeny the counterpart, in any marked degree, of both parents. In fact it could not be.

The most that nature could do in that case would be to produce progeny that would bear resemblances to both parents. Those resemblances could not exist equally in all features of the progeny, since they differ in the parents. But even where the mating is eminently correct, there are some exceptions to uniformity of action in this law. Were it otherwise, there would not be the same room for the existence of the law of variation, nor would there be any necessity for examples to illustrate it and proofs to support it. Had it been unvarying in its action, it is probable that it would not have received any other attention than the mere recognition of its existence.

This Law Early Recognized.—We are too prone to conclude that but little was known with reference to the art of breeding until within a comparatively recent period. Such a view is not correct. The short cut to improvement through in-and-in breeding does not appear to have been practiced before the time of Bakewell. But the existence of the law has unquestionably been recognized for a very long period. It is equally certain that many of its principles were well understood. Evidence of the same is found in the breeding operations conducted by the patriarch Jacob. The narrative of the management of his father-in-law's flocks makes it clear that much attention had been given to the subject at least eighteen centuries before the modern era. The influence of external objects in determining color had been so far recognized that the patriarch was enabled to turn the knowledge to excellent account, that is to say, so far as his own personal interests were concerned. The statement of holy writ with reference to the color of the males in actual service as seen in the vision, is a clear recognition of the law now under discussion. Further evidence is furnished in the monstrous forms that were bred for the amusement of the Roman people about the time that the decline of the empire began. The very fact that such monstrosities were then produced tends to show that experimental crossing had been practiced long before that era. The pedigrees kept by the Arabs of their horses centuries before the era of pedigrees began among Anglo-Saxon peoples furnish additional evidence of the certainty of the comparatively early recognition of the law that like produces like by that nation of wanderers, and of the importance which they attached to it. The justification of pedigrees could not exist in the absence of such a law.

Illustrations in the Human Family.—When applied to the human family the law that like produces like finds ample illustration in the distinctive peculiarities of feature common to the different races. Each of the five different races into which mankind has been divided has distinctive peculiarities. These are such as relate to physical form, color, and intellectual development. It is further illustrated by the differences and resemblances observable in sub-divisions within each race, and more especially in those sub-divisions in which there has been no mingling of alien blood. While the various tribes of North American Indians which dwelt amid the forests possessed in common certain peculiarities, as, for instance, the copper color and the straight hair, each individual tribe possessed peculiarities more or less common to all the individuals thereof and yet different from those in other tribes. Yet, again, it is illustrated in the resemblances discernible in very many instances between the members of the same family. So strong are these resemblances that oftentimes the family relationship of each can thus be discerned. These resemblances cannot be accidental. Admit the existence and the potency of the law that like produces like, and the explanation is easy. Deny it and no satisfactory explanation can be given.

Uniformity in Results.—The degree of uniformity in the results obtained in breeding will be largely dependent on the methods of the breeder. In no instance will they be absolutely uniform else there could be no law of variation. But so generally uniform will these results be that the skillful breeder may carry on his operations with no little certainty. But before he can succeed thus he must, in the first place, breed to a standard of excellence. Such a standard must determine his choice of breeding animals. It must guide him in mating them. It must be ever present while selections are being made. It, too, must determine which shall be discarded. Second, he must set a proper value on improved blood. The value of such blood as a factor in breeding has already been referred to in Chapter I., and is further discussed below in the present chapter. And third, he must understand the art of selection and the principles of management generally. The question of selection is discussed in Chapter XXIV. The principles of management are so comprehensive that they cannot be stated here. The author hopes to discuss these sometime in the future, when writing on the subject of feeding.

Benefits Arising from this Law.—The following are chief among the practical benefits that may result to breeders because of the existence of the law that like produces like: First, it makes it possible for them to effect improvement until a certain standard of excellence is reached. The standard thus set may be placed where they are pleased to place it. The standard of no breed in existence has been raised to the level to which it is possible to bring it. Standard bred horses have probably been brought nearest to the limit of possible improvement, but there are no good reasons for supposing that the speed of such horses will not be farther increased. Second, it makes it possible for breeders to maintain improvement. In all animated nature there would seem to be an inherent tendency in the direction of deterioration in the absence of influences, natural or artificial, such as tend to secure the survival of the fittest. And to prevent such deterioration it would seem to be necessary that these influences are continually operative.

This statement may and doubtless will be challenged, and in certain instances with much show of truth, but in the judgment of the author, the history of the animal and vegetable kingdoms since man left Eden, will sustain it. But the law is sufficiently uniform and constant in its action to enable the breeder to more than counteract such tendencies when the work is properly conducted. Third, it makes it possible to form new breeds and to mold new types. Nature can accomplish both because of the existence of this law. Turn loose into nature's domain a number of cattle comprising representatives of several of the improved breeds and where the conditions are such that they can be maintained without the aid of man, and in time nature will mold them into a new breed. Give her time enough and the resemblances between the progeny of those diverse breeds will be striking. Take some of those animals and again relegate them to the care of nature where the conditions are different, and the type will be changed. These modifications would be impossible were it not for the fact that in animal breeding, when alien blood is excluded, the tendencies toward assimilation would seem to be decidedly stronger than toward variation. What nature, unaided, can do can be done more quickly when man comes to the aid of nature, and makes a more rigorous selection than nature could make without the aid of man.

Benefits from Want of Uniformity in this Law.—The exceptions to the want of uniformity in this law have been taken advantage of, 1, to improve the standard of the breed, and 2, to form certain breeds and mold certain types which could not otherwise have been called into existence. These statements, though apparently contradictory to those just given, are not really so. While the evolution of breeds is the outcome of general uniformity in the action of the law that like produces like when aided by selection, it is equally true that some breeds could never have been evolved at all but for the absence of such absolute uniformity. Such are the polled breeds of cattle and certain of the improved breeds of sheep from which the horns have been eliminated. Nor could the level of improvement have been raised had none of the progeny varied to the extent of exceeding their parents in desirable development. The discussion of this question will be further considered in Chapter IV.

It may also be proper to mention here that variations in type within a pure breed are seldom to be desired, since, when made to the extent of practically supplanting a type previously existing, they necessitate a change in the standard of excellence. The more of diversity in type found within a breed the greater the want of unity and harmony among the breeders, and when such conditions exist the interests of the breed suffer in proportion as these are present.

Transmission in Mixed Breeding.—In cross-breeding and grading where different types are mated, the result is in a sense a mean between the two. The progeny cannot be exactly like either. The characteristics of both parents are transmitted in part, but they are seldom transmitted equally. There is in nearly all instances a preponderance in resemblance to one parent or the other, arising in a great measure, at least, from the greater prepotency of that parent which is most closely resembled in the progeny. Prepotency is discussed in Chapter IX.

Influences that Affect the Action of this Law.—The influences that affect the action of the law that like produces like are strong: First, in proportion to the purity of the breeding in one or both parents. This will be readily apparent from what has been said in Chapter I., page 8, when treating of breeding from parents whose ancestors have long been bred without any admixture of alien blood. The influence of alien blood must prove a disturbing factor to potency in transmission, since it is alien, and the degree of such disturbance will be proportionate to the degree in which alien blood is present, and to the degree in which it fails to harmonize with the dominant blood elements in the animals. In other words it will increase the tendency to variation in transmission.

Second, it will be strong in proportion to the period during which the animals have been bred pure. This, at least, is true up to a certain limit of duration. Whether a time comes when antiquity in the purity of the breeding ceases to affect the influences concerned in transmission has not been determined. In other words it has not been determined whether purity of breeding for a thousand years is a greater power than purity of breeding for five hundred years. If there is a time, as would seem probable, when duration in purity of breeding ceases appreciably to affect transmission, that time has not been determined, and if it could be, it would probably not be the same in all breeds. Experience has shown that one hundred years of pure breeding assures much potency in transmission, as evidenced in more than one of the dark faced breeds of sheep.

Third, it is strong in proportion to the closeness of the blood relationship in the parents. For instance, the progeny of animals closely related have usually a closer resemblance to the parents and to one another than the progeny of animals of the same breed but not closely related. The blood elements in the former would seem to have a stronger affinity; but why, has not been fully explained. This fact, however, has been turned to good account by the originators of new breeds. (See Chapter XXVII.)

Fourth, it will be strong in proportion to the nearness of the resemblance of the parents to one another in structure and form and in all leading characteristics. Conversely, it will be weak in proportion as the opposites of these are present in the parents.

It is evident that the more nearly the parents resemble one another in the features named, and in fact in all features, the less will be the gap to be bridged over in the process of assimilation through transmission. For instance, a well developed hind flank is more likely to be present in the progeny when this feature of form is correct in both parents than when it is correct only in one. Potency in transmission, therefore, will be strong in proportion to the intensity of the sum of all these influences acting in conjunction.

Features of Resemblance in the Offspring.—The resemblance of the offspring to the parents produced by the action of this law is not, by any means, confined to external form, although the evidences of such resemblance are thus most readily observed. It extends to every physical feature of the organization, as, for instance, structure, function, color, hair, and handling qualities. The rounded out, somewhat cylindrical form of Aberdeen polled cattle illustrates transmission in structure. The progeny of these have this form of body in contrast to the more square body of the Shorthorn because the parents have the same. The easy action of the limbs in the trotting horse and the more labored action in the limbs of the draft horse are illustrations of transmission in function. The black and white color in Holstein cattle, the white hairs never mingling with the black, illustrates transmission in color. The long, wavy hair possessed, more or less, by all Galloways and the short hair that characterizes Jerseys, illustrate transmission as to the nature of the hair. The strong, harsh hide in the scrub, and the soft, pliant hide in the Guernsey, illustrate transmission in handling qualities.

This resemblance also extends to habit and to the mental traits which frequently control habit and govern the disposition. A cow whose ancestors have grazed on the range for generations, will go dry in five or six months from the date of calving, while the period of lactation in the cow whose ancestors have been in the dairy for an equal number of generations will be not less than ten months. The difference illustrates transmission in habit. The young collie dog instinctively takes to the heels in driving because its ancestors have done so from time immemorial. The lambs of sheep used to the corral take kindly to the same, while those of other sheep are restless for a time under such restraint. These are illustrations of mental traits which control habit. The progeny of a bull, naturally vicious, are also likely to possess this trait in at least some degree. The calf of a cow whose ancestors have been in the dairy for generations can usually be taught to drink in a day, while the calf of a cow whose ancestors had roamed for several generations on the range would pretty certainly require several days to accomplish the same end. These are illustrations of mental traits that govern the disposition. Furthermore, this resemblance extends to abnormal qualities including diseases. The transmission of abnormal qualities is discussed in Chapter VI. and of diseases in Chapter VII.

Transmission Seldom Equal in Parents.—Theoretically one half of the characters possessed by the progeny when the conditions are apparently equal will be inherited from each parent. In fact, however, such a result is probably very seldom found. Though the qualities are apparently equal, they will probably not be so in reality. One will almost certainly be more prepotent than the other, while the evidences of this difference may not be apparent in the external individuality of each. The same is sometimes true of inherent vigor. When a preponderance of these and kindred influences are present, they will certainly accord to the parent possessing the same, an excess of influence in transmission, and yet, such preponderance may not be known beforehand. The deduction, therefore, is legitimate, that the sum of the characters inherited from one parent seldom or never equals the sum of the same inherited from the other.

CHAPTER IV.

THE LAW OR PRINCIPLE OF VARIATION.

It has been noticed that in many instances the progeny are not like the parents in every particular. Sometimes the difference is very slight and confined to but few particulars. At other times it is very marked and extends to many features, both of form and characteristics. And since these variations are never entirely absent, it would seem to indicate the existence of a law or principle in heredity that produces results different from the first great law of heredity, that is, the law that like produces like.

The Law of Variation Defined.—The law of variation may be defined as the tendency in animals to produce characters which differ from those of the paternal type. It may not unfitly be termed the law that like does not always produce like. These two laws, viz., the law that like produces like and the law of variation, would seem to be antagonistic to one another. That two such principles should be found concerned in transmission, however, is not more improbable than that the two opposing principles of good and evil should be found in the one moral nature. These changes may relate to both form and function. Lack of capacity in the barrel of a female as compared with the same in her dam, illustrates the first, and decreased milk production in the progeny as compared with milk production in the dam, illustrates the second. In time, these changes may become so pronounced in certain directions as to become modifications of the systems of animals. Such are some of the changes that follow a change of environment. Since these variations differ greatly in the time which is necessary to produce them, and also in their intensity, they may be classed as gradual, or general and ordinary, and as sudden or spontaneous and extraordinary.

General Variation Defined.—General variation is that tendency to change from the original type which characterizes in a greater or a less degree all the individuals of a breed. Sometimes it is in the line of improvement and sometimes in that of retrogression. The general direction which such variation will take will depend upon the causes which lead to it. These are given below under the proper heading. In either case it is an effort of nature to adjust the system to the surrounding conditions. But this does not explain the cause of variations that constantly occur in some degree in animals, when the conditions are as uniform as man can make them. The causes in these instances are to be looked for from within rather than from without, and they are such as relate to dominance in transmitting properties, or in what may be termed units of transmission.

General Variation Illustrated.—Illustrations of the principle of general variation may be found: First, in the tendency of grain to deteriorate when it has fallen upon an unkindly soil. This variation affects not only the straw but also the grain. There will, likewise, be variation in the time of maturing and in the ability to withstand disease. Second, in the quick deterioration of the heavy breeds of sheep when confined to unproductive or rugged pastures. Such sheep cannot find sufficient sustenance on those pastures without expending more strength and energy than the system can spare. It, therefore, seeks adjustment by reducing the size and weight of the sheep and by lessening the weight of the fleece. And the opposite is true of sheep taken to richer and more level pastures than those which they have previously been accustomed to. Third, in the tendency to the production of fat developed in the Hereford simultaneously with a diminished production of milk. A century ago many cows of this breed were abundant producers of milk. Now, that early maturity is so much sought in this famous breed of grazing cattle, free milk production in the dams is the exception. And fourth, in the exceeding fineness of fleece developed in the Saxon Merino but at the cost of diminished vigor. The causes which led to the production of wool so fine grew out of the management of the flocks and cannot now be further dwelt upon.

The Causes of General Variation.—The causes of general variation in animals are numerous, but chief among them are the following, viz.: Changed conditions of life, as climate, food, and general environment, also habit and dominance in internal powers of transmission. Climate, food, and environment are discussed in Chapters XX. and XXVIII. Habit is largely the outcome of management. It is happily illustrated in the more or less permanent increase or decrease in milk production in females, based upon the general management of the same through successive generations. The variations caused by dominance in the internal powers of transmission are less abiding. They are also less well understood, and consequently less perfectly under the control of man.

These influences are so intimately connected that oftentimes it is difficult to determine what is due to each. Doubtless, in some instances, they all act in conjunction. Probably in others some of them are antagonistic forces and made so by natural conditions or by management. A happy climate and sparse food production would be an instance of the first, and abundant food production accompanied by ill treatment or neglect an instance of the latter. General variation will be hastened or retarded very largely in proportion as these causes act in the same direction or otherwise.

Food a Powerful Factor in Variation.—The variations in the improved breeds with reference to the increased production of meat, milk, and wool are largely due to a liberal supply of nutritious food during the period of growth. Without such aid the marked improvement made during the past century could never have been secured. Nor can it be maintained in the absence of such supplies. It would probably be correct to say that up to a certain point, food has been more potent in affecting variation in the line of improvement than any single influence. In some instances this improvement has been realized in directions where primarily it was not sought. Illustrations are found in the breeding of sheep both in England and America. With many of the breeds in these respective countries, the dominant aim of the breeder was to effect improvement in the production of mutton. But it was also found, that improvement was effected in the production of wool. The weight of the fleece was not only increased, but the strength of the fiber was also improved. It has also been found that when improvement has been carried beyond a certain limit in one direction, in some instances it has been followed by retrogression in other directions. Improvement in the beef and mutton form of cattle and sheep, respectively, has frequently been carried so far that it has resulted in a decrease in milk production and also to a lessened power to breed well. Increased compactness of form in some of the breeds of swine has also been followed by decreased fecundity.

Spontaneous Variation Defined.—Spontaneous variation may be defined as that tendency sometimes found in animals to produce progeny more or less unlike either the parents or the ancestry of these. It differs from general variation in its violence and intensity, that is to say, it differs in degree, and it differs also in the greater tendency toward individualization. The changes in ordinary variation are gradual. They only become marked, when, by increase or decrease through repetition, there is, as it were, accumulation in variation. When the changes are sudden and extreme they may be said to be violent, and when the tendency is strong in these sudden variations to reproduce and perpetuate themselves, they may be said to be intense. Moreover, in ordinary variation the tendency to change in certain directions may affect many of the animals in a herd or even in a breed, whereas, in spontaneous variation they relate to but one animal. As with general variation, the change is sometimes in the direction of improvement and at other times in the direction of retrogression. It is also less under the control of the individual than ordinary variation. The latter is in many of its phases measurably controlled by the breeder, but not so the former, since it cannot be known beforehand when it will appear nor in what form.

Spontaneous Variation not Well Understood.—But little is known definitely regarding the action of this law or the principles that control it. It is thought in some instances that spontaneous variations arise from a sudden shock given to the pregnant mother, and in other instances from mental impressions at the time of conception or during the early stages of pregnancy. Thus, it is probable, that monstrosities are sometimes produced. These influences, as already intimated, would seem to be much more potent during the earlier stages of development in the fœtus. Whether this will apply to psychical as to physical development has not been positively ascertained. But these influences do not explain nearly all the instances of spontaneous variation which occur. They do not occur regularly or in any fixed order and since man cannot anticipate them he is almost entirely helpless to prevent them. And yet it may be true that they are as much under the control of law as transmission in the direction of likeness.

Illustrations of Spontaneous Variation.—Illustrations of the principle of spontaneous variation are found, first, in the occasional production of monstrosities. These are products of conception, sometimes alive, but more frequently not living at birth, and so malformed as to shock the sense of the fitness of things. Sometimes they are greatly defective in certain physical features of their being, and in other instances they have these in excess. A rabbit with but one ear would furnish what may be termed a mild instance of the former, and a calf with two heads or six legs an instance of the latter. The cause of malformations is discussed in Chapter XV. They are found, second, in the production of progeny very un-

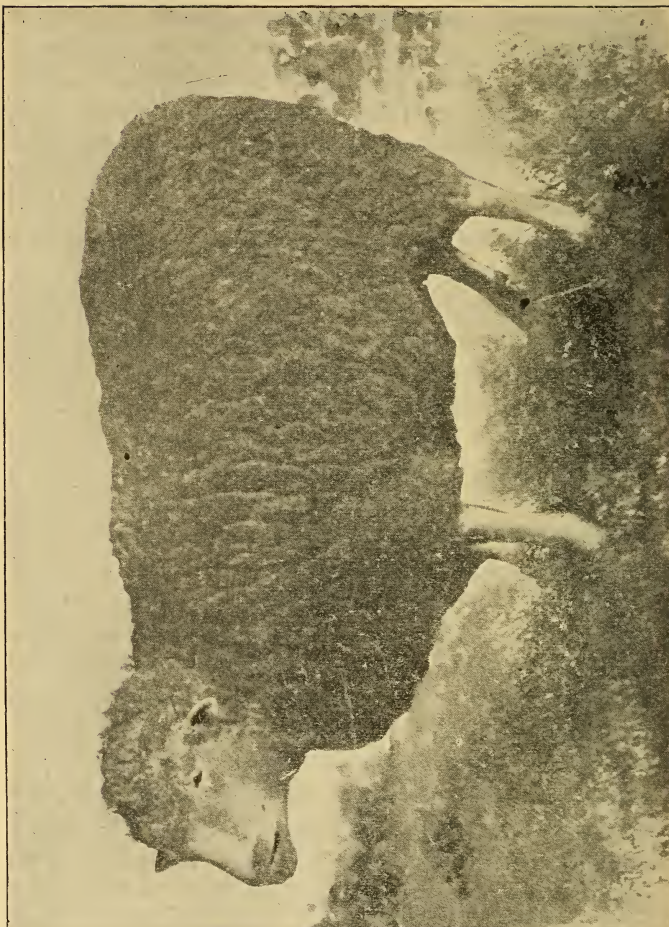

Fig. 2. Grade Dorset Ewe.
(Illustrating Spontaneous Variation.)
The property of the Minnesota University Experiment Station.

like the parents or the ancestry in color, form, and other characteristics. A black sheep appearing in a flock in which no animals of that color had ever appeared before would furnish an instance of the first; a dairy bred calf possessed in a considerable degree of the essentials of beef production furnishes an instance of the second; and a child of unusual timidity, the offspring of courageous parents and descended from a courageous ancestry, furnishes an instance of the third. A further illustration is found in the case of a woman on exhibition in Minneapolis in 1895, who was more than eight feet high, although neither of her parents were of more than average size. They are found, third, in the various hornless breeds of cattle. It is now considered certain that these are all descended from races which at one time were horned. This conclusion is sustained by the absence of hornless specimens in the more ancient of the geological formations in which the skeletons of cattle are found, and also by what is known regarding the origin of at least some of the hornless breeds.

Spontaneous Variations Cannot Perpetuate Themselves.—That spontaneous variations cannot perpetuate themselves unaided by man is owing largely to the infrequency with which they occur. Even under circumstances that are deemed most favorable to their production their occurrence is infrequent. So infrequent are they in some well bred herds, that the owners may not be able to cite a single instance of such variation at all pronounced in a lifelong experience in breeding.

It is certainly fortunate that it is so, for in a large majority of instances they are disturbing factors in breeding. So infrequent are they, that notwithstanding the marked power which they often have to reproduce themselves they are soon obliterated through the overwhelming preponderance of blood flowing in normal channels. Because of this it would probably be impossible for any instance of spontaneous variation to perpetuate itself so as to become a peculiarity of the breed, without the aid of man. But when man comes to the rescue, as he has done in forming the hornless breeds, he can, through judicious selection, make the new characteristic a characteristic of all the animals of the breed. The fact, however, must not be overlooked that some forms of ordinary variation are secured and perpetuated through changed conditions. Take, for instance, Shetland ponies to a milder climate and surroundings of improved food production, and they will increase in size even though running wild.

Variations more readily Produced in Domestic Animals.—Variations in both forms and the susceptibility to them are more readily produced in domesticated than in wild animals. This is owing to the greater changes in the conditions that surround the former. The conditions that surround wild animals are much the same from generation to generation. Those to which domesticated animals are subjected are frequently changed, and in some instances the changes are marked. All changes in surroundings and management tend to produce variation, as previously shown, and this tendency is markedly strengthened by the admixing of alien blood elements. That variations would multiply, therefore, as changed conditions and mixed breeding increase, is what is to be expected, and that the violence of such changes would increase with the intensity of changed conditions is a natural sequence. It is also owing to the greater resistance to variation offered by wild animals through fixity of type of long duration.

It has been shown that purity of breeding long continued is a dominant factor in producing certainty in transmission. (See page 32.) It follows, therefore, that the opposite of this will also prove true, that is to say, that the decrease in the duration of the period of pure breeding will lead to an increase in variation. But it would not be quite safe to say that duration in breeding in any line, however long continued, would so intensify heredity that variations even spontaneous in character would never occur.

Perpetuating Variations.—In a preceding paragraph it has been shown that variations cannot perpetuate themselves unaided by man, save through changed conditions, and that even with changed conditions, spontaneous variations cannot perpetuate themselves without such aid. It is true, nevertheless, that when variations do occur, there is in them frequently an inherent tendency to reproduce and perpetuate themselves. Particularly is this true of some forms of spontaneous variation. For instance, when, in a pure horned breed a hornless male appears, and is mated with females of the same breed, it is almost certain that a majority of the progeny will be hornless. Because of this, improvement has been made possible in breeds by selecting the desirable variants and breeding from them so as to effect further improvement. On this principle, also, new breeds have been formed possessed of distinct peculiarities, as, for instance, one branch of the Polled Durhams.

Nearly all the breeds of sheep and swine that have been improved chiefly by using materials within the breed itself, have been so improved by taking advantage of distinctive variations that existed at the time when the improvement began and that subsequently appeared and breeding the animals with a view to render these permanent. Notably was this true of the old Dishley breed of sheep which the genius of Bakewell transformed into what has since been known as the Leicester breed. It is true nevertheless, that in a larger number of instances transforming power has been brought in through cross-breeding, and for the reason that the desirable variations were more readily secured in animals of another breed. But when the latter method is chosen the tendency to revert to the original type is much stronger, hence permanent improvement is slower. This tendency to reversion is very marked in hybrid plants. For many generations do they show a tendency to reversion. Variations in type within a breed that have assumed what may be termed fixity of type, have also been used to effect improvement by fusing or intercrossing them, if the term may be thus used. It was thus that the Cruikshank Shorthorns were evolved through more or less of the blending of Bates and Booth blood, accompanied by selecting to a type different from either.

Variation Consonant with Highest Development.—The repeated and systematic exercise of any organ or set of organs is necessary to secure and maintain variation consonant with the highest development, as witnessed in the training of athletes. Again and again it is necessary for them to repeat the same acts until performing them requires but little effort, unless the performance of these particular acts is very extreme. But even when thus secured in the individual, several generations of such training would be necessary before what may be termed a family of athletes could be produced. Such a necessity is also shown in the development of the milk-giving function in cows. Milking qualities of the highest type could not be secured by transmission alone, that is to say, by selecting from cows noted for milk production and by breeding only from them. It is also further necessary to milk them by hand so that all the milk may be taken from them, to breed them young that the energies of the system may be early turned to milk-production, and to milk them for a long period that persistence in milk production may be secured. In other words it is necessary to strengthen the milk giving function through what may be termed repetition in milk-giving.

The same is true of the strengthening of the intellectual powers. By repetition in effort the mental powers of the individual are strengthened. What is thus gained is secured in part by transmission, and through repetition in effort in the same direction, a higher level is reached. Thus it is that nations become possessed of individual characteristics, and thus it is that they are lifted to higher levels of attainment.

Power of Transmission in Some Families.—Some families of a breed have a much greater power in transmitting their peculiarities than others, and for the reason that these have been intensified by a certain line of breeding. Illustrations may be found in the Webb Southdowns, in what is sometimes termed the Dishley Leicesters and Longhorns, and in the Ben Tompkins sort of Herefords. In these respective instances families had been evolved within the breed.

They had been so evolved through the aid of in-and-in breeding, a process which speedily intensified properties. Males of correct form and qualities that have been thus bred are able to secure desirable variations in the progeny, and to render them permanent. It is this persistency of transmission which makes variation possible in improving breeds in a certain direction already established and in producing new ones. Were it otherwise, what would be gained in one generation would be lost in the next.

CHAPTER V.

THE LAW OF ATAVISM.

It has been shown, that by the first great law of breeding, viz., the law that like produces like, improvement may be secured in a definite line through judicious breeding. It has also been shown that through the second law of breeding, viz., the law of variation, higher improvement may be secured when the proper steps are taken to perpetuate desirable variations and to eliminate those that are undesirable. There is yet another feature of breeding frequently spoken of as atavism, that cannot, properly speaking, be said to come within the realm of either of the above laws. The evidences of it are so frequently apparent as to justify the conclusion, that, notwithstanding the erratic character of its action, it is under the direction of law. It will, therefore, be denominated the third law of breeding.

Definition of Atavism.—By atavism is meant that innate tendency in animals to revert to the original type. It is frequently spoken of as reversion, at other times as throwing back and yet again as breeding back. It differs from the law that like produces like in the production of resemblances to an ancestry more or less remote rather than to the parents or to a near ancestry. How far back these resemblances may be traced is not certainly known, but they have been traced to several, even to many generations. It differs from the law of variation in producing resemblances to an ancestry more remote than the parents or the near ancestry, whereas the latter produces dissimilarity to the ancestry whether near or remote.

Illustrations of Atavic Transmission.—Illustrations of atavic transmission may be found: 1, In the occasional appearance of scurs or horns in the polled breeds of cattle bred pure for many generations. 2, In the Shorthorn herd books, where many instances of atavic inheritance are found which appertain to color. 3, In the occasional appearance of tan-colored spots on the ears and face of the American Merino. And 4, in the occasional out-cropping of physical defects and peculiarities in the human family after the interval of generations. Scurs or miniature horns appear with more or less frequency in the polled breeds, notwithstanding the efforts of the breeders to remove them entirely. In some instances these efforts have been persistent for more than a century. The same is true of the white color in Shorthorns, notwithstanding the deep rooted prejudice against this color during the past decades. The breeders of American Merinos have sought for more than half a century to remove the tan-colored spots which at one time more or less characterized the face and ears of many individuals of the old Spanish Merino breed, and yet they appear occasionally. Physical defects, as, for instance, a deficiency in the proper number of fingers, have frequently appeared in descendants removed several generations from ancestors thus affected.

Forms of Atavic Transmission.—Atavic transmission may relate to form, color, habits, mental traits, predisposition to disease, and, indeed, to any feature of the organization. The comparative frequency of the light thigh in the Hereford, notwithstanding the efforts of breeders to remove it during recent decades, illustrates atavic transmission relating to form. The occasional appearance of a belted Galloway furnishes an illustration of atavic transmission relating to color in addition to that given above. The occasional production of a superior milking cow in breeds long bred almost wholly for beef production is an instance of atavic transmission pertaining to habit, and also to function. The love of the descendants of the Indian for a comparatively idle life and also for a roaming life after the lapse of generations and after the effort of generations to teach him habits of industry, furnishes an illustration of the atavic transmission of mental traits. The appearance of certain tuberculous diseases after the lapse of several generations, not only illustrates the atavic transmission of those diseases, but of the tendency to the same through the intervening generations. These illustrations could be multiplied indefinitely. Not only is it true that these peculiarities may appear in the offspring without having appeared for many generations previously, but it is also true that they have been transmitted without the possibility of detecting even a trace of their presence, and yet it is doubtless true that the tendency to produce them was present all the while, though in what may be termed the latent form. Other influences were doubtless present which kept those tendencies quiescent for the time being.

Atavic Transmission not Well Understood.—The laws which control atavic transmission are very imperfectly understood. Much less is known with reference to the influences which control them than with reference to those which control ordinary variation. From certain lines of breeding, as, for instance, cross-breeding, variation may be expected. The same is true of animals of the same breed widely dissimilar in form when bred together. It could not be otherwise, since elements positively alien are blended in the first instance and elements of dissimilarity in form are fused in the second. The attempt, at least, is made to blend in the one instance and to fuse in the other. But it cannot be known beforehand just when atavic transmission will appear any more than the extent of the same may be known when it does appear. The conclusion is legitimate then, that the laws which control atavic transmission are apparently uncertain and variable in their action. But this uncertainty and variability is doubtless only apparent. What appear to be erratic results is doubtless the outcome of influences, some of which are so subtle as to be beyond the realm of human scrutiny. In some instances it is not easy to distinguish between what appertains to atavic transmission from that which is the outcome of spontaneous variation. It may be that in some instances the two principles act in conjunction.

Two Classes of Atavic Transmission.—The observed instances of atavic transmission have been divided into two classes. To the first class is referred the reappearance of lost characters in purebreds after the interval of a number of generations. To this class would belong the reappearance of the undesired dark muzzle in Shorthorns, the reappearance of scurs in the dark faced breeds of sheep, of bristles in the improved breeds of swine, and of the red color in the Aberdeen Angus Polls. It would not be quite correct to say that these are in no degree under the control of man, since it has been observed that the tendencies to reversion decrease with increase in the duration of the breeding in a certain line. To the second class belong those instances in cross-breeding where a peculiarity of the animal used to effect the cross appears which had not formerly occurred in the cross-bred descendants, or which had been early lost on the return to the use of a single strain upon the descendants of the cross.

For instance, when a Galloway sire is used on a pure-bred of one of the horned breeds, the horns are almost certainly absent in the first cross because of the greater prepotency of the Galloway blood, based, doubtless, in a considerable degree on the longer period of pure breeding in the Galloways. The absence of horns will almost certainly characterize successive generations of the descendants when the use of pure Galloway blood is continued. But there might be instances when horns or scurs would again crop out. If so, they would almost certainly arise as a result of the cross-breeding, that is to say, as a result of what may be termed latent potency in the pure breed first crossed upon by the Galloway. Such a conclusion finds countenance in the fact, that atavic transmission is much less rare in the progeny of pure bred animals than in the progeny of cross breds. Observation has also shown that atavic transmission is much less frequent in the progeny of animals of mixed breeding that are unexpectedly crossed upon by pure breds, than if both breeds were pure when first mated.

Influences that tend to Produce Atavic Transmission.—The tendencies to atavism would seem to be strong in proportion: 1, To the want of duration in the purity of the breeding. 2, To the lack of purity in the blood when alien pure breds are bred together. 3, To the lack of purity in the blood when animals of the so-called pure breeds are mated, that is animals of the same breed. And 4, to the lack of prepotency on the part of the parents. Scurs appear more frequently in the Aberdeen Angus Polls than in the Galloways. This is doubtless owing to the less prolonged period during which the former have been bred pure than the latter. Pure Yorkshire swine are very rarely "off" in their color markings. The same cannot be said of pure Berkshires. The former have been bred pure for a considerably longer period. Reversion is much less common in the Merinos than in the Oxford Downs, since the former is the more ancient breed, and thus it is with various other pure breeds that may be thus contrasted. These facts point to the conclusion, that sometime in the breeding of pure breds a place will be reached where the influence of atavic transmission would practically cease as far as relates to the original characters of the breed. That want of purity in breeding and duration in the same increases the tendency to reversion has already been touched upon in the preceding section.

The more nearly balanced then, that breeds are, in antiquity of breeding, the more numerous will be the instances of atavic transmission when they are crossed, for then the resistance to fusion would be stronger than under different conditions. Under such circumstances it has been noticed that there is a tendency to reversion to the original traits of one breed or the other rather than to blending or fusion. The reasons cannot be satisfactorily given. With animals of a so-called pure breed of recent formation, the tendencies to atavism will be strong in proportion to the recentness of the formation of the breed. This, at least, will be true of such breeds as are of composite blood, for then alien blood is present more or less, and it has been shown that the blood of cross-breds tends to increase the inclination to atavism. That the tendencies to atavism as to variation would increase as prepotency is weak, would seem to be reasonable, since prepotency from its very nature tends to produce resemblance to the parents rather than to their ancestors, near or remote.

Alternations in Atavic Transmission.—In some forms of atavic transmission there is a tendency to alternations of generation in the inheritance and more especially with reference to certain forms of disease. Such transmission may be more or less regular in its appearance, as, for instance, in every second or third generation, or it may be irregular, owing, in part, at least, to the presence or absence of exciting causes acting upon the rudiments of yet future diseases that have been transmitted. In many of the lower animals the alternation of generations is a fixed law of transmission. According to Miles, in a certain order of plant lice, the aphides, nine or ten generations of individuals are produced in succession before those having sexual organs that are capable of producing eggs make their appearance. But alternations of this class vary in the number of generations which they cover in different orders.

Reversion surrounded with Difficulties.—Because of the alternations just referred to and also the apparent irregularities in transmission, the theory of reversion is surrounded with many difficulties. This irregularity may arise, in part, from the inheritance of two or more than two antagonistic characters, either one of which may become dominant in the offspring. They may dominate in a regular or irregular alternation. That one or the other of these characters should dominate in what may be termed irregular alternation may be accounted for through the influence of natural causes, as, for instance, changed conditions, and to some extent they may be and doubtless are influenced by the character of the breeding. And yet these influences are so subtle in their action that, heretofore, they have baffled all attempts to explain them. This, at least, is true of many of them. But the explanation just given does not sufficiently account for transmission in an alternation of generations whether the alternation be regular or irregular. External influences of an even character should tend to produce uniformity in transmission. When the external evidences, therefore, are of this character, and yet there are alternations in transmission, such transmission certainly points to the conclusion that these belong as strictly to the organization through inheritance as any other part of the system.

Reversion not Spontaneous Variation.—Individual instances of reversion cannot be referred to spontaneous variation. The difference between these has already been touched upon when defining atavism. It was there explained that atavism produced resemblances to an ancestry more or less remote, whereas spontaneous variation produced dissimilarity to the ancestry whether near or remote. Spontaneous variations are extremely irregular and they are not only dissimilar to the ancestry, but also to one another. In individual instances of atavic transmission, there is not only resemblance to the ancestry, but resemblances to one another are frequent in the instances of such transmission. There can be no effect without a cause. The more constant the effect, the more apparent is the cause. The constancy, therefore, with which some pre-existing characters are transmitted proves the existence of definite physiological laws governing atavic transmission. The mistake, however, must not be made that because spontaneous variations are so extremely irregular they are not under the domain of law. But it must be acknowledged that extremely little is known in the meantime of the laws that control atavic transmission, whatever may be known of these in the future.

Theorizing on Variation.—Some have accounted for the phenomena of all variation, including reversion, on the hypothesis that the union of two different natures in reproduction may give a result essentially different from either. If this were true, there could be no assurance of constancy in the transmission of ancestral forms. The first great law of breeding could then be no longer looked upon as a law. It would be of no value to the breeder because of the extreme uncertainty of the character of the transmission. This hypothesis is not true even in instances of spontaneous variation that are quite pronounced in character. In such instances the variation belongs only to certain features of the animal. Take, for instance, Polled Durham cattle. One branch of the breed is purely Shorthorn. Through spontaneous variation foundation animals were secured that were hornless. Notwithstanding such variation, the Polled Durhams have all the characteristics of Shorthorns with the exception that the horns are absent. Such a hypothesis would imply the correctness of the theory that the elements of the organization may be again resolved into their original constituents. This would scarcely seem possible, for if it were so, accumulation in dominant properties could not be secured. The tendencies to reversion might then be as strong as those in the direction of transmitting like properties.

Dominant and Latent Characters.—In the discussion of the various forms of heredity it is necessary to distinguish between dominant and latent characters in heredity. The dominant characters include those that are prominent and obvious. For instance, the power to transmit fine and dense wool in the Merino sheep is a dominant character. It is known to be so, since it has been observed that they always transmit wool fine and dense. A century ago the Spanish Merino was narrow in body and flat in the rib. American breeders have sought to widen the body and round out the rib, and with considerable success, and yet not infrequently individuals appear with those characteristics as they were originally. The characters which reproduce them are latent. The presence of the dominant characters are known by the constant character of the transmission. The latent characters can only be shown to have existed by occasional transmission in the offspring. It may be true that all characters are transmitted as physiological units, some of which are dominant and others latent. This theory, if correct, would throw some light on the subject of heredity, but it would not throw any light on the causes of dominance in the various units of transmission. On much that relates to transmission the word mystery can be written, and it is the only word that will fitly apply at present, whatever the future may bring forth.

An Assemblage of Characters not Inherited.—It is not probable that the offspring inherits an assemblage of peculiarities representing the aggregate of parental characters. That it is so is shown in the inheritance of certain diseases. The morbid characteristics of one or the other parent are frequently either completely repeated or are altogether absent, and yet other prominent characteristics will be inherited from the parent whose morbid characteristics were not transmitted. It is doubtless true, therefore, that dominant features in the offspring may be inherited from both parents, while other features in each may not be inherited in any marked degree except in what may be termed the latent form. Hence it is, that the offspring may inherit the defects of one parent and the good qualities of the other. It also happens that a defect disappears for a number of generations and then suddenly appears. Theoretically it has been bred out, but the fact of its reappearance shows that it has been transmitted all the while but has in the interval been quiescent.

Atavism not necessarily Antagonistic to Improvement.—Atavism is usually looked upon as antagonistic to improvement in breeding, but good may come from it in some instances on the principle that good may result from what is in itself an evil. So-called improvement in breeding has not always been unmixed improvement. Poland China swine have been greatly improved as compared with their ancestors in form and feeding qualities, but in very many instances at the sacrifice of stamina. When, therefore, atavic transmission relating to inheritance of this character appears it is distinct gain. But it is only when improvement in some features has been accompanied by retrogression in others that any direct benefit can be gained from atavic transmission. When, however, breeders are led, through the fear of atavic transmission, to discard the use of grade sires on their farms and to avoid cross-breeding in an aimless and uncertain way, great good may result from the fact of its existence. It then becomes a rod, as it were, to whip the breeder into line who might otherwise be careless in his methods.

CHAPTER VI.

HEREDITY OF NORMAL, ABNORMAL, AND ACQUIRED CHARACTERS.

All transmission is the outcome of natural law. But it has been shown that the laws which govern transmission are not equally apparent. For instance, the laws that control variation and reversion are more obscure in their action than the law that controls likeness in transmission. The same things may be said of the heredity of normal, abnormal, and acquired characters. While all such heredity is under the control of law the transmission of normal, abnormal, and acquired characters is by no means equally uniform or equally apparent.

Definition of Heredity.—Heredity is the result of the operation of that law whereby characters and qualities of like kind with those of the parents and ancestors are transmitted to the offspring. It is another name for inheritance, and is so closely akin to transmission that the terms as applied to breeding may be considered synonymous and interchangeable. This transmission relates to structure, function, habit, and qualities, and, indeed, to every feature of the organization. Thus far it is on a par with transmission which is the outcome of the law that like produces like. But, unlike the former, it relates to all kinds of transmission as well as to the transmission of like qualities. The inheritance of spavin in a colt from one or both parents thus affected illustrates heredity that relates to structure. The inheritance of high stepping and free knee action in the progeny of one or both parents thus characterized, illustrates heredity relating to function. The difficulty found in teaching a calf to drink milk when immediately descended from ancestry that have roamed on the range, as previously stated, as compared with a Holstein calf whose ancestry have been reared by hand for generations, illustrates heredity which relates to habit. And the superior handling qualities in an Aberdeen Angus Poll descended from parents that were thus furnished, as also previously stated, illustrates the heredity of a quality, that is to say, the quality of good handling. The supposed exceptions to heredity are doubtless the result of the predominant influence for the time being of other laws acting in opposition to the hereditary tendency. Heredity may be characterized as normal, abnormal, and acquired. These will be considered separately.

Heredity that is Normal.—By the heredity of normal characters is meant the inheritance or transmission of characters natural to the type. These characters are of two classes. They have been original traits bestowed upon the species, or they may have been acquired, and rendered permanent by continued transmission. To the former class may be referred the readiness with which the horse obeys, the teachableness of the dog, the natural timidity of the sheep, the thirst of the tiger for blood, the readiness with which swine seek the wallow in time of heat, and the eagerness of the collie dog to assist in driving the flock without harming it. It is not always possible to distinguish between heredity that is normal to the type and heredity that is acquired. For instance, the habit of milk giving in the cow is normal, but the habit of abundant milk giving is acquired. That which is acquired may in time come to be looked upon as normal when it becomes so engrafted on the species as to be transmitted with as much regularity as characters that were original traits.

Illustrations of Normal Heredity.—Illustrations of the persistent and uniform action of the law of heredity of normal characters may be readily drawn from the different departments of organic life. In geological formations covering immense periods of time, fossil species and generic forms present the same essential characters throughout the entire range. The ox, for instance, has the essential features of anatomical structure in his organization in the skeletons found in the earliest geological formations, as he possesses to-day. The lapse of time represented in the historic period has made no appreciable change in the characters of wild animals. The lion is neither more nor less fierce to-day than in the days when he was hunted by Nimrod. The wild hare is no less timid than it was long centuries ago. The elephant of to-day is characterized by his enormous size as he was in the days when he trod down the enemy in battle while Alexander the Great was conquering Persia. The wild goat loves to graze upon the mountains as in the days before the flood. And the eagle builds its eyrie in the cleft of the rock as it did in the days when the earth was green and young. The animals that have been preserved in the monuments of Egypt from a remote antiquity are essentially the same as those now found on the banks of the Nile. In these various illustrations is evidenced the constancy and persistency with which original traits are transmitted when nature is not interfered with in her processes. It would, therefore, be correct to assume, that nature unaided has not performed any important part in the evolution of breeds. It is only, or at least chiefly, when the guiding hand of man has come to the aid of nature that evolution has become at all permanent.

Heredity of Individual Peculiarities.—The heredity of normal characters is by no means confined to those that belong to the species as such. It extends as well to individual peculiarities. Illustrations of such transmission are found, first, in the families of athletes and giants. In the Old Testament Scriptures families of giants are referred to and in a way which points to the conclusion that such extraordinary physical development was the outcome of inheritance. In ancient Greece were families of athletes noted as such from generation to generation. Second, in the very large number of running horses descended from Herod and Eclipse and of trotting horses descended from Messenger. The winners in the individual progeny of these horses aggregate a large number. Third, in the remarkable development of the musical talent found in certain families for successive generations. As Miles has stated, many of the descendants of Sebastian Bach, who lived in the sixteenth century, were organists and church singers in Thuringia, Saxony, and Franconia. For nearly two centuries subsequently to his death they furnished many musicians of great eminence. Fourth, in the longevity of certain families even though the conditions are unfavorable to such longevity. To so great an extent is longevity in families taken as the estimate of the duration of life, that insurance agents lay much stress upon it when issuing policies. Fifth, in the fecundity or sterility of certain families. This is witnessed in

FIG. 3. CALF WITH SIX FEET.
(Illustrating Abnormal Transmission.)
The property of Mr. G. W. Kinyon, Owatonna, Minn.

the human race and also in domestic animals, and these distinctions are noticeable where the conditions of life are very similar. And sixth, in the inheritance of mental and moral traits. Some families are noted as being quarrelsome from generation to generation, others are pre-eminently distinguished by their generosity, and yet again others are noted for the long line of individuals who have devoted their lives to the Christian ministry.

Heredity that is Abnormal.—The heredity of abnormal characters means the inheritance of characters which have deviated from the natural and acquired characteristics of the type. It would, perhaps, be correct to say that all disease is abnormal, and that the discussion of the same should be included in the discussion of abnormal characters. But there are some points of difference between disease and other abnormal characters. While all disease is in a sense abnormal, characters that are usually spoken of as abnormal do not necessarily constitute disease. For instance, there may be malformation of structure, as an excess in the number of the fingers, or derangement of function, as deafness, found in persons who have excellent health. There is more of obscurity surrounding abnormal characters which do not constitute disease than in those which do constitute the same. It has, therefore, been deemed advisable to discuss the two separately. Abnormal characters which do not constitute disease may appear as malformations of structure or derangement of function. When they constitute disease they assume many forms of the same as will be shown in Chapter VII., which treats of the heredity of diseases.

Heredity of Malformations in Structure.—The heredity of malformations in structure may be illustrated as follows: 1. Certain families have been found with an excess or with a deficiency in the number of fingers and toes or of joints in the same, and these have been inherited with more or less of regularity for generations. Females in the human family have been able to give nurse to their children from more than two nipples, and some of these have been irregularly placed. 2. Dorking and Houdan fowls have a fifth toe, which is, of course, supernumerary. The Houdans especially were not always characterized by this peculiarity, though now it is a constant characteristic of the breed, and in the Dorkings the tendency is strong to further variation in the production of toes. 3. The Niata breed of cattle grazed by the river Plata. As described by Darwin in "Animals and Plants under Domestication," they had a peculiar malformation of the skull, by which its nasal end was curved upward. The lower jaw projected beyond the upper, and had also a corresponding upward curvature. It is reasonable to suppose that this deformity is the outcome of inheritance in malformation. 4. A family of one eared rabbits has been originated, as described by Dr. Anderson in "Recreations in Agriculture," by breeding together a closely related pair in which the abnormal character had appeared. Illustrations of this feature of abnormal transmission could be multiplied indefinitely.

Heredity of the Derangement of Function.—Illustrations of the derangement of function may be found in the tendency of some families to use the left hand. This tendency has frequently been transmitted from generation to generation. The tribe of Benjamin was noted for its left-handed slingers. These appear to have been so numerous that they constituted the rule rather than the exception. The narrative would seem to show, at least, that the most famous of the slingers in the tribe were left handed. Further illustration of the same is found in the inheritance of deafness, dumbness, and impaired vision. These are frequently transmitted from generation to generation though not by any means in an unbroken line of transmission. The inheritance may be direct and obvious in some members of a family, but not so obvious in others, and yet it may reappear in the children or in the descendants of the latter.

Abnormal Characters not Uniformly Inherited. —Abnormal characters are not so likely to be perpetuated through transmission as original traits or acquired habits in harmony with the original peculiarities of the animal. If a record were kept of all the instances of inheritance of abnormal qualities in the offspring thus affected, it would be found that as a rule the number of the progeny not inheriting such qualities would considerably exceed that of the progeny in which such inheritance appeared. But this result may arise in part from the fact that parents possessing abnormal peculiarities are usually mated with those who do not possess them. Normal inheritance from the latter would tend to counteract abnormal inheritance from the former. But, sometimes, there is an increase in the development of an abnormal character. Such would appear to be true of Houdan fowls, which, according to Wright in his work on poultry, very rarely showed the fifth toe when first introduced into England, while now the absence of the fifth toe is exceptional. Why the tendency to transmit abnormal characters should be so much stronger in some instances than in others cannot be fully accounted for in the present state of our knowledge.

Abnormal Transmission not always Apparent.—It is not by any means certain that the abnormal peculiarities of parents have not been transmitted to the offspring when they are not discernible. Sometimes such transmission is not apparent for at least a limited number of generations, when suddenly it reappears with more or less of completeness. The fact of such reappearance as with ordinary atavic transmission proves that the tendency to these abnormal characters has been transmitted all the while. Their obscurity in the meantime has been the result of the presence of some more dominant character or characters. Their non-inheritance can only be fully determined by an exhaustive examination of all the individuals in the direct and collateral lines of descent, and for a period that will cover several generations.

Functional Derangement not Always Followed by Structural Changes.—The transmission of functional peculiarities does not always involve the transmission of some corresponding structural change. Functional derangements from an injured nervous system have frequently been transmitted without malformation of the nerves. Nor does the inheritance of the use of the left hand involve any structural change. In a majority of instances it would be correct to say that such transmission is accompanied by structural changes. For instance, the inheritance of diminished capacity for milk production, as when the inheritance comes from the male, is accompanied by less capacity in the development of the udder, and by an udder less glandular in character. It should also be remembered that in-and-in breeding tends to intensify all forms of abnormal inheritance. It should, therefore, be most sedulously avoided when the aim is to breed out abnormal characters that may have appeared.

The Heredity of Acquired Characters.—By the heredity of acquired characters is meant the inheritance of characters engrafted upon those original traits peculiar to the type. They differ from normal characters in not having originally belonged to the type, and they differ from abnormal characters in their being in harmony with the original constitution of the race, which the latter are not. They may be produced by such influences as food, environment, education, and training. The much greater size of the American Merino as compared with the Spanish Merino is an acquired character produced by good food aided by good care. The relatively large development of the forequarters of the sheep reared on mountains is an acquired character produced by environment. The readiness with which domestic animals submit to human direction as compared with wild animals of the same species is a character acquired through education. And the tendency in the collie dog, as previously intimated, to drive at the heels rather than at the head is a character acquired through generations of training. These characters may be more quickly secured and intensified by the aid of in-and-in breeding than in its absence. Especially is this true when they are in the formative stage.

Heredity of Acquired Characters Illustrated.—Illustrations of the inheritance of acquired characters are numerous: 1. It is seen in the sagacity and fidelity of the collie dog and in the striking peculiarities of other breeds of dogs. The wisdom of the collie dog is such that it would almost seem to be guided by reason. The readiness with which the Newfoundland dog takes to the water is simply wonderful. So, too, is the service rendered by the St. Bernard dogs of the Swiss Alps, and by the pointer and the setter. These distinguishing traits are all acquired. 2. It is seen in the tendency of beef breeds to lay on fat and of the dairy breeds to secrete an abundant supply of milk and for a long period. The marked differences which in these respects characterize breeds did not always characterize them. They have been first acquired and then intensified. 3. It is seen in the speed of the American trotting horses, in the ambling pace of those of the Cordilleras, and in the readiness with which Norwegian ponies obey the human voice. These characters have been developed through long years of training, until they have come to be transmitted with much regularity. 4. And it is seen in the disposition to wariness which has come to characterize various races of wild animals, which at one time manifested no uneasiness because of man's presence. Birds, and also quadrupeds, inhabiting various islands when these were first discovered, manifested no fear of man, but their descendants now flee at his approach.

Acquired Characters and Original Traits Conflicting Elements.—From what has been said it will be apparent that acquired characters and original traits are conflicting elements, either one of which, from its intensity, may predominate in hereditary transmission. The former are less certain to appear for a time in heredity, but eventually they may be looked for with as much certainty as the original traits. In many instances they supplant the former. Such was the case with the wild birds just referred to in which the absence of fear because of man's presence was succeeded by great fear because of the same. From a practical point of view, therefore, the engrafting of acquired characters is without any limit.

The fact is not to be lost sight of, however, that the characters thus engrafted must be in harmony with the original constitution of the race. The dog is naturally teachable, hence, with the dog the engrafting of an acquired character is not usually difficult. Swine are not nearly so teachable by nature. Generations of careful training would doubtless improve them in this respect, but would never make them so susceptible to training as the dog.

It is not difficult to so modify physical characters in animals that were of primal bestowment, that in turn they become acquired characters. The strong tail head possessed by many of the old time Galloways is much less pronounced in the Galloways of to-day. The reduced size of the tail head has, therefore, become an acquired physical character of the breed. But it is difficult to entirely eliminate an organ of primal bestowment, as, for instance, the removal of horns or tail in domestic animals without the help of spontaneous variation. During past centuries it has been customary with some, at least, of the English breeds of sheep, to remove the tail at an early age, with the exception of from one to two inches nearest the root of the same, and yet when lambs of these breeds are born, the tails are as long, apparently, as they ever were. The change would probably be made much more quickly by constantly selecting animals for breeding possessed of the shortest tails. It would, therefore, require many generations of breeding before dehorning alone would produce hornless animals, if, indeed, that alone would ever produce such a result.

CHAPTER VII.

HEREDITY OF DISEASES.

That certain forms of diseases are transmissible does not for one moment admit of question. That all forms of disease are transmissible is not true. It is equally certain that in many instances disease may be present, or the predisposing influences that lead thereto, in a form so subtle as to escape notice, and that when thus present it may be transmitted directly, or the tendency to it only may be transmitted, requiring only certain conditions to develop into the active form. This question, then, is one of great practical moment to the breeder of live stock and should receive at his hands the most careful consideration.

Heredity of Disease Defined.—By the heredity of diseases is meant the transmission to the progeny of certain abnormal conditions of the system which characterized the parents. It has already been shown in Chapter VI. that all abnormal conditions do not constitute disease, and that while all disease is abnormal, all that is abnormal is not disease. It should also be remembered that only certain kinds of disease are transmissible. While it may not be easy in all instances to distinguish between diseases that are transmissible and those that are not, it would be correct to say that all diseases of that class known as constitutional are transmissible. Those of a tuberculous character are by far the most numerous. Many contagious and infectious diseases are not only not transmissible, but their having been once borne by the individual would, in some instances, appear to render the progeny less susceptible to the disease. Such it has been claimed is true of hog cholera, although authorities are not agreed as to this question.

Heredity of Diseases Structural and Functional.—As with the heredity of abnormal characters which do not constitute diseases, such inheritance may relate to a modification of structure or to a derangement of function. When such heredity relates to the modification of structure it is seldom or never questioned, since the evidences of its presence are so apparent to the eye, but when it relates to derangement of function, it is more liable to be overlooked. For instance, when ringbone has been present in one or both parents and again appears in the offspring, the inheritance of ringbone by the latter from the former is not questioned, since the evidences of it are so apparent to the eye. But suppose that the udder of a dam is tuberculous, the presence of the same, for a time at least, may not be patent to the eye. Should the cow so affected beget progeny it will inherit the tendency to tuberculosis, and should she suckle the same, the progeny will be almost certain to contract tuberculosis from the dam. Now suppose such inheritance is exactly similar in kind, function in the udder of the progeny will be deranged, and yet it may not be possible to be absolutely assured of such derangement, at least for a time, save through the process of a post-mortem on the cow, and even then the functional derangement would be accompanied by structural derangement. It would seem to be true, therefore, that all inherited disease is accompanied by structural modification or derangement and that this may be so even when only the indications pointing to disease are present. It would also seem to be true that any peculiarity of the functional activity of an organ if long continued, is likely to result in a habit of the system which will be inherited by the offspring.

Hereditary Disease Congenital or of Latent Transmission.—Hereditary disease is either congenital or there is a predisposition to it. It is congenital when it is apparent at birth. A brood mare may have certain joints greatly enlarged. If, in her offspring, the same is apparent at birth, it illustrates congenital transmission. The same is true of goitre in lambs when it is present at birth. Of course it makes no difference how the disease came to be transmitted, whether through the immediate ancestors or those more remote, it is congenital when the indications of it are present at birth. The predisposition to disease is inherited when the tendency only is transmitted, but does not actually constitute disease until some exciting cause develops it at a later period.

The tendency to tuberculosis may be transmitted. This tendency for a time may be latent. The health-giving influences surrounding the animal may be such that for a time no evidence of tuberculosis is apparent. Later, however, the surroundings become unfavorable, and the disease appears. Again, it may not appear until the next generation or even for a longer period, but finally develops. In such instances the conclusion is fair, that the predisposition to the disease was transmitted all the while. It is evident, therefore, that there is always more or less of hazard in breeding from animals that are tainted with disease, though to the eye they may seem to be in perfect health. The tuberculin test may single out animals that are affected with tuberculosis. It may be that to the eye they are in perfect vigor. Possibly they are pure bred and rich in blood lines of famous ancestral descent. While the owner consents to quarantine them he continues to rear progeny from them. In such instances the fact should not be lost sight of, that the predisposition to tuberculosis has probably been transmitted. There is the possibility, however, that through wise management the predisposition thus transmitted may eventually be eliminated. On the other hand the predisposition to certain forms of disease may become hereditary. The cattle beast with a narrow chest falls an easy prey to the influences which produce tuberculosis. Breeding such animals in direct descent for generations ensures the heredity of a predisposition to tuberculous diseases.

Diseases that are Hereditary.—While various forms of disease are transmissible, those of a tuberculous character are peculiarly so. To so great an extent is this true, that a close examination of the question would probably show that the instances of transmission of diseases, tuberculous in character, would probably outnumber those of the transmission of all other forms of disease combined. And this is true of domestic animals to a greater extent than it is true of the human family. Tuberculous diseases are characterized by the formation of tubercles in various organs of the body and by a perversion of the nutritive functions. These tubercles are by no means uniform in their location, even with the same form of disease. For instance, in tuberculosis, the tubercles may be found in one instance in the lungs, in another in the bowels, and in a third instance, in the udder of females. In aggravated cases all these organs and indeed various other organs are affected. The most common forms of tuberculosis include consumption, diarrhœa, dysentery, mesenteric disease, hydrocephalus and glandular swellings.

Tuberculous Diseases Frequent Among Domestic Animals.—Tuberculous diseases are frequent but not equally so among horses, cattle, sheep, and swine. Cattle are much more likely to be affected with such ailments than horses, sheep, and possibly swine. Horses are more frequently affected than sheep, and the trouble in horses is much prone to assume the form of swollen and otherwise diseased joints and limbs. Tuberculosis may not have actually developed, and yet there may be a predisposition to it, the indications of which are manifest.

These indications are various. They include the following, viz.: 1. A thin carcass and lacking in depth, a narrow chest and loin, flat ribs, large barrel depression and hollow flanks. 2. Extreme thinness and fineness of the head, neck, and withers, want of fullness in the eyes, hollowness behind the ears, undue fullness under the jaws, and a small and narrow muzzle. 3. Much prominence of the bones in certain parts as at the joints, and a coarse and ungainly appearance. And 4, a hard, unyielding skin, thin and dry hair, and irregularity in changing the coat. A thin carcass, of course, means one lacking in width throughout its entire length. Narrowness of chest, flatness of rib and smallness of muzzle are all associated with circumscribed respiration and a low vitality. Want of width and depth in body are associated with a lack of digestive capacity. The low vitality and the lack of digestive capacity account for the lack of fullness in the eye, behind the ear and in the flanks. They are the outcome of a weak nutrition, which in turn is the outcome of the causes named. The undue length of the limbs in such instances is probably a result of the law of correlation discussed in Chapter VIII. The undue prominence of the joints arises from a perverted nutrition. The harsh, unyielding skin, and the characteristics of coat mentioned are the outcome of a feeble circulation which in turn grows out of a feeble digestion. Animals thus formed fall an easy prey to tuberculous diseases, hence, to breed from them would be very unwise.

Variations in the Inheritance of Diseases.—The inheritance of the so-called constitutional diseases varies in many instances in the organs affected. In these there are sometimes alternations in the transmission, that is to say, the parents may have diseased lungs, and the transmission in the next generation will manifest itself in the form of tumors or glandular swellings, while in the following generation it may again assume the form of lung disease in one or the other of its forms. But it is also true that the location of the disease may depend in many instances on the method of infection, that is to say, whether through the digestive organs or through the lungs. The conditions to which the animals are subjected may, in part, account for such alternations in transmission, but they do not furnish the explanation of all the instances of such variable transmission. The injudicious treatment of animals predisposed to such diseases may also aid in determining the particular organ that will be affected. For instance, the injudicious use of a violent cathartic may locate the inherited tendency to chronic diarrhœa.

Cause of Tuberculosis.—Tuberculosis is one of the most common forms in which disease appears in domestic animals. Because of the extent to which it prevails, especially among cattle, it has been thought that greater loss arises from this source than from all the other forms of disease combined. It should, therefore, not be out of place to give some special consideration to this question. The direct cause of tuberculosis is a rod-like microscopic parasite which may, in various ways, be transferred from one animal to another. In the congenital form the disease changes may be in process of development or they may be developed. The germs may be conveyed in the mother's milk or in the nasal or bowel discharges. They may also be inhaled in the atmosphere of surroundings where tuberculous cattle have recently been kept. There is no way, however, in which the contagion will more certainly be conveyed than in the milk of the dams whose udders are tuberculous. It does not happen with much frequency that the disease is transmitted in the congenital form, but the predisposition to it is probably invariably transmitted by tuberculous parents.

Predisposing Causes of Tuberculosis.—There are several predisposing causes of tuberculosis aside from inheritance. These include disorder of the digestive organs, food deficient in quantity and quality, impure water, confinement in dark, damp, filthy, unventilated apartments, and undue exposure to cold or to any other influence that lowers the action of the vital powers. The extent to which cattle have been confined in damp, dark, and ill-ventilated stables is perhaps responsible for the great extent to which tuberculosis prevails more than any other single ex-

FIG. 4. YEARLING GRADE HEIFER.
(Illustrating predisposition to tuberculosis.)

ternal cause. Cattle reared on the ranges are but little subject to tuberculosis, notwithstanding that in many instances they are frequently subjected to privation because of short supplies of food. This fact should be carefully considered by those who require to keep cattle housed much of the time in winter. It emphasizes the necessity for supplying them with ample fresh air in the stables and also with sufficient exercise.

Continued in-and-in breeding, or even protracted close breeding and breeding from immature or enfeebled parents are also responsible for much of the tuberculosis that prevails. Of this fact there is evidence in the greater extent to which tuberculosis has prevailed in the families of Shorthorns and Jerseys that have been thus bred, than in other families of these respective breeds. It is also evidenced in the less extent to which the disease prevails in semi-mountain breeds, as the West Highland, which have been subjected to less artificial conditions than the breeds just named. But the conclusion must not be reached that artificial conditions of necessity conduce to the increase of tuberculosis. It is only when these conditions are made such as to lower the vitality of the animals that they foster tuberculosis. Of course, when the predisposition to tuberculosis is inherited, the conditions named become intensified in their action. Similarly, when the predisposition to any form of disease is inherited, the action of the exciting causes becomes intensified.

Inherited Predisposition to Disease from One or Both Parents.—The inherited predisposition to disease may be derived from either parent or from both. When such predisposition is derived from both parents it becomes intensified. It would follow, therefore, that the hazard of transmitting the predisposition to tuberculosis in the progeny will be greatly increased when both parents are thus affected. To lessen this danger herds should certainly be, at least occasionally, subjected to the tuberculin test as otherwise there can be no certain assurance that such a mistake will not be made. There are some instances in which the limitation of disease is confined to one sex and transmitted by the other, as, for instance, when the inheritance of skin diseases is manifest in the male descendants only, although the females transmit the same with more or less of regularity to their male progeny. Many instances of such transmission have been noted in the human family. Such transmission also occurs with more or less frequency among domestic animals, although with them it has probably been less noticed. This would seem to be akin to similar transmission of abnormal qualities already noticed.

Suspension in the Transmission of Disease.—In the transmission of hereditary disease there may be suspension for a time as well as alternation, that is to say, the disease may not be transmitted for a time and may again reappear. The suspension may continue for several generations. This may be due to the absence of exciting causes, or it may be owing to favorable sanitary conditions, followed by those less sanitary or indeed of an entirely opposite character. Such transmission is atavic in its nature, and is probably subject to the same laws that control atavic transmission. It is also true that alternations of development are frequent in the transmission of hereditary diseases. So frequent are those alternations that such transmission would, in many instances, seem to be the rule rather than the exception.

These alternations in transmission, especially in the human family, may relate, first, to alternation in generations, and second, to alternation in the individuals affected in the same family. For instance, certain diseases will sometimes be entirely absent in the first generation, but will reappear in the second. They will be absent in the third generation and reappear in the fourth. Again, in individual families, the first born may be free from the taint, and the second may inherit it, the third is free and the fourth affected, and thus the transmission descends through the entire family. And yet again, the alternation may relate to sex, that is to say, the inherited disease will manifest itself only in one sex. In still other instances, the disease will be confined to one sex and transmitted only by or through the other, as previously pointed out. . These alternations in transmission would appear to be under the control of influences which, though not understood, are regular in their action. They would seem to be the outcome of two antagonistic characters which alternate in dominating power, but why they should act thus is yet a veiled secret.

Disease may be Transmitted Potentially.—Disease still future in the parent or the tendencies to it, though undeveloped, may be transmitted potentially to the offspring. Such instances are of frequent occurrence in the transmission of cancers. The tendency to these in the human family is probably transmitted in all instances before the disease has appeared in the parent. Nor does it follow that the tendency to disease in the parent thus transmitted potentially to the offspring will ever become operative, that is, it may never develop into actual disease in the parent. In breeding horses instances of such transmission are not infrequent. Parents notorious for the development of swollen limbs, or ringbones in some instances beget progeny in which these ailments do not appear until subsequently to the birth of the latter, and in some instances they do not appear at all. Such transmission is somewhat akin to transmission characterized by suspension, nevertheless they are not the same. The strength of the predisposing conditions acting in conjunction with other conditions, particularly those of an external character, have an all powerful influence in determining the exact character of the heredity.

Predisposition to Disease through Faulty Conformation.—Animals free from constitutional taint transmit indirectly to their offspring a predisposition to certain forms of disease through the faulty conformation of certain physical features of development. 1, A disproportion in the width and strength of the leg above the hock to the width and strength of the same below this part in the parent horse, predisposes to spavin in the offspring. And this predisposition may lead to the development of the disease even when spavin or the tendency to it has not been transmitted directly from the parents. 2, In draft horses round limbs containing an unusual proportion of cellular tissue predispose the offspring to such diseases as weed and grease. 3, Chests that are narrow, pasterns that are upright and toes that are turned out beyond a certain limit, beget a tendency in the offspring to bone diseases of the foot, as, for instance, ringbone. Such instances could easily be multiplied.

The same principle has been referred to when treating above of the indications of tuberculosis. Because of such danger, every care should be taken when selecting breeding animals to avoid selecting those that are thus constituted. In the choice of these, as much importance should be placed upon freedom from the taint of inherited disease as upon the absence of the various features that indicate inferior physical development.

CHAPTER VIII.

THE LAW OF CORRELATION.

Three principal laws have been given in previous chapters which govern the breeding of domestic animals. These are the law that like produces like, the law of variation, and the law of atavism. In addition to these there is another law, viz.: the law of correlation. This law, however, is more of what may be termed an inherent feature of the organization than of modification in the same and yet it would not be correct to say that it is not susceptible of modification. The relation of the different parts of the organization in virtue of this law may be much modified but this relation can never be entirely obliterated.

Definition of Correlation.—Correlation in its relation to animal life means that correspondence or relation which exists as to form and function between the different organs of the body. In virtue of this relation certain peculiarities of structure will obtain between those organs which belong inherently to the species. It may be said to form a dividing line between the species. In fact, without it the classification of animal life would be impossible. Because of this law there must be a certain relation in kind between the teeth of the cat and the claws of the cat and between form in an animal and the breeding qualities of the same animal. As intimated previously, these relations may be greatly modified but never entirely suppressed.

The Law of Correlation Defined.—The law of correlation means that interdependent principle of development and suppression that seems to obtain between the different organs of the body and the various functions of the same. By the operation of this law a change in one organ or set of organs is followed by a corresponding change in another organ or set of organs, in some part of the body. For instance, in wild cattle there is a certain relation between the parts of the individual animal in virtue of the species to which it belongs, that is to say, because the form and action of the jaw are of such a kind, the form of the digestive organs and the nature of the digestion are of such a kind. This relation always obtains without great modification. There will also be a certain relation between development in the fore and hind parts of the animal respectively. When they must needs graze on rugged pastures and among enemies, development will be large and strong in the muscles of the front limbs. They have both to climb and run. Subject the same class of animals for generations to level pastures and domestic or semi-domestic conditions, and these relations will change. The muscles that help to control locomotion in the front part of the body will grow less relatively, and those that govern locomotion in the hind parts of the same will increase. And the modification of the parts is always or nearly always of an opposite character.

If there is increase in one part of the animal there will be decrease in some other part of the same, and the change is usually proportionate in degree to the change made in the co-related organ or set of organs. In some instances the corresponding change is dependent on a change in structure, in others on a change in function, and is of like kind, that is to say, a change in structure is dependent on a change in structure, and a change in function on a change in function, and in yet other instances the change, whether of structure or function, may, to some extent, be dependent on changes in both structure and function.

The Anatomist and Correlated Structure.—Correlated structure in an animal enables the anatomist to determine from a single bone: 1, The class and order to which it belongs; 2, its habits and modes of life; and 3, the food required for its support. For instance, the jaw bone of the skeleton of an ox with the teeth in it, tells the anatomist that the living animal chewed the cud and that, therefore, it belonged to the order of cloven hoofed mammals. Since it chewed the cud its natural food was coarse herbage. Because its natural food was coarse herbage it had the grazing or browsing habit or both, and since it was a mammal it suckled its young. These are only a few of the conclusions that could be reached regarding the animal and its kind from the jaw bone mentioned and its bony belongings. How easily then could the skilled anatomist construct a perfect skeleton of an animal that no man had ever seen alive, from a confused mass of skeleton materials which contained in it all the parts of the bony framework of such an animal.

Correlation with Reference to Structure.—Illustrations of the law of correlation with reference to structure are numerous. 1. They may be found in the highly organized carnivora, in whom, as Cuvier has said, the form of the teeth has an intimate correspondence to that of the condyle, blade bone, femur, and claws. In the lion, for instance, there are teeth to lacerate and hold. There are also teeth to cut, which play upon each other like scissor blades. This calls for great strength of jaw and a cutting motion up and down. Both are made possible by the form of the condyle, of the teeth and jaws and of the strong muscles attached to the jaws. The blade bone is powerful and so muscled as to give great strength. The femur is so formed with the muscles attached to it as to admit of crouching when lying in wait for prey, and the claws are of a character to enable the animal to grasp its prey and to lacerate it almost at will. 2. In the structure of ruminants, in which there is an intimate relation between hoof and horn development, and also between the form of the teeth, the articulation of the jaw and the complex character of the digestive organs. Ruminant animals have all the cloven hoof and they all have horns that grow out from the frontal bone. Moreover the number of the horns corresponds to the number of the divisions in the hoof. In ruminants the teeth are made to grind. The joints of the jaw bones and the muscles of the jaws provide for the lateral or grinding movement of the latter, and the digestion in its complexity provides for the grinding of the food in chewing the cud when the animal is otherwise at rest. 3. In the development of the brain in men and reptiles respectively and of the bones which surround these. In the former the brain cavity is large and the bones encircling it are relatively light, whereas in the latter the opposite conformation exists. And 4, They are further found in the development of the fore and hind parts respectively of the bat and kangaroo. In the bat the anterior members are widely extended and the posterior but slightly, so as to facilitate rising easily. In the kangaroo there is much development in the posterior members and relatively little in the anterior, so as to facilitate the taking of long leaps 5. In the comparative unproductiveness of the male sebright-bantams without sickle feathers and of rumpless fowls. And 6, in the effect of castration upon other organs of the body, as witnessed in the decreased development of the muscles of the neck which it produces and the loss of fighting spirit which results from it. The two illustrations last given also bear somewhat on the relation which structure has to function.

Correlation with Reference to Function.—Illustrations of the law of correlation with reference to function are found: 1. In the influence of extreme development of the beef form on milk production, and *vice versa.* Experience in growing beef cattle has shown that when the beef form is pushed to an extreme, milk production is lessened, and that when the dairy form is pushed to an extreme, beef production is hindered. An illustration is thus given of the influence of a change in structure on function. But in this instance, modification of structure is not the sole cause of modification in function. The former works hand in hand with habit in producing such modification. Nor is the fact to be overlooked that what may be termed middle ground modification is not inconsistent with the production of a fair amount of meat and of milk in the one animal as illustrated in the development of the dual purpose cow. 2. In the influence of a marked increase or decrease in flesh production on locomotion. The wild hog is swift as well as fierce. He is well muscled but not loaded down with fat, hence he can run swiftly. His descendant, the domestic hog, when loaded with flesh cannot run fast. It is possible so to load him with fat that he rises upon his feet with difficulty. Here, again, is an illustration of the modifying influence of structure upon function. 3. In the close relation between abundant milk production and prolificacy. It has been noticed that females which produce milk freely, breed more regularly than those which are shy milkers. They also breed more abundantly when more than one animal is produced at a birth, and, of course, the opposite of this is true. In this fact an illustration is furnished of the modifying influence of function on function, both in the direction of suppression and increase. And 4, in the unusual development of one sense where another is deficient. Usually persons who are blind are possessed of the sense of touch in an unusual degree. This, of course, is owing chiefly to the care bestowed by the individual in educating that sense, that is to say, in developing the sense of touch. But it shows at the same time the indirect influence of function on function. Similarly the sense of hearing is sometimes developed in an unusual degree by persons who are blind, and also the sense of smell. The same principle is operative in plant life. When an unusual growth is produced in grain or in fruit trees, it is so produced at the expense of grain production in the one instance and of fruit production in the other.

Influences that affect Correlation.—The chief of the influences that affect correlation are: Environment, habit and use, food and selection. Illustrations of the influence of environment on correlation may be found in the lack of size in Shorthorns, confined to mountain pastures, without a corresponding decrease in the size of the bone; also in the adverse influence of conditions too artificial on the breeding powers, though these conditions may secure good physical development. The influence of habit and use on correlation is shown in the increase of capacity in brain power which is frequently obtained at the expense of diminished muscular development, and in the increase in muscular development and staying power which may be obtained in the hard working boy and even in the athlete, though frequently at the expense of mental development. But, as with the development of milk and beef in the same animal in equilibrium, so is it with physical and mental development. It is only when either is carried to an extreme that it becomes incompatible.

The influence exerted by food may be seen in various ways. Keep a young and growing animal on scant supplies, and the relation between the normal development of muscle and bone will be disturbed. There will be want of development in the former and overmuch development in the latter. Again feed a young calf an undue quantity of hay tea and adjuncts instead of new milk, and what may be termed the correlated harmony of development will be disturbed. The stomach will so distend that the animal will be always somewhat paunchy, and this, of course, at the expense of harmony of development. That selection in breeding may be made to exercise a powerful influence on correlation may be readily shown from any one of a hundred illustrations that may be given. For instance, cross pure Southdown rams upon pure American Merinos and upon the progeny for several generations. Eventually the progeny will have the

Southdown form, that is to say, an excellent mutton form, but it will have been obtained at a sacrifice of quantity and fineness in the wool.

Value of the Knowledge of Correlated Structure.—A knowledge of the correlated structure of domestic animals is of great practical utility, as by certain indications of external form cognizant to the senses we can judge of qualities hidden from view. For instance: 1. A strong horn and head and much bone in the limbs and tail indicate an undue amount of bone in the system for the highest production of meat. Because of this an animal, large and heavy, will frequently be rejected by the skilled butcher for one considerably less in size but with bone less coarse, for he knows the latter is likely to kill better, that is to say, it is likely to have less waste in the carcass and to possess a superior quality of meat. It is by external form accompanied by handling qualities as described in Chapter XVIII. that he is guided in the choice of animals for the block. From what he sees and finds without, he knows what to look for in the matter of flesh and fat within. 2. A wide chest and a low set, compact form are a guaranty of a good constitution. These are not by any means all the indications of a good constitution, as shown in Chapter XXIII. But so frequently has such form been found to indicate good constitution, that it is looked upon as a reasonably safe guide in judging of constitution, aside from the influence of the taint of inherited disease. 3. A long neck, flat ribs, hollow flanks, large joints, and ungainly limbs are among the indications of a natural tendency to delicacy of form as shown in Chapter VII. 4. Large capacity of body, a fine head, neck, and limbs, and a good development of udder, are among the leading indications of good milking qualities. Though they may not furnish an exact measure of milking capacity they furnish so safe a guide as to enable the dairyman to rely much upon these indications when choosing dairy animals. And 5, a hard, unyielding skin and harsh coarse hair indicate poor feeding qualities.

These indications are further discussed in Chapter VII. From what has just been said, it will be evident, that a knowledge of the laws of correlation lies at the basis of all selection in live stock, whether the selection has reference to the block, to the pail, or to breeding.

Correlation and Highest Development of Individual Qualities.—This law explains the difficulty experienced by breeders whose aim has been to secure, in the highest degree, development of essentially different characteristics and qualities in the same animal, as illustrated: 1, in the apparent antagonism in the development of beef producing and milk producing qualities in bovines; 2, in the difficulty in producing wool and flesh of the highest excellence in the one individual sheep; and 3, in the apparently impossible attainment of highest excellence in mental and physical achievement by the one person. Push beef production beyond a certain limit and it reacts against milk production. Push milk production beyond a certain limit and it reacts against beef production. These results have been experienced so frequently as to put this question beyond the realm of doubt. The highest excellence in wool production, at least as regards fineness, has been found incompatible with a high standard of mutton production, as witnessed in the breed known as Saxon Merino. The experiments of Bakewell in perfecting the mutton form were found to be antagonistic to equally high development in wool production.

The most renowned thinkers in the world have never stood in the first rank as athletes, and those on the pinnacle of attainment in athletics have not stood in the first rank as thinkers. Carry attainment to its possible limit in any one of these directions and by the action of this law of correlation it hinders attainment in the other. It has the effect of lessening stamina even in the athlete. Those, therefore, who seek highest development in one quality will fail unless they give due heed to the retention of stamina in the same. It must not be concluded, however, that the development of antagonistic characters, at least in degree, is strictly incompatible. Their simultaneous development up to a certain limit is not only not incompatible but it is mutually helpful. The dairy animal may be bred so far away from the beef form as to weaken dairy qualities. The beef form may be bred so far away from the dairy form as to almost obliterate the milking qualities and thereby react against beef production. Comparisons similar in their results could be made between wool and flesh production in sheep, and between mental and physical attainments in men. Dual attainment, therefore, up to a certain limit in each of the two kinds of development thus contrasted is positively advantageous. This is strikingly apparent in the adverse influence which lack of physical vigor exercises on mental development. But it may not be possible to tell just exactly where the border line runs between action that is cooperative and helpful in the development of these different characters, and action that becomes antagonistic and hurtful.

Equilibrium in the Organization and Correlation.—From what has been said it will be very evident that an equilibrium of the organization can only be attained by the arrangement of its elements in strict accordance with the laws of correlation. A modification of a single character may involve rearrangement of the dominant characteristics, and this may result in the transposition of latent characteristics which generate atavic tendencies. And this tendency to reversion may be much influenced by the character of the surroundings. For instance, when the attempt has been made to modify size in a breed beyond what the natural food supplies will maintain it has been noticed that the tendencies to reversion are particularly strong, and that these tendencies are further accentuated when cross breeding has been called in to aid in making the change. This accounts, in part, at least, for the many difficulties experienced by those who have attempted to improve animals by crossing them.

CHAPTER IX.

PREPOTENCY.

The question of prepotency is of great practical moment to the breeder of live stock, because of the direct influence which it has upon improvement or the want of this, in a stud, herd, or flock. Like many of the features of breeding it is only understood in part, but happily enough is known regarding it to enable the skilled breeder to choose animals possessing it with a reasonable degree of certainty.

Prepotency Defined.—Strictly speaking prepotency is the superior power which one parent has over the other in determining the character of the offspring. But the term is more commonly used to indicate that power which an animal has to transmit its own qualities. Sometimes prepotency is general, having reference to breed, race, or species. When it is said that a breed is prepotent, it is meant that animals of that breed are all possessed of much power to transmit the characteristics of the breed. In other instances prepotency is special, having reference to the individual. When an individual is said to be prepotent, it is meant that it has much power to transmit its own qualities to the offspring, that is to say when two animals are mated the parent possessed of superior prepotency will transmit in a greater degree than the other its own properties to the progeny. The great value of such power when breeding animals, especially in males, will be at once apparent.

Prepotency of Breed.—Prepotency of breed or race is clearly brought out when two distinct breeds are crossed. The offspring will more nearly resemble the breed possessed of the most marked prepotency. There is a great difference in the prepotency of breeds as such. The Galloways among cattle are noted for their prepotency. When crossed upon other breeds and especially upon grades, the progeny are nearly all black and hornless. Similarly, the American Merinos among the breeds of sheep have great power to transmit the characteristics of the breed to the progeny when crossed upon other breeds and more especially when crossed upon the grades of these. The mule, the progeny of the ass and the mare, is possessed of more of the features and characteristics of the male parent. The cause, as is further shown below, is the same in each instance, viz., the long periods during which these animals have been bred pure. Breed prepotency is also shown in the quick transformation of the common or mixed classes of animals to the type of the breed from which the males have been chosen. All the breeds will not effect transformation with equal rapidity, since all are not equally prepotent. The most prepotent breeds will, of course, effect such change the most quickly. And they will effect it more quickly on animals much mixed in breeding than on those more highly graded. The reasons are given at length in Chapter XXVI., which treats of up-grading.

Individual Prepotency.—Prepotency in the individual is shown in the closeness of the resemblance in the progeny to the parent and to one another. The second result mentioned is, of course, effected by the same influences as produced the first, and is one of

FIG. 5. GROUP OF HEREFORD BULL CALVES, SIRED BY IMPORTED SALISBURY (19083) 76059.
(ILLUSTRATING PREPOTENCY.)
The property of Murray Boocock, Castalia, Keswick, Va.

the strongest evidences of prepotency in the individual, since it shows in a marked degree the power of the one individual animal to transmit its own individual characteristics to the progeny, though mated with different individuals. These will, of course, be possessed of different degrees of prepotency. The power of the one animal so to overcome these as to produce a progeny that closely resemble one another is the highest evidence of prepotency. And each animal added to the list of such progeny is an additional evidence of prepotency. The greater the diversity in the parents of the progeny thus assimilated, the stronger is the evidence of prepotency in the one parent of the opposite sex which has effected such assimilation. Prepotency is usually more manifest in males, for reasons given below in the paragraph which discusses prepotency specially important in males, but it may also characterize females as well as males. Instances are not uncommon in which the resemblance between the different members of one family is so close, that family relationship may readily be traced from such resemblance, and it has been inherited from the mother.

The evidences of prepotency are usually more clearly apparent when the resemblance is manifest in the offspring of animals of the same pure breed or of different pure breeds as contrasted with grades. For instance, if a pure male in the one instance were to beget progeny from females of the same breed which bear a close resemblance to the male parent, this result would be a stronger evidence of prepotency in the male than a similar result produced by mating him with females of mixed breeding, since the resistance to modification in the progeny of the females in the first instance would be stronger than resistance to the same in the females in the second instance. And if there was a close resemblance in the progeny of pure females of different breeds, no stronger evidence of prepotency in the males could be furnished, since in these instances his potency had to effect change when resistance was both strong and diverse in character. In rare instances, however, the resemblance in the progeny to one of the parents may be traced in grades. The reason why those instances are rare arises from the lack of dominant properties which characterize grades because of the mixed character of their breeding.

Influences that Produce Prepotency of Type.—The following are chief among the influences that produce prepotency of type or breed, viz.: the duration of the period during which the animals have been bred pure, and the inherent vigor of the type, race, or breed. The fact has been noticed as stated previously in Chapter III. that animals whose pure breeding is of great antiquity transmit their properties with more certainty than those of breeds formed within a comparatively recent period. Galloway cattle, for instance, transmit their properties with more exactness than Aberdeen Angus cattle. The progeny which is the outcome of a Galloway crossed upon grades, will more uniformly inherit the black color and the hornlessness of Galloway sires, than the progeny of Aberdeen Angus sires crossed upon similar grades.

The progeny of American Merino rams crossed upon grades will more surely inherit the form and properties of the Merinos, than will the progeny of Oxford Down sires crossed upon grades inherit the properties of the Oxford Downs. Similarly the progeny of Yorkshire swine crossed upon grades will inherit the properties of the Yorkshires more than will the progeny of Poland Chinas thus crossed inherit the properties of Poland Chinas. The progeny of the Yorkshires will be almost uniformly white in color, that of the Poland Chinas will be variable in color. The reason is the same in each instance, that is to say, the Galloways, the American Merinos, and the Yorkshire breeds have been bred pure for a longer period than the Aberdeen Angus the Oxford Down and the Poland China breeds.

But it is probable, as previously intimated, that there is a period when antiquity of breeding will cease to add to the prepotency of animals, that is to say, it is not certain that an animal from ancestry bred pure for five hundred years will be less prepotent than an animal from ancestry bred pure for one thousand years. It is not known, however, where antiquity of breeding will cease to add to potency in breeding. It is probable that the time will vary with varying conditions. Inherent vigor of type, race, or breed is a powerful factor in determining prepotency in the breed as it is in the individual. The reasons doubtless rest upon the acknowledged superior transmitting power which strength has over weakness and stamina over the want of stamina. This in part accounts for the superior transmitting power of Galloway cattle, Merino sheep, and Yorkshire swine.

Influences that Produce Prepotency in the Individual.—The following are chief among the influences that affect prepotency in the individual, viz.: Purity of blood, strong constitutional development, and in-and-in breeding. Purity of breeding and duration in the same strengthen prepotency in the individual as they do in the breed or race. They strengthen prepotency because they make and maintain dominance in properties. Each increment of alien blood introduced becomes a disturbing factor to fixedness in properties, and, therefore, it becomes a disturbing factor to certainty in transmission. On the other hand each generation of pure breeding adds to dominance in properties till these become so dominant that further improvement in that direction may not easily be made. Because of this the unwisdom of using grade, cross bred, or scrub sires or any other sires not purely bred will be at once apparent. The reasons why strong constitutional development strengthens prepotency in the individual as also in the breed or race are the same. They come from that inherent mastery which strength has over weakness. This explains why breeding from animals in the meridian of vigor, that is to say, neither young nor old, gives a progeny superior to those bred from animals immature or declining through age.

The room for selection on the lines of vigor is far greater in the individual than in the race, because of the many individuals in the race or breed as compared with the fewness of races. Vigor in the individual, therefore, can be turned to more practical account than vigor in the race. In-and-in breeding aids prepotency because it strengthens dominant properties. The more inbred animals are, the more intense their power to transmit such properties as they possess. This explains why the masters in forming breeds always resorted to in-and-in breeding for a time when they were doing this. It also shows the wisdom in some instances of giving the preference to desirable sires that are more or less inbred and that are at the same time possessed of much bodily vigor. These three influences acting in conjunction should give the highest prepotency attainable.

Minor Influences that Affect Prepotency.—Prepotency is influenced more or less by certain minor influences, as, 1. The existence of what may be termed secondary sexual characters. Sebright bantams with the perfect hen-formed tail in the males are less productive than those with a tendency to the development of sickle feathers. Rumpless fowls with the tail entirely wanting are much prone to lay infertile eggs, and sires with what may be termed a feminine head are rejected by skilled breeders, since it has been noticed that they prove less satisfactory as breeders.

2. The limitation to one sex of the power to transmit certain characters. For instance, it has been ascertained that in some instances only males, and in other instances only females, transmit certain forms of disease, at least for a time. The claim has also been made, based on certain statistics, that some diseases as consumption, for instance, are more readily inherited in males from the male parent, and in females from the female parent.

3. The lack of affinity in certain characters which makes it difficult to blend them. These make the influences that modify and tend to unify stronger than when there is more of affinity between alien properties. The causes of variation are seldom well understood. The fact, however, has been noticed, that animals of known prepotency will beget much more of resemblance to themselves in the progeny resulting from a cross upon certain pure breeds than upon certain other pure breeds.

4. By the effects of a previous fertilization of the mother. In certain instances it has been noticed that when a female of a certain breed produces by a male of another pure breed, and is then bred to a sire of her own breed, she does not always breed true to type. And in some instances females thus mated have never bred quite true to type again. But this question is further discussed in Chapter XIV. Here then are elements that disturb prepotency, but they do not disturb it equally nor so seriously as to make breeding a game of chance.

Animals Similarly Bred may Differ much in Prepotency.—That animals similarly bred and possessing precisely the same blood elements frequently differ widely in the degree of the prepotency which they possess has been noticed again and again, hence, there is no absolute guaranty of prepotency in near relationship. Many instances could be cited in support of the statement just made. In few of these has the contrast in prepotency between animals bred just alike been more apparent than in the thoroughbred horses, Touchstone and Launcelot. Stonehenge records of the progeny of the former, that they showed much uniformity of color and on the whole possessed high form as race horses, while the progeny of the latter were of all colors and below mediocrity on the turf. These horses were full brothers. Instances have come under the observation of the author in which pure bred males have been purchased, because of prepotency and good breeding qualities in members of the same family, which were quite disappointing. The conclusion must not be reached, however, that similarity in breeding is no guaranty of prepotency, for in other instances several, if not, indeed, all, the members of the same family have been noted for their prepotency. It is simply not an absolute guaranty. Nor can prepotency be absolutely assured, as being the outcome of any particular method of breeding, as instances have been found in which highly inbred animals have not been prepotent. Again, some animals are prepotent, if the term may be thus used, in transmitting the qualities of their ancestors rather than their own. This accounts for the fact that some sires not possessed of sufficient finish themselves to enter the show ring, have proved noted sires of prize winners. Such was the great stock bull, Knight of Warlaby (29014) owned by J. & R. Hunter of Alma, Ontario.

Rules Governing Prepotency not easily Framed. —The difficulties which surround the subject of prepotency are emphasized by what has been said in the preceding paragraph. Because of these difficulties it is impossible to formulate rules which govern it. But, as previously stated, purity of breeding and indications of bodily vigor taken together furnish a strong guaranty of its presence. These are, indeed, the most tangible guaranties of prepotency that can be furnished before it has been proved by actual test. It is also true that marked prepotency is likely to be transmitted, at least in degree. If that were not true the first great law of breeding would not be to the breeder a reasonably safe guide. An animal, the progeny of prepotent ancestry, is certainly likely to be more prepotent than an animal whose ancestors have not been prepotent. There is also a close interdependence between prepotency and in-and-in breeding. But when practiced by those not well skilled in the art of in-and-in breeding, it can scarcely be reckoned as a factor in choosing prepotent sires by the average breeder. On the other hand it has been used as an aid in producing some of the most prepotent sires that have ever existed. But this result has only been secured by skillful breeders.

Prepotency in Animals Inferior Individually.—Prepotency somewhat marked is sometimes found in animals inferior in individual characteristics, and in those with a strong bias to certain forms of disease, and the more pure the breeding the more likely is such prepotency to be found. Because of this, there is always much hazard in using sires possessed of inferior individual qualities. In breeding pure breds some inferior specimens will appear, even when the work is wisely and skillfully conducted. When those animals are offered for sale for breeding purposes, they are usually held at reduced prices. Those who are about to introduce pure bred sires into their herds, it may be for the first time, are much prone to invest in those inferior specimens, because of the comparatively low price at which such animals are offered. It would appear that such purchasers expect pedigree to make up for inferior individual merit. The effect may be just the opposite. In fact, it is likely to be, as a result of the first law of breeding. Because of this hazard it is considered safer to breed from high grades of superior individuality than from pure breds of inferior individuality. There is the chance, however, that the individually inferior pure-bred parent may transmit the qualities of an ancestry superior to themselves, but that such transmission will follow is far less probable than that the transmission will take after the parents. Inferior individuals, therefore, however purely bred, should not be bred from.

Marked Prepotency not of Great Frequency.—Very marked prepotency is not of great frequency even in pure-breds. Of this fact no stronger proof can be furnished than that which comes from the "Grasmere" herd of Shorthorns located near Lexington, Ky. This herd was founded in 1831, and was owned and personally supervised by Mr. William Warfield, the author of "Cattle Breeding" and probably without a peer in the knowledge of the rules that govern breeding. Mr. Warfield testifies that during fifty-seven years of the existence of this herd, of the twenty-seven sires used, only five or six of the entire number possessed prepotency in a marked degree, although without exception they had been chosen on principles that were likely to insure prepotency as far as these principles are known.

Each pure breed has its list of sires of outstanding prepotency but the list is not a very long one. Some of these animals were wonderfully impressive in their day, howsoever mated. So famous were they as sires that breeders to this day frequently refer with pride to the fact that animals owned by them trace to these potent sires, even after the lapse of one hundred years and more. But those who do thus would do well to remember that with animals as with men, too much may be made of memorable ancestry. The value of such blood may have been greatly neutralized by subsequent breeding. But even though not thus weakened, after the lapse of a limited number of generations, it can only be present in an infinitesimal degree except where more or less of continued in-and-in breeding has been practiced.

Prepotency Specially Important in Males.—The prepotent quality is specially important in males, owing first, to the much greater influence which they exert relatively and absolutely in the stud, herd, or flock, and second, to the use that is made of them in the improvement of all classes of stock, hence, all the great breeders aimed at choosing their males from sub-families more highly inbred than the average of their stock. When but one male is used in a stud, herd or flock his influence on the progeny is equal to that of the sum of the influence of all the females combined when the individual excellence and prepotency of each female is on a par with that of the male. When, however, his individual excellence and prepotency are greater than that of each female, his influence on the progeny will be as much greater than that of the combined influence of all the females as his individual excellence and prepotency exceeds theirs. The importance, therefore, of choosing sires of the very highest excellence and prepotency cannot easily be overestimated. If the desired prepotency can be obtained without in-breeding it is usually preferable to have it so, but marked prepotency is more frequently found in animals more or less inbred.

Prepotency not Assured until Proven.—Prepotency in a sire is not assured nor can it be, until it is proved in his progeny. All the requisites may be present that tend to assure prepotency, and yet it may not be present in a degree that is satisfactory. Because of this a young sire should be used cautiously at the first, that is to say he should be mated with only a limited number of high bred females until evidences of his prepotency are furnished in the progeny. To mate a male whose prepotency is unproved with all the females in the stud, herd, or flock, would be a hazard which no breeder of valuable, pure bred stock can afford. But as soon as it has been ascertained that a sire is prepotent the most should be made of his presence by using him to as great an extent as is practicable, but not to the extent of shortening the period of his usefulness.

A sire in the meridian of vigor whose prepotency has been proved, is a far safer investment than a younger sire equally good but whose prepotency has not been proved. And yet in choosing sires the rule with many is to purchase the latter in preference to the former. Valuable sires that are markedly prepotent should never be discarded until they have passed the meridian of their usefulness. If the owner must make a change to avoid in-breeding, some one else should secure the prepotent prize. The value of a markedly prepotent sire, many of whose progeny are good enough to win prizes in leading show rings cannot be easily overestimated. There have been instances in which the possession of one such animal has brought competency to the owner.

CHAPTER X.

IN-AND-IN BREEDING.

No feature of animal husbandry has given rise to more controversy than that of in-and-in breeding. From the days of Bakewell onward there has been a wide difference of opinion as to the place that should be assigned to it in the experience of the ordinary breeder. Some have regarded it as altogether helpful and others as altogether harmful. Because of this extreme difference in view the question has been much discussed in the agricultural press, and frequently to but little purpose. These differences in opinion are doubtless the outcome of shortsighted and incomplete views on this question. Many have looked only at certain phases of the subject without viewing it in its entirety, consequently they have failed to discern the place that should and should not be assigned to it by the breeder when conducting his operations. It will be the aim in this chapter to discuss the question from an unprejudiced standpoint.

Terms that Indicate Close-breeding.—The terms applied to the breeding of related animals are various, and they have been used in a sense so loose that frequently using them has brought confusion rather than clearness of conception to the mind of the reader. Such terms as in-breeding, close-breeding, inter-breeding, and in-and-in breeding, have frequently been used as though they were synonymous and legitimately interchangeable. This may be said, in a loose sense only, of the first three terms, but not of the fourth, and even in the former a shade of difference in the meaning is discernible. The terms in-breeding, close-breeding, and inter-breeding, are generally used to indicate the breeding together of animals more or less closely related, in a single instance, or at intervals of a greater or less distance. These terms have been thus applied indiscriminately, and yet as stated above, a shade of difference is discernible when they are critically compared. Manifestly in-breeding denotes the breeding together of related animals in a single instance without much regard to the closeness of the relationship. Close-breeding indicates closeness of relationship in animals thus bred. And inter-breeding naturally raises in the mind the breeding together of related animals of alien blood, and should be so used.

In-and-in Breeding Defined.—The term in-and-in breeding properly indicates the breeding together of animals that are closely related for a number of successive generations. It has reference to repetition and close continuity in the breeding together of the related animals, whereas in-breeding has reference to single acts of coupling relatives, even though there should be occasional repetition in these acts. Such repetition in breeding even at intervals, would seem in a sense to involve in-and-in breeding of a weak sort, but to avoid ambiguity the author prefers to include these under the head of in-breeding.

No absolute rule has been chosen to define the exact degree of the relationship, nor, indeed, can it be so chosen. The animals of kin may be of the closest possible relationship, as parent and progeny, sister and brother, or the relationship may be more distant.

The more close the relationship in the animals mated the more intense is the in-and-in breeding. Since the degree of the relationship in the animals mated may differ much, the results growing out of such mating will also differ much, and this throws some light on the wide difference in view as to the value of in-and-in breeding.

Practiced Purposely and Inadvertently.—In-and-in breeding has been practiced purposely and inadvertently. It has been practiced purposely by the improvers of live stock and as a means to an end, and when judiciously practiced by them has effected great good. The precise objects sought, or at least some of them, are given below. It has also been practiced inadvertently by the careless breeder of grades who has chosen his males from within the same herd or flock from generation to generation, and very much to the injury of the same. The injury resulting has not grown solely out of the in-and-in breeding as such, but also from the lack of intelligence shown in the selection of the males chosen. In the selection of such males, size without regard to form has usually been the determining factor. Under such a system of breeding no substantial progress can be made.

Objects of In-and-in Breeding.—The objects of in-and-in breeding are, or ought to be, 1, the more speedily to secure desirable characters in animals, and, 2, the more quickly to secure uniformity and permanence in the transmission of these. The first object, then, is to secure the desirable characters and to secure them quickly. Why in-and-in breeding can effect this and do it quickly may be illustrated as follows:—

In one instance take animals of mixed breeding and mate them. Choose sires of the form desired if they can be obtained from outside sources and of similar breeding and mate them. Such breeding, howsoever long continued, would not result in marked fixedness of type or indeed in fixedness of type at all. In a second instance take animals of the same breed, though differing in form, and mate them. Continue to choose sires within the breed of desirable form, but unrelated, and mate them with the progeny and ultimately but not for several, probably many generations, will fixedness of type be reached. In a third instance, choose females of the same breed but unlike in form, select a male of desirable form within the breed to mate with these, and select males from the progeny to mate with the females of the same. In a very limited number of generations unification in type will have been reached.

In the first instance the alien blood in the sires of mixed breeding becomes a disturbing factor antagonistic to fixedness in type, hence it cannot be reached by such breeding. In the second instance purity in blood gives potency in transmission favorable to unification in form providing the unrelated sires are carefully chosen with regard to such form, hence in time fixedness in type is reached. In the third instance related blood intensifies the transmission and usually in proportion to the closeness of the relationship in the animals mated, hence the shortness of the time required to secure unification in type. The influences that lead to unification in type also lead to uniformity and permanence in the transmission of the same, hence the great power which in-and-in breeding has to further these ends.

In-and-in Breeding a Necessity in Forming

Breeds.—In the formation of breeds, in-and-in breeding has been found a necessity, as in no other way can desirable qualities be unified speedily and rendered permanent, and in no other way can undesirable variations be quickly eliminated. The quick unification of desirable qualities and securing permanency in them has just been illustrated. To secure these quickly, let it be observed two things are necessary; first, the animals mated must have these desirable qualities, and second, breeding them in-and-in must be practiced. Similarly, in eliminating undesirable qualities, the animals mated must be as free as possible from these and they must be bred similarly. But to secure these results in a marked degree the greatest care must be exercised in selecting animals possessed of the desirable properties and as far as possible free from the undesirable variations. That a long time would elapse before similarity of type could be reached without in-and-in breeding has also been shown above.

In-and-in Breeding Practiced in Forming new Breeds.—Since in-and-in breeding has been found a necessity in forming new breeds, it is only to be expected that it would be practiced by the framers of new breeds and also by the improvers ot all or nearly all the improved breeds that have been so improved. It was only in a few animals that the desirable variations were found which they sought to render permanent.

To some the statement just made may seem far fetched, but it will not be challenged by anyone who has had experience in the search for animals that exactly represent an ideal. They are few, indeed, and the higher the ideal the more rare are they. And in many instances these have been derived from a common ancestry. Especially is this true of animals chosen within a breed as the materials to be used for its improvement. This cannot be true, however, at the first, of the materials with which new breeds are formed from others of alien blood. But in forming these it has frequently happened that crossing and inter-crossing animals of those breeds has been practiced for some time before the attempt was made to form them into new breeds. The excellent results obtained from such inter-crossing created the idea of distinct breed formation. The materials, therefore, that were thus used, at the time when the idea crystallized to form them into a new breed, were consequently in a sense derived from a common ancestry. Thus it was that the Hampshire Down and Oxford Down breeds of sheep were established.

In-and-in Breeding more Practiced to Produce Sires.—Of course in the formation of new breeds or types, all the animals, the progeny of these first chosen as foundation materials, were more or less inbred. But as time went on the in-breeding became less intense as the progeny multiplied, and as other females were added as they sometimes were from outside sources. In other instances out-crosses were finally introduced more or less, so that with the herd or type as a whole it could scarcely be said that in-and-in breeding was kept up. At the same time it was frequently practiced more or less within one or more families from which the sires were chiefly drawn, as experience proved what science had proclaimed, that such males were more prepotent than males not thus inbred. The advantages from in-and-in breeding are thus substantially secured with less hazard than if both males and females had been thus inbred. Because of this the in-and-in bred property in the males is relatively more valuable than in the females.

Evils Resulting from In-and-in Breeding.—In-and-in breeding, when carried too far, will produce along with other evils: loss of size, delicacy of constitution, and general deterioration. Illustrations of such loss are given below in each of the several ways mentioned, and these evils may be hastened or retarded by the nature of the conditions to which the animals are subjected. The influence growing out of these conditions and which lead to delicacy will be intensified in their action through in-and-in breeding. These results would seem to be a protest of nature against the too persistent use of influences that hinder variation. Too much of sameness in form would perhaps be a greater evil than too much of variation.

Loss of Size from In-and-in Breeding.—That in-and-in breeding tends to loss of size is shown in the necessity for it in breeding toy pigeons and bantam fowls. With these want of size rather than size is sought, and experience has shown, other things being equal, that the more closely the fowls are inbred the smaller they are. The same thing is also clearly brought out in the condition of the common herds and flocks where the sires are chosen as it were in an aimless way from within the limits of the same. As a rule the size grows less and less the longer and the more rigidly the plan is adhered to. When such animals have been taken to other surroundings, and other sires have been brought from outside sources, improvement has at once been noticeable, and this has given rise to the popular but fallacious idea that a change in pastures and surroundings will of itself tend to renovate.

Greater Delicacy from In-and-in Breeding.—That in-and-in breeding tends to greater delicacy of constitution is evidenced in the much greater frequency of tuberculosis and other diseases in the descendants of animals that have been long inbred. Among the Shorthorn types none have been more persistently inbred than the Bates families, and it would probably be correct to say that in no other class of Shorthorns is tuberculosis so frequently found. In-and-in breeding has also been carried to a great length among certain families of Jerseys, and in these the tendency to tuberculous affections has been quite pronounced. It has further been noticed in the delicacy of many of the calves of highly inbred females. The mortality among these is much larger than among calves of cows not thus inbred. It may not be easy to substantiate these statements in the absence of figures collected from the facts, but the belief in their correctness among intelligent breeders is so general as to influence them when purchasing animals of either of the classes named. Nor is it to be understood that they apply to any but families that have been long and persistently inbred.

This increased tendency to disease may in part be accounted for by the greater certainty with which vitiated powers arising from other causes are transmitted. For instance, conditions unduly artificial would sap general stamina, and the loss of stamina would accentuate the tendency toward tuberculosis begotten by in-and-in breeding.

Loss of Reproducing Power from In-and-in Breeding.—That in-and-in breeding carried beyond a certain limit eventually leads to impaired powers of reproduction cannot be questioned, it has been so long and so frequently noticed in families that have been closely bred together for a prolonged period. Experiments in breeding swine in-and-in for several generations have shown that the breeding powers became greatly impaired in consequence, and that physical degeneracy manifested itself in other ways. This tendency to impaired reproduction may manifest itself in various forms. It may come in the form of impotency or the inability to beget, infertility or the inability to reproduce, or in the form of impaired fecundity, that is to say, a lessened power to breed frequently and numerously. It may also be shown in the greater tendency to abortion or in some form of organic disease of the generative organs.

But the loss of reproductive power may in many instances be intensified only, rather than caused by in-and-in breeding, and in other instances the reproductive power may be said to be latent or partially so. This will be all the more apparent when it is remembered that in-and-in breeding is only one of the causes of a lessened power of reproduction. It has been noticed that some females are incapable of breeding to males near of kin to them, while they will breed to males of alien blood or of the same blood though unrelated. This would point to breeding powers in a sense latent under certain conditions, but not so under others.

General Deterioration from In-and-in Breeding. —In-and-in breeding when long continued evidently leads to deterioration of the whole animal system, as witnessed in the degeneracy manifested in Longhorn cattle after the master builders had passed away. The most noted breeders of these contemporary with Bakewell and subsequent to his time, followed his plan of breeding them too closely. The final outcome has been that the society for promoting the interests of Longhorns in England has gone out of existence. It would not, perhaps, be correct to say that in-and-in breeding alone is responsible for such a result, as the Longhorns never stood so high in the public estimate as the Shorthorns, yet the fact remains that it was one of the potent factors which contributed to such a result.

It is further witnessed in the necessity which compels its virtual abandonment in families in which it has been long practiced. No instance is on record in which in-and-in breeding has been continued indefinitely. In but few instances has it been practiced with entire success during the whole of the period covered by the experience of one individual, when such experience covered many years. It is not recorded that Robert Bakewell was forced to modify the intensity of the in-and-in breeding which he practiced, but it should be remembered that the material with which he began was vigorous. There are no reasons for believing that it had upon it the taint of weakened stamina, the outcome of previous in-and-in breeding. It has also been noticed that disastrous results have flowed from it wherever long practiced in the human family. The proportion of deaf and dumb in such instances, of imbeciles, of idiots, and deformed, is unusually large. Evidently no mistake was made by the divine Lawgiver in the legislation which He gave to the race prohibiting incestuous marriages.

In-and-in Breeding Cannot be Carried on Indefinitely.—Although in-and-in breeding may be adopted with much advantage for a time, under proper conditions, there is a limit which it cannot safely pass. This limit line beyond which it cannot be carried without hazard cannot be fixed by rule, as so much depends on the vigor and stamina of the stock used where in-and-in breeding is practiced. A breed with powers unimpaired by artificial conditions of domestication will longer withstand the undermining tendencies of in-and-in breeding. The more of stamina and vigor possessed by the animals at the outset, the longer, of course, can the process be continued before the evils that have been named appear. The in-and-in breeding practiced in the famous Sittyton herd was less intense than that practiced in the herds of some of the master Shorthorn builders, created at an earlier period, hence the Sittyton "sage," the immortal Amos Cruikshank, was able to close his useful work on the lines on which he had all along conducted it.

In the formation of breeds, the stock chosen to be inbred are the best formed and most vigorous types that are to be found. The process is safe, therefore, and helpful for a time. But suppose a new departure were made from foundation animals already so highly inbred that they showed signs of weakened vigor, it would result in the most complete failure, however skillfully conducted. Thomas Bates, one of the most skillful of the breeders which his century has produced, was compelled to introduce certain out-crosses to mate with at least some of the animals of his herd that had been highly inbred.

Since, therefore, certain evils eventually grow out of in-and-in breeding no matter how wisely conducted, it should be discontinued before such evils appear. It may be difficult to tell just where the danger line is before the indications manifest themselves. These indications should be taken as warning signals by the breeder and he should govern his work accordingly.

In-and-in Breeding Conducted Understandingly.—In-and-in breeding should not be adopted by those who do not understand it, or who may practice it in a haphazard way. It is like a sword with two edges, which cuts backward and forward according as it is wielded. When the animals so in-and-in bred are wisely chosen desirable properties will be secured and so stamped upon the progeny as to be rendered permanent. But if the materials should be unwisely chosen then undesirable properties would appear and with a persistence that would tend to discourage those engaged in the work. The task of selecting animals to be thus inbred is not an easy one even for the skilled breeder. How much more then is it difficult for the unskilled. Defects may be present such as those, for instance, which are not apparent to the eye, and when they are they become intensified by in-and-in breeding.

CHAPTER XI.

LINE BREEDING.

Line breeding has been practiced by not a few who object to in-and-in breeding in the full meaning of the term. It would probably be correct to say that but a few of the more noted herds and flocks have been long maintained without more or less of line breeding having been practiced in the families from which the males have been chosen.

Line Breeding Defined.—Line breeding may be defined as the process of breeding within the members of one family or of a limited number of families possessed of similar types. As usually conducted no animals are inter-bred which are not closely connected in the general lines of their blood. Strictly speaking it is in a sense a continuation of in-and-in breeding, the relationships in line breeding, however, being more distant. The animals that are line bred are more commonly descended from animals that have been bred in-and-in. For instance, from a few foundation animals closely in-and-in bred, several divergent streams may flow out. These divergent streams represent families and very probably more or less divergent types. When the streams become fully divergent, that is to say, from the time the families become distinctly separate, the males are chosen from within these families, sometimes called strains, and from that separating period line breeding may be said to begin.

But line breeding may also be the outcome of the blending of two distinct strains, each of which has probably been more or less in-bred. It differs from in-breeding in the virtual exclusion of alien blood and in continuity. The relationships in the former are in a sense closer. When in-breeding, the blood may be promiscuous in its near origin. When line breeding, it is unmixed with extraneous blood from what may be regarded as its starting point. Line breeding may be spoken of as repeated acts of in-breeding, the relations becoming less close as the starting point is receded from, because of the increase in the number of the individuals.

The Starting Point in Line Breeding.—As now understood it would not be possible in all instances to define exactly the starting point of line breeding. It may commence with a pair of animals, or with a limited number. When it does, in-and-in breeding of necessity is practiced at the first. But it may also commence at a later period in the history of the breed. More commonly it begins at that point where the outcome of in-and-in breeding diverges sufficiently to admit of the formation of distinct families descended wholly or chiefly from one ancestor. In line breeding the males are subsequently chosen from this family.

Close Breeding Defined.—Close breeding signifies the mating of animals closely related. Its relationship to in-and-in breeding has already been pointed out (see page 112). In some instances it may mean the same thing as line breeding, but ordinarily it differs from the latter in the relationships being closer, and from in-and-in breeding in their not being so close. It differs further from line breeding in the less degree of the continuity in the breeding. As with the other terms applied to breeding it is not easily defined. It is not easy to distinguish in all instances between what should be regarded as close breeding and what as line breeding.

High Breeding Defined.—High breeding signifies a rigorous selection of breeding stock with reference to a definite standard. It is sometimes regarded as synonymous with close breeding, but it differs from close breeding and also from line breeding in allowing the selections to extend to unrelated animals. High breeding may have reference to form only or to pedigree or to both. Usually it has reference to both. Where practiced, a high standard is set as to both form and pedigree, and the animals to be mated are chosen accordingly. They may be related or unrelated, that is to say, this line of breeding may be the same as in-and-in breeding or the same as line breeding, or it may be neither, or a combination of these systems.

When it considers only animal form it is not likely to be markedly successful. Nor will it be any more successful if it simply regards pedigree without considering form. When it duly considers both form and pedigree and does not include too much of line breeding or of in-and-in breeding, and when, moreover, good judgment is shown in the selections, high breeding is but another name for wise breeding, and is worthy of all consideration. But when it is followed practically on the lines of in-and-in breeding, the results will be practically the same.

The Objects of Line Breeding.—The chief objects of line breeding are to obtain uniformity of type in the stud, herd, or flock, and to maintain the same in these. In other words it is an effort to obtain greater average prepotency in the animals. Similarity of type in the whole herd is at once an evidence of prepotency in the parent or parents and a guaranty of the same in the offspring. Now this result is facilitated by the maintenance of identity or of similarity of blood in both sexes. This will, of course, secure and render permanent certain dominant properties.

But the same end may be obtained though not so quickly by carefully selecting males from a line bred family. This method of line breeding is considered safer than the former and many of those who practice it now do so on these lines. But eventually it becomes line breeding of the first class rather than of the second, where no fresh blood is brought into the stud, herd, or flock, through the purchase of females. And just here it may be stated that there is a magic influence about that word uniformity when applied to animal breeding, which is apt to lead the average breeder to place too high an estimate upon it. The advantages of uniformity depend almost entirely on the character of the uniformity. There may be uniformity of a low type as well as uniformity of a high type. In breeding, the first is not so desirable as less of uniformity of a higher type. It is when the uniformity sought is of a high standard that it is to be prized.

The Evils from Successive Line Breeding.—Line breeding is usually beneficial for a time, but it should not be carried too far, as there is danger that it will intensify defects, as well as useful qualities. When it does it becomes so far an evil. Ultimately it will produce all the evils consequent upon in-and-in breeding, though less in degree. These include loss of size, delicacy of constitution, impaired powers of reproduction and gradual deterioration. As these have been discussed in Chapter X. they will not be further discussed here. It should be noticed, however, that some of those evils may be gendered in the system before they become markedly apparent. For instance, the seeds of increasing delicacy of constitution may be sown before they are distinctly apparent, as evidenced by the results that flow from them. The results come later. When the evils do appear in a marked degree, they have become so incorporated in the animals, so much a part of the system, that much loss results before they can be corrected by judicious outcrossing. In this tendency first to create defects and then to transmit them, lies the greatest danger from in-and-in breeding and also from line breeding.

Illustrations of Excessive Line Breeding.—Illustrations of long continued line breeding are furnished in the various herds of wild cattle sheltered by certain parks in Great Britain during the past century. While at the beginning of the century there were at least seven herds, now more than half the number are gone, and their total extinction in the not distant future is by no means improbable. It would seem peculiarly fortunate that illustrations of this question are furnished by herds which cover so long a a period. Some of them have been kept within the inclosed grounds of certain noblemen for more than 500 years. The most famous of these herds, viz., that at Chillingham Park, has been line bred for more than seven hundred years. These wild or semi-wild cattle have been bred under circumstances the most favorable to successful line breeding that could well be imagined. The continuity of sameness in blood-lines has not been disturbed by out-crosses. The breeding has been from the most vigorous sires, as each in turn secured the mastery in the herd. The exemption from the enervating influences of domestication was most complete, since they were not confined. They were also supplied with food when necessary in winter. And yet, from natural causes, these herds are gradually waning in numbers, insomuch that it is feared that the extinction of those that yet survive is only a question of time. These cattle are not prolific, although their surroundings are eminently favorable to prolificacy. Nor are they of large size. Is not the conclusion legitimate, therefore, that these results are the outcome of too long continued line breeding?

The results of the experience of the molders of the various leading types of Shorthorns point in the same direction. The Collings Bros. inbred closely as a rule, though not at the outset, but their practice varied. It was they who introduced into their herd the Galloway blood, and the resultant fact remains that the highest priced animals at their dispersion sale were those possessed of this blood. But too much should not be made of this fact as the per cent of Galloway blood in many of the animals possessing it was small indeed. Darwin states that during the first thirteen years of breeding at Kirklevington, Thomas Bates bred most closely, and during the next seventeen years of breeding he made several out-crosses, that is to say, he introduced Shorthorn bulls from other herds. It was after he began the introduction of these out-crosses that his greatest triumphs were made in the showing. During the earlier period of the breeding conducted by the Booths, new blood was repeatedly introduced by purchasing females, and an occasional out-cross was also made by bringing males from other herds, and for a time all went well. Later the breeding was closer, with the final outcome that it was found necessary to introduce fresh blood freely to preserve the high average of excellence in these cattle.

The Cruikshank cattle were much mixed in their blood lines during the first decades of the breeding conducted at Sittyton, that is to say, many of the females brought into the herd from without were chosen from various sources and were not specially line bred. Later the breeding was more closely in line and probably for the reason, among others, that by breeding thus, Mr. Cruikshank was the better able to reap the fruits which grew out of his great reputation as a breeder. The fame which in time came to those cattle was doubtless due to the great skill shown in the selection of males to use upon females of varied breeding. But the herd was dispersed at a period too early to show what the outcome would finally have been from the closer breeding practiced. The experience of those breeders, therefore, as far as it goes, is certainly less favorable to long continued line breeding than to the more promiscuous blending of blood elements within the breed.

Line Breeding Cannot be Carried on Indefinitely.—From what has been said above it is manifest that line breeding cannot be carried on indefinitely without sowing the seeds of ultimate deterioration. The postponement of the evil day will depend upon such conditions as the skill of the breeder, the numbers of the herd or flock, the naturalness, or otherwise, of the conditions of keep, and the management generally.

Of course the more skillful the breeder, the greater the number of animals in the herd or flock, the more natural the conditions and the more sensible the management the less quickly will the evils from line breeding too long continued show themselves. At least one excellent flock of line bred sheep is now in existence into which an out-cross has not been introduced for about a century. The reference is to the famous flock of Border Leicester at Mertoun Lodge in Berwickshire, Scotland. But the fact is greatly significant that American purchasers at the present time are looking to other flocks not thus line bred when making selections. They assign as a reason, that while the Mertoun Lodge flock furnishes sires of much prepotency, they are somewhat lacking in scale.

Remedy for Evils from Breeding too Closely.—The evils consequent upon line breeding or in-and-in breeding too long continued may be remedied in part by the judicious introduction of an out-cross or a succession of out-crosses, carefully made. The timely introduction of the same may be made to ward off those evils or to prevent them entirely. That line breeding may be made to aid in furnishing prepotent sires cannot be questioned and in this fact lies one of the strongest arguments for practicing it. That a time eventually comes when it ought to be discontinued even for this purpose is equally true. There is decided difficulty, however, in knowing when and where to stop, that is, just when and where to introduce the out-cross. As soon, however, as signs of deterioration in any direction become apparent, they should be taken as danger signals calling to the breeder to halt.

When the evils have become at all pronounced this remedy may work slowly, since the evils may have become in a sense dominant. Whether there is any way by which the benefits of line breeding in the production of sires may be secured continuously without gendering the evils complained of does not yet appear to have been demonstrated. Possibly it would be practicable to draw sires, for a time, from a line bred family, and at the same time to have another line bred family coming from which sires could be chosen later. Such breeding would, however, encounter two difficulties, viz.: That the period covered by the breeding of the average individual is too short for such a demonstration, and the results from the males of the second line bred family would be uncertain until proved. With all the merit that line breeding possesses it must be acknowledged that it is a steed which breeders cannot always control to their satisfaction.

An Out-cross Defined.—An out-cross may be defined as the use of a sire of unrelated blood upon females of the same breed that have been bred in line or that are in-and-in bred, but it may also mean crossing high grade or pure bred females with a male of another breed. It is only in the former sense that it will be discussed in the present chapter. Unrelated blood, if healthy and vigorous, infuses fresh vigor into the stocks upon which it has been crossed. The reasons for this increase of vigor are not well understood, but it has been noticed that it is frequently greater when the animals used in making the outcross have been brought from places wide apart, and when the conditions such as relate to climate and production are different. Thus it is that Shorthorn blood brought from Britain seems to have a renovating influence on herds in this country though not bred in line, and probably the same would be true of Shorthorn blood exported from the United States to Britain. This would seem to be akin to the renovation which in many instances comes through the introduction of the seeds of plants from outside sources. But it would not be correct to say that all such changes with animals or plants bring renovation.

Benefits from Introducing an Out-cross.—The benefits which flow from increased vigor the result of an out-cross include: 1. An increase of size and flesh-forming qualities; 2. An increase of milk production; 3. Increased productivity; and 4. Extended longevity. These benefits are virtually the opposites of the evils created by too close breeding and too long continued. They grow out of that upward, onward stimulus which increased vigor brings along with it, and which extends to every part of the system. Thus it is that prize winning animals are so frequently found in the earlier progeny from out-crosses.

Animals Long Line Bred Produce few Specimens of Highest Excellence.—While animals long bred in line or in-and-in bred may produce an occasional specimen of high excellence, they do not produce nearly so many of these as pure bred animals of what may be termed mixed breeding. Such has been the record written on the page of history in the breeding of Shorthorns for the past one hundred years. No class of Shorthorn cattle have been line bred to a greater extent than certain of the Bates families. They have been in the hands of many skillful breeders, and yet the prize winners from such herds have not been relatively numerous for the past fifty years. But, when those cattle have been judiciously crossed by Cruikshank males, the results have been of the most satisfactory character. The progeny of these out-crosses stand high in favor in the herd, in the show ring and on the block. That mixed breeding, or, as it is sometimes termed, "natural breeding," when judiciously conducted will produce a high percentage of excellent animals has been clearly demonstrated in the Grasmere herd already referred to (see page 109). The fact only can be stated here.

Out-crosses Should be Made Cautiously.—Out-crosses should be introduced with much care lest the variations resulting should be in a different direction from what was intended. The prepotency even of a vigorous animal cannot be measured definitely by conjecture. When these out-crosses are made they should be made in a tentative way, that is to say, in about the same manner as sires are tested to judge of their prepotency. They should be mated with only a few females until the results of the out-cross are apparent in the progeny. When these are quite favorable those sires should then be used freely on the herd and for as long a period as may be judicious.

CHAPTER XII.

FECUNDITY.

The relation between the breeding properties of animals that are kept for breeding and the profits arising therefrom is both intimate and close. No sooner has an animal reached the proper age for breeding when kept for that purpose, than the relative profit from keeping it grows less than it would otherwise be, every day that it is kept subsequently without discharging, at least in reasonable degree, the breeding function. And this is more especially true of animals that are kept chiefly for the milk that they furnish. It is greatly important, therefore, that every attention shall be given by those who keep domestic animals to the maintenance of a high standard in productivity in the stud, herd, or flock.

Fecundity Defined.—Fecundity means the quality of bringing forth offspring freely, regularly, and in many instances abundantly. It means about the same thing as prolificacy when the latter is applied to animal breeding, but prolificacy is the broader term and therefore has a wider range of application. Fecundity has reference to frequency in reproduction as well as to the numbers produced. Of course, in those classes of animals which produce but one at a birth, it can only have reference to frequency and regularity in production. In such instances the most fecund animals will be those which produce the most freely and regularly from the time that breeding

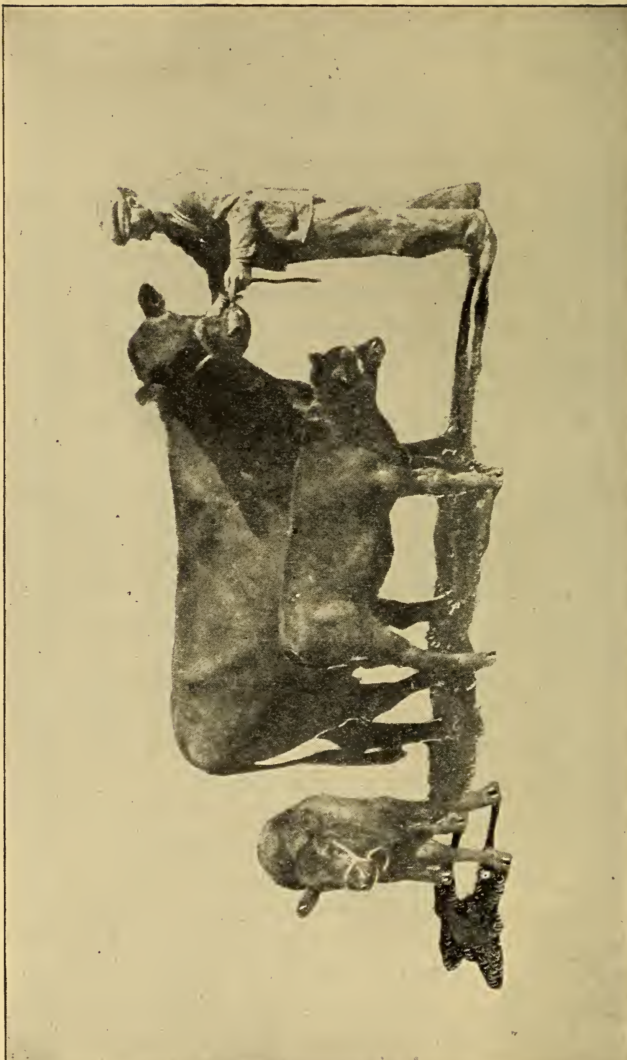

FIG. 6. ABERDEEN ANGUS COW, ROSELLA OF GLENDALE, NO. 22862, AND HER TWIN CALVES.
(Illustrating Prolificacy.)
The property of the Minnesota University Experiment Station.

should begin. But when more than one is produced at a birth, the most fecund animals will be those that produce the most freely and regularly, and that bring forth most numerously at each season of parturition. It will be noticed that this property is the attribute of females only, but it is doubtless influenced more or less by the males used in service. It differs from fertility in that it has reference to the numbers produced rather than to the ability to produce. Fertility is of varying degrees, but an animal that is susceptible of impregnation is fertile. It is the opposite of sterility and barrenness in females. Females that breed irregularly and infrequently are commonly spoken of as shy breeders, and males that are unable to beget are spoken of as impotent.

Influences that Affect Reproduction.—The reproductive powers of animals are much influenced by changes in their surroundings and habits and by the modes of life to which they are subjected. All such changes as tend to equalize conditions are favorable to reproduction. For instance, when regular supplies of food supplant those where food has been in excess a part of the year and insufficient another portion of the same, the influence on productivity is favorable, and so of all other influences that tend to equalize. Regularity even in the habit of breeding tends to perpetuate such regularity. But the results are adverse when the changes in themselves are unfavorable to the healthy action of the system. The African ostrich, for instance, has been transplanted to certain other countries where the surroundings are considered less favorable than in South Africa, and with the result that there has been a decrease in productivity. The influences that affect productivity favorably and adversely are much the same as those that affect fecundity similarly, and they are given below.

Influences that Affect Fecundity Adversely.—The following are chief among the influences that affect fecundity adversely: 1. Confinement and lack of exercise. 2. Irregular supplies of food and lack of uniformity in conditions. 3. Food lacking in succulence or containing too much sugar. 4. A plethoric condition of the system. 5. Meager milk production. And 6, In-and-in breeding, line breeding, close breeding, excessive breeding, and in some instances heredity. These influences may act singly or more or less in conjunction. The more they act in conjunction the more adversely will they influence fecundity. They will now be considered somewhat in detail.

Influence of Confinement on Fecundity.—Fecundity is affected adversely by confinement and the lack of exercise which confinement brings with it. This may be shown in various ways. It is seen in the relative frequency of impotency in males and of barrenness in females among domestic animals that have been much confined. To so great an extent has this fact been recognized by breeders that they invariably adopt some measures whereby such exercise can be obtained for breeding animals. Paddocks are provided for those which may not usually run with the females, and pastures of more or less extent are provided for females which must needs be kept on the soiling system. Devices are sometimes resorted to which shall compel the animals to take exercise, as, for instance, when bulls and stallions are made to work. In the human family the relation between a life of labor or the opposite on reproduction is sharply drawn. Large families are usually found only among the classes who toil.

It is seen in the impaired or destroyed powers of reproduction in wild animals when deprived of their liberty and in the inability of their offspring to breed. Animals once wild and confined, as in a menagerie, breed very shyly and when they do, in but few instances beyond the first generation. The males become impotent and the females barren. The same principle has also been demonstrated, as stated by Darwin, in certain experiments conducted with fowls in France. These were given different degrees of liberty. The fecundity increased with the increase of liberty given to the fowls, at least, up to a certain limit.

Influence of Food Supplies and of Conditions on Fecundity.—Irregular supplies of food and lack of uniformity in conditions affect fecundity adversely. This has been shown in the shy breeding qualities of the Spanish Merino sheep in its native country as compared with the same in other lands. In Spain prior to the present century the traveling flocks were oftentimes on short supplies, especially when journeying to and from the mountains. The conditions otherwise were uneven, as, for instance, when exposed to adverse weather. When those sheep were first brought to the United States their want of fecundity was distinctly noticeable. Since that time their breeding qualities have improved, especially on arable farms where they can be given regular supplies of suitable food and subjected to fairly uniform conditions. On the western ranges not only Merinos but also other breeds of sheep breed more shyly than when suitably cared for on the farm. It is also shown in the less prolific character of the mountain breeds of sheep as compared with those of the lower land.

It would not be easy to give statistics that would form a just comparison, but the fact has been noticed to the extent of being commonly recognized by those who are acquainted with sheep husbandry. The reasons for the less fecundity of the mountain breeds are very similar to those which explain the same in range flocks. It is further shown in the greater fecundity of domesticated animals as compared with the same when wild, as instanced in pigeons, geese, and ducks, rabbits, dogs, swine, and other animals. Some varieties of pigeons breed but twice a year in a wild condition, and when domesticated the same varieties will breed much oftener. Swine seldom breed in the wild state and produce but few at a litter. Under domestication they may be made to produce litters regularly twice a year and of about twice the number in each litter produced by the wild species. The increase in the prolificacy of tame rabbits as compared with wild ones is even more marked.

Influence of Nutrition on Fecundity.—Nutrition materially affects the activity of reproduction, since it supplies the organs of the latter with materials concerned in its operations. If these materials are insufficient or unsuitable the generative powers suffer accordingly. Sometimes there is a certain degree of antagonism between the nutritive and generative functions, the one operating unduly at the expense of the other. This antagonism always exists more or less when the normal equilibrium of suitable conditions is disturbed, and this will probably be true let the disturbance arise from whatsoever cause it may. It may not always be easily possible to tell just where this equilibrium lies. It is to be gathered from cumulative experience and observation. Any excess in the nutritive activity of the system acts prejudicially on the powers of reproduction as shown in the partial or total sterility of fat animals, over-luxuriant plants and nut bearing trees. Animals that have been made excessively fat for show purposes are usually indifferent breeders. To so great an extent has this fact come to be recognized that it affects their sale adversely for breeding uses. Many of them breed irregularly, and produce progeny lacking in size and stamina at birth or do not breed at all. But poor breeding qualities are less frequently found in show animals kept in uniformly high condition from birth than in those subjected to alternations of high and low conditions.

In over-luxuriant plants and nut bearing trees the energies of the plant and of the tree are so concentrated in the production of stems and leaves in the one case, and of wood in the other, that little or no fruit is produced. The opposite is also true, namely, that any marked deficiencies in nutrition impair and hinder breeding properties and in some instances destroy them altogether. This finds ample illustration in the decline of life. The nutritive processes weaken with advancing age till at length these cannot sustain the generative function in the male or the reproductive function in the female, until impotency is produced in the former and sterility in the latter. Certain forms of disease lead to similar results, more especially those forms which seriously impair the nutritive function. The intimate relation between abundant food supplies and the judicious feeding of the same may be further illustrated in various ways.

Cows regularly supplied with enough suitable food will breed at almost any season of the year.

Those kept on innutritious food in the winter and on good pastures in summer will mate only in the summer after the grasses have become plentiful. During the winter while on innutritious and dry food, the whole system languishes including the generative function. The rich and abundant pastures stimulate the whole being of the animal including the organs of reproduction. They at once become active.

Flockmasters have found that when ewes whose lambs have been weaned are put upon rich pastures they breed more quickly than when on poor pastures, and when the pasture is supplemented with some stimulating grain food, as barley or wheat, the tendencies to breed quickly are intensified. The function of breeding shares in the renovation of the system, hence, the stimulus given to the breeding impulse which leads to early mating. In this way more uniformity is secured in the time when the lambs are dropped and more lambs are produced. The bearing of suitable food, when suitably fed, on increased fecundity is thus very clearly shown. The wisdom of feeding females liberal supplies of nutritious food when reduced in flesh through nursing their young when it is desired to have them breed quickly again will be at once apparent, as also the necessity for feeding males similarly when preparing them for active and prolonged service.

Stallions in charge of intelligent grooms are thus prepared for the service of the mating season. When males are much used in service they also require liberal nourishment. This explains why intelligent stockmen feed nourishing and suitable food freely to their sires during any seasons of breeding in which the instances of mating are frequent. It has been noticed that such treatment has a marked influence on ability to beget as well as upon increased numbers in the progeny begotten when more than one is produced at a birth.

Influence of the Quality of the Food on Fecundity.—The quality of the food exercises an important influence on fecundity. A large proportion of sugar in the same injures the reproductive functions. This arises, in part, at least, from the abundance of carbohydrate elements in such food. When fed in large quantities and for a prolonged period it also tends to cloy the appetite. Foods rich in sugar stand in high favor with many who prepare animals for exhibition. For such a use sugar is frequently fed in the pure form and it has been noticed that when thus fed freely to young animals their breeding powers are affected adversely, and the general tone of the system likewise suffers more or less.

A dry dietary is unfavorable to impregnation, and a rich, juicy and succulent vegetation is favorable to the same. A diet unduly lacking in succulence, as, for instance, hay long stored, is unfavorable to reproduction when fed alone. Such a diet tends to induce a constipated condition of the digestion and the breeding powers suffer in consequence. When, in addition to the dryness, the nutritive quality of the food is low, as when straw constitutes the food, the outcome is still more adverse to breeding. This explains why seasons of extraordinary drouth are unfavorable to fecundity. The grasses are both dry and innutritious. It is easily possible, however, to feed foods too succulent to get the best results from breeding. In seasons of excessive rainfall the grasses though abundant are not sufficiently nutritious, and not infrequently they keep the bowels in a condition too lax. Foods rich, juicy and succulent are favorable to free and regular breeding. Richness in food furnishes the needed nutrition, juiciness tempts the appetite, and when the foods are also succulent they act beneficially on the digestion. A fresh Dwarf Essex Rape pasture well matured, furnishes an excellent instance of a single food possessing all these properties in a marked degree.

A carbonaceous diet is also unfavorable to fecundity, while a nitrogenous diet is favorable. The carbonaceous diet tends to produce fat and heat, while the fœtus during development is more in need of muscular sustenance. This is obtained from the elements of a diet nitrogenous in character. Brood sows reared on a corn diet are shy breeders. When fed on the same during pregnancy the pigs are likely to be small and deficient in vigor at birth, and the danger is imminent that the sow may have trouble in farrowing. In the distinct corn belt such a diet has diminished the fecundity of swine.

A Plethoric Condition Diminishes Fecundity.—Diminished fecundity may arise from a plethoric condition of the system. Such a condition is accompanied by overloading with flesh, which begets sluggish tendencies in the whole being unfavorable to reproduction. It may also arise from congestion and inflammation in the organs concerned in procreation, induced or at least aggravated by these influences. The correctives for the first are, active exercise even though enforced, and a diminished diet, but the depletion of the system should be gradual. In this way the breeding powers of males that have become impotent and females barren through over high fitting for the shows have been restored. When organic disease, however, is present in either of the forms named or in other forms, the most skillful treatment will often fail to remove the same.

When the Breeding Powers are Most Active.—The breeding powers are most active when animals are in what may be termed moderate condition as to flesh, and in the meridian of vigor. A marked tendency to lay on fat is frequently accompanied by a delicacy of condition and a diminished secretion of milk, as well as by a loss of fecundity. The first comes from the sluggishness which it induces. The second results from the energies of the system being too much concentrated in the opposite direction, that is, in the production of milk. And the third is the outcome of the antagonistic influence of these causes acting in conjunction. When breeding is rendered impossible, as by castration or spaying, the tendency to lay on fat is increased. This arises from the more restful habits of castrated or spayed animals and from the less extent to which the energies of the system are divided. The moment that either operation takes place the generative function no longer requires to be sustained. Nor is milk production any longer, usually, possible in females. Castration and spaying are further discussed in Chapter XXIX.

Sterility in Fat Animals.—The immediate cause of sterility in fat animals frequently rests in what may be termed fatty degeneration. It is caused by the conversion of the albuminous or gelatinous materials of the tissues of the reproductive organs into fat. While in that condition reproduction is impossible. In other instances the tubes in females that convey the seminal fluid to the ovum fail to do so, they are so filled with fatty matter, hence impregnation cannot take place, howsoever vigorous the male may be. The mistake, however, must not be made, that a fat condition of the animals is essentially incompatible with the ability to breed, since both males and females have gone through years of successful exhibiting without ceasing to breed with normal certainty. In such instances, however, the animals have been high fleshed from the beginning and have been subjected to much uniformity of treatment. But the progeny, notwithstanding, are not often the equal of the parents in vigor or individuality. Long continued succession in the generations of great prize winners, at least in animals kept for meat, has never occurred.

The Relation Between Milk Production and Reproduction.—There is an intimate relation between the milk producing powers and those of reproduction. This is owing, in part at least, to the dependence of milk secretion on the mammary glands. These in turn are under the direct influence of the breeding organs, or they sympathize very closely with them, hence animals which breed with the least difficulty and which produce the most healthy and vigorous offspring, usually yield the best supplies of milk among animals of that particular type. The logical conclusions from these premises are, first, that it is quite possible in meat-producing animals to reduce the milk-giving function below what would be for the best results in breeding, and for the best maintenance of the progeny, and second, that mere selection in dairy herds based on abundant milk-giving should of itself improve the breeding qualities of the animals of the herd. Regular breeding in meat-producing herds or flocks will therefore exist in the most marked degree when no little attention is given to the retention of milking qualities in the females. But in dairy herds it would be possible to so stimulate the milk-giving function as to react injuriously on the whole animal by reducing its vigor and consequently injuring both the breeding and milk-giving functions. These results however are not of frequent occurrence.

The proper sustenance of the animal during gestation has also an important bearing on milk giving and consequently on subsequent reproduction. Many fear to keep the pregnant animal in a good condition of flesh during the period of pregnancy, lest there should be trouble at parturition. Such a fear is groundless, providing the food producing the flesh has been duly succulent and has had in it a sufficient proportion of protein. It is a mistake to have animals thin in flesh, beyond a certain limit, when they bring forth their young. It is not fair to the progeny before birth and it will react against abundant milk-giving.

If a female is low in flesh when her progeny is born she is dependent entirely on food supplies for the milk that she gives. If she is in a good condition of flesh when her progeny is born she has a residuum of milk-producing materials stored up in her own body which in due time is turned into milk. This explains why a brood sow in good flesh when her large litter of young are born is usually thin by the time they are ready to wean. When the dam is low in flesh at parturition the drain upon the energies that follows reduces her vigor. This reduction of vigor extends to the assimilative powers, hence she remains low in flesh during the milk giving period. The breeding powers through sympathy are also enervated, hence time is lost before the animal can be bred again.

The Influences of Over-Breeding and of Heredity on Fecundity.—The term over-breeding is used here to mean breeding excessively, that is to say, breeding from relatives so close that injurious results follow. It also means breeding too young and too frequently. Reference has already been made to the adverse influence which in-and-in breeding, line breeding, and close breeding have on fecundity. (See Chapters X and XI.) Immature breeding produces results similar in kind and usually even more quickly. When at all excessive it tends not only to reduce stamina, and to weaken seriously if not indeed to destroy the generative functions.

Force a young child to walk before its limbs have strength enough to support it, and the limbs become weak and unshapely. Encourage it to tax the brain unduly at too young an age and the danger is imminent that it will become a physical and probably a mental wreck. So when a sire is used in breeding at too young an age the whole being of the same is injured, including the generative organs. And when a female is bred too young, normal size in her is not likely ever to be reached. When she is bred too frequently the stamina of both the dam and progeny suffers. The latter always suffer when the dam has been bred excessively. In many lines live stock has thus suffered from excessive breeding during recent years.

But the greatest mistakes have probably been made by dairymen in breeding heifers too young, by some swine growers in breeding sows too early and by the growers of beef and mutton in the extent to which young sires have been used. The first have to some extent been influenced by the desire to establish the habit of milk-giving in the young female so that the energies of the system would be encouraged to concentrate in that direction. The second have sought profit in trying to reduce the duration of the rearing period prior to the time of reproducing, and the third have been influenced by the low price at which old males must be sold when they cannot longer be used in the herd. All have erred. Good breeders are opposed to breeding sows so as to reproduce under the age of twelve months, and to produce twice a year, to breeding ewes under the age of nineteen months, and to using young males with much frequency until they are quite beyond the age at which they become capable of begetting. But the age at which animals may be used in breeding depends somewhat upon the individuality of the same, as, for instance, on the development and vigor, hence no cast iron rules can be framed that will equally apply to every case. But there can be no question of the wisdom of not allowing males to run with females, as a rule, at the mating season, lest the energies of the latter shall be taxed to no purpose by excessive service.

Heredity will influence the breeding qualities of animals favorably or otherwise according to the breeding qualities of the ancestry. The assumption is no doubt correct that fecundity is quite as much a matter of inheritance as of form. This has been repeatedly demonstrated in the practice of breeding. When it is desirable, therefore, to increase the fecundity, much care should be taken to choose both males and females from families which have been free producers. Free production is probably as much dependent on heredity as on food supplies in the ordinary operations of the breeder. The proper selection of breeding stock will therefore have much influence upon the rate of increase in a flock or herd.

Heredity not only influences fecundity as such, but it may also be made to exercise a powerful influence on the season of breeding. Under normal conditions grade ewes of mixed breeding drop their lambs in the spring. In experiments conducted by the author at the Minnesota University Experiment Station, the breeding habit has been so changed in the first generation of the female progeny, that a large percentage of them, when bred, dropped lambs in the autumn, that is to say, between the end of September and the close of the year. In a few instances females of the first cross dropped lambs in September. But those lambs were not of the first birth. Pure bred Dorset sires were used, and the change in the time of breeding already noted was unquestionably due to inheritance from them, although it was influenced to some extent by the food given to the dams.

Relation Between Size in Animals and Fecundity.—There is a marked relation between the size of animals and fecundity throughout the animal kingdom. The smaller species breed more frequently, more numerously, and at an earlier age. Cattle breed but once a year and produce but one at a birth. Swine breed twice a year and produce several at a birth. Belgian hares breed many times a year and also produce several at a birth. This may be owing in part to the modifying influence of the nutritive functions, but it would seem to be owing more to the inherent original constitution bestowed upon the different species. While, as has been shown, fecundity may be influenced favorably in various ways, there is a limit to the possibilities of such influence. The cow could never be made to produce as the sow does, nor the ewe as the female Belgian hare.

Freemartins Usually Barren.—When a male and a female are produced at one birth, the barrenness of one has only been observed in the progeny of bovines. The female is generally barren. Such females are called "freemartins." It is only among bovines that this peculiarity occurs, and it is confined to instances in which one of the pair is a female and the other a male. The male would seem as able to beget as males ordinarily are. In rare instances the females also breed. The primary reasons for this peculiarity are as yet unexplained. The internal generative organs of the female partake somewhat of the nature of those of the male. This explains the immediate cause of the barrenness, but no light is forthcoming as to the cause of such inheritance.

CHAPTER XIII.

THE RELATIVE INFLUENCE OF PARENTS.

No question pertaining to breeding has given rise to more controverted opinions than that which relates to the relative influence of parents as male and female, in determining the characteristics of the offspring. Many have claimed, and with much positiveness, that certain characters are derived chiefly from the male and certain other characters are derived chiefly from the female. But, since there is not much agreement between the leading advocates of these theories, even when the same in some leading essentials, and since the arguments presented in support of them are chiefly of a negative character, they fall short of incontrovertible demonstration.

The Relative Influence of Parents in Breeding Defined.—By the relative influence of parents in breeding is meant the influence which they exert as male or female in determining the character of the progeny. It differs from prepotency in drawing the contrast between the influence of the parents as male and female in determining transmitted characters, whereas prepotency has a regard to the influence exerted by either parent without inquiring as to whether any peculiarities of transmission belong to one sex or the other. And it may be mentioned here that if the contention were true that one parent because of its sex influences certain features of transmission, then such transmission would be a disturbing factor antagonistic at least in some instances to prepotency. Such disturbance would complicate the laws that govern transmission to such an extent as to seriously hinder successful breeding. At the outset, therefore, it would seem improbable that influences so antagonistic should inhere in the same animals.

Sex Alone Does Not Affect Transmissive Power.—Much of what will be said in the remaining portion of this chapter will have a bearing on the affirmation just made. The correctness of any theory that would assign a greater relative influence to one parent as such in determining the characteristics of the offspring has not as yet been established. It has been claimed that there is a preponderance in resemblance in the offspring to the male parent. It has also been claimed that there is a preponderance in resemblance to the female parent. But more commonly both claims have reference to certain characters in the progeny rather than to the whole being, otherwise their absurdity would be so manifest that it would not be necessary to consider them. Some have said that the male parent transmits certain features of form, function, or of disposition, while others have said that the female parent transmits like properties. But the theory that the male parent exerts on the whole the greater influence because it is a male has long been popular. That it does exert the greater influence, on the whole, is true, as will be shown below, but not in virtue of its sex. Were it true that this greater influence was exerted because of its sex, there would not be so many instances in which there is a preponderance in resemblance to the female.

In the human family children very frequently resemble the mother more than the father in form, in features and in mental powers. This preponderance in resemblance to the female parent among domestic animals is also frequent, though not so frequent relatively as in the human family, and for the reason that in the latter there is no selection in breeding as with domestic animals, hence the average female is likely to be as prepotent as the average male.

Why the Male Parent Exerts the Greater Influence in Transmission.—The theory that the male parent exerts the greater influence in virtue of its sex has arisen probably from the greater number of instances, in which, in breeding domestic animals a preponderance of resemblance may be traced to the male parent. But this may be owing first, to the greater care used ordinarily in breeding males, which renders them more prepotent, and to the greater pains taken in choosing them, and, second, to the larger number of the progeny relatively tracing to one male. Males are usually more purely bred than females, and they are usually possessed of a greater average individual vigor. They are in consequence more prepotent than females as shown in Chapter IX. It could not be otherwise then, but that the resemblance to the males would preponderate in each of the individual progeny. And since the progeny of one male is in nearly all instances in practical breeding much more numerous than the progeny of each female, the sum of the resemblance in the progeny to the male is greater than the sum of the same to all the females combined.

The Offspring Resemble Most the Parent Most Highly Bred.—The probability is strong that there will be a preponderance in resemblance to the parent most highly bred, whether male or female. It has been shown above why the progeny more frequently resemble the male. But suppose the conditions of choice were reversed, that is to say, that more pains were taken in breeding and choosing females, then it would doubtless follow that in the progeny of each female there would be more of resemblance to the female than to the male parent. This is well brought out in crossing a well established breed with one but recently established, and in mating a pure bred with an animal of mixed breeding.

If a male chosen from a well established breed is mated with a female of a breed but recently established, other things being equal, there will be a preponderance of resemblance in the progeny to the male parent. Reverse the process and there will be a preponderance in resemblance to the female parent. Both results are due to the greater potency of the breed that has been long established. Similarly, if a pure bred male is mated with a female of mixed breeding, there will be more of resemblance in the progeny to the male. Reverse the process and there will be more of resemblance in the progeny to the female. Both results are due to the greater potency of pure blood as compared with that from mixed blood. Ordinarily therefore the progeny will bear the closer resemblance to the parent of the more ancient lineage in the one instance, and to that of the purest breeding in the other. But there may be some exceptions for reasons that will now be given.

Unexpected Variations in Transmission.—Although the predominant influence of the best bred parent is the rule in transmission, the intensity of other conditions may interfere so as to produce unexpected variations. For instance, where high breeding is practiced, with reference to securing a single quality only, or a limited number of desirable qualities, in securing these strength and constitution may have been so neglected as to result in transmission that is variable. Much depends upon the strength and constitution of each parent, as well as upon the composition of the blood. Under normal conditions the best bred parent would almost certainly transmit a preponderance in properties to the offspring. But a weakened constitution, sometimes at least and generally, weakens potency in transmission. Diminished strength of constitution including present vigor may therefore tend to counteract potency in transmission, the result of pure breeding. The antagonism may become so strong even, that its influence in producing variation may be stronger than that of good breeding in perpetuating likeness in transmission. It is possible, therefore, that in many instances as much depends upon the strength and constitution of each parent as upon the composition of the blood.

This variableness in transmission may arise, in part at least, from the inheritance of variable characters represented in the ancestral line, and it may be that impaired vigor enables these to assert themselves in a way which would be hardly possible where much vigor is present, since the latter probably would prove a controlling influence running counter to them. Whatever may be said of the explanation, the fact remains, that in both sexes, animals possessing blood precisely similar have shown a marked difference in their powers of transmission, whether male or female.

The Influence of Age on Transmission.—The ability of either parent as male or female in transmitting characteristics to the progeny is to some extent influenced by old age and consequently by bodily vigor. As the bodily vigor of an animal decreases with advancing age, its prepotency in many instances would seem to suffer more or less. In such instances the decrease in prepotency is charged up to a decrease in bodily vigor. As this decrease in bodily vigor will affect alike male and female, it follows that it will affect the ability of either to transmit characters. If it were true therefore that sex as such were capable of certain kinds of transmission, because of sex, advancing age with its decrease in bodily vigor would step in and form a disturbing factor, that is to say, an animal declining in vigor would have less power than one of the opposite sex in the zenith of bodily vigor, to transmit properties when mated with the same. Such mating would therefore so far disturb transmission in virtue of the sex, if such transmission did exist. But advancing old age and diminished bodily vigor are not always accompanied by diminished prepotency, as in some instances animals deficient in strength and vigor are highly prepotent. Such transmission is oftentimes readily apparent in the progeny of animals with an inclination to certain diseases or already suffering from the same. In this fact lies the great hazard in breeding from pure bred animals deficient in these qualities.

Transmission When Prepotency is Not Marked. —When there is no marked prepotency on the part of either parent it has been claimed that the male offspring frequently resemble the sire and the female offspring the dam. Such resemblances have been noticed in the transmission of disease. Carefully gathered statistics have shown, as quoted by Miles, that in a certain number of cases of consumption and also of insanity, the instances of inheritance of these respective diseases from the male parent were more numerous in males, and of inheritance of the same from the female parent were more numerous in females.

This would seem to favor the view that it is possible for a male or a female in virtue of its sex to transmit certain peculiarities to the progeny. But the force of such an argument is greatly weakened by what is said in the succeeding paragraph, that is to say, by the power of transmission which one sex sometimes possesses to transmit peculiarities which affect only the other sex. The principle involved, however, tends to emphasize the importance of careful selection in the sires introduced into the stud, herd or flock.

Transmission of Peculiarities Through the Opposite Sex.—Instances are not infrequent wherein disease and other peculiarities are limited to one sex and transmitted by the other. This has already been referred to in Chapter VII., but will now be further enlarged upon, because of its bearing on the subject that is being discussed. Such transmission has been observed in the inheritance of certain forms of ichthyosis. There have been instances in which the disease was confined to one sex and transmitted through the other, that is to say, it would affect only males though transmitted by females in which it was not apparent. But the opposite of this has happened with the same forms of disease, that is to say, the disease was apparent only in females though inherited from males. It has been observed in the inheritance of a tendency to obesity when only one sex will be thus affected. But as with the inheritance of skin diseases, such a tendency has at one time manifested itself in one sex, at another time in the opposite sex, and in yet other instances the transmission is variable and mixed.

It has also been observed in the influence of the dairy sire in transmitting form and functional activity to the udder of the same. It is claimed, however, that such transmission is more marked when the females are grades. This is just what may be looked for, and it is doubtless the outcome of that greater prepotency which a pure bred sire has when mated with a female of mixed breeding. The greater prepotency of the male affects the whole organism of the female though of the opposite sex. Nor has it been proved to a demonstration that one sex as male or female has the power of transmitting those peculiarities in a greater degree than the other. And the whole question is still further obscured by the preponderance in resemblance to one parent which is observable at one period of development, and to the other parent at another period of development.

Theories Regarding Transmission by Parents as Male and Female.—Various theories have been advanced to the effect that in generation the male progeny determines the character of certain organs, and also of other features of the organization, and that the female parent likewise determines the nature of yet other features and characteristics of the organization. Chief among those theories are the following:

1. That the male parent influences chiefly the external characters of the offspring and the female the internal characters of the same. According to this theory the male parent chiefly determines the nature of the bony framework, its covering and locomotion,

and consequently its appearance, while the female parent chiefly determines the internal structures, as the vital and digestive organs, thus controlling very largely the stamina and growth of the animal. Such propagation is done as it were in parts, one parent determining certain characters of the organization and the other parent determining other characters of the same.

2. That one parent will chiefly determine the character of the forehead and organs of sense along with the vital and nutritive organs, while the other parent chiefly determines the character of the back of the head and also the locomotive organs. This theory claims also that which parent will produce these peculiarities will depend somewhat on sameness of blood, difference in blood, and closeness of relationship.

3. That propagation is done, as it were, by halves, that is to say, that each parent gives to the offspring the shape of one half of the body more or less. According to this theory as propounded by certain of its advocates the male parent generally determines the character of the back, loins and hind-quarters, the size, skin and general shape, while the female chiefly determines the character of the fore-quarters, head, vital and nervous system. In other words this theory virtually claims that the female parent determines chiefly the nature of the anterior part of the body including what may be termed the higher features of the organization, while the male parent determines chiefly the nature of the posterior parts, and what may be termed the lower features of the same.

The first theory was propagated by Orton, the second by Walker and the third by Spooner and others. They all agree in claiming that in transmission certain features of the organization are more influenced by one parent than by the other, but when they attempt to particularize regarding the organs affected, the disagreement is most marked. Other theories have been propounded which only tend to further complicate and obscure the question.

Objections to Theories Advanced Above.—The probable if not indeed the absolute incorrectness of the theories just submitted may be shown without great difficulty.

1. It is evidenced in the marked lack of agreement in the theories themselves and in the advocates of what is practically the same theory. There is a wide gap between the theories as enunciated. While they all rest on a substratum of the idea that propagation is done by halves, they differ most widely as to what constitutes the half. For instance Orton is positive that size is governed chiefly by the female parent, and Spooner is equally positive that it is governed by the male parent. Nor have the advocates of any of those theories sustained them by arguments strong and convincing.

2. It is evidenced in the influence of a prepotent male on the whole organization, that is to say, on internal structure as well as external form, on the higher as well as the lower parts of the organization, and on the anterior as well as the posterior parts of the being. Mate a vigorous pure bred sire with a grade female whose blood elements are much mixed, and the whole being of the progeny will bear the stamp of the male upon it. The same will be manifest in the external form, in the color, size and locomotion of the progeny, and in vital, digestive and nervous

action. Reverse the process and there will be a like preponderance of resemblance to the female in all the avenues of the being of the progeny. This one argument alone should prove fatal to any theory that claims that one parent, in virtue of its sex, influences only certain characters in the progeny.

3. It is further evidenced in the fact of the antagonism of several of those theories to what has been ascertained regarding the progress of development in the embryo. But the discussion of this phase of the question cannot be considered here.

Practical Deductions.—From what has been advanced the conclusion is inevitable that at the present time it would not be safe to attribute a preponderance of influence in transmission to either male or female in virtue of its sex. From the whole ground gone over it is apparent:—

1. That the relative influence of parents upon the offspring evidently depends upon conditions that cannot always be determined. Potency is sometimes absent when all the conditions would seem to favor its presence, and in other instances it is present when the conditions are against it.

2. The transmission of characters resembling the parent in which they have become dominant are likely to prevail. This is but another way of saying that the most prepotent parent is likely to have the greater influence in determining the character of the offspring. The guaranties of prepotency, as purity of blood and superior individual vigor, will therefore ordinarily be the strongest guaranties of likeness in transmission by either parent in the progeny.

3. On the other hand this will not exclude the inheritance of peculiarities from either or both par-

ents other than those which are dominant. Particularly will this be true in cross breeding. The unexpected will then happen more frequently than in other lines of breeding.

CHAPTER XIV.

THE INFLUENCE OF A PREVIOUS IMPREGNATION.

THAT the succeeding progeny of the female previously impregnated, does in some instances possess resemblances to the male by which she was thus impregnated cannot be gainsaid. The instances in which it has been noticed have been so many and the resemblances have been so marked that they cannot be accounted for in any other way than by attributing them to the influence of such impregnation. On the other hand the instances in which such resemblances cannot be traced are also numerous. As the different results that follow such impregnation cannot positively be determined beforehand, the whole question is obscured by the uncertainty of the results. Enough, however, has been gleaned from observation and otherwise, to make it clear to the breeder of high class stock, that to breed thus is always attended with an element of hazard, since it may introduce into the progeny variations that are not desirable.

The Influence of a Previous Impregnation Defined.—The defining of this question has been in a manner anticipated in what has just been said. In more precise language, it may be said to mean that in the process of procreation, the influence of the male sometimes extends to the offspring of the female by another male. The fact, as already intimated, has been abundantly established by observation. The instances in which it has so occurred have been numerous, not only among the lower animals but also in the human family. So marked has been this influence that it has in many instances proved a source of serious loss to the breeders of pure bred stock. Especially has this been the case when certain color markings are required as an evidence of purity of breeding.

Illustrations of the Influence of a Previous Impregnation.—The recorded instances of such inheritance are so many that the only difficulty found is in choosing between them. The following have been selected:—

1. In the Royal stud at Hampton Court, England, it is stated on the authority of Goodale, that several colts were dropped in one year sired by the thoroughbred stallion Acteon, but which had the markings of the thoroughbred stallion Colonel to whom the mares had been bred the previous year. These markings consisted of a white hind fetlock and a white mark or stripe on the face. Acteon had no white markings.

2. The same authority states that Mr. A. Morrison, Bognie, Scotland, had a superior Clydesdale mare bred to a Spanish ass in the year 1843. The progeny of course was a mule. She was subsequently bred to a horse, with the result that the progeny so closely resembled a mule that parties who saw it at a distance took it for a mule. And what is even more remarkable this animal inherited in a marked degree certain attributes of the mule, as for instance endurance.

3. Miles records from his own observation the case of a Chester white sow, owned by the Michigan State Agricultural College, which had been bred to

an Essex boar, and the following year was bred to a pure Chester white boar. The pigs were all more or less spotted with black. This could be accounted for in no other way than through inheritance from the Essex boar, which is of course black.

4. Professor Agassiz states that he coupled a Newfoundland bitch with a water dog and subsequently with a greyhound. The progeny from the second mating bore a close resemblance to the progeny from the first, which were a mixture of Newfoundland and water dog with scarcely any resemblance to the greyhound.

5. This influence has also been detected in many instances in the close resemblance which children by a second husband have borne to those by the first husband. This has been specially noticeable in the children of white parents when the mother had previously borne one or more children to a negro father. The children subsequently begotten by the white father are in many instances darker in color than other white children, and they also frequently have certain features of the negro.

The Influence of a Previous Impregnation May Extend to Successive Births.—In some instances the influence of a previous impregnation extends to the progeny of a number of births successively by the same mother. The following illustrations are selected:—

1. Mr. Shaw of Leochel-Cushnie, Scotland, as recorded in the *Farmers' Magazine,* had six pure Black faced ewes bred to a pure Leicester ram. Other Black faced ewes were mated with a Down ram. The Black faced ewes were all horned. The produce were of course cross-breds, and showed more or less the

characteristics of sire and dam. The next year all the Black faced ewes were bred to a pure Black faced ram. The progeny had brown faces and were hornless. When mated a second time with a Black faced ram, the progeny showed less resemblance to the Leicester and also the Southdown than they did the previous year, but two of the produce were still polled, one was dun faced like the Southdown and had small horns, and three were white faced like the Leicester.

2. Mr. Geo. T. Allman, of Tennessee, testifies that he bred a pure Berkshire sow successively to a pure bred Berkshire boar, and in every instance the progeny had little or no hair, in this respect resembling a Neapolitan sire, with which she had been first mated. The *Country Gentleman* records the testimony of Mr. A. W. Frizzell of Maryland which in summary is as follows: He had a pair of prize winning Dark Brahma fowls which were inadvertently mated with pure White Brahma cocks, and with the result that three years hence White Brahma markings still manifested themselves in the progeny.

Instances are also on record where pure bred mares bred to an ass and subsequently mated only with pure bred stallions of kindred blood, never again bred true to type. On the other hand it is also true that in many instances of breeding, similar in kind, like results have not followed, that is to say, the females that have thus been coupled with males of another breed do again breed true to type.

A First Explanation of the Influence From a Previous Impregnation.—From the instances cited, and from a great array of other instances that may be cited, it cannot be doubted that the influence of one impregnation does frequently extend to the progeny from succeeding impregnations. Three explanations have been offered which will now be submitted, but no one of the three is entirely satisfactory. The first submitted, however, is more so than either of the others.

The first explanation of the influences under consideration supposes that the mother has been impressed with the paternal characteristics of the fœtus during its intra-uterine existence, that is to say, that the blood of the female has imbibed from that of the male through the placental circulation some of the attributes which the fœtus has derived from the male parent, and that the female may communicate these with those proper to herself to the subsequent offspring of a different male parent. Dr. Carpenter and others have advocated this theory. This explanation is probably the most satisfactory that has yet been offered of the reasons for the influence under discussion. It does not seem unreasonable nor contrary to the laws of physiology. If correct, it not only furnishes an explanation of the resemblances in the offspring from a different male, to that from a male of a different breed previously coupled with the mother, in the first birth that follows such coupling, but also in succeeding births where such resemblances continue to manifest themselves. Where they do, it has been noticed that they become less pronounced as time goes on. This is just what would be expected, as the attributes of the male thus imbibed, as explained above, would in the absence of renewal, naturally become obscured by the attributes proper to the female which are continually being renewed by the processes which sustain life.

But the objection has been raised, on the ground that similar influences have been observed in fowls where the egg is separated from the mother before the incubating process begins. The core of the objection raised is found in the fact, that during the entire process of incubation, in which the materials furnished by the mother fowl in the egg are being transformed into new life, the entire process goes on entirely separate from the mother. Because of this, it would seem impossible that during the process its character could be in any way influenced by her. The plausible answer, however, may be offered to this objection, that the attributes of the male may have been imbibed through the circulation, while the egg was in process of development.

A Second Explanation of the Influences From a Previous Impregnation.—A second explanation supposes that the impregnated ovum impresses its own characters on the mass of the decidua, and through this on the maternal placenta, and that the maternal placenta in turn impresses its characters on the decidua and embryo of the next succeeding generation. The objections to this theory are, that the placenta and decidua are temporary organs that disappear at the time of parturition, or within a short time subsequently, and that the mucous membrane itself is removed and replaced with new tissue. It is possible, however, that the new mucous membrane formed to take the place of the old one may in some way have been impressed by the former which it replaces. On the principle that adjacent cells do tend in some instances to ingraft their plastic or formative powers upon each other, the new mucous membrane may have become impressed more or less by characters of the one which it supplants, since the former begins to appear some time before the latter is removed; in the human family as early as the eighth month of pregnancy. It would seem impossible, however, to apply this theory to fowls, as Miles has intimated, when the embryo is separated from the mother during incubation.

A Third Explanation of the Influences From a Previous Impregnation.—A third explanation of the influences from a previous impregnation claims that through the tendencies of habit the female reproductive system is inclined to repeat strongly marked characters which it may have produced. It has been observed that impressions transmitted by males of the purest breeding are the most marked on the future progeny. For instance, the influence from mating an ass with a mare is more far reaching on the succeeding progeny from stallions to which the mare has been subsequently bred, than would be the case had the mare been bred to a stallion of another breed rather than to the ass. Likewise, the influence of a Galloway sire would be more far reaching on subsequent progeny than the influence from a grade sire. It has also been observed that in some instances all the succeeding progeny are more or less affected by the first impregnation, but that the influence traceable is usually less and less pronounced as subsequent breeding from the same female progresses. It is easy to understand why intensity of breeding should more powerfully affect the sexual system of the females, but on the recognized principle that habit is usually strengthened with repetition, why should not those influences which first gave bias to the sexual system in a certain direction grow stronger rather than weaker? The argument therefore that these influences result from habit is not satisfactory.

The Intensity of the Male Element in Fertilization Differs Widely.—The intensity of the influence of the male element of fertilization upon the ova seems to vary widely in different species, and also in animals of the same species. In many species of fowls a single act of copulation is sufficient to impregnate a number of eggs, while in other species a repetition of the act is necessary. In the hen, for instance, eggs are fertile from four to sixteen days after the act of copulation, while with turkeys a single act of copulation is sufficient to impregnate all the eggs of one laying. It has even been claimed that in some instances the single act of copulation will fertilize the eggs of a second period of laying. But it has been noticed, that incubation is not so satisfactory nor are the young birds so strong and vigorous as when the male turkey mates more frequently with the female.

Agassiz states that certain varieties of turtles which begin to copulate at seven years do not begin to lay eggs until four years later, and copulation twice a year seems thenceforth necessary to fertilize succeeding sets of eggs. Impregnation therefore is a question of degree, and this may at least in part account for the influence of a previous impregnation upon impregnations that follow.

It has been noticed that, in some instances at least, the whole female sexual system is thus impressed when the male animals used in breeding are from any cause deficient in bodily vigor. Then it is, that when the reproductive energies of cocks have been overdrawn upon, through overmuch mating, the hatching process which begins is never completed because of inadequate fertilization. In other words, the sexual system of the female has been so feebly influenced, that it does not properly perform the function of which it is capable through strong impressions made upon it by the male element of fertilization.

Fecundation Sometimes Affects the Whole System.—It is very probable, therefore, that the act of fecundation does, in some instances at least, affect the whole system, and more especially the whole sexual system, hence, the ovary to be impregnated afterwards is so modified by the first act, that later impregnations do not efface the first impressions. This theory finds support in analogous observations made with reference to plant fertilization. Darwin inclines to the belief that in such fertilization the male element not only affects the germ, but also the surrounding tissues of the mother plant, and that therefore the male element acts directly on the reproductive organs of the females, and not simply through the intervention of the crossed embryo. If it is true, therefore, that the sexual system as a whole is influenced by impregnation then it follows that traces of such impressions may show themselves in progeny from subsequent impregnations.

Influence Greatest From a First Impregnation.—It seems probable that the influence of the male upon succeeding impregnations by other males is more marked in the first impregnation. General observation most assuredly gives countenance to this view, and the influence is greater in proportion as the male used in fertilization is prepotent. Such a result may arise, first, from the greater impressibility of the sexual system when first capable of being impregnated, on the principle that youth is always more plastic and therefore more easily impressed than age. In other words, impressibility lessens with the increase of the impressions already made. In the second place it arises from the power which the potent sire has to impress. The counter fact, however, should not be lost sight of, that in many instances a previous impregnation makes no perceptible influence on the progeny from succeeding impregnations. This may possibly arise from the greater potency of the female to resist impression on the part of the male of another breed that may have been coupled with her. This phase of the question does not seem to have been much discussed, if indeed at all, hence, evidence bearing on the question does not seem to have been collated.

Practical Bearing on Stock Breeding.—The practical bearing of this question on stock breeding is very direct. It follows, first, that it would be very unwise to use valuable pure bred females for purposes of cross breeding, if they are again to be used in breeding pure breds. As has been shown, there is more or less probability that they may not again breed true to type. In other words, when pure females have been used in cross-breeding they should not, as a rule, be again kept for producing breeding animals of the same pure breed. It follows, second, that young females especially should not be thus crossed, because of the greater certainty that they will not again breed true to type. And it follows, third, that young females especially should be carefully guarded from impregnation through inferior or ill bred sires.

In other words, it follows that inferior sires should be shunned because of the influence that they may exercise upon succeeding impregnations as well as upon the immediate progeny. But it is fair to concede, that the influence from a sire of mixed breeding upon the progeny from subsequent inpregnations is likely to be less than that of a sire vigorous and purely bred.

CHAPTER XV.

INTRA-UTERINE INFLUENCES.

The relation between influences chiefly external in their origin and certain features of development more or less abnormal in their character, has been affirmed and denied. These abnormal characters are generally apparent at birth, but when they are not physical in their character, they may not be noticed until sufficient time has elapsed to enable them to manifest themselves. Observation has shown that in development *in utero,* certain results occasionally appear of such a character that it would seem reasonable to link them with certain occurrences, in the relation that result bears to cause. Others again claim that it is not necessary to link these occurrences with the external causes to which they are frequently attributed, since they may be otherwise accounted for.

Intra-Uterine Influences Defined.—Intra-uterine influences in the broad sense of the term are those influences which affect development in the embryo, but in the present discussion only such of those are considered as in the main tend to produce abnormal characters. That abnormal peculiarities which cannot be recognized as family characters are occasionally observed in animals when they are born cannot be denied. They occur not only in mammals where the relation between the mother and the embryo during the period of utero-gestation is both close and intimate, but also in fowls and reptiles where the egg is separated from the mother before there are any indications of embryological development.

Illustrations of Influences Affecting Intra-Uterine Development.—1. Within a few months after the violent cannonading and explosion of the arsenal which occurred at the siege of Landau, in 1793, Baron Percy states that ninety-two children were born in the district, fifty-nine of whom were still born, or died soon after birth, or were possessed of abnormal peculiarities. These results have been assigned to the alarm caused by the influences referred to and the natural results therefrom upon the organization of the mothers who bore the children. Two of them were born with numerous fractures of the bones and limbs.

2. The color of animals has frequently been influenced by that of external objects presented to the vision of the parent or parents at the time of conception. The relation between the influence and the results named had evidently been noticed at a very early period. So well was this relation understood in the days of the patriarch Jacob, that he was enabled to utilize the knowledge in a way that greatly enhanced his wealth, as recorded in Gen. xxx. 25-43. The knowledge of this relation has also been turned to good account in practical breeding, as when, for instance, colts have been sought from a valuable stallion but possessed of an undesirable color. In many cases colts of pleasing colors have been obtained by introducing an animal before the vision of the mother at the time of conception, which possessed the color or colors desired.

3. Deformed children have frequently been produced by mothers whose attention has been strikingly

arrested while the said children were in process of development in the uterus, by objects possessed of deformity more or less similar to those which have characterized the children. These, it has been noticed, are more liable to occur when the pregnant mother has been suddenly startled or affrighted by some sight or sound that has made a vivid impression on the mind. So frequent are those instances and so prevalent is the belief as to their cause, that mothers are oftentimes careful to warn their pregnant daughters to avoid, when possible, the sight of objects that are calculated to produce impressions that are disagreeable or repulsive, and more especially during their first pregnancy. These results have also been traced to causes which were operative some time before conception. Dr. Allen Thompson, as quoted by Miles, cites the case of a woman, who six weeks before conception was suddenly affrighted by a beggar who had a wooden leg and who also presented a stumped arm as he threatened to embrace her. The next child had two stump arms and one stump leg. Peculiarities have also characterized individuals which would seem to be the outcome of the habitual mental condition of the mother. In Minneapolis, in 1895, a woman was on exhibition who had a long and flowing beard. She was married and had borne children, which, however, had died young. She was gentle and ladylike in manner. In conversation with a young physician who accompanied the author, she accounted for the beard by saying that her mother had been passionately fond of looking at the pictures of men with handsome beards.

4. But the most remarkable instance probably on record of what would seem to be the influence of

the perceptive powers on intra-uterine development occurred at Maysville, Kentucky, in the year 1864. In that year a Jersey heifer owned by John B. Poyntz, produced a calf with the letters U. S. distinctly traceable on the left shoulder. The heifer was reddish or fawn in color, and the letters were distinctly traceable in the white hairs that composed them. This heifer along with others of the same breed was being pastured in a wood lot simultaneously with some twenty to thirty horses belonging to the United States government, each one of which on the left shoulder bore the brand of the letters U. S. The heifer in due time produced a calf with similar markings, except that the S was not quite so distinct as in the dam. Sworn statements to these facts were secured by Dr. Miles in 1875 from John B. Poyntz and others personally cognizant of these facts.

Two Theories as to the Cause of Intra-Uterine Peculiarities.—Two theories have been advanced as to the cause of abnormal peculiarities in the development of the fœtus. The first associates them with some mysterious influence exerted on the imagination of one or both parents at the time of conception, or with impressions violent or otherwise made upon the mental or emotional nature of the mother during the process of intra-uterine development. These influences however are usually considered as applicable only to the female. The only influence of course that could possibly be attributed to the male would be that which affects the imagination and it would not seem possible for it to exert any influence on the progeny subsequent to the time of mating, that is to say, it would seem absolutely impossible that any mental condition of the male subsequent to that period could have any influence on his progeny already in process of development.

Whether the imagination of the male exerts any influence is a question not easily susceptible of demonstration. There should be little doubt, however, but that the habitual mental condition of the male does affect transmission in virtue of the first law of breeding, but whether any vivid conception that may possess the male at the time of mating or but a short time previously does affect the progeny, is not so apparent. The second theory attributes them to the operation of natural laws governing physiological and pathological conditions, nearly all of which are understood and which interfere with the natural processes of development.

Reasons Sustaining the First Theory.—The following are the principal reasons advanced in support of the first theory: 1. The instances are numerous in which the relation between the alleged causes of intra-uterine malformation and the results is both intimate and close. This has been shown in the illustrations given above, and as intimated, many more could be given equally strong in character. So direct does the relation seem to be in many of those instances that to deny such a relation in the absence of reasons positive in character which account for those peculiarities in some other way, would do violence to the claims of evidence positive in character over that which is negative.

2. It is a fact that the arguments which would assign such malformations to other causes is chiefly of a negative character. This of course so far weakens their value as testimony. The chief of these will be given in the paragraph below.

3. The correctness of the assumption has been utilized with advantage in breeding. This has already been referred to when speaking of the possibility of obtaining desirable colors in the progeny by placing an animal possessed of such color before the vision of the female at the time of conception. It is not reasonable to suppose that such practices would have been resorted to had experience not shown that there was at least reasonable certainty in the results that were to be looked for.

Reasons Opposed to the First Theory.—The following are some of the objections urged against the first theory: 1. Malformations of the fœtus oftentimes do not agree with the apprehensions, *a priori,* of pregnant mothers. For instance in the human family pregnant mothers who have been greatly concerned lest they should bear malformed children because of some sudden shock given to the system through fright or otherwise, have borne children quite free from any deformities. Mothers who have borne one or more deformed children and who are greatly apprehensive lest such deformity should again manifest itself in the offspring, frequently bear children subsequently that are perfectly healthy. The most that this objection would seem to prove would be, that the alleged causes of such deformity are not always operative.

2. Malformations occur among the inferior animals in which the development of physical life is very imperfect and when oviparous generation would seem to preserve the young from the influence of disordered maternal imagination. Malformations occur with serpents and other inferior orders of animals when it would be scarcely possible to link the imag-

ination with the malformation that occurs. In oviparous generation it would seem difficult to link any influence of the imagination of the mother with the generation of malformed progeny, since the latter are developed in embryo entirely apart from the mother. The most, however, that such evidence proves, is, that all instances of malformation would not seem to be dependent on a disordered condition of the mind or nerves of the mother.

3. When twins are born in the human family, one child may be well-formed and the other malformed. With domestic animals that produce two at a birth the same is sometimes true, and with those that produce more than two, some may be normally developed while others will be malformed. It would seem reasonable to suppose that any influence of the imagination that would cause malformation in one of the progeny would similarly affect others of the same birth. But this idea must not be pressed too far, since where all the influences are normal, there is frequently a marked difference in the size, form and color of individuals in the progeny, and yet but little is known as to why those differences exist.

4. The more deeply situated organs, the existence of which may be unknown to the pregnant mother, are frequently malformed. For instance, the internal structure of the ear may be so malformed as to produce deafness, and yet the mother may know nothing of the structure of that part of the organ of hearing, not apparent to the eye. This argument however like the preceding, only proves that instances of malformation may occur from causes altogether separate from any influence that can be exerted by the imagination.

5. The anatomical relations of the embryo and its uterine envelopes would seem to render it improbable that any mental impression of the mother can be made to affect any particular part of the fœtus. The limitations of our knowledge, however, may only be thus rendered more apparent, since some instances of malformation seem to result so directly from the influence of the imagination that it would seem hazardous to separate the result from the alleged cause.

Reasons Sustaining the Second Theory.—The following are chief among the reasons given to support the view that natural causes furnish a sufficient explanation of the abnormal peculiarities which manifest themselves during the process of intra-uterine development:—

1. In malformed births dissimilar parts are seldom fused into or united with each other. While the gullet sometimes fuses with the larynx, not being originally dissimilar but formed from a common mass, neither larynx nor gullet ever fuse for instance with the bladder or rectum.

2. No malformed organ loses entirely its own character or determinate place, and no malformed animal loses its generic distinction. For instance, the malformed fore-leg is associated with the development of the fore quarter rather than with that of the intestines, and the malformed sheep never so far loses its identity as to be mistaken for the bovine species.

3. Nature does not deviate ad infinitum, since even in monstrosities a distinct gradation and natural order are observable. These are observable, as Vrolik has shown, (*a*) in the number or proportion in which they occur within a certain period of time; (*b*) in the

sex; (*c*) in the definite proportion between the species of animals and the more frequent monstrosities in them; (*d*) in the constant form of monsters even among heterogeneous animals; and (*e*) in the greater predisposition to monstrosity among some animals. From certain statistics compiled it has been found that one monster occurs in the human family in about 3,000 births. In females, malformations more frequently occur from impeded development and in males from what may be termed excessive development, but there are exceptions. Monsters with one eye and which have a snout are more frequent in swine, and double monsters in man. Headless monsters and also other forms have the same characters in the mammalia as in birds.

The occurrence of monsters is more frequent in the higher orders of animals and it becomes less frequent as the scale descends. According to the author quoted above, three fourths of the entire number of monsters occur among mammalia and one fourth among birds. They are infrequent among reptiles and still less frequent among fishes. They are also more frequent among domestic than among wild animals. These arguments tend to show that even the development of monsters is subject to fixed organic laws so far at least as the immediate cause is concerned. This fact it has been argued would exclude the influence of paroxysmal causes. In the judgment of the author, such a conclusion is not necessary, since it fails to distinguish between what may be an original and an immediate or secondary cause. The conclusion would seem to be legitimate that the greater frequency of monstrosities among the higher orders of animals tends to sustain the view that mind, when viewed as the original cause, does exercise an influence through paroxysmal conditions for which it is responsible, in the production of monsters.

Resemblance in Foetal Development in its Early Stages.—The fancied resemblance in the fœtus in the human family to that in some of the lower animals may be explained in accordance with the known laws of embryological development. There is a close resemblance in the embryo of all vertebrated animals in the early stages of development. This arises from the fact that animal development is general at the first. As development progresses the more special features evolve themselves. Up to a certain stage of fœtal development the order even to which the fœtus belongs cannot be known from its characters. But, with the progress of development, the order, the family, the genus, the species, the variety, the sex and the individual, gradually unfold themselves, and in the order named. It follows, therefore, that the earlier the cessation in development occurs, the closer is the resemblance likely to be between malformations in the human family and those in the lower orders of animals.

The Immediate Cause of Malformations.—Reference has already been made to the immediate or secondary, and original or first causes in the production of these phenomena. The latter influence is much better understood than the former. The immediate cause of the malformations under consideration is impaired nutrition of the embryo or of some of its parts. This may arise from any severe shock of the nervous system in the mother by fright or otherwise. But why these influences should thus affect nutrition, or how, is yet a mystery. The dependence of the immediate cause, however, on the primary cause, would seem to be so clear as not to be gainsaid. The habitual mental condition of the mother may also tend to arrest development by impairing nutrition.

This influence is better understood when the habit of the mind of the pregnant mother in the human family is continually sorrowful, the vital energies are lowered, in consequence of which the fœtus suffers in common with all parts of the system. But this influence may be operative and yet it may not produce any form of malformation. In fact it may be questioned whether malformations ever result from this cause alone. The extent of the malformation is largely owing to the stage of pregnancy when the development of the deformed organ or organs begins. The earlier that it occurs the greater will be the deformity since the individual parts are then less distinctly evolved.

Obscurity That Yet Veils the Subject.—The explanations given throw some light on the causes of these phenomena, but they do not satisfactorily account for all classes of abnormal peculiarities. Some of these appear to arise from influences which act upon the imagination and which are not paroxysmal in character. Such are color markings and in some instances possibly even certain peculiarities of form. The relation between the influence of the imagination that is not paroxysmal in character and the results, is even more mysterious than those results which appear to come from paroxysmal influences.

In the present state of our knowledge the whole question may be thus summarized: 1. The immediate cause of malformations is arrested development.

2. But many, at least, of those instances of arrested development would appear to be in some way dependent on original or primary causes such as strong mental impressions made on the mind of the mother at or shortly before conception, and paroxysmal influences such as arise from sudden fright. 3. The way however in which those influences tend to produce arrested development is not clearly understood.

CHAPTER XVI.

INFLUENCES THAT AFFECT THE DETERMINATION OF SEX.

The influences that determine sex have formed a common battle ground for those who have written upon the subject for many years. No question relating to the breeding of animals has been more controverted. And no phase of the subject probably has been so much discussed in the agricultural press. Adventurers into the domain of animal breeding have, one after another, given out to the world that they had discovered the secret of the influences that control the determination of sex. So positive have some of those men been in their assertions, that they have offered to stake high wagers as to the correctness of the claims which they have made, and yet, in all, or nearly all, lines of animal increase, the world goes on producing about an equal number of males and females on the average.

Theories Regarding the Determination of Sex.—Several theories have been propounded as to the influences that lead to the determination of sex in procreation. Seven of these will be noticed in this discussion. They include the more important of the many theories put forward on the subject. That the influences concerned in the production of sex are controlled by definite physiological laws which are uniform in their action cannot be questioned, since there can be no effect without a cause. But up to the present time, it would be correct to say, that they have in the main, if not entirely, eluded the grasp of the most patient investigators. Notwithstanding the immense amount of research given to the study of this question and the much experimenting done regarding it, the little progress that has been made in the inquiry thus conducted is in a sense humiliating. But some things have been learned with reference to it that probably can be turned to some useful account by the breeder, as will be shown below.

First Theory Regarding the Determination of Sex.—This theory claims that the right ovary and the right testicle are concerned in the production of males, and that the left ovary and the left testicle are concerned in the production of females. In various ways it may be shown that this theory is untenable.

1. Males with but one testicle and females with but one ovary produce offspring of both sexes. This has been noticed in the human family and also in the breeding of domestic animals. Since the defect mentioned is apparent to the eye in males, and it is not so apparent in females, the evidence showing that males with but one testicle beget progeny of both sexes is cumulative, and this result would seem to follow equally whichever testicle may be wanting. But post mortem investigations have shown that females in which one ovary was wanting, or imperfect, or diseased, have produced animals of both sexes, regardless of the fact as to whether the right or the left ovary was missing.

2. Experiments have been conducted to test the correctness of the theory. That conducted by Mr. J. Buckingham of Zanesville, O., is probably the most significant of these that have been recorded. It

is significant because of the number of the animals in the experiment. It included nine sows and three boars. The sows were divided equally into three lots. From one in each lot the right ovary was removed, from another the left ovary, and the third sow in each instance was left in possession of both ovaries. The sows in lot one were mated with a boar from which the right testicle had been removed and those in lots two and three respectively were mated with a different boar, from each of which in each instance the left testicle had been removed. Each sow produced from seven to nine pigs. In each litter there were not less than three males nor more than five. The males and females in the aggregate were nearly equal in number. The facts relating to the experiment were given in the *Country Gentleman* as early as 1865, and yet this theory still finds some advocates.

3. Instances are on record in the human family wherein females with but one ovary have produced twins and this has happened when the right ovary has been wanting in some instances and the left ovary in others. The evidence then against the correctness of the theory under consideration is simply overwhelming.

Second Theory Regarding the Determination of Sex.—This theory affirms that the sex is determined by the degree of the maturity of the egg at the time of fecundation. That which has not reached a certain degree of maturity at the time of impregnation produces a female, and that which is impregnated later produces a male. In other words early impregnation produces females and late impregnation males. This theory was first advanced by Prof. Theury of the Academy of Geneva, and for a time it met with considerable favor. It is based on the assumption that the production of male organs arises from the greater maturity and consequently the more complete development of the germ. But the observed results from ordinary farm practice in breeding are sufficient to disprove this theory, for, when males and females run together, the service always takes place during an early stage of the period of heat in the female, and yet the proportion of the females is not materially increased.

Were this theory correct the entire progeny from males and females which run together would be females. In other instances, when the time of mating has been under the control of the individual and has not taken place until a late stage of the period of heat in the females, the proportion of the males has not been increased. In such instances impregnation could not have taken place early. But there is the further objection to this theory growing out of the fact that the conjunction of the male and female elements of generation does not always take place at the time of copulation, hence, it is impossible to tell the precise time of fecundation. Impregnation cannot of course take place until the male element in generation, the spermatozoa, comes in contact with the ovum, the female element of generation. Now, it has been ascertained that the ovum in some instances escapes early from the ovary during the period of heat and at other times late. The time of its escape then is uncertain. Consequently the exact time of the impregnation is uncertain. It is possible, therefore, that copulation may take place early during the period of heat in the female and impregnation at a later period of the same than in other instances when the copulation is also late in the period of heat. With some animals, as dogs and rabbits, several days may elapse after copulation before the male and female elements of generation come together to produce impregnation. This theory therefore cannot be accepted.

Third Theory Regarding the Determination of Sex.—This theory claims that the degree of the impregnation influences the sex. It holds that a preponderance in the male element in impregnation would produce males and in the female element, females. In other words when just enough of the male element unites with the ovum of the female to produce impregnation or when there is a preponderance in the female element the result will be a female, but when the opposite is true the result will be a male. It finds some countenance in the number of males begotten by sires possessed of marked vigor. But the number and striking character of the exceptions tend to bring discredit on the theory. For instance, some males apparently vigorous have begotten females largely in excess of males, howsoever they may have been mated.

It is also in direct conflict with apparently well authenticated facts observed among certain insects. In bees, for instance, the queen is a perfect female, the drones are males, and the neuter workers which gather the honey are imperfect females. If the last named lay eggs they produce drones. When the queen is unimpregnated the eggs which she lays produce drones. When impregnated her eggs produce females, that is to say the neuter workers. With bees therefore the male element of fertilization would seem to be necessary only for the production of females. But granting that the theory under consideration were true, it would scarcely be possible so to control mating that the results could be relied on with any great degree of certainty.

Fourth Theory Regarding the Determination of Sex.—This theory affirms that every alternate egg or germ produced by the female is of the same sex. According to this theory, therefore, the sex of the offspring will depend upon the egg or ovum impregnated. For instance, if a cow had produced a bull calf, and a heifer calf were next desired, she should be served during the first heat after calving, or during some period of heat subsequently indicated by an odd number. But if a bull calf were desired then service should take place during the second period of heat after calving or at some subsequent period indicated by even numbers. But the production of one sex only or mainly by certain individuals regardless of the order of the period of heat at which the service takes place, discounts this theory. Nor can it be reconciled with the instances in which twins are produced, one of which is a male and the other a female. With animals that produce several at a birth as swine, for instance, the respective litters almost invariably include animals of both sexes. The theory is also in conflict with the observed influence of nutrition on the sex of certain insects and plants. In the development of these, the sex is chiefly determined by the character of the nutrition as is further shown below. (See page 195.)

Fifth Theory Regarding the Determination of Sex.—This theory claims that a preponderance of influence in determining the sex lies with the female. This conclusion has been reached because of the frequently observed fact, that some females usually produce animals of one sex no matter how mated. That some females do breed thus cannot be disputed, but in some instances the progeny are all or nearly all males. If the theory were true, therefore, it would be of no practical value, since it could not be determined beforehand which sex would be in excess in the progeny. Nor can it be denied that a far larger number of females beget animals of both sexes without any apparent bias toward one line of production or the other.

If the theory under discussion were true, the numerical superiority of females could be made to have a marked influence on the relative numbers of the sexes. But in extended experience any bias one way or the other has not been observable. Nor should the fact be lost sight of that what is true of some females is also true of probably as large a percentage of males in proportion to the entire number of both used in breeding. In instances, not a few, males will beget nearly all male progeny and yet other males will beget all or nearly all female progeny. The most that can be said with positiveness is that some individuals and also some families have a tendency to produce more of one sex than another. The fact has been observed but it cannot be pre-judged beforehand in which direction the bias to the production of more of one sex than another will lie. This theory therefore must be set aside.

Sixth Theory Regarding the Determination of Sex.—This theory claims that the number of the males or females will be in excess in proportion as the sire or dam is strong or weak, in vigor of maturity or otherwise. The most extensive experiment on record that has yet been made bearing upon this theory is that conducted by M. C. Giron de Buzareingues, in France, in 1826. Two flocks were experimented upon. To obtain ewe lambs young males not yet matured were mated with strong and well fed ewes, and to obtain ram lambs, vigorous and matured rams were mated with the weaker ewes of the flock. When young males were mated with mature and well fed females the female progeny were considerably in excess, and when vigorous and matured rams were mated with weaker ewes the male progeny were considerably in excess. These experiments, therefore, would seem to show that there is an element of truth in this theory. Statistics compiled from the birth records of the British peerage also lend countenance to this theory, but as Miles has shown, these are not in entire agreement with figures bearing upon the question and gathered from a wider field. The variations that may have arisen from the causes which this theory is based upon can scarcely be said to be sufficient to establish incontrovertibly its correctness. There does, however, seem to be some relation between a preponderance of vigor in the sire or dam and excess in the numbers of the sex in the progeny to correspond, in some measure at least, with such preponderance. And this theory is in agreement with that which relates to the influence of nutrition on the sex as noted below.

This theory may not seem in accord with the actual results obtained in breeding, since in breeding pure breds and high grades more care is taken in the selection of the male than of the average female in the herd or flock. The males are usually possessed of more individual vigor, and yet there is not any noticeable predominance in the production of males. But the excess of vigor inherent in such males as compared with that possessed by the females may be counteracted by the extent to which he is used in service, at least at certain seasons of the year. The fair way to test this theory would be to mate only one such male with one female, or to mate him only with that frequency which could not in any way lessen his vigor, and then compare the results.

Seventh Theory Regarding the Determination of Sex.—This theory argues that the determination of sex is influenced by the activity of the functions of nutrition. It finds some countenance in the development of queen bees from neuter eggs and in the influence of light and heat in determining the sex of plants. A queen bee may be produced from neuter eggs,that is to say, the eggs that ordinarily produce working bees, and they are so produced when a queen bee is lost to the hive. The process in the transformation in the development would seem to depend first, on enlarging the quarters in which development takes place, and second, on feeding to the larvæ when hatched food more stimulating in character than the ordinary bee bread laid up for the sustenance of the workers. In the development of the perfect female among bees, therefore, liberal nutrition would seem to exercise an important influence. Experiments conducted with certain insects show that when the larvæ are not well sustained before going into the chrysalis state, the perfected animals developed from them are males, but when the opposite is true they are females.

As the result of careful observations made with plants the conclusion has been reached that the sex in plants is largely dependent on the kind and more especially the degree of the nutrition. The higher grades of nutrition produce females and the lower males. Light and heat in proper balance and accompanied with liberal nutrition seem to favor the production of females. With certain plants, however, according to Knight, if exposed to heat excessive in proportion to the light, the flowers produced are male, but if light is excessive in proportion to the heat female flowers only are produced. The evidence is certainly clear that with certain orders of insect life and also with certain kinds of plant life, nutrition does exercise an influence on the sex. By analogy, therefore, the inference would seem fair, that the same physiological law would apply to domestic animals, in the absence of evidence to the contrary. This theory throws some light on the observed fact, that in some seasons there is a great preponderance in males in the domestic animals produced, and in other seasons in females. The character of the nutrition in the pastures is probably at least measurably responsible for the results.

According to the theory under consideration, a liberal nutrition, and of course suitable in kind, should prove favorable to the production of females. But with live stock grown upon the farm the evidence would seem to be wanting to show whether the actual facts chord with the theory. Data bearing on this question, as far as known to the author, have not been gathered. Nor does the fact that in one class of domestic animals as cattle, males should be in excess, while in another class as sheep, females should be in excess necessarily invalidate the argument, since the kind of nutrition favorable to the development of but one sex in the former may not be exactly the same as that favorable to the development of the same in the latter. For instance, pastures in that condition best suited to dairy cows are not those best suited to sheep. And along with succulence in the pastures the element of nutrition must not be overlooked, since succulent pastures are not necessarily nutritious.

Prepotency not a Factor in Producing Sex.—The use of the term prepotency as a factor in producing sex is objectionable, as it relates rather to the transmission of qualities than of sex. Nevertheless, it has been frequently applied thus. That it should not be so applied is apparent from the fact that in many instances a pure male may stamp his characters upon the offspring and yet they may be of both sexes, or many of them may be females. An animal therefore may be prepotent in the highest degree, in the correct sense of the term, and yet have no special power to beget progeny of the one sex or the other.

Uniformity in the Proportion of the Sexes.—The uniformity in the respective numbers of each sex produced indicates the existence of some general law, though it is not yet discovered, that is uniform in its action. In this way, the equilibrium in the sexes is maintained under all the changed conditions to which animal life may be subjected. The proportion of males born is perhaps slightly in excess of that of females. This at least would seem to be true of the human family. Statistics gathered from various sources would seem to indicate that it is so, but the excess is slight. Whether the same is true of the lower animals cannot be known until sufficient data are gathered on which to base a conclusion. So far as such data have been compiled it would seem to show that the proportion of females born in domestic animals was slightly in excess. In the human family the slight excess in the number of males would seem to be a wise provision, as the early mortality and the death rate from other causes among males is greater. These causes are such as relate to accident and war. Because of these influences, the number of females who reach maturity is probably somewhat greater than that of the males. Whether the laws that relate to the production of sex can ever be so fully ascertained that it can certainly be controlled at will the future alone can disclose. And whether such knowledge would be helpful to mankind in regulating the sex of the human family is problematical. It would seem to be true, however, that in breeding domestic animals it could be made a source of legitimate gain, hence the search for light on the question should be continued.

Summary of What is Known Regarding the Determination of Sex.—From the discussion of the whole question it will be apparent that but little is known as to the precise influences that control sex. Of the seven theories considered five at least when weighed in the balances are found wanting. The theories that relate to the influence of vigor of body in the one instance and of nutrition in the other would seem to be possessed of some value, but in actual practice they are not easy of application. It would seem to be true, other things being equal, that the animal possessed of greater vigor and maturity at the time of mating does exercise the greater influence in determining the sex, and that an abundant nutrition during the period of gestation and probably earlier, is favorable to the production of females. In seeking an excess of females, therefore, in the progeny, the females should be relatively strong and liberally sustained with a suitable nutrition. These two influences may also act in conjunction with other influences not as yet understood. It is also true that some individuals and families have this power in a greater degree than others. But the reasons for such preponderance are so obscure that but little can be offered regarding them that will throw any light on the question. The fact, however, makes it clear that vigor and nutrition are by no means the only influences concerned in the production of sex.

CHAPTER XVII.

NUTRITION.

The relation between nutrition and development is so intimate and close that it may be said the latter is regulated by the former more than by any other individual influence. The question of feeding animals suitably is simply another name for supplying them with suitable nutrition, and consequently the study of this question is simply a study of nutrition. The whole art of feeding is based upon the proper adjustment of the relation between nutrition and development. But the influence of nutrition is not by any means confined to development as such. It so influences the whole animal system that it more or less affects transmission, generation, fecundity and vigor.

Nutrition Defined.—Nutrition is the act or process by which organisms, whether vegetable or animal, absorb into their system their proper food. When restricted to animals it may be defined as the process of assimilating food taken into the stomach. When confined to plants it means the proper appropriation of food secured by the plant through the medium of its roots and leaves. In animals nutrition is most intimately associated with digestion, in fact it is the outcome of the latter. The whole process of digestion in the stomach is simply a process whereby the food taken into the same is prepared for being assimilated by the system, that is to say, appropriated by it.

Through the medium of the assimilative and circulatory processes, every part of the system receives its appropriate food.

Conditions upon Which Nutrition in Animals Depends.—The activity of nutrition in animals is dependent upon such influences as age, inheritance, bodily vigor and food. Digestion and assimilation, and consequently a well sustained nutrition, is more active at birth and gradually becomes less so as the animal becomes older. This fact furnishes the explanation why, as a rule, animals make less gain and require more food to make the gain, the further the birth period is receded from. It also explains why the food of maintenance increases with advancing age, and why as old age advances decline becomes inevitable. But this question is further discussed in the chapter on early maturity. These qualities, that is to say, the qualities of digestion and assimilation, are as much a matter of transmission as of bodily form.

This has been abundantly shown in the much greater increase in weight that has been obtained from animals whose parents showed much capacity for making such increase, than could be obtained from animals of similar age and similarly fed whose parents showed little capacity for such increase in proportion to the food fed. It explains why, in the growing of meat, it is so important to use sires possessed of "good feeding qualities," which means, that they have good appetites and therefore consume much food, good digestion to prepare it for assimilation, good assimilation to prepare it for absorption into the system and the capacity to produce meat of a good quality and abundantly where specially valuable. Digestion and assimilation are also vigorous in proportion to the inherent bodily vigor of the animal as they suffer along with the other organs through a naturally weak or impaired bodily vigor, hence the great importance of seeking to secure all necessary stamina in the animal produced.

But the fact should not be lost sight of that stamina alone is not a sufficient guaranty of the highest type of digestion and food assimilation, since animals possessed of apparently equal stamina in many instances do not show an equal capacity for appropriating food. These qualities are, moreover, vigorous in proportion to the abundance of the food supplies up to a certain limit, and to the easily digestible and nutritious character of the same. Put an animal on an insufficient supply of food and it will not only lose flesh and weight, but if the food is insufficient beyond a certain degree the digestion and assimilation through sympathy with a decreased vigor will also become less vigorous. A parallel is found in the running of a steam engine on an insufficient supply of steam. That foods easy of digestion and also rich in nutriment would favorably affect digestion and assimilation is so apparent that further discussion thereon is unnecessary.

When a Defective Nutrition is Most Harmful.—Defective nutrition is most harmful when animals are young and immature, and the nearer the birth period that it is defective or insufficient the more harmful is it.

1. Defective nutrition at the period indicated begets assimilation unduly concerned in building up those parts of the body which are not so intrinsically valuable, and building them up in a way not in consonance with the highest types of development at

a more advanced period. Feed a calf for instance on food insufficient in quantity and the bones, hide and hair will develop more relatively than the muscles. Feed it food innutritious and excessive in quantity and it will become paunchy as when it is fed on whey. Feed it food with an excess of nutriment in proportion to the bulk and the stomach will not distend sufficiently for the most effective work at a later period. And these features of development will in a greater or less degree characterize the animal when matured and subsequently. No later management, howsoever orthodox, will ever completely obliterate them, and they will be permanently harmful in proportion to the intensity of the causes that produced them, the duration of the period that these were operative and the earliness of the period in development at which they occurred. As with the youth who has gone astray and come back again to the paths of rectitude, the scar remains.

2. It hinders development when it can be most cheaply and effectively made, that is to say, during the growing period.

3. When any periods of stagnation in development occur there is not only present loss during the continuance of the same but the capacity for future development is weakened, and it is so weakened in proportion to the duration of such periods of arrested development and to the extent to which the nutrition is defective in them. Thus it is that young animals passing through such periods of arrested development can never again be made as profitable as they otherwise would have been, and the loss from the last named source is often much greater than from that first named.

Insufficient Nutrition Attended with Loss.— An insufficient nutrition is always attended with loss. When it occurs before maturity it prolongs the period of development. The extent of such prolongation will be somewhat proportionate to the length of time during which the nutrition was not sufficient to fully meet the requirements of the animal. When it occurs after maturity, what may be termed the working capacity of the animal is hindered. A horse thus fed will not be able to perform a maximum of labor. A steer thus fed will not be able to produce a maximum return in meat. A cow thus fed will not be able to give a maximum amount of milk. Thus it will be with all other domestic animals. They will not give to the owner the best return that they are capable of. When it happens during gestation the animal is measurably incapacitated for properly sustaining its young after birth. And if the nutrition is wanting before birth beyond a certain degree, the fœtus also will suffer deprivation along with the dam which carries it.

In all instances an insufficient nutrition tends to increase the cost of the food of maintenance. This may be readily shown when it is remembered that the only profit that can be obtained from keeping an animal is the return which it gives above the cost of maintenance. Reduce the power of a horse below what may be its maximum capacity for labor and the cost of maintenance is relatively increased in proportion as the said capacity goes below the maximum. Keep a growing animal on an insufficient food supply and the cost of the food of maintenance will increase relatively in proportion to the extent that its capacity for gain is kept below what may be termed the normal maximum. Give it only enough food to maintain it, and there is no increase in weight whatever.

It follows, therefore, that when growing animals are so wintered that they weigh no more in the spring than they did in the fall, there is no direct return whatever for the food fed during that period. There may be in some instances a prospective return, as when animals are wintered on cheap fare that they may make increase on cheap pastures the following season. It is greatly important, therefore, that as a rule, growing animals should have enough of suitable food during the maturing period to enable them to make a maximum increase in weight, without forced feeding.

To attain the highest possible increase in weight, as with animals that are forced for exhibition, it may be necessary to feed foods that will unduly increase the cost of production to admit of any profit accruing. And it is equally important that a matured animal should receive food enough at all times to enable it to give a maximum return without forced feeding. If the highest possible production in milk is to be obtained from a cow for a limited period, forced feeding must be resorted to which will unduly increase the cost of production.

Relative Importance of a Free Nutrition.—What may be termed a free nutrition, that is a liberal nutrition, is more important relatively for improved animals than for those inured to what may be termed a scant fare, that is, an insufficient fare. The reasons for this are, that the inherited qualities of digestion and assimilation in the former call for full supplies of food, whereas, with those inured to a scant fare the digestive habit of the system is not seriously interfered with when food supplies are short. In other words the former suffers more than the latter when food supplies are insufficient for any prolonged period. And the degree of the ill-doing that follows will be proportionate to the extent to which they have inherited the high capacity for profitable digestion and food assimilation, but on the condition that the food supplies shall be sufficient.

This accounts in part for the ill-doing, not infrequently noticed, of pure bred animals which may have fallen into the hands of careless owners. It also explains, in part, why a large breed or grade of animals introduced into pastures that do not furnish sufficient food for those of so much weight, fare less well than smaller animals. In both instances the equilibrium in digestion is upset.

Abundant Nutrition Wards Off Disease.—An abundant nutrition is a safeguard against the inroads of disease. By strengthening the system it gives it a power to resist the influences of disease which it could not otherwise have. The principle is so generally conceded that a system naturally weak, debilitated or lacking in robustness falls an easy prey to disease that it does not require to be argued. Any influence therefore that tends to build up and to tone the system, gives it increased power to withstand the inroads of disease, hence the value of an abundant nutrition for such a purpose. When the tendency to disease is transmitted it is also much more likely to remain quiescent when the nutrition is abundant, and for the reason that such abundance in the food tends to keep the system of the animal so well sustained that those inherited tendencies are more than matched by the vigorous condition of the animal.

An Excessive Nutrition Harmful.—In young animals it may so weaken the digestive and assimilative powers as to permanently injure them, after which perfection in growth and in future well-doing are impossible. Overtax the arm of a child and weakness in the arm more or less harmful and more or less permanent follows. Overtax the brain of a child and its capacity for labor is permanently lessened. The extent of the injury in both instances will be proportionate to the earliness of the period at which the overtaxing occurred and to the severity and prolongation of such overtaxing. Likewise when the digestion of a young animal is overtaxed by feeding excessively, strong, stimulating and concentrated foods, as for instance, certain kinds of rich meal, injury to the digestive organs more or less permanent follows. When this happens the completest development can never be secured in the animal thus overfed. Partial recovery may follow by promptly changing the system of feeding, that is, by feeding less concentrated foods and more or less limited in quantity according to the appetite of the animal, which for a time should be whetted by feeding a little less food than the animal would consume if allowed to feed at will.

Matured animals may be permanently injured in the same way, but this does not happen so frequently in breeding stock as when they are young, for the reason that they are less frequently overfed. But it often happens with animals that are being fattened. The remedy is virtually the same in both instances. It consists in promptly lessening the amount of food fed, and changing the variety of the same for a time. With animals intended for the dairy an excessive nutrition would be fatal to a capacity for milk production of the first order. An excessive nutrition in such an instance would not necessarily imply food excessive in quantity to secure sufficient growth in the animal so much as food excessive in richness, that is, in fat producing ingredients. Such a diet would beget in the young dairy animal a habit in the system of laying on flesh which would be more or less permanent, and which so far militates against milk-giving because of the food that would be utilized in making flesh rather than milk during each period of lactation that would follow. And in any event an excessive nutrition is wasteful. But the loss which thus arises from wasting the food is frequently less than the loss in other respects which arises from excessive feeding.

Nutrition and Fecundity.—Nutrition has an important bearing on fecundity. An insufficient nutrition and an excessive nutrition are both adverse to the healthy and vigorous action of the generative functions. There is a close relation between activity in the breeding powers and nutrition. When the latter is unduly wanting the breeding impulse is not called into exercise. Thus it is that the rutting season with wild animals is at that time when the system has been brought into an equilibrium of condition through the abundance of food supplies (see p. 140), that cows poorly wintered will not come into heat until some time after the pastures have become plentiful (see p. 141), and that brood sows much reduced in flesh through nursing young will not breed again until the emaciated form is at least partially built up again. It also explains why the lamb crop is so deficient numerically from range ewes in seasons following those of marked deprivation arising from storms or other causes at the mating season.

On the other hand if the nutrition is excessive, that is to say, if it is present in oversupply and is unsuitable in character, as when it induces a sluggish and plethoric condition of the system, it acts prejudicially on the organs concerned in generation, as shown in Chapter XII. when discussing fecundity. A dry dietary is less favorable to generation than one succulent and juicy (see p. 143). The fact has been noticed again and again. This partly explains why a flock of ewes taken from dry grass pastures and put upon abundant pastures of well grown rape will soon come into heat. Similarly an excess of carbonaceous food tends to weaken and impair the generative functions (see also p. 144). Thus it is that females under forced feeding on a dry diet and abundantly supplied with grain carbonaceous in character, as corn, do not conceive readily. It would not be possible perhaps to give all the reasons for the results mentioned, but a potent reason is found in the inability of a dry dietary and likewise one carbonaceous to supply the organs of generation with the materials necessary to the full performance of their respective functions.

An improving condition is peculiarly favorable to generation. The generative organs are stimulated into action by such improvement. Hence it is that animals insufficiently supplied with food in the winter breed soon after the system has felt the renovating influence of good pastures. It also explains why a generous and more or less stimulating diet is recommended to be fed to animals to hasten the breeding impulse.

Nutrition and the Embryo.—Nutrition materially affects the embryo during gestation. A carbonaceous diet does not adequately furnish to the fœtus the requisite materials for growth, any more than it furnishes the materials concerned in conception. As a result the young animal will be lacking in size and vitality at the time of birth. It may also be deficient in hair and when the deprivation has been excessive it may be still born. Such a diet is also unfavorable to easy delivery, hence it has frequently occurred that both mother and young have been lost at the time of parturition from no other cause. A diet insufficient in strength or quantity also tends to hinder development of the fœtus. But it sometimes happens that the deprivation mentioned will affect the female adversely more relatively than the fœtus which she carries. In other words she may produce a well-developed calf apparently at the expense of her own flesh and vigor. The opposite of this also occurs frequently, as when an overfat female produces progeny small and lean. In such instances the elements of nutrition would seem to be unevenly distributed whatsoever the cause may be. Why the currents of nutrition should thus vary and should also vary in their intensity in individual instances when flowing in the same direction is not well understood.

Nutrition and Malformations.—The relation is close between nutrition and malformations in the embryo. The immediate cause of these is arrested nutrition as shown in Chapter XV., when discussing intra-uterine influences. This question, treated at some length in the said chapter, will not be further discussed here, but it will be proper to add, that the causes which thus arrest nutrition may be quite beyond the control of the feeder. The food may be unexceptionable in character, and fed with the highest of skill, and yet abnormal development may follow, arising from causes which are as yet imperfectly understood.

Nutrition and Sex.—That nutrition may possibly exercise an influence in determining the sex has been shown in Chapter XVI., which treats of sex. It was there shown that a generous and proper nutrition would seem to favor the production of females. The understanding of this question, however, is as yet so imperfect that what is known regarding it must not be too confidently relied upon to produce results. This question has already been discussed at some length in the chapter just mentioned (see page 195).

Nutrition and Inherited Qualities.—Nutrition is much influenced by inherited qualities. Animals of improved breeding adapted to meat making or milk production in a marked degree are through inheritance possessed of a vigorous digestion and consequently of a vigorous nutrition. With the latter the food consumed is not absorbed into the system to remain as in the former, but the large milk production resulting is none the less the outcome of a vigorous digestion. On the other hand animals descended from those of unimproved breeding and ill adapted to the uses named cannot turn the food given to equally good account, since they inherit digestive qualities of a different character. That such inheritance extends to breeds or types has been denied, but if the character of the digestion is a matter of inheritance, which it certainly is, such an affirmation is most reasonable.

Experience in handling such animals and careful observation favor the same view, but more extended experimentation is wanted before all who take the other view will be silenced. The following illustration has a very direct bearing upon the subject:—

Take a vigorous Hereford calf descended from parents which have been noted for flesh production, and place it in a box stall when born. Feed it all the food suitable in kind that it ought to have to produce a maximum of growth until it is one year old. In a box stall beside the former put a scrub calf at birth, and subject it to precisely similar treatment. Weigh both at the end of one year. The Hereford will certainly weigh more in proportion to the food consumed than the other. The weak point in the illustration is, that it is to an extent hypothetical. The author can only point to one experiment actually conducted to throw light on this question though others may have been so conducted. The facts which relate to this experiment are given in Bulletin LXX, issued by the Ontario Agricultural College in 1892. The increase in weight was in favor of the well bred animals.

Nutrition and Profits.—Nutrition has an important bearing on the profits obtained from animals. That it should have is the inevitable conclusion that must be reached from much that has been said above on the subject. When the food is insufficient or unsuitable in character, there is a proportionate waste in the food of support. The loss from this source is, in the aggregate, very great, and this applies more or less to every state and to all countries where live stock is kept. It has also been shown that when the food fed is entirely suitable, but given in excess, there is waste and consequently loss through the lack of ability on the part of the animals to which it is fed to digest and assimilate it properly. It has further been shown that food too concentrated impairs digestion and results in loss. The best results are obtained when the food is exactly adapted in character and quality to the present needs of the animal. The importance of an intelligent understanding of all the principles that bear upon the feeding of animals by those who feed them is thus strikingly apparent.

Nutrition and the Improvement of Breeds.—Nutrition has a marked effect on the improvement of breeds. The advantages gained by careful selection and breeding in size, vigor, and good digestive qualities cannot be maintained without a suitable and abundant nutrition. Too many illustrations of this fact may be cited from the rapid degeneration of pure-breds of good form and faultless breeding in the hands of owners who have not cared for them properly. Nutrition alone will not lift breeds to a higher standard, in the absence of suitable breeding and selection. Nor will these lift breeds to a higher standard in the absence of a suitable nutrition. The three go hand in hand wherever improvement made is to be maintained and wherever further improvement is to be made.

Nutrition and the Coat of Animals.—The character of the coat and handling in animals is a good indication of the character of the nutrition. The coat and the skin underneath it are nourished through the medium of the blood vessels beneath the latter, that is to say, through the medium of an active circulation. This circulation sustains the sebaceous glands and stimulates them into action in proportion as it is strong or weak. These glands in turn oil the skin, so to speak, and the hair which covers it. The active circulation is the outcome of a vigorous digestion and correct food assimilation, growing out of good digestion, hence, when assimilation is active, the handling of the skin will be soft, mellow, pliant, and elastic, and the coat will be plentiful, glossy and soft to the touch. When the assimilation is of the opposite character, indications the opposite are found in the hide and hair. But the skin and coat will be further discussed in the respective chapters which bear upon quality and the coat, that is to say, in Chapters XVIII. and XIX.

CHAPTER XVIII.

QUALITY IN LIVE STOCK.

This chapter will be devoted to the discussion of a term that has been used for many years by those who grow live stock and who deal in the same. The reference is to the term "quality." Those who use the term have doubtless some well defined idea of what it expresses to them, but, since it has various shades of meaning, as will be shown below, the idea intended to be conveyed may in many instances be obscure to the persons addressed. Because of those various shades of meaning and the loose sense in which the term is used, it should be given more than a passing notice.

The Term Quality Frequently Used.—So frequently has the term quality been used by the breeders of live stock, and so frequently is it used, that it may not be longer ignored when discussing the question of animal breeding. As implied from what has been said above, it has been variously used and not always with due precision. Those who write on live stock in the agricultural press are constantly using it and in nearly all instances in an indefinite way, that is to say, they refer to an idea that is prominent in their own mind while the reader may have a somewhat different apprehension of their meaning. Such misapprehension may readily arise from the various shades of meaning which the term may be made to convey, as will be shown below. Because of those differences in application of which the term is susceptible, and of the very loose and careless way in which it is used, the need is urgent that an attempt be made to define its meaning or meanings with some degree of accuracy. As a result of the free and easy way in which the term has been used and of the many shades of meaning which it may be made to express to the average mind, it is surrounded with a mist that ought to be dispelled.

Quality and Ripeness in Animals.—In some instances the term quality has been used in comparing animals when ready for the block. When thus used it has reference to the amount of flesh as compared with the offal and to the distribution and ripeness of the same. The contrast in the relative amounts of flesh and offal respectively, that is to say, in the amounts of dressed meat and offal respectively, is very great. The same is true of the way in which the flesh is distributed over the body. In some animals the relative weight of the good cuts, as for instance, the loin, is large, and of the cheap cuts, as the neck, is light, and in other instances the opposite is true. Now when the term quality is used with reference to these features of the body, alive or dead, it means that in them the proportion of meat to the offal and of good meat to that less valuable is large in both instances.

A ripe condition of flesh is that which cannot be profitably improved upon by further feeding. Its indications are a good covering of flesh on the portions more usually bare and more particularly firmness of flesh. The extent of the covering, however, on the more bare parts will vary much with the character of the animal. When the animal is ripe, there will be a resistance to gentle pressure on the fleshy portion that is not found in unfinished animals. The degree of the resistance will be proportional to the degree of the ripeness, but it is also increased somewhat by age. The idea of ripeness therefore arises through the sensation of touch rather than through the medium of the eye.

Quality and Present Thrift of Animals.—Quality in other instances has been used to denote present condition as to thrift or well doing. For instance, when an animal is lean in flesh and rough in coat, that is to say, what is frequently termed "out of condition," it is said to be off in quality. Such an application of the term, however, should be made with great caution, if indeed it should be made at all, as these conditions may arise from neglect, and may not therefore be incompatible with the highest quality. And just here it may be stated that the ability to detect the indications of future well-doing in such animals, that is, the indications of high feeding qualities, bespeaks a skill and judgment that are found all too seldom among those who feed and breed live stock.

Quality and Well-Doing.—In yet other instances the term quality has been used to denote capacity for well-doing, as indicated chiefly by what are termed the "handling qualities." This is perhaps the most common use made of the term. These are readily cognizant to the sense of touch and they furnish the most tangible and important index of good digestion and assimilation. Just exactly what is meant by good handling cannot be easily explained in words and for the reason that it is an indication that is discerned through the medium of touch. An exact idea of the sensation thus conveyed by touch must be felt, to be fully understood, hence the impossibility of showing exactly what it means by the use of language. But enough may be said to enable the individual to get the idea approximately, hence the justification for dwelling on this question in the paragraph that immediately follows. A thorough knowledge of what is meant by good handling can only be secured through correct teaching followed up by much experience or practice in handling animals.

Handling Qualities Defined.—By good handling qualities is meant those indications of good digestion cognizant to the sense of touch, as for instance:—

1. A hide of medium thickness for the breed, which sways readily under gentle lateral pressure, more especially over the ribs, and which when grasped on that part will readily fill the hand. When making this test place the inside of the hand and especially of the fore-fingers flatly over the ribs. Press gently and, while doing so, move the hand back and forth laterally on the side, with a rather quick movement. When the handling is good, the skin will vibrate or tremble over much of, or the whole of, the space covered by the ribs. It does so because it rests on a well oiled cushion of glandular substance underneath, and this condition is the outcome of active secretions, which in turn are the outcome of good digestion and good assimilation. If the handling is not good, there will be but little vibration. But in making this test, the animal should stand straight. If the head and neck turn toward the individual making the test, it will appear unduly favorable, but if turned in the opposite direction not sufficiently favorable. Then catch the skin over the ribs between the thumb and two fingers

and lift it up from the side. The proportional ease with which this can be done is the indication of the character of the handling. Or, grasp the skin gently in the whole hand. The more easily the hand is filled the stronger indication is it of good quality. In poor handling animals the skin cannot be grasped, as it will not lift up from the flesh underneath. The test of handling over the ribs, as thus described, is the most readily made and it is also one of the most reliable tests of quality. But the present condition of the animal as to flesh exerts an influence. This test is however sufficiently accurate to furnish in itself a reasonably safe guide as to the quality of an animal. The thickness of the hide is largely influenced by the breed. The average Hereford for instance has a somewhat thicker hide than the average Shorthorn. A reasonable degree of thickness in the hide is not objectionable, providing it handles well. A hide inclining to strong is one indication of constitution. A thin "papery" hide is objectionable as it is frequently associated with forms inclining to spareness and delicacy.

2. These indications further signify an impressibility and elasticity of flesh on various parts of the body under gentle pressure. This is measurably true of the flesh on every part of the body, but there are some parts of the same where the indications are more readily apparent, that is to say, where judgment may more easily be made in regard to them, as for instance, the covering of the ribs already referred to, the loin and the shoulder blades. If these are covered with flesh impressible and elastic, they furnish the assurance that other parts of the body will be properly covered, since the parts which are most difficult to

cover with suitable flesh are those just named. But due allowance ought to be made for the degree of flesh which the animal carries as a whole. If it is lean, these parts cannot be well covered. When the more muscular parts of the body, as the hips and buttock, are thus subjected to gentle pressure of the finger tips, and they show much of impressibility with but little of elasticity, there is too much of a leaning in the meat to what may be termed flabbiness in character. If in an unfattened animal there is but little impressibility, the meat will be over-fibrous, and the carcass wanting in power of expansiveness, but here again the character of the food given will exercise an influence that may tend to mislead the judgment. A diet too succulent tends to the production of muscle too soft, and a diet too dry to the production of muscle too firm.

3. The indications of good handling also include a soft and mossy coat, agreeable to the sense of touch and withal abundant. The abundance of the hair, its softness and mossiness are largely but not entirely the outcome of good digestion, hence, the importance attached to them as indications of digestion. When nutrition is wanting, the coat will become dry and harsh to the sense of touch. When cattle are on a poor diet in winter, as of straw, the hair becomes stiff and inclines to stand at right angles to the body. After the same animals have been out on pasture for a time, the new hair which pushes off the old becomes glossy and lies closer to the skin as a result of its greater pliancy. Contrast also the glossy character of the hair of a young man or maiden as compared with the dry character of the same in old age.

Quality in its Widest Sense.—Quality in its widest sense has reference to capacity for well-doing as previously intimated, or for fulfilling in a high degree the end for which the animal is designed. In this broad use of the term, quality is simply another name for capacity. When thus used it will include: 1, the form of the body and the relation of the different parts to one another; 2, the character of the flesh and the distribution of the same; 3, the nervous temperament; and 4, the nature of the covering of the body including the skin. Quality therefore in its most comprehensive sense may be defined as an aggregation of good properties, but as ordinarily used it more commonly has reference to the handling qualities as described in the preceding section.

Quality Different in Different Species.—The indications of quality in the different species of animals are not always identical, nor are they always identical in different classes of the same species. They will differ somewhat in the dairy cow and in the beef producer, as will be shown below. They are not the same precisely in the sheep as in the hog, nor will they be exactly the same in either of the three classes of cattle. In the discussion that will now be submitted of the essentials of quality as belonging to these different classes of animals, the term will be used in the broad sense.

Quality in Beef Cattle.—The chief indications of quality in beef cattle include: 1, certain requisites of form essential to a high order of beef production (see p. 286); 2, good handling qualities; and 3, a quiet disposition (see p. 297). Correct form is not, strictly speaking, so much of a quality in itself as an essential to quality in the sense in which the word is more commonly used, for, with good form in a beef animal, the value of good handling would proportionately be discounted as good form was wanting. Likewise a quiet disposition is an attribute or characteristic rather than a quality, as the term is usually applied to animals, and yet in beef production it enhances the value of good handling qualities as correct form does, in proportion as it is present, for a restless animal does not fatten so readily as one not thus restless, other things being equal.

Quality in Dairy Cattle.—The chief indications of quality in dairy cattle include: 1, certain requisites of form essential to milk production of a high order (see p. 287); good handling qualities though not necessarily so marked as in beef animals; 2, indications of sufficient nerve power (see page 297); and 3, good development of the lacteal system (see page 287). In beef animals the other essentials, in a sense, center in the handling qualities, in milk production they center in the leading indications of free milk elaboration, that is to say, free milk production. Without these, good handling qualities will not avail, as these may be quite as much present when the leading indications of milk production are absent as when the opposite is true. In other words they may be quite as much present in a dairy cow inclined to beef production as in a dairy cow inclined to milk production.

Handling qualities in a dairy cow are not so important relatively as in a beef cow as an indication of fitness for the end for which each is kept. The important place given to nerve power among essentials in a dairy cow should be duly noticed. These indications strongly accentuated are antagonistic to beef production, being the opposite of that quiet disposition so essential to fattening qualities of a high order in the beef animal.

Quality in Sheep.—The chief indications of quality in sheep include: 1, certain requisites of form, essential to making good mutton freely (see p. 286), and 2, good handling qualities, including a pinkish color of the skin and lustrous wool possessed of a plentiful supply of yolk (see p. 288). Handling qualities in sheep are not ascertained in quite the same way as those in cattle. On the body generally they are sought through gentle pressure of the fingers laid flat on the part of the animal being examined rather than through pressure of the finger tips. Such handling would mar the appearance of the well trimmed fleece, more especially in the medium and fine wooled breeds. In applying the handling over the ribs the hand may be placed flatly on the same as in cattle and moved laterally or back and forth over the side, but it would not answer to try and fill the hand with skin, as in cattle, or even to grasp it between the finger and thumb as sheep are so easily injured. The handling is ascertained chiefly through the covering of the essential parts, the elasticity of the flesh, and readiness of vibration in the skin under gentle lateral pressure over the ribs. The pinkish color of the skin is one indication of present good health. When sheep are out of health the skin becomes pale from a defective nutrition. But in some instances the skin may be dark as a breed or type characteristic and yet be perfectly healthy.

The wool is an important indicator of present and past well doing or the opposite. If it has not been well nourished at any time the fiber will be weak just at that point where the nutrition was defective in the growth of the wool. When nutrition is ample, which of course is a consequent of good food and good digestion, the wool will be as indicated, lustrous and amply supplied with yolk. When lustrous, that is, when it is bright, in a sense shining, it is also strong. Ample yolk indicates active secretions.

Quality in Swine.—The chief indications of quality in swine include: 1, certain requisites of form essential to the production of a large quantity of meat on the more valuable parts (see p. 286), and 2, good handling qualities. Good handling qualities in swine differ materially from those in cattle and sheep. The handling in the former relates more to the hair than to the skin. The skin should be smooth and clean and not inclined to the production of scurf or scales. If the digestion is good, these will be practically absent when the food supplies are suitable and ample. The skin in swine hugs the flesh more closely than in cattle and sheep, hence to the sense of touch it is not so important an indicator of quality. But to the sense of sight it is an important indicator of the same as has been shown. Handling in swine therefore as an indicator of quality relates chiefly to the hair. The brighter it is and the more pliant and strong, the better does it indicate quality. These are to be taken together rather than separately, as hair may be plentiful and dull rather than bright, and it may be pliant and yet too weak. Hair such as indicated in swine goes along with size, thrift and vigor. Coarse bristly hair is objectionable, since it indicates lack of refinement in breeding and coarseness in the grain of the flesh.

Indications of Quality Not Clearly Apparent at Birth.—The indications of quality are not so clearly apparent at birth as at a later period, since good digestion is one of the most important requisites in evidencing quality, and some time must transpire before the exact character of the digestion can be ascertained. At birth it may be apparently correct, but the degree of its power cannot be ascertained until demonstrated by the results. Forceful assimilative power does not always accompany large food consumption, and digestion that is all that can be desired. Nor can form be judged of accurately when it is judged prospectively, especially when near the birth period. Animals change in relative development with advancing age. Hence it is, that a calf or a lamb of great promise at birth, frequently gives place at a later period of development to one of less promise. In a litter of young pigs those of most perfect symmetry and plumpest form are frequently left in the race of subsequent development by others of less promise. Because of these changes in relative development, experienced breeders prefer not to select animals for future breeding at any age quite near the birth period. In fact the longer the choice can be deferred up to the age when breeding may begin, the more certain are the assurances of correctness in choice.

Quality More Frequent in Well Bred Animals.—Quality is more frequent in well bred animals than in those of common or mixed breeding. It is so because the former have been reared with a view to secure the capacity for well doing in a high degree. In other words more attention has been given to the presence of quality in the former when making the selections. It is only reasonable that it should be so, since the former are more valuable and therefore should be selected with greater care, and the guaranty of quality through inheritance from the ancestry can be more readily ascertained. Nevertheless there is much difference in the quality of animals bred alike, even in those possessed of blood precisely similar. It has been shown that this also is true of relative form in the same (see p. 37), and of relative prepotency (see p. 106). In each instance, much obscurity hangs over the reasons for those differences, but a partial explanation is probably furnished by the condition of the parents at the time of mating, and of the dam during the period of maternity.

Quality and Quantity.—With reference to quality, the aim should be to secure the largest quantity and of the best quality in the same animal. Not infrequently animals deficient in size are possessed of good quality, and yet they are not the most profitable from lack of capacity for development. Much difference of opinion has existed in the past with reference to the standard size that will best represent various breeds, and so it may be in the future. It would seem to be a simple solution of this question to say, that the more of size the better in the individual animal, and in the breed, so long as it is not obtained at the expense of quality. Thus it is that size standards may properly shift with changed conditions of environment. It is not so easy perhaps to secure and maintain good quality in large as in small animals, but since the food of maintenance is less relatively in large animals, it would seem commendable to try to secure them possessed of all the size compatible with the retention of high quality.

Recognizing Quality in Animals.—It is an indispensable requisite in the successful breeder and feeder to be an apt judge as to the presence or absence of quality in live stock. Several reasons may be advanced in support of this view: —

1. Animals not possessed of high quality should not be selected or retained for breeding. The individual who is not apt in recognizing quality cannot therefore judge correctly as to what should be selected for future breeding or as to what should be discarded.

2. When store animals, that is to say unfattened animals, though ready for being fattened are purchased for the block, quality has to be relied upon almost entirely as the basis of selection, since reliable information cannot usually be obtained as to the exact breeding of the same. Quality in the broad sense of the term should therefore govern in the selection of these animals. But, in the absence of the knowledge of what constitutes high quality, it cannot be thus applied. It is always more satisfactory when the stock thus purchased can be tested by handling, but in purchasing animals reared under range or semi-range conditions, this cannot be done. In these quality must be judged chiefly by the eye.

3. Where large profits are looked for from the rearing or feeding of animals deficient in quality, disappointment will almost invariably follow. The only exceptions will be when animals are purchased for feeding and when the conditions of purchase and sale and of feeding have been exceptionally favorable. But with animals of good quality, the results would have been just so much the more favorable.

4. When animals deficient in quality do appear in a herd or flock, the aim should be to send them to the block, and at an early age. Supplanting them with animals possessed of quality will show better business judgment.

CHAPTER XIX.

THE COAT AND THE INFLUENCES WHICH AFFECT IT.

The difference in the character of the covering of animals of the same species is very great. Take for instance the sheep. In some of its varieties the wool fibers have attained the length of fully eighteen inches in one year, whereas in others it is said that they do not exceed one inch in the same time. And the difference of the fibers in relative coarseness and fineness is no less marked. These differences are not accidental, but result from causes which are the outcome of influences natural and artificial that produce them. It will be the aim in this chapter to discuss the more important of the influences that produce variation in the covering of animals.

The Term Coat Defined.—In the discussion of this question, the term coat is used to denote the skin and that which covers it, whether hair or wool. The relations between these are so close and intimate, that what affects the former will, in many instances, affect the latter. For instance, the skin handles nicely when the secretions are active. They then form that soft cushion under it which makes vibration of the skin so easy under pressure from the hand. When these conditions prevail the underlying blood vessels and the sebaceous glands are active. When these are active, the hair or wool fibers, as the case may be, are well fed and oiled, with the result, that they are attractive to the eye and pleasant to the touch. The condition of the skin, therefore, cannot be improved without improving the condition of the coat, and generally speaking the opposite of this is also true.

Two Classes of Influences Affect the Coat.—The influences which affect the coat of animals may be divided into two classes, viz., those which are internal and which may be said to properly belong to the animal itself, and those which are external and come from outside sources without regard to the inherent qualities of the animals. These influences are further discussed below. Usually these two classes of influences act in unison. For instance, heredity, an internal influence, may transmit hair fine and dense in character, and cold, an external influence, may further intensify the tendency to fineness and density in the hair. But sometimes they act antagonistically, as when heredity may transmit fine and dense wool, and weather excessively hot tends to thin the fibers and to render them less dense. The measure therefore of the relative strength of those influences cannot be accurately taken. It will be a quantity that will continually vary with varying conditions.

Internal Influences Which Affect the Coat.—The chief of the internal influences which affect the coat are: 1. Those which come through heredity. 2. Those that come through digestion and food assimilation. And 3. Those which come through sex as such. Here also it may not be easy to say how much of the influence exerted may be due to each of these factors. The character of the digestion and food assimilation, for instance, are largely the outcome of heredity, hence, in a sense, a part of the influence exerted by these should, strictly speaking, be credited to heredity, but how much, in a given case, cannot be accurately determined. These influences will be further discussed separately.

External Influences Which Affect the Coat.—The chief of the external influences which affect the coat include: 1. Exposure to cold, heat, sunshine and moisture. 2. Protection from adverse influences. And 3. The character and quantity of the food. It was stated above that the various influences affecting the coat sometimes act antagonistically. Whenever this happens the aim should be so to neutralize any antagonism between influences through the aid of artificial environment, that these will not be greatly harmful. It is also eminently wise to try to harmonize the ends sought with reference to the hide and its covering, that these will be in unison with the natural environment of the locality in which the animals are grown.

To illustrate: It would not be wise to try to grow a covering for cattle in a hot climate such as would be suited to the needs of Galloway or West Highland cattle in their native home. The influence of natural environment cannot be too carefully considered in all its details. Though the cattle just named were introduced into latitudes equally cold but less moist, it would be found difficult to sustain the length of the outer coat in them, notwithstanding the ease with which density in the inner coat could be sustained.

Influence of Heredity on the Coat.—The peculiarities of hide, hair and wool which distinguish the breeds as such, and also certain families of the same, are largely due to heredity. The hide of the West Highland cattle for instance is thicker than that of the Hereford, and the hide of the Hereford thicker than that of the Shorthorn. The reference here is to breeds rather than to individuals, for these differences may not be always true of the latter. The West Highland cattle have a denser coat than the Devons, and also one that is longer; the contrast in density and length of fleece between Cotswold and American Merino breeds of sheep is very great, and the difference in the hair on the well fed Poland China pig and the vagrant razorback is marked.

Again, certain families of the Herefords have the hair more curled than others, certain families of Merino sheep have folds and wrinkles on the skin more numerous than others, and certain families of Yorkshire swine have the hair more plentiful and fine than others. Such inheritance, however, does not preclude the conjoined action of several of the influences named or indeed of all of those of a character which makes it possible for them to act in conjunction in the establishment of these peculiarities. For instance, exposure to cold and damp weather along with certain peculiarities of food acting on the digestion, are largely responsible for producing the thick hide, the fine thick under coat, and the long shaggy outer coat that characterize the West Highland cattle, but the transmission of these is due to heredity, and the further fact that these peculiarities appear in some families of the breed in greater degree than in others, is also to be charged up to the same influence. It is easy to see therefore how these qualities may become intensified or otherwise through careful selection and breeding.

Influence of Digestion and Food Assimilation on the Coat.—The hide and hair, like other parts of the physical structure, are nourished through the medium of the circulatory system. The circulation will be active in proportion as the vital forces are vigorous, as the food is suitable in kind, as the digestion is correct and as the secretions do their work well. Every part of the system appropriates materials suited to its growth or maintenance in plentiful supply, with the result that all parts of the system are well sustained as long as food supplies are suitable and properly given. When the other conditions are right, such animals possess good handling qualities (see p. 218). For the more particular influence exerted on the coat by food (see p. 213).

Influence of Sex on the Coat.—As a rule males have somewhat thicker hides and a coarser and stronger coat than females. The reasons for such peculiarities of structure and the precise causes which produce them are but little understood. The fact however cannot be disputed that the greatest strength and vigor of body are in some sense associated with what may be termed a strong hide and strong hair. Thus it was that the targe of the Scottish clans was covered preferably with the hide of bulls. On certain parts of the body, as the crest for instance, these conditions are intensified. The crest of the bull has stronger hair than is found on the top line of the neck of the cow, and the top line of the neck of the boar has stronger, coarser and longer hair than the same in the sow, and these peculiarities frequently characterize more or less the covering of the whole head and neck. Long wavy hair about the head, neck, shoulders and also other parts of the Galloway and West Highland cattle is more pronounced in the males than in the females, and doubtless the microscope would discover the same contrasts in the wool of males and females of the various breeds of sheep, even of those that produce the finest wool.

These exist in consonance with that law which associates more of strong development and less of refinement with masculinity. The coat of castrated animals occupies an intermediate place, and is influenced more or less by the age at which the castration is done. The earlier that males are castrated the more nearly do they resemble females in coat and hide, and the later they are castrated the more nearly do they resemble uncastrated males in their characteristics. But, though castration is done at an age quite early, the male so castrated has less of average refinement in this particular than the female. The exact ways in which creative and developing forces thus influence the coat in virtue of the sex as such, and in virtue of castration and noncastration in males, are as yet among the inscrutable things.

Influence of Cold on the Coat.—Cold tends to thicken the coat, and when the animals are subjected to certain forms of privation it has the further tendency to strengthen it, that is to make it longer and probably thicker, but at the sacrifice of flesh. In the polar bear the hair is thick. The same is true of fur-bearing animals that frequent northern waters. Nature has thus made provision for protection from the cold. When animals under domestication are much exposed to inclement weather, the hair in time becomes longer and thicker than when they are shielded from the same in a marked degree. Such increase in the development of the coat, however, is made at the sacrifice of flesh, at least in some degree, since a portion of the materials that would otherwise be used in making muscle is diverted to strengthening the hide and hair. Thus it is that the hair of animals ill nourished in winter and much exposed becomes stronger, notwithstanding that they shrink much in flesh. In some instances the exposure produces a double coat of hair, as it were, an upper and an under one, the upper being long and wavy or shaggy, and the under one fine like fur. Such is the coat of Galloway cattle and also of some other animals in northern exposures.

Influence of Heat on the Coat.—Heat considered in itself, tends to shorten the coat, and to reduce it in closeness, as witnessed in the covering of sheep in hot countries. It also tends to increase the coarseness of the fiber. But too much must not be made of the influence of either heat or cold acting singly, since some of the fine wooled breeds are native to countries with high summer temperatures, as for instance the Merino of Spain. On the other hand some of the very coarse wooled breeds are native to bleak climates, as for instance, the Black-faced Highland sheep of Scotland. Yet the fact remains, that without any selection on the part of man, the tendency in hot climates is, as stated above, to shorten the wool fibers and, more particularly, to lessen density in the same, and the tendency in cold climates is just the opposite.

Influence of Sunshine on the Coat.—Sunshine in moderation is helpful to the production of a good covering for the body. In excess it gives the outer surfaces of the hair a dry, singed appearance. When animals are kept entirely shut away from sunlight and its influences the whole system will at length be affected adversely and, in sympathy with it, the coat will lose its accustomed bloom. But on the other hand constant exposure to glaring sunlight will produce the effects mentioned. Hence it is, that cattle, for instance, that are being fitted for exhibition are not exposed in the heat of the day, although there is also the further reason, that they shall be protected from excessive heat. Undue exposure to very hot sunshine, as in the case of pigs but thinly covered with hair, will sometimes cause the skin to blister. In this fact is found a reason for breeding pigs with a sufficient covering of hair to resist such an influence.

Influence of Moisture on the Coat.—Moisture tends to strengthen the fiber of hair and wool, and also to lengthen it, as witnessed in the greater length of covering relatively on cattle and sheep in Great Britain as compared with the same in the drier regions of the Central West in the United States and Canada. But this idea must not be pressed too far. The buffalo which were native to those same regions had long and strong coats, and withal dense in the under covering, thus admirably fitting them for braving the intensity of the cold in winter. Yet the fact remains, that under artificial conditions it is easier to maintain length and mossiness in the coat of the cattle in Great Britain than in the cattle reared between the Mississippi river and the Rocky Mountains. The character of the food, however, may be quite as much responsible for the differences noted as the character of the climate.

Influence of Protection on the Coat.—Judicious protection has the effect of refining the coat and of rendering it more pliable and mossy. Such protection may take the form of housing or of blanketing, or of the two combined. It is necessary to protect animals intended for the show ring from undue exposure to sunshine, prolonged rains and low temperatures. The breeders of Merino sheep in Saxony were careful to protect their sheep thus when they sought much of fineness and pliancy in the wool fibers. It is said that they were even careful to protect them from exposure to the dews of night. Cattle and sheep that are to be put in high show condition are kept much of the time under the cover of light blankets, especially as the season for showing approaches. The moisture which exudes through the pores of the skin is thus retained in the hair to a greater degree than it would otherwise be, with the result, that a mossiness of touch is given to it and also a pliancy that could not be attained in the absence of such blanketing. From what has been said regarding the influences that affect the coat, it will be apparent that temperate regions are the most favorable to the production of what may be termed a desirable coat, as well as of a desirable form underneath it.

Influence of Food on the Coat.—It is probable that no one influence affects the coat so much as food. Succulent food, when properly nourished and fed in due balance, improves the coat by strengthening it, and rendering it more abundant, by imparting to it a sleek, glossy, and attractive appearance, and by rendering it soft, pliant, and mossy to the touch. This influence is much in evidence in the spring of the year, when cattle have been changed from dry and ill balanced winter diet to a diet of succulent and nutritious grasses. The old hair will loosen and fall off much more quickly than if they had still been maintained on the winter diet just referred to. The new coat will also be much more abundant than under the other conditions and it will possess more of that luster and glossiness which adds so much to the attractiveness of the coat. The favorable influence exerted on the coat from the liberal feeding of field roots in winter furnishes an illustration of the benefit to the coat resulting from feeding succulent food at that season. But it is possible, under some conditions, to secure these desirable qualities in the coat without feeding succulent foods, although it is not so easy to do so, nor can they be so well maintained in the absence of succulent foods. When these conditions are secured in the absence of what may be termed succulent foods, it is through the specific action of certain foods on digestion in the animals to which they are fed, and through digestion on the coat.

For instance, to feed steamed barley for a time exerts a favorable influence on the coat of horses. Oil meal and linseed meal properly fed will affect favorably the coat of all kinds of animals. The same is true of skim milk, but its best effects are probably seen in the improvement which it effects in the coat of swine. A deficiency in the quantity of the food has the effect of lengthening the coat to protect the animal in the absence of a sufficient supply of animal heat. But such increase in the coat is secured at the expense of development in other directions. Irregularity in food supplies strengthens and weakens alternately the fiber in wool. It probably exerts a similar influence in degree on the hairs that cover other animals, but less in degree because of the slower growth in the same. The value of wool affected thus is much impaired.

An excess of carbonaceous food destroys the handling qualities of an animal, through the medium of deranged digestion. When cattle have been thus fed the hide is less pliant and the hair loses its bloom.

It also becomes more harsh to the touch. Both hair and hide are insufficiently nourished notwithstanding the abundance of the food supplies as specified.

How Influences that Affect the Coat May Act.—Several of these influences may be operative at the same time. For instance, suppose that a cattle beast is come of an ancestry noted for the excellent character of the covering that they possessed. Suppose that in winter they are given a diet in which turnips and oil-cake are prominent factors, and suppose that at the same time they are kept sufficiently protected from the cold by proper housing and suitable blanketing. In the instance supposed, all these factors exert a favorable influence on the coat. They act in conjunction but it is not possible at the same time to determine exactly the proportionate influence exerted by each. Suppose cattle are fed chiefly on straw in one instance and unprotected, and in another instance they are fed and exposed similarly, with the difference that in the second instance a liberal diet of turnips is given. The coat of the cattle to which the turnips are fed will be much superior to that of those fed straw only. Here then is an illustration of the power exerted by a single influence.

The Best Coat.—The best coat is that which is best adapted to the wants of the animal subject to the conditions under which it must be kept, and to the needs of the market when it has a market value. A sheep for instance may have wool which keeps it in the highest comfort possible in a certain country, and the said wool may bring the highest price in the market because of its adaptability to the needs of the manufacturers of that country, and yet it would be easily possible to find countries in which these conditions would be reversed if the attempt was made to rear the breed in these. An excess of hair or wool beyond the requirements of the animal for protection is an unnecessary drain upon the system. It is different with wool because of its relatively high market value. But the production of wool should not be so stimulated as to bring positive discomfort to the animals because of its length or density. On the other hand an insufficiency in the covering as is sometimes found in the case of pigs is a serious mistake.

CHAPTER XX.

THE INFLUENCE OF ARTIFICIAL CONDITIONS.

Animals in a state of nature dwell amid surroundings which nature has furnished them with, and which in themselves they have no power to change. When subjected to the human race, even when in the savage state, the conditions are somewhat changed, and these changed conditions bring along with them corresponding changes in the animals, and the only limit to these changes is the limit of the change in the conditions. The influence of these conditions therefore is worthy of the most careful consideration.

Artificial Conditions Defined.—Artificial conditions are those changed conditions of life to which animals are subjected, as compared with those surrounding them in a state of nature. Those conditions therefore are such as man has made or may make for the animals under his care, and to which he may subject them. The only limit to these changes so far as their creation is concerned is the limit of man's ingenuity. And the only limit to their successful application is the limit of the susceptibility of the animals to improve under the conditions to which they are subjected. Here then is a wide sea in which the breeders of live stock may virtually sail forever.

The chief of these influences are such as relate to food, shelter, exercise, habit and selection in breeding. The gap that separates the various breeds of wild animals in a state of nature and improved is a very wide one, as instanced in the wild hog and the same domesticated. The bridging over of this gap is due to the influence of artificial conditions, hence it would not be putting it too strongly to say that all or nearly all the improvement made in the various breeds of live stock is due to the influence of those conditions. But the fact should not be lost sight of, that artificial conditions can be carried to such an extreme, that deterioration rather than improvement may follow. The breeders of Saxony subjected the Saxon Merino to conditions of keep so artificial that they injured stamina in the same. The improvers of Longhorn cattle inbred them to such an extent and managed them otherwise so artificially that retrogression rather than advance came to them.

The breeders of dairy cattle during those decades, when prolonged confinement in stables in the winter season was popular, reaped as a result a greatly increased harvest of tuberculosis. So greatly has disease been created and disseminated because of artificial conditions, that it would not be stating the fact too strongly to say, that nearly all the maladies that afflict domestic animals, and the degree of the virulence of such is due to the artificial conditions to which live stock have been subjected. This great lever to the improvement of domestic animals that has come to man, if not used with discretion, may easily be turned into a boomerang that will bring disastrous results out of well intentioned effort.

Seeking Improvement Through Artificial Conditions.—When the attempt is made to improve live stock through artificial treatment, improvement should be sought first in those lines in consonance with the original constitution, and second, without doing violence to any of those principles concerned in the maintenance of sufficient stamina. The attempt to ingraft the leading traits of the dog for instance upon the pig, would be labor expended to but little purpose as intimated in Chapter VI., when discussing acquired characters. The dog is useful chiefly because of the use that can be made of the higher intelligence that he possesses. The pig is useful chiefly because of the meat which he furnishes in a machine like fashion. Far better then to seek to turn to still higher account the intelligence of the dog by improving him still further in teachableness and obedience and in the development of physical features as strength or swiftness that will enable him to turn these to better account, than to try so to change the pig that he will render service in the line that the same is rendered by the dog. And yet the fact remains that labor expended in improving the intelligence of the pig is not all lost. He must be measurably obedient before he can become profitable.

The improvement that can be made without too much reducing stamina is a question of conditions. It may be thought that it would not be possible to have an excess of stamina. That is true, providing it can be attained and maintained without interfering with development in other important lines. Whenever it does so interfere it is excessive. Although in breeding domestic animals the reverse is generally true, it would be possible to have stamina in excess of the needs of the animal as a meat or as a milk producer. For instance, the wild hog has an amount of stamina far above the actual needs of the same in domestic swine. In the former it is actually necessary to enable him to run, to endure and to fight. In the latter so much of it would be associated with restlessness not in keeping with the highest quality of meat making. The razorback still found in some parts of this republic furnishes another illustration of the same. But stamina may be readily reduced beyond that line that would be in keeping with the realization of highest profit. This should be guarded against. In fact the reduction of stamina has seldom or never to be considered in the practice of breeding but rather the maintenance of the same.

The Influence of Food.—Food artificially supplied more than anything else, probably, has been instrumental in the improvement of live stock. In a state of nature the energies of the system are largely expended in securing food, and the animals are on short rations during a portion of the year. Whenever an animal not kept for purposes of labor has to expend energy in securing food beyond that sufficient to keep it in normal health, it is so expended at the sacrifice of production in meat or milk, and in some instances of both. When the animals are on short rations during a part of the year, they lose in flesh proportionately, and the loss has to be all made up again before any advance in production can begin. Wild animals therefore cannot advance beyond a certain standard of performance in any direction, and that standard will not be a high one. Its measure will be the measure of the adaptation in the conditions which surround them to their needs. But when suitable food supplies are furnished regularly and abundantly the energies of the system are concentrated on building up the frame or in useful production, hence the standard of improvement may be advanced indefinitely. And when these supplies are suitable in kind as well as ample, every feature of development is so sustained that one part of the system is not built up at the expense of another part as when food supplies are short.

Suitable and abundant food supplies, aided by careful choosing of the breeding animals, have effected much improvement in digestion and food assimilation. In virtue of this second law of breeding, specimens appear with the evidences of increased digestive power. Food adapted to the needs of such makes it possible to secure an advance on previous development. It does so by furnishing fuel that drives efficiently the whole machinery of digestion and all the vital forces of the being. Thus improvement is not only secured but the way is opened for still further improvement by increasing the capacity for the same. There is therefore no limit to the improvement that may thus be made in domestic animals.

The character of the food supplies and the proper combination are but less important than their abundance. This fact is apt to be overlooked. The variety and the suitability of the food products in Great Britain are unquestionably largely responsible for the high standard of average excellence in the many breeds of live stock grown there. The same is true of Ontario in Canada. In the United States and especially in the corn and sorghum growing states, the danger exists that because of the super-abundance of the production in corn and sorghum, that these will be made to form too large a proportion of the entire food ration to be compatible with highest development.

To secure the highest possible development from food, it must in every respect be suitable, that is to say, it must have the food nutrients in due balance and must also have sufficient succulence and digestibility. And this adaptation in the food is relatively more important while the animals are yet short of maturity, and less important as the birth period is receded from. Suitable variety and the proper blending of foods therefore cannot be ignored when stock is to be advanced. Happily, with animals under domestication, these influences can all be controlled. Notwithstanding all the advance that has been made in the improvement of live stock, the whole question of feeding is yet very imperfectly understood.

The Influence of Shelter.—Shelter artificially provided has proved a potent factor in the improvement of live stock under domestication. Expose animals to cold beyond what may be termed the line of comfort, and additional food is wanted to provide animal heat. Expose them to storms that produce discomfort; and the same holds true. In the absence of shelter at such times, the excess in food consumption over what would otherwise suffice, is just equal to the difference between the amount required to sustain animal heat under normal conditions and under the conditions named. Consequently there will not only be the waste in food referred to but the machinery of digestion will be necessarily taxed to the extent of the energy expended in digesting the afore-mentioned excess of food.

When the exposure is severe and prolonged, high attainment in performance cannot be sustained though food supplies should be abundant. Too large a proportion of the food is utilized in defense against the cold through the production and maintenance of animal heat. While the aim should be to protect domestic animals from any exposure to weather that will injure them, it is specially important that they shall be protected from cold storms of rain or sleet. The latter more or less endanger the health in addition to the intensity of the discomfort produced. Dry cold, though much more intense, is less injurious in every way, and changeful temperatures, especially when the changes are violent as in winter in certain states far inland, are far more injurious than lower temperatures in which the cold is steady. Suitable shelter therefore is more of a necessity in the former than in the latter.

But animals require protection not only from cold and storms, but from heat and flies, and indeed from anything that would cause worry and annoyance. Protection from heat in many climates is far more important than protection from cold. Protection from heat means the furnishing of shade either indoors or out. Ventilation is also necessary with indoor protection. Removing the fleece from sheep on the approach of warm weather is one of the most important means of protecting them. Such protection may call for shearing twice a year, at least with some breeds. Darkening the sheds in which the animals are kept is the surest means of protecting them from flies that has yet been discovered. But it is scarcely practicable when animals are kept in large numbers. The various chemical preparations heretofore used as remedies for flies, protect only for a short time. The frequency with which they have to be renewed makes them expensive. Some preparation that would be at once cheap and effective, that would not need to be renewed frequently, and that would not injure the animals on which it is applied, would be an inestimable boon to stockmen.

While protection from undue cold and from storms is very necessary, it is at least problematical if live stock do not suffer more in the aggregate from heat and also from flies than from cold and storms. Shelter and protection can only be said to be adequate when the animals are protected from causes which worry and annoy, or produce any form of discomfort. When protection secures this end in the simplest and least expensive manner and with the greatest saving of labor to the attendants, it is then also likely to be economical. But when it promotes discomfort, as, for instance, when it produces undue heat along with a faulty ventilation, shelter certainly becomes excessive and may result in greater harm than good.

The Influence of Exercise.—Under domestication, the degree of exercise given to animals has been so modified as to effect great improvement. Excessive exercise wastes the energies of the system to no good purpose, as, for instance, when animals have to search unduly for food in sparse pastures. Exercise may be said to be excessive when it is more than is necessary for the maintenance of sufficient stamina. It has already been shown that sufficient stamina does not necessarily involve the idea of a maximum of stamina in the absolute sense of the term, but rather the idea of stamina enough to enable animals from generation to generation to give a maximum of production. On the other hand, insufficient exercise weakens the constitution and impairs the breeding powers. Immense injury has been brought to domestic animals of the more highly improved types by unduly reducing the amount of exercise. That degree of exercise which will be enough will vary with the object for which animals are kept. Under domestication improvement in performance has usually been attained by materially reducing the amount of the exercise unless when the improvement sought has been in the direction of food and labor. The bearing of this question on the adaptation of breeds to pastures is very direct. The small breeds are less labored in their movements than those that are large, hence, the wisdom of choosing breeds relatively smaller in proportion as the pastures on which they are to graze are more sparse. The proper amount of exercise will vary with such conditions as the class of the stock, the use for which it is kept, size, age, sex and present condition.

Horses and especially brood mares require more exercise than other classes of domestic animals, since action is more in consonance with the requirements of their being. Even enforced exercise moderate in character may be advantageous in the cases of heavy draft mares that are pregnant. Animals used for labor require more exercise than animals kept for other uses. Breeding animals certainly require more exercise than those that are being fattened. Small animals exercise more than those that are large. Young animals need more than those that are mature. In young animals exercise is necessary to develop properly the various functions of the being, and to keep them healthy and in due equilibrium. Exercise is on the whole probably more needful for females than for males, because of the influence that such exercise has upon the development of the fœtus. But owing to the more restricted conditions under which males are sometimes kept, especially stock bulls, enforced exercise with them may sometimes be advantageous.

When animals are being fattened some exercise is necessary to strengthen the appetite and thus promote the consumption of food. The frequency with which animals must be exercised depends upon conditions. Usually breeding animals should be allowed to take voluntary exercise every day when the weather is suitable. It is not so necessary for animals that are being fattened. But when these even can be allowed to take some exercise daily, under favorable conditions, they are probably all the better for it. Large liberty to exercise indoors and out is indispensable to the well being of breeding sheep, and cows and brood sows should have the chance to take exercise outdoors every fair day.

The Influence of Habit.—The habit of the system of animals under domestication has been so modified as to effect great improvement in certain directions. Habit is simply, in a sense, another name for repetition, continued long enough to secure uniformity of action, or uniformity in results in one direction. Thus it would be correct to say that the uniformity in transmission shown by animals long bred pure is simply a result of habit repeated sufficiently often to secure action in one direction. And this will apply to those repetitions in transmission which relate to form as well as to function. And as with those habits which are the outcome of intelligence in the human family, every repetition strengthens the tendency to further repetition in the same direction. Illustrations of such transmission may be found in the maintenance and increase of speed in the running horse, of milk production in the cow, various kinds of wool in the sheep and sagacity in the shepherd's dog.

Repetition in function aided by careful training and careful selection in breeding have made those horses what they are. The habit of giving milk in the cow for ten months in the year rather than for six months has been developed through the repetition which persistent milking necessitates. Succession in the production of wool of a certain kind through successive years, and it may be centuries, has fixed the habit of such wool production with much certainty. Sagacity in the shepherd's dog has been so fixed by the repetition in sagacious acts, that it has become, as it were, an essential part of the being of the dog. And thus it is with all the acts which constitute habit, as shown in Chapter VI. when treating of acquired characters. The increased strength of habit has thus been secured through the increased exercise given to the organs concerned aided by selection. All such advances have been more or less gradual, since time is necessary to develop habit in any one direction. By thus gradually intensifying the action of habit, as it were, through selection, further improvement is secured.

The Influence of Selection.—Selection has been materially aided in intensifying the various modifications of the system secured through the other influences that have been named. The only law of selection among animals in a state of nature is the law of strength, hence, with them change and material variation are impossible under normal conditions. They are not in any sense subjected to artificial conditions. But when man steps in he not only seizes accidental variations which are likely to prove helpful with a view to perpetuate them, but he labors to produce variations that will be a distinct gain. The only decided variations produced by nature are accidental, and as has been shown (see p. 43), nature cannot perpetuate these. By improving artificial conditions, man can secure variation which he may use still further in effecting improvement. Thus the field which opens to him for improvement has no limit. At least it has in itself no limit. The only limitations which hedge it in are the limitations of human capability. Through judicious selection in mating he secures a uniformity and excellence which would be impossible even though all the other conditions essential to improvement were utilized to the utmost in the absence of selection.

Thus it is that the proper selection of the animals for breeding and the judicious mating of the same assume a significance in its bearing upon live stock production that cannot be overestimated. But, when it is impossible to improve the food conditions and also those which relate to shelter, as where the animals have to forage for their own living through all the year on lands that cannot be cultivated, the benefits from selection will be much more restricted. Such is open range country where cattle rove in bands so large that sufficient protection cannot be provided for them in the conditions under which they are kept.

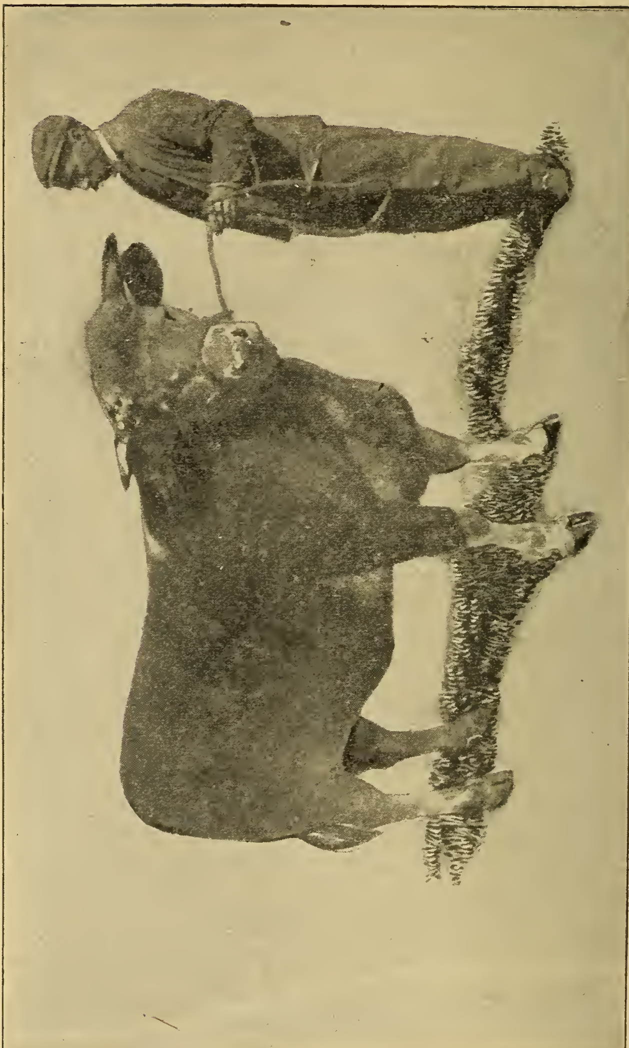

FIG. 7. HEREFORD GRADE HOLSTEIN STEER "TEDDY ROOSEVELT." WEIGHT AT 18 MONTHS, 1350 POUNDS.
(Illustrating early maturity.)
The property of the Minnesota Experiment Station.

CHAPTER XXI.

EARLY MATURITY.

Until recent years early maturity was not given that close attention which its importance demands. During the more recent of the decades it has made greater advances than in all time previously. The two influences that have contributed to this end more than any other are, first, the fat stock shows in the United States and Great Britain, chiefly the former, and second, the market demand for carcasses quickly grown but not overgrown. This demand is, of course, the outcome of modification in the taste of the consumers.

Early Maturity Defined.—Maturity means that period in the life of an animal when it may be said to have attained complete development. Ordinarily it means complete physical development, but to this there are some exceptions, as when development in performance is included. A dairy cow, for instance, does not always reach the maximum of development in performance as soon as she reaches the maximum of physical development. Early maturity means the completion of development in form and function at a period earlier than is or has been usual in the average of the breed or class, and late maturity means just the opposite, that is to say, the completion of development in form and function at a period later than is usual in the average of the breed or class. In the use of both terms the contrast is frequently drawn between breeds as such. For instance it may be said that the Hereford breed matures earlier than the West Highland, but very commonly it is also drawn between individuals in a breed as compared with the average in the same.

Early Maturity in Dairy Stock.—Early maturity as commonly applied to dairy stock has reference rather to the free and abundant production of milk at an early period, than to the completion of growth, but strictly speaking it means the completion of development in form and function at an early period, or, at a period that is earlier than usual in the average of the breed or class. The period of growth in the dairy animal cannot be hastened as in the beef producer, since the rapid forcing of the physical powers is antagonistic to the highest development of the milk producing function. Milk production in the dairy animal begins at a period considerably earlier than completed physical development. Yet, notwithstanding, complete development in form takes place at an earlier period as already intimated than complete development in function. If dairy animals were to be forced for growth beyond a certain limit, and especially for growth accompanied by any considerable degree of fat production, a habit of the system would be begotten that would too much tend to the production of flesh, and when once produced, this tendency would remain with the animal. The free feeding of suitable food to young dairy animals tends to secure large growth rather than early maturity. It is evident therefore, first, that early maturity cannot be reached so early in milk producing as in flesh producing animals, and second, that it is less influenced by food than the production of meat.

Influences Which Produce Early Maturity.— The chief of the influences concerned in producing early maturity are three, viz.: 1, A careful selection of animals for breeding that have evidenced an aptitude for quick growth when young; 2, furnishing plentiful supplies of suitable food; and 3, breeding from animals at an early age.

Selection such as that just referred to has a very important bearing upon early maturity, especially when supported by liberal supplies of suitable food. In this way advance is continually made upon previous maturity, and when thus made it may similarly be retained. In time, it will become a habit of the system, so fixed, that the tendency is regularly transmitted. The difference in the tendency in individual animals to mature early is very marked, and should be carefully noted by the person seeking to hasten maturity in his flock or herd. Especially is this true when selecting breeding males.

Furnishing plentiful and suitable food supplies is one of the surest means of promoting early maturity. When food is thus supplied, a maximum of growth is secured from day to day and without any cessation in the same until maturity is reached. If the supply is insufficient, growth is proportionately retarded, and if made up at all, must be made up at a later period, that is by prolonging the period of growth. But, as has been shown (see p. 203), stagnation in development takes away the capacity for development, consequently, the size of the animal may be materially lessened when matured.

Breeding from animals at an early age will unquestionably hasten maturity, and because of this, it has been recommended as a means to this end. But if used at all for such an end it should be used with great caution. If animals are mated while far short of maturity, the tendency of such mating is to reduce size and to weaken stamina, as has already been shown (see p. 263), hence, any gain to maturity accruing from this source is of questionable ultimate advantage. But when breeding dairy heifers, it may be proper to do so while they are yet quite immature, that in them the tendency to milk-giving may be early developed. And when growing animals for meat, especially those that are being freely fed, if breeding were delayed until the animals were first matured they would probably breed less freely. When females produce young while quite immature the burden is put upon them of completing their own growth and of maintaining their young and this tends to lessen size. The better plan, therefore, is to avoid extremes when determining the age at which animals shall be bred.

Advance in Early Maturity.—Great improvement has been effected in recent years in the early maturing of meat producing animals. The average age at which they are now put upon the market has been shortened nearly, if not quite, one half. Less than half a century ago the favorite age for marketing cattle was from three to five years; now it is one and one half to two and one half years when the cattle are grown on arable farms. Wethers were formerly sold at two years and upwards; now they are sold at one year and under. Swine were marketed at eighteen months, now they are marketed at nine months and short of that age. It would not be quite correct to say that these respective classes of animals attain the average weights of those sold in former years, but it is correct to say, first, that they do attain far greater weights at similar ages, and second, that they may easily be made to attain these weights at the respective ages mentioned, to meet the favorite requirements of the market. That such shortening of the period required for maturing animals should materially enhance the profit to the grower will be shown below.

Laws Governing the Cost of Development.—Physical development in animals with reference to relative gain and the cost of producing it would seem to be governed by the following laws, viz.: 1. The nearer the birth period the more rapid the daily gains when the food is given in sufficient quantities, and as the birth period is receded from the relative daily gains continually decrease. 2. The nearer the birth period the less the amount of food required to produce a pound of increase in live weight, and as the birth period is receded from the food required to produce the same is increased. 3. A period is at length reached after which further gain ceases, notwithstanding that a large amount of food is required to maintain the processes of life.

These laws are so generally operative as to be fairly uniform and constant in their action. Take a calf for instance, of the pronounced beef type. Such a calf may easily be made to gain two pounds a day on an average the first year. The second year on food not more forced it will not gain much more than one and three quarters pounds per day and the third year not more than one and one quarter pounds per day. The difference will be even more than the figures given to represent the decreased relative gains as the birth period is receded from. But while there is usually decreased relative increase in weight with advance in the age, there is continual increase in the food consumption up to the period of maturity. This is owing probably to the greater activity of the organs concerned in digestion and food assimilation near the birth period, and to a continual decrease in the relative activity of the same with advancing age.

From what has been said the following deductions will be in order: 1, Animals increase in weight less rapidly as the birth period is receded from; 2, the relative cost of producing a pound of gain increases as the birth period is receded from; and 3, the cost of the food of maintenance will increase as the birth period is receded from. But the first and second of these deductions, though generally true, may require some modification. It has not yet been proved conclusively that young animals will make less gain per day every day as the birth period is receded from. Young pigs, for instance, would seem to be capable of making more gain per day some time after the weaning period than earlier. But suppose the maturing period were divided into three parts equal in duration, then the statement would seem to be invariably true, which claims that the relative gains would be considerably greater during the first period than the second and the second than the third.

Again, while the consumption of food increases as the birth period is receded from, it does not follow that the relative cost of food is always more, though it generally is. For instance, a calf may be fed for several months on new milk to force growth. Such a diet is so costly, that it would involve more outlay to make a pound of increase during the milk period than during a period equal in duration immediately following. If, however, the calf had been fed skim milk and adjuncts, then the reverse would probably be true. The greater relative cost of the food of maintenance with advancing age arises from the constantly decreasing activity of the digestive organs and of the secretions.

The further deduction is also generally true, viz., that the greater profits are secured from animals grown for meat when pushed on all the while through liberal feeding from birth until they reach the block. But exceptions may be found in locations where the animals are reared much on pastures, and where the pastures grow on low priced lands. To such animals food supplies in winter, not costly, and producing but little increase in weight for a time, may be followed by more profit ultimately than would accrue from more rapid gains during those wintry periods, but secured through feeding costly grain foods. Let it be observed that the exception applies rather to range and semi-range conditions than to the conditions of the arable farm.

Meat May be Marketed too Young.—Notwithstanding the general uniformity of the laws given above it may not be profitable to market animals while yet quite immature, as, in reckoning the cost of production, there must be taken into account: 1, the cost of the keep of the dam when pregnant and not producing any direct return; 2, the extra cost of maintenance during the period of development in the embryo; 3, a proportion of the cost of the keep of the sire; and 4, the hazard attendant upon breeding. Take for instance two sows in the one case, and one in the other. Suppose the sows rear sixteen pigs in the first instance and these are sold at the age of four months, and that in the second instance the sow rears eight pigs which are sold at eight months. It does not follow that because the sixteen pigs weigh more than the eight pigs, that the profit on these has been greater. The cost of the two sows during the period of gestation and subsequently would be greater than the cost of the one. In other words the cost of production increases with increase in the number of dams kept to produce a certain weight in meat in the progeny. This argument is less applicable to animals that are producers during much of the period of pregnancy, as for instance in the case of dairy cows. It is also true that a dam will require more food when pregnant than when not pregnant, that is to say, she will require additional what is necessary to develop the fœtus during all the period of its growth.

Thus, animals cost for maintenance and development before they are born, and this must not be lost sight of when estimating relative profits from the sale of animals at different stages of development. If, in order to multiply animals more rapidly than would be necessary if not marketed quite young, another male must be secured and maintained. This also would bear upon the question of profit. And there is also some hazard in breeding. The young of the dam may be injured prior to birth. The dam herself is more liable to take harm when pregnant. And relative hazard increases somewhat with the multiplication of animals on the farm. All these influences have a bearing on the cost of production. Each points to the conclusion that it would be easily possible to market animals quite too soon to produce the greatest profit.

Most Profitable Age for Marketing Meat.—The most profitable age at which to send meat making animals to the block will depend: 1, on the age most in favor with the dealer and consumer; 2, on the prices that can be obtained at certain seasons; 3, on the prices of food as compared with those of the finished product; and 4, on the cost of the animal at birth.

The public taste decides what the dealer must furnish. The dealer will only buy what the public taste decides that the dealer must furnish. The dealer will only buy what the public taste demands. The public taste therefore decides virtually at what age the grower shall market animals grown for meat. Higher prices will be paid per pound for animals which approximate a certain weight and age than for those older or younger. The grower therefore who is wise will study the taste of the consumer not only in regard to the character of the meat product which he puts upon the market, but also as to the age at which he shall market it, and that age at which the meat product will sell for the highest price after the animal has been at least reasonably well grown. As markets are, quickly grown cattle should sell at about the age of not more than thirty months to bring the greatest profit. Sheep should sell at not more than twelve months and swine at not more than eight or nine months. These statements relate to the conditions of the arable farm.

The price of meat varies more or less at different seasons of the year. On the approach of winter the market is usually glutted with nearly all kinds of meat and the price falls more or less. The aim should be, therefore, to market the animal when the market is not so glutted. And to be in a better position to do so, attention ought to be given prospectively to the regulation of the age before the dam is served, so that the progeny shall be ready for the market at that time which experience has shown to be the most profitable age of disposal. Usually the greatest profit is obtained when the animals are brought to a high degree of finish, but there are times, as when food is unduly dear, that more profit may be obtained from disposing of the animals before they are thus highly finished. At such times when feed is both scarce and dear, the highest profit may be made by selling directly from the autumn pastures, and doing so will of course have a bearing on the age at which to sell.

From the ages given above as those considered the most profitable for disposing of cattle, sheep and swine, respectively, it will be noticed that there is a relation between the cost of the animal at birth and the age of marketing. The more the animal has cost at the time of birth, as in the case of the calf, the later is the period for most profitably disposing of the same.

Maturity Affected by Various Conditions.—Under some conditions early maturity can only be measurably attained. For instance when flocks and herds gather their food wholly from the pastures on ranches and ranges, which it is not easily possible to improve, only a certain standard of maturity will be reached. The measure of that standard will be the character of the pastures in relation, first, to their abundance, second, to their nutrition, and third, to their accessibility during all seasons of the year. The climate, more especially the winter climate, will also exert an influence under those conditions. Some influence may be exercised by man, first, in placing breeds upon the pastures which will best sustain them, and second, by regulating the closeness of the grazing of the same. Maturity may thus be advanced somewhat by placing small breeds on the pastures and not allowing them to be grazed too closely, but maturity quite early cannot thus be attained or maintained.

Advance in Maturity and Food Supplies.—When the tendency to an earlier maturity has been secured, it should be maintained by liberal food supplies, otherwise there will be serious disturbance of the system followed by ill doing. In such animals a habit of vigorously appropriating food has been begotten. If this habit of the system is not sustained by liberal supplies of food, the equilibrium of the system as a whole is thrown out of balance. Thus it is that pure bred animals of much merit usually fare much worse than common animals when subjected to hard fare in the hands of inexperienced stockmen who may have purchased them.

Early Maturity and the Constitution.—Early maturity may be made to affect the constitution adversely, owing: 1, to the undermining influence of breeding from immature animals, and 2, to the extremely artificial conditions which frequently attend such breeding. This has been already referred to, (see p. 256). An illustration of the weakening tendencies of breeding from animals quite immature is found in many herds of Poland China swine as now reared in the corn belt. To hasten maturity, animals are also kept under extremely artificial conditions, especially with reference to confinement, and they are fed foods unduly forcing. Such management will result in decreased vigor. Yet the fact should not be lost sight of, that early maturity may be attained in a marked degree without hazard to constitutional vigor.

Early Maturity and Size.—There appears to be some antagonism between early maturity and large size in breeds and in animals of the same breed. Observation shows that the smaller breeds mature more quickly than the larger. Southdown sheep mature more quickly than the Lincolns. Small Yorkshire swine mature more quickly than Yorkshires of the large types. This principle of development seems to pervade the animal kingdom. The rabbit for instance reaches full size in much less time than the mastiff, and likewise the horse matures much more quickly than the elephant. It has also been noticed that individuals within a breed or type that are small in size, fine in limb and neat in form, mature more quickly than those that are of large size and more rangy in form. It follows, therefore, that where the attempt is made to shorten the period of maturity in animals it will not be possible to so reduce the same that the period for full development in a large breed will be no longer than the same in a small breed of the same species, the conditions being the same.

Early Maturity and Longevity.—Early maturity is also in some respects antagonistic to longevity. The relation between the duration of life and the rapidity with which maturity is reached seems to be close and intimate. This relation pervades all life, vegetable as well as animal. Since domestic animals except horses and mules are usually slaughtered, it is almost impossible to state what would be the average duration of life with each class, but it will be approximately correct to say, that the domestic sheep which matures in from two to three years, would die of old age in from eight to twelve years, and that cattle which mature fully in from four to six years would die of old age in from sixteen to twenty-four years. Small song birds live only a few years. Some eagles it is thought live for more than a century.

The quick growing cottonwood tree in many localities does not usually survive fifty years. The slow growing yew tree will in some situations live for more than a thousand years. No sooner is the maximum of development reached than decline at once sets in, hence the conclusion would seem to be legitimate, that the life period will be shortened in proportion to the degree to which early maturity is hastened, although in the meantime it would be scarcely possible to furnish facts that would transform what is simply a seemingly correct conclusion into an actual demonstration.

The practical bearing of this question upon the development of animals from which years of service are expected in the line of performance is by no means unimportant. It would mean that rushing the horse on to maturity would tend to shorten the entire period during which he could labor; and likewise rushing the dairy cow to maturity would tend to shorten the period of her ability to milk profitably. It would therefore seem to be easily possible to hasten maturity in horses and dairy cows overmuch.

Hindrances to Early Maturity.—Hindrances to early maturity may arise: 1, from insufficient food supplies; 2, from excessive feeding; and 3, from stagnation of growth arising from any cause whatever. That maturity will be delayed by insufficient food supplies is so self evident that it does not require demonstration, but that excessive feeding may delay maturity may not be so clear at first thought. It does so by overtaxing the digestive powers. Such overtaxing is accompanied by loss of appetite and consequently insufficient food consumption. The remedy is comparative rest for the digestive organs for a time, which means delay in development while such rest continues. It may also mean lessened capacity for quick development subsequently, as the digestive powers may be more or less permanently weakened. But digestive and assimilative capacity may likewise be weakened from insufficient food supplies though otherwise suitable, hence stagnation in growth is also followed by diminished capacity for growth (see p. 203), and this in turn means deferred maturity.

Economic Value of Early Maturity.—The value of early maturity in meat producing animals viewed from the standpoint of economy cannot be well overestimated, as it effects a saving: 1, in the food of maintenance; 2, in the food of production, and 3, in the labor of attendance.

The saving in the food of maintenance is of course effected by shortening the period of growth. The extent of the saving is proportionate to the period during which maturity has been hastened. If, for instance, one animal is matured in thirty months, and another in thirty-six months, a saving has been effected in the food of maintenance for six months. And the fact should not be lost sight of that the cost of the food of maintenance increases with the advancing age (see p. 257).

The saving in the food of production is effected by the increase in digestive and assimilative capacity in the early maturing animal. Without effective digestive power it cannot be a quick maturing animal. Effective food assimilation means economy in the utilization of food. Economy in the labor of attendance will be at least measurably proportionate to the extent to which maturity is hastened. It is not absolutely thus proportioned since the quick maturing of animals may call for more attentive care than would otherwise be necessary.

CHAPTER XXII.

PEDIGREE.

Pedigrees of domestic animals may be kept by individuals for their own guidance in breeding, but usually they are kept by associations formed to protect the interests of individual breeds. It will never be known, probably, when the keeping of pedigrees first began. That the Arabs kept records of the breeding of their horses many centuries ago is a well established fact. If all the facts were known, however, it would pretty certainly be found, that individual records were kept of the pedigrees of horses long before the modern era. The fact remains, nevertheless, that the era of keeping public records of the pedigrees of domestic animals is essentially modern. The first herdbook published was that which recorded English Shorthorn cattle, the first volume of which appeared in 1822. At the present time public records are kept of every pure breed of horses, cattle, sheep and swine now found in the United States and Great Britain, and those public records now extend to various other classes of domestic animals, as dogs and goats.

The Term Pedigree Defined.—Pedigree is a record of the ancestry of an animal for a longer or a shorter period. It is said to be complete when it traces back on the side of both sire and dam to the foundation animals first admitted into the herdbook. The idea originated doubtless in the desire to trace descent to noted performers, hence, the prevailing opinion underlying it is the fundamental law of breeding that like produces like, and hence also the popular view, that it is in itself a guaranty of superiority. A pedigree therefore usually enhances the commercial value of an animal, and in proportion as it contains noted performers in the ancestry and especially in the near ancestry. That it should do so is perfectly legitimate, since it costs more to produce pedigreed animals than those not so pedigreed. The added cost will usually be proportionate to the high performance in the ancestry. The public therefore should not expect to purchase good pedigreed animals at meat values. On the other hand it is easily possible to pay too high a price for pedigree. That pedigree is in itself a guaranty of superiority is not always true, though generally true, since it is possible to breed animals with so little judgment for generations, that pedigree may prove a bane because of the harm that may result from it.

Objects Sought in Keeping Pedigrees.—Prominent among the objects sought in keeping pedigrees are: 1, in all instances to enable the breeder to trace lineage; 2, in some instances to enable him to trace performance in the ancestry; and 3, in nearly all instances to furnish him with a guaranty of purity of breeding.

The extent to which pedigree enables the breeder to trace lineage will depend upon the length of the pedigree. In some of the pedigrees of Shorthorn cattle, lineage may be traced for more than twenty generations. The limit of such tracing is usually the period when records of the breed began to be compiled. Lineage, therefore, at the present time, cannot usually be traced beyond one hundred years, but the duration of the period during which it can be traced in the future will increase continually with the lapse of years. The question, therefore, as to how far back it is important that lineage may be traced will soon be one of much significance, for the labor of such tracing becomes increasingly cumbersome as the pedigree grows longer. But more will be said upon this point below. Let it be observed, that it is only in some instances that pedigree enables the individual to trace performance in the ancestry.

It is only pedigrees of a certain character that give the pedigree of performance, as is shown further on. When such performance is not given in the pedigree, it can only be gleaned from historic records, usually more or less fragmentary when these may have been kept, or from traditional sources. In all instances pedigree would furnish the breeder with an absolute guaranty of purity of breeding, were it not for the fact that designing men may forward pedigrees for record that are either not genuine or authentic. How this may be done is shown below. There are good reasons for believing, however, that such deception is seldom practiced.

Terms Used to Indicate Lineage.—The more common of the terms used to indicate lineage are: thoroughbred, pure-bred, cross-bred, grade, and scrub or native. Thoroughbred in the strictest sense denotes the English race horse. That was the primary use of the term and it is so applied yet, but it is also now frequently used to denote any class of horses, cattle, sheep or swine that are purely bred. The term pure-bred is frequently used as synonymous with full blood, and thoroughbred, as the latter is now understood. It indicates animals of a well defined breed without admixture of other blood. So frequently is the term pure-bred applied to animals without admixture of alien blood, that they are seldom referred to by the use of the other terms mentioned, except in the instance of the running horse. The term cross-bred in the primary sense, denotes the progeny of two distinct breeds bred together, but it has also a more extended use as shown in Chapter XXV.

A grade is the produce of a cross between a pure bred and an animal of mixed breeding. But this term also is of wider application as shown in Chapter XXVI. A scrub or native denotes the produce of animals of mixed blood, bred in an aimless way, and without individual excellence. There is usually at least a shade of derision associated with the use of the term scrub, because of the inferior individuality of the animals to which it is applied.

Pedigree and Purity of Blood.—Pedigree does not necessarily bring along with it purity of blood, nor is it in itself any guaranty of individual excellence. Grade animals may also have pedigrees. Such pedigrees in practice are seldom kept, since the animals are not usually considered sufficiently valuable to justify the labor of keeping them. Nevertheless, where grades are of high excellence, and more especially where they are kept for milk-giving, and when records are kept of the milk production, it may also be advantageous to keep private records of the breeding. Individually, pure bred animals are frequently inferior to grades. This does not arise from any law necessarily leading to such a result, but rather from improper breeding.

The Pedigree of Lineage.—The pedigree of lineage more commonly gives only the names of the female ancestry and the sire of each female for a number of generations, although in some instances it furnishes a record of both the sires and the dams. When the names of the female ancestry only are given, with the sire of each, the herdbook number of each sire is also given, which makes it possible to trace the lineage of each sire as well. When the names of both sires and dams are given, the record of lineage is, of course, more complete than in the former instance. Examples of both forms of pedigree are given in Appendix A. It will be observed that neither of these forms of pedigree necessarily give any facts regarding the history of the animal, aside from lineage, other than those which relate to ownership and the date of birth.

The Pedigree of Performance.—The pedigree of performance more commonly applies to speed in horses and to milk production in cows. It also includes the pedigree of lineage. In fact, it is simply the pedigree of lineage with certain facts added thereto relating to performance. These may relate to one, or to several of the animals named in the pedigree of lineage, and in the second form of pedigree above referred to, they are stated immediately in connection with the name of the animal (see p. 276). In the form of pedigree first given, it would not be possible to give such information otherwise than by appending it in the form of foot notes under the pedigree of lineage. See also what has been said in Chapter II. under the division relating to advanced registry (p. 20).

Pedigree Not a History of the Ancestry.—Pedigree is not necessarily a history of the ancestry of the animal, only in so far as it relates to lineage or to lineage and performance taken together. Other facts relating to the history of the individual animal must be obtained from other sources. These are such as relate to size, weight, breeding qualities, prize winnings and disposal. The chief of the sources of such information are, the private records of the breeder, the prize lists as published by the agricultural press and in some instances herd records. The histories of the various breeds also give more or less of such information. In private catalogues of studs and herds issued from time to time, it is customary to give such details in foot notes immediately below the pedigree.

Measure of Value in Pedigrees.—The value of a pedigree depends largely: 1, On its authenticity; 2, on its genuineness; and 3, on the excellence of the individuals in the ancestry, more especially in those that are near rather than remote. If a pedigree is not authentic, its value is lessened in proportion as its authenticity is wanting, as is shown below. If not genuine, it is valueless. The common measure of pedigree in the popular mind is, in many instances, its length, and the noteworthiness of the ancestry in or near the foundation crosses. That this view is not correct is shown below (see p. 275).

Authenticity in Pedigree.—The authenticity of a pedigree has reference to the truthfulness of the statements of fact regarding it. If facts such as relate to the date of birth, to the breeder, to the circumstance of importation, or in the case of more than one at a birth, to relationship, are incorrectly stated, the authenticity of the pedigree is so far impaired and along with it the value of the pedigree. Nor can it be authentic unless consistent with itself and the known facts regarding the history of the breed. For instance, suppose the date of birth assigned to the animal was prior to the age at which it would be possible for the dam to produce, or the sire to beget, it would not be consistent with itself. If any transposition was made in the proper order in which the dams or sires should come, the same would also be true. If, moreover, a Shorthorn sire of ancestry somewhat remote, were given an American herdbook number, and yet it was certainly known that the said sire was never imported into America, this fact would at least presumably be contrary to the known history of the breed. The same would be true of an American born Shorthorn with an English record number, unless within the more recent of the decades, since the current of Shorthorn exportation has been from England to the United States rather than the opposite.

The only protection from such misstatements of fact is, 1, the integrity of the breeders, and 2, the vigilance of the party or parties who pass on the completed pedigrees forwarded for registration. But the said persons can only certainly detect inconsistences of statement. Frequently, it may be impossible for them to detect incorrectness of statement, as, for instance, misrepresentation regarding the sire used.

Genuineness in Pedigrees.—The genuineness of a pedigree has reference to correctness of personation. This means that one animal shall not be substituted for another in applications for registration. This species of fraud is happily not frequent, but there are good reasons for believing that in some instances it has been practiced. The temptation to misrepresent thus, comes only with the breeding of animals of much value. A pure bred cow, for instance, of a noted family loses a calf. Another cow of a much less noted family produces a calf about the same time. If the breeder is dishonest enough to forward for registration an entry form filled out which represents the calf as the progeny of the cow first referred to, by so doing he may add much to the selling price of the calf. The editor of the herdbook may have no good grounds for suspecting fraud, and though he had, it may be quite impossible for him to get the true facts. The only real protection, therefore, against such misrepresentation is the integrity of the breeder.

Excellence in the Ancestry.—Excellence in the ancestry is much more important in the near than in the remote parentage, since the preponderance in the blood elements of the latter greatly exceeds that of the former. Suppose that in one instance a Shorthorn traces to the famous bull Hubback (319) and that more than twenty generations of Shorthorn blood intervene. It is very evident that the inheritance of blood elements from Hubback is so infinitesimal that it is scarcely worthy of being taken into account at all. Suppose that in another instance a Shorthorn has been sired by some famous stock and show bull. The said Shorthorn has at least 50 per cent of the blood elements represented in that sire. The influence therefore exercised by the sire in the second instance will be beyond all comparison greater than that exercised by the remote ancestor, Hubback, in the first instance.

It is manifest, therefore: 1, that the value of a pedigree depends more upon the excellence of the individuals in the near ancestry than in that remote; 2, that such value is enhanced by each instance of individual excellence in the near ancestry on the side of sire or dam; and 3, that general excellence in the near ancestors in a pedigree is of far more consequence than length of pedigree in the absence of such excellence.

Leading Methods of Writing Pedigrees.—Two leading methods of writing pedigrees have been adopted. The first of these gives: 1, the name of the animal, its sex, color, and date of birth; 2, the name, post office address, and state, province or country of the breeder, and also similar particulars relating to the owner or successive owners, if the animal has changed hands once or oftener; 3, the name of the sire and his record number; and 4, the name of the dam and her sire and of all the dams in the ancestry with the sire of each and the record numbers of all the respective sires. The record numbers of the dams are also given when numbers have been assigned to these. But in the case of several breeds, especially those for which records were earliest begun, unfortunately no numbers have been assigned to the dams.

The second method of recording pedigrees gives: 1. The name of the animal to be recorded, and also the date of its birth. 2. The name of the sire and dam connected by a bracket and the record number of each. 3. The name likewise of each successive sire and dam in the ancestry with the record number of each and similarly linked. And 4, In some instances particulars are added with reference to some of the more noted of the ancestry. These particulars may relate to any fact which is considered greatly important with reference to the animal, but usually they are restricted to facts which relate to some kind of performance in the individual. The pedigree to be recorded is made out by the owner of the animal and usually on a blank form furnished on application, by the secretary of the association. For the illustration of these two methods of writing pedigrees and also of the way to read them see Appendix A.

Designation of Herd Records.—Pedigrees are now generally recorded in some public record, more commonly known as a herdbook, but other designations are used, some of which have reference to the class or species to which the animals belong whose pedigrees are recorded. Thus, the public records of horses are usually called "stud books," of cattle "herd-books," of sheep "flock-books," and of swine simply "records." But the last mentioned are usually preceded by the name of the breed. For instance, the records for Poland Chinas have such designations as the "Standard Poland China Record" and the "Ohio Poland China Record." But the designations given above do not apply in all cases. For instance, the book which records Cotswold sheep in the United States is designated the "American Cotswold Record," and that which records Devon cattle as the "American Devon Record."

Objects in Keeping Public Records.—The objects sought in keeping public records include the following: 1, To preserve the purity of the breed with a view to the advancement of its interests. It has already been shown that one idea underlying pedigree is to furnish the breeder with a guaranty of purity of breeding (see p. 269). But in the absence of public records, such a guaranty would only be of value to a very limited number of persons. This is true of all records privately kept. But when pedigrees are recorded in public records the guaranty becomes public property, since public records are open to the world.

2. To guard the integrity of pedigrees as far as may be practicable. It has been shown above that even with the safeguards of public registration it may not be possible in some instances to prevent designing breeders from forwarding pedigrees for entry of their own manufacture (see p. 273). Public records, however, greatly limit the area within which such crooked work may be carried on, since no fact can be stated in a manufactured pedigree that is inconsistent with what has already been put on public record.

3. To furnish a ready means of tracing pedigrees. If only private records existed, it would be absolutely impracticable to trace pedigrees when the numbers of the breed had multiplied and become distributed to any considerable extent, since the labor and cost of such tracing would be great. How pedigrees are traced is explained in Appendix A. It may also be stated that the information commonly given in the records will in itself furnish to the reader the key that will enable him to trace pedigrees. Such tracing is seldom so involved as to make it greatly difficult.

The associations which issue public records are usually controlled by breeders who are members of the same. When the recording of pedigrees first began, the issuing of the records which contain them was done of necessity by private enterprise, as associations had not then been formed in the interests of the breed. When these associations were formed, sooner or later they secured the rights to such records by purchase, hence, now, in scarcely a single instance are proprietary rights held by any party or parties other than the associations formed to promote the interests of the respective breeds. Although such records are open to anyone who pays the recording fee, in the price charged there is usually discrimination, and very properly so, in favor of those who are members of the association.

Mode of Recording Pedigrees Not Uniform.—The mode of recording pedigrees in the various public records is by no means uniform. In the past they have more commonly been recorded as written in the first method given (see p. 276), but the tendency now is more and more to record them by the second method given (see p. 276), because of its greater completeness. In some records, however, the former method is followed to secure greater brevity in recording. The pedigree in these records is not followed further than the names and respective numbers of the sire and dam. If the breeder wishes to know further particulars about the lineage, he must trace the ancestry from the key or starting point thus given. It is probable that as pedigrees multiply some such method will have to be adopted in all records. Some records have certain features which throw added light on the ancestry or the history of the breed.

The following are samples of the same: In the Red Polled herdbook the tribal ancestry are given in abbreviated form, and a reference to the same is prefixed to the pedigree by the use of a letter known as the tribal letter. When this letter is seen the tribe or family to which the animal belongs is thus at once communicated to the individual who knows its significance. In other records as, for instance, the Ohio Poland China, a sketch is given in condensed form of the work of certain of the breeders. The wisdom of inserting such sketches is at least open to question, since the way is thus opened as to discrimination in admitting the sketches thus given. The more fitting place for these would seem to be in some distinctive history of the breed. In the advanced registry of Holstein Friesian cattle in the United States, an accurate description of the animal admitted is required of the examiners. This description relates not only to color but also to form and measurements of the same. A properly attested record of performance is also required.

Distinguishing Marks in Records.—In some records certain marks precede and follow the record numbers. The chief object in using them is to furnish a ready means of distinguishing between the records, more especially when more than one record has been established for the same breed. For example, suppose the number 25 has been assigned to an animal in the English, the Canadian and the American Shorthorn herdbooks respectively, in the first it will be written thus, (25), in the second thus, =25=, and in the third simply 25. But this explanation does not account for the use of all such marks, as the numbers used in the English Shorthorn herdbooks were inclosed in round brackets from the first, and at a time when no other records of the breed were being kept.

In Britain the tendency is to use brackets, and in the United States not to use them. When more than one record exists of the breed and especially in the same country these marks are decidedly helpful as a ready means of distinguishing between records, but when only one record exists of a breed, the use of any form of distinguishing marks would seem to be quite unnecessary. Other marks than those given above are also used, as for instance, the sign — placed before and after the record number. In the Canadian Yorkshire record the number 25 assigned to an animal on record would read —25—.

Terms Referring to Parentage.—When speaking of the descent of the progeny from the female parent the term *out of* or *from* is more commonly used. For example, if reference were being made in herd-book language to the fact that Princess 2d was a daughter of Princess, it would more commonly be said that Princess 2d is out of the dam Princess. When speaking of descent from the male parent the term *got by* or *by* is used in the language of the herd-book. For example, if reference were being made to the fact that Scotsman 2d was a son of Scotsman, it would be said that Scotsman 2d was got by or by Scotsman.

Choosing Names for Animals.—Usage governing the choice of names varies in the different live stock associations. All are agreed that the frequent repetition of the same name is undesirable except when it denotes family descent as indicated by the number in the family affixed to it. Thus Duchess 27th at once conveys the idea that this female is of the Duchess family, and that preceding her were twenty-six females of that family whose pedigrees were recorded. When family names are affixed, or the name of the breeder's farm comes before or after the name given to the animal, information is thus conveyed in the first instance as to the family to which the animal belongs, and in the second, as to the farm where it was bred. The names Lord Macduff, Earl Macduff or Prince Macduff convey to the mind the idea of relationship to some previous noted ancestor named Macduff. And the names Mary of Kinnoul Park, Jennie or Lizzie of Kinnoul Park tell the reader at once that these animals were bred at the Kinnoul Park farm.

Where the ancestor in the first instance has been quite famous, and where the farm in the second instance has been noted for the production of stock of high excellence, such names are doubtless of some advantage to the breeder when viewed from a financial standpoint, but there is the objection that names are thus made cumbrously long. In yet other records the name of the animal is the proper name of the individual in conjunction with the ear tag number given by the association. Thus if Mr. Jackson were recording Shropshire sheep the records would run or may run, Jackson's 1, 2, and 3. This method is adopted by the American Shropshire Association in recording Shropshire sheep, and also by some other associations. The plan is most commendable. It gives registration that is brief and simple. In the very name of the animal it gives information as to the breeder, and in the number of the same as to the extent of his previous breeding.

CHAPTER XXIII.

ANIMAL FORM AS AN INDEX TO QUALITIES.

That animal form is an index of qualities cannot any longer be questioned. It is at least a general index of the same. But to say that it is an infallible index of the degree to which they possess qualities would scarcely be true. For instance, from the general form of a dairy cow it may be known with certainty that she is a large milk producer. But two dairy cows may be about equal in form, and yet one will produce more abundantly than the other, and the best of judges may not be able to say which will be the superior producer of the two. This may arise from the influence of some internal forces the exact strength of which can only be known accurately by the actual results. Yet the fact remains that the indications of external form, when correctly interpreted, are sufficient to furnish the breeder with a safe guide when making selections for breeding.

Interpreting Animal Form.—The channels through which such interpretation must come principally, if not indeed wholly, are the senses of sight and touch. The judgments formed through these respective mediums are based on what observation and experience have taught with reference to the relation between form and qualities. It follows, therefore, that the best interpreters of what is indicated by form will be the best judges of live stock. The qualities referred to are such as relate to capacity for speed, labor, meat making, milk secretion and wool production. These will be further considered and somewhat in detail.

Intimately concerned in the production of the aforementioned qualities are indications of breeding, strength of constitution or the opposite, the activity of the nutritive processes, nervous energy, present condition as to bodily vigor and age. These also will likewise be further considered. They differ somewhat in some instances in the different classes of live stock, though more generally they are the same. To illustrate: Roominess of barrel in all classes of females is associated with capacity for breeding, but the shape of the roomy barrel differs somewhat in these respective classes. In sheep the shape is cylindrical. In swine it is a deep parallelogram.

Indications of Speed and Labor.—The indications of speed and labor are such as relate chiefly to the horse, and they will be submitted only in a summary and general way. Chief among them are strong chest development, light relative development of the hind quarters, lightness of limb and quality of bone. Strong chest development indicates bodily vigor and endurance. In its absence the vital organs work more feebly, hence nerve power and staying power so essential to the maintenance of speed will not be sufficiently present. Development of the hind quarters beyond a certain degree would add unnecessary weight. A certain degree of length and lightness of limb is so necessary to speed that in its absence it would be vain to look for speed.

The character of the bone is indicated by its shape and cleanness and by the nature of the joints. Among the leading indications of capacity for labor

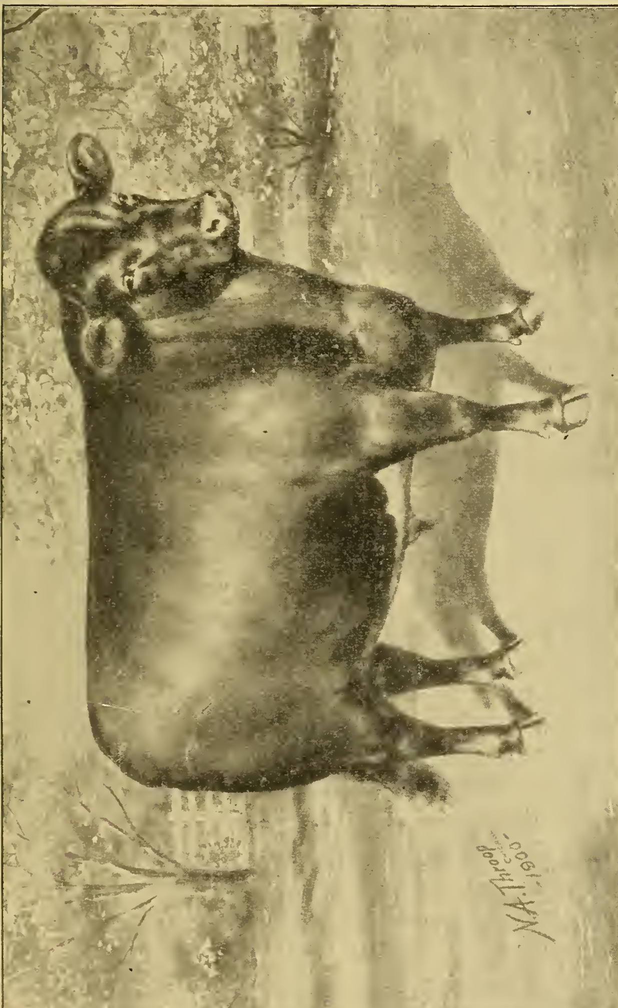

FIG. 8. ABERDEEN ANGUS STEER "ADVANCE," CHAMPION STEER AT THE INTERNATIONAL FAT STOCK SHOW, CHICAGO, DECEMBER, 1900.
(Illustrating typical beef form.)
Weight 1420 pounds. Sold at $1.50 per pound, live weight. The property of Stanley R. Pierce, Creston, Ill.

are good muscular development, generally strong relative development of the fore quarters and strength of limb. The general muscular development should relate to every part, but nowhere should it be more strikingly manifest than in the collar, shoulders, arms, back and thighs. Without sufficient strength of limb the latter must break down when subjected to a severe strain.

Indications of Meat Production.—The indications of capacity for meat production in the bodily form include all the essentials of bodily form which belong to the respective meat producing classes of live stock, as cattle, sheep and swine. To give them in detail would be to give in substance the standards of excellence for these respective breeds. This the author has done in the book "The Study of Breeds." If, however, the two most important indications of capacity for meat production were asked for, the answer would probably be correct that would say, first, a compact form, and second, good handling qualities. The first includes a good back and a good development of fore and hind quarters. It furnishes a framework which experience has taught is most easily covered with meat, see "Study of Breeds," p. 10. The second furnishes evidence of good digestive capacity (see Chapters XVIII. and XIX.).

Bodily Form in the Various Classes of Meat Producing Animals.—Although the essentials as to form in all meat producing animals are in many respects the same, they are not so in all. In the various breeds of beef cattle, sheep and swine, the following essentials are possessed in common, viz.: a certain lightness and cleanness of head and some degree of lightness and shortness of limb, a fair length of body of good depth and width, and the parallelogrammic shape. In sheep the parallelogrammic shape merges more into the cylindrical, and in swine the parallelogram is relatively deeper and narrower, the neck is relatively thicker and the body is relatively longer. Of course, from the very nature of things, notwithstanding the resemblance in these essentials, they will all differ somewhat. Yet, it will be found that in the features of outline noted, there will be, what may be termed, general resemblance in a certain direction. Thus, although the heads of swine and cattle differ materially in shape, and the legs differ in relative length, coarseness of head and limb are equally condemned in both. The three classes should also be covered with a coat indicative of proper digestive capacity. This coat in each should be long and plentiful for the breed, attractive to the eye and soft to the touch, since all these evidences bear testimony to activity in the assimilating processes.

Indications of Milk Production.—The indications of capacity for milk production in the bodily form of dairy cattle have been given by the author in detail in Lecture No. 5 in the book "The Study of Breeds," and also of the dual-purpose form, that is, the meat and milk form combined, in Lecture No. 6 of the same. The most prominent of these indications are barrel capacity and refinement of form. The first means a long and capacious barrel for the reception of much food. The second means a head, neck and limbs inclining to long and fine and what may be termed spareness of form, that is an absence of all tendency to an overmuch covering of flesh. The indications of good milk production in other animals will be present or absent in proportion as they in a general way resemble or are unlike the typical dairy form in the cow.

But in meat making animals, the principal object for which they are kept is of course to produce meat. In order, however, to secure vigorous growth in the progeny, the dams should give milk enough to promote excellent growth in the young during the nursing period. This they will not do if of the extremest beef form. On the other hand they will not produce meat enough nor of sufficiently high quality if they lean too much toward the dairy form. Some leaning toward the dual-purpose form therefore is desirable in such females, that is to say, they should first be capacious in the barrel, and inclining to fine in the head, neck and limbs. To guard against swinging too far in the direction of dairy form and to maintain constitution, the sires ought to be kept in near conformity to the high type of the beef form.

Indications of Wool Production.—The indications of capacity for wool production as to quantity are essentially the same as those which indicate capacity for good mutton production. Indications of the latter are given in Part II., Lecture No. 3 in "The Study of Breeds." The fact has been noticed that in the improvement of the mutton form in the breeds of sheep, there has also come a corresponding improvement in the growth of the wool as regards quantity, and in some respects as regards quality, as for instance, in increased strength of fiber. But it would be possible to push flesh production to the extreme of reacting against abundant wool production. This may arise from the strengthening by selection of that habit of the system fostered by abundant feeding which tends to produce meat rather than the covering for the same. The indications of capacity for improving the quality in wool would seem to belong to breed rather than to form. But form also would seem to be a factor in such improvement. The statement is certainly true that extreme fineness in the wool has never yet been associated with the highest type of development in the mutton form. It has been rather associated with that form which in a sense approximates to the dairy form in cattle. The less heat generated in such a form would seem to call for increasing density and fineness in the wool. But this great question cannot be further discussed here.

Indications of Breeding and of Breeding Capacity.—In the form can be traced evidences of the degree in which improved blood is present or absent and of the particular breed or breeds from which it has come. These indications are especially valuable in the selection of grades, since they furnish safe data for judgment based upon what is known of the economic value of such blood. To illustrate: When a grade steer has a compact form, a wide and level back, a white head bearing long, flat and spreading horns, and more or less white on the legs and underline, it is safe to conclude with reference to him that he is rich in Hereford blood. Likewise an approximate estimate of the blood of the grades of any breed may be approximated by the nearness or otherwise to which they approach any pure breed which they resemble in form and color.

The evidences of productive capacity in females is recognized in that form which has ample and symmetrical development accompanied by that tendency to refinement in the head, neck and limbs which belong to femininity of the most approved type, These indications are not easily described, but when once understood are readily recognized. The indications of the same in males include, evidences of masculinity, as strength in the head, chest, neck and limbs, but without grossness, and they also include that inherent activity of movement begotten of irrepressible vigor. These distinguishing evidences have in the judgment of the author been too much ignored by the average judge at public exhibitions.

Indications of Constitutional Vigor.—The leading indications of constitutional vigor are beautifully illustrated in Fig. 9, an exact representation of the Shropshire Ram Diamond Prince, Imp. (542), 144139, owned by Boynton & Welch, Dexter, Minn. They include the following:—

1. A broad, deep and compact form, with coupling or barrel medium or less, rather than long. In all classes of animals more vigor and strength may be looked for when this form is present, rather than that which is opposite in character. Obesity may, however, reduce both strength and vigor in such a form, and its powers of locomotion and action generally will probably be somewhat less than when these characteristics of form are really pronounced.

2. A head short rather than long and wide between the ears. This form of head through correlation has been found associated with a body, similar in kind, that is to say, a compact body. Much width between the ears is linked with large development of the spinal chord, which in turn is associated with nervous force.

3. A full, clear eye. This reflects a vigorous condition of health, which in turn is the outcome of constitution.

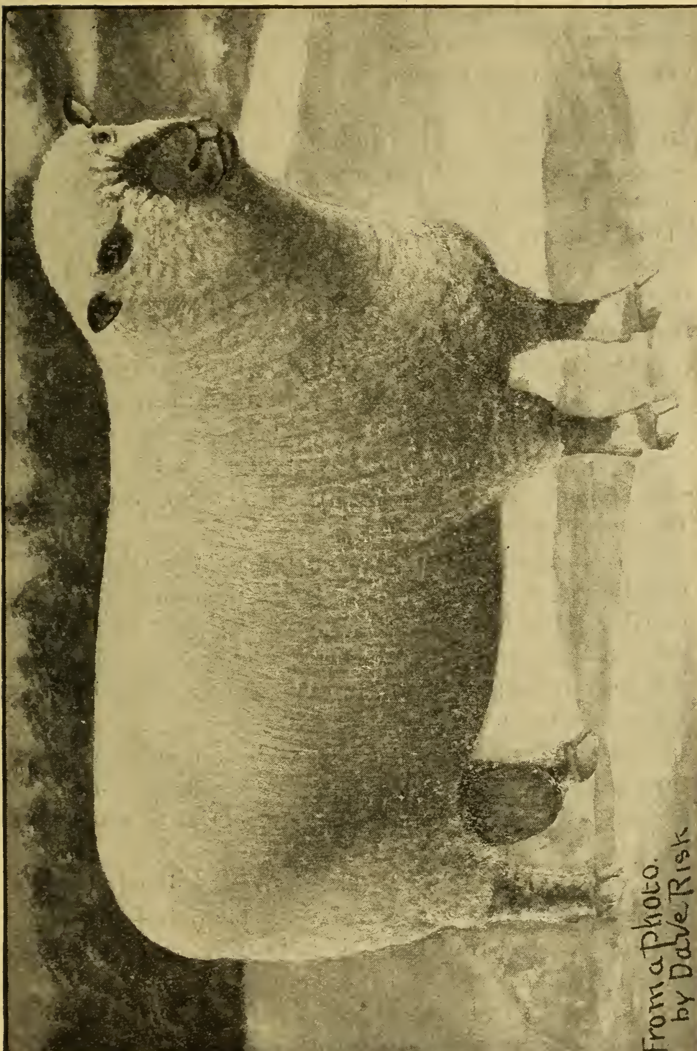

FIG. 9. SHROPSHIRE RAM, "DIAMOND PRINCE," IMPORTED (542) 14139.
(Illustrating constitutional vigor.)
The property of Boynton & Welch, Dexter, Minn., 1901.

4. A wide expansive nostril. This feature is associated with roomy air passages, and a strong and vigorous play of the lungs.

5. A short neck well rounded out and strong and full at the base. This indication like some of the others is an index of present strength, but by correlation it is also associated with a strong constitution. This feature, like some of the other indications of constitution, is more desirable in males, since in females some of these in highest development are not favorable to abundant milk-production.

6. A wide breast, broad brisket and capacious chest. These are associated with roominess within the chest cavity, hence, the vital forces within, as the heart and lungs, have abundant room for vigorous action. They also furnish that form which is the embodiment of strength.

7. A good round deep spring of the ribs and closely spaced. Through correlation the round spring of rib follows much width through the chest and the deep rib the deep frame. The close spacing of the ribs prevents undue length in the coupling which is so far associated with weakness. The round and deep spring of ribs insures the capacious barrel, and this in turn is associated with the large consumption of food and vigorous digestion which are essential to robustness as well as utility.

8. Deep full flanks. These are associated with sufficient heart and flank girth. The hind flank, especially, when thus filled, is indicative of an abundant nutrition.

9. Limbs inclining to short and well apart and possessed of smooth joints. Short limbs by correlation accompany the compact body. Width between them

accompanies width in the frame, and smooth joints indicate a correct nutrition.

10. A lively carriage. This is the outcome of much power in the vital forces, and of much activity in the digestive processes driven by these. It would not now be possible to place all the above in the exact order of relative importance, but the wide breast, broad brisket, capacious chest and good heart girth should unquestionably be given the first place. Nor is it to be understood that a really vigorous constitution cannot be obtained without all these indications being present in a marked degree, since in the running horse length of limb is wanted, and in the dairy cow a neck long and fine. The absence of that development in these that would link them with the highest vigor is atoned for by marked indications of vigor in other directions.

Indications of a Lack of Constitution.—These are of course the opposites of the indications given above. They have been discussed with some fullness in Chapter VII. But it will not be repeating to state that prominent among these are a dull eye, a long thin neck, a narrow chest and body, flat ribs, hollow flanks and long legs.

Indications of an Active Nutrition.—Prominent among these are good handling, and associated with them are indications of strength of constitution, a large mouth and much barrel capacity. Good handling has been discussed in Chapter XVIII. In applying this test present condition as to flesh should always be duly considered. In some instances nutrition naturally active has been perverted during the period of development. If perverted because of insufficient food supplies, the evidences of such perversion will remain more or less in an undue development of bone, large joints, a thick and unyielding skin, and want of symmetry in form. The earlier the period at which such perversion takes place, and the more prolonged it is, the more marked will be those instances. Nutrition is also perverted when it is too much drawn away from the purpose which it is most intended to serve, as when, for instance, the fleshing habit is too much encouraged in animals that are being grown for the dairy.

Indications of a Good Quality of Flesh.—The chief indications of a good quality of flesh include the following:—

1. Good general development of the meat-making form. This has already been discussed in the present chapter (see p. 286). Without such a form flesh will not be sufficiently present on the frame, including those parts where it is most valuable. It would be as reasonable to expect marked symmetry and adaptation in a building with an unsuitable framework, as to look for successful meat-production from a frame ill adapted to such production.

2. Marked development in those parts of the body where the meat is most valuable as the back, loin and hind quarter in cattle and sheep, and the side and ham in swine. The loin and sirloin furnish the highest priced cuts in the carcass of horned cattle, hence it is specially important that these shall possess large development.

3. Bone, moderate to fine, as evidenced in the head, horns, tail and limbs. With bone unduly coarse in these it will be so also through the entire framework, hence, the amount of the flesh will be lessened proportionately to the excess in the development of

bone, and such a framework is almost certain to carry flesh coarse in the grain.

4. The absence of coarseness of texture in horn and hoof. Such coarseness may be detected by examining the grain of the same and also in some degree by the tendency in these to scale off.

5. The absence of a thin, papery hide. Such a hide shows an insufficient nutrition and it covers flesh that is flabby and lacking in firmness.

6. The absence of protuberance at the buttocks. The flesh in these is coarse in fiber and dry, and when markedly pronounced they accompany sparse laying on of internal fat and scant distribution of the same throughout the system. They also include the absence of undue development in the parts less valuable, as the dewlap. But it would be easily possible to press this idea too far, since a wide and large brisket is absolutely essential to wide chest capacity so important in furnishing constitution, and yet the meat in the entire brisket is relatively quite low in price.

7. The absence of patchiness in the outer surfaces. Patchiness means development in which the flesh underneath the skin accumulates in puffs and rolls or ridges. These are most frequently seen at the rumps, ribs and shoulders. They are made up of soft oily fat and in addition to the low value of such flesh these patches indicate too much of a tendency to separate the fat and lean during the breeding period.

8. The absence of the indications of old age. These are given below. With advancing age, increasing toughness of fiber may be looked for. Other indications of quality in flesh are given with more or less of directness in Chapter XVIII.

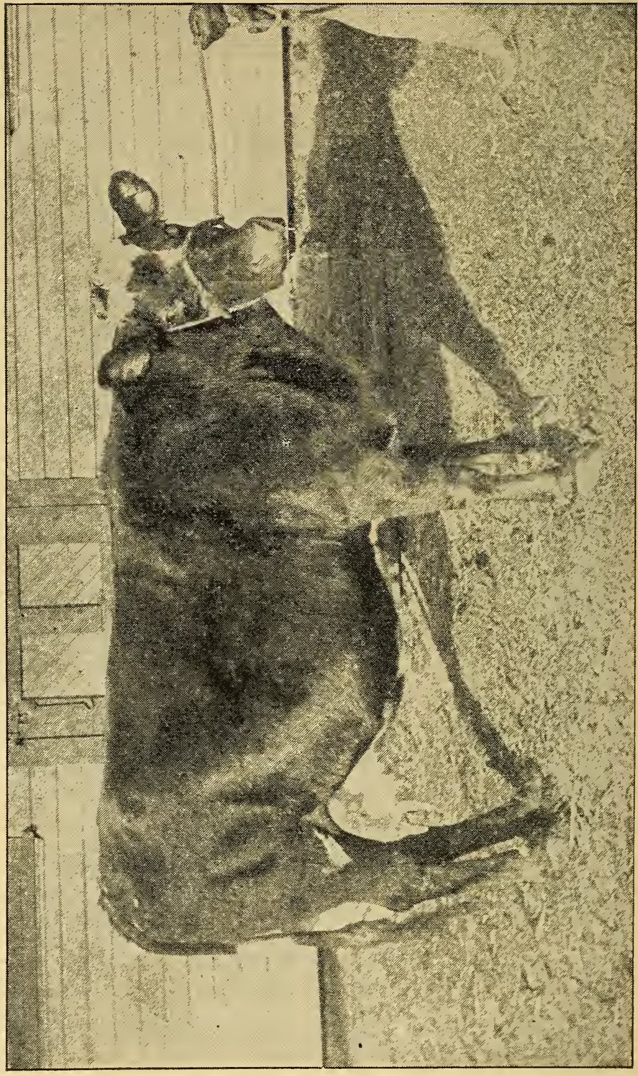

FIG. 10. DUAL PURPOSE COW, "CONTENTMENT."
(Illustrating quietness of disposition.)
The property of The Minnesota University Experiment Station, 1901.

Indications of a Quiet Disposition.—Among the indications of a quiet disposition are: 1, A calm expression of the eye; 2, An easy moderate play of the ears, which should also be of good size for the breed; and 3, The absence of tokens of timidity and unrest when approached. When the disposition is restless there is much movement of the ball of the eye, and a wariness that is not in keeping with the restfulness which is necessary to secure well-doing in domestic animals in a high degree. A quick play of the ears is also incompatible with the same. Quick movement of the ear and erection of the same in a considerable degree usually go together. But care should be taken to distinguish between the restful and the languid eye, and the sufficiently active and the drooping ear. Indications of timidity and unrest on being approached, as shown in more or less of restlessness of movement, are antagonistic to meat production in proportion as they are present. But here also due allowance must be made for the character of the previous surroundings. Animals handled but little when young will all show much timidity at first when approached, but even in these the same will be manifested in different degrees.

Indications of Nervous Force.—The indications of nervous force include: 1. An active eye and ear. There is a difference, however, between activity which is the outcome of strong vigor and abundant nerve power and activity which is the outcome of natural timidity and unrest. The first is always more or less present, and is not violent in its action. The second is the outcome of exciting causes which the animals always interpret, with or without reason, as danger signals. 2. A wide, expansive, and active nostril. The wide nostril favors free respiration, which in turn helps to strengthen all the vital powers. When thus strengthened, vigor is generated and likewise nerve power. 3. A broad forehead. This means a large brain and frequently not a little of will power, which in a certain sense is nerve power. They also include, 4. A prominent and open spine. The large spine means also a large spinal column, that is to say, a large distributer of nervous energy. 5. Activity of movement. Here again that natural activity of movement which is easy and spontaneous should be distinguished from fitful activity generated by disturbing causes. The first indicates the spontaneous action of strong and healthy nerves, the latter may indicate nerve power not under proper control.

Indications of Present Bodily Health.—Chief among the prominent indications of present bodily health are the following: 1. A full bright eye. The moment that the general health becomes impaired the eye begins to lose its brightness, and as disease progresses, it sinks and becomes languid, the immediate cause being lack of sustenance. 2. A moist, dewy muzzle. With derangement in the circulation and a rising temperature moistness in the muzzle, which is always abundant in a healthy animal, grows less, the immediate cause being inactivity in the excretory organs. 3. A fairly active play of the ears. Such action is the evidence of generated power seeking opportunity to expend itself. 5. A smooth, glossy coat. The same influences that produce elasticity in the hide produce glossiness in the coat. 6. An active carriage. An active carriage bears testimony to healthful action in all the organs of the system, and especially of those concerned in digestion. No sooner do these organs lose vigor than there is a corresponding loss of freeness of movement and activity in the carriage.

But natural disposition also affects action of the body in some degree. Nor is it possible to determine how much of an active carriage is to be attributed to natural organization or to good health. However, action the outcome of disposition will not long be maintained unless sustained by the support which comes from the healthy action of all the organs of the body.

Indications of Old Age.—The indications of old age include: 1. Many wrinkles on the horns. These are only general indications of age, since there is not absolute uniformity in the time at which the first wrinkle appears, and it is probably true that a period is also reached in old age when, if made at all, they will become less well pronounced. Each wrinkle is supposed to represent a year, after the first two or three years have passed. This indication is only to be understood as general, rather than specific.

2. Diminished prominence of the eye. The eye sinks in the orbit. It also gradually more and more loses the luster of youth.

3. Usually more or less depression at the chine and sagging of the paunch. The first arises from the decrease in strength in the spinal column, without any decrease in weight in the paunch. The latter gradually lowers with the weakening of the muscles that sustain it and repeated distensions of the stomach when packed with coarse food.

4. Bareness of the shoulder blades and loin when otherwise in fair flesh. These are among the most difficult parts to cover when the secretions are active,

and in consequence are among the first to suffer when the activity of the secretions begins to wane.

5. Prominence of the bones, as at the shoulder points, hooks and rumps. This prominence is caused by the shrinking of the flesh that surrounds and covers these points. But the fact must not be overlooked, that insufficient food in a young animal will also produce these results at least in some degree.

6. Harsh, dry handling of the hair. It handles thus because it is not well nourished, but such handling may also arise from other causes.

7. Lack of activity of movement. When an animal has a labored gait and indications of good health are present it may be safely charged up to old age.

CHAPTER XXIV.

SELECTION.

The importance of the ability to select animals with skill and judgment when breeding them cannot easily be overestimated. In the absence of such ability mistakes will be made all along the line of the breeder's work. He will not be able to make improvement save in a sort of accidental way, nor will he be able to maintain it if perchance he should be so fortunate as to make it. His work as a breeder can never rise above the level of mediocrity, howsoever much wisdom and care he may exercise in other respects in conducting his work.

What is Meant by Selection.—Selection in breeding means the ability so to choose animals for propagating their kind, that, with proper care, a high standard of excellence will be acquired and maintained. As implied in what has been said above, such ability is indispensable to the highest success in breeding. That it should be so is self evident, for it is only through the skillful mating of animals accompanied by judicious management in other respects that improvement can be made. If the improvement thus secured is made the basis of wise selection, it will result in still further improvement, but in the absence of such selection it is likely to sink again to former levels. And yet, this acquisition, notwithstanding its great importance, is possessed in a high degree by the few only, even among breeders of pure breds. It is an acquisition that money alone cannot purchase. It is in itself an intuitive gift, but is susceptible of cultivation in a high degree. The evidences of it are not found in show yard successes, unless the animals who are winners have been bred by the exhibitor. They are manifest in the uniformity shown in the average of the herd or flock, in the high average of the standard of uniformity, and in the number of outstanding animals produced, that is to say, of animals of high excellence.

The Necessity for Selection.—The necessity for selection is based on the tendencies to variation found in all animals. These tendencies have been referred to at length in Chapter IV. When they are downward as they frequently are, selection eliminates them. As is also shown in Chapter IV. the tendencies to variation that is downward manifest themselves more or less, howsoever skillfully the work of the breeder may be conducted. Such downward variations may be eliminated lest they should be reproduced in the progeny. When these variations are upward, selection utilizes them to secure still further improvement. The field that is thus opened up for improvement has no limitations other than those of the skill of the breeder and the inherent capacity of the animals which he breeds to be improved. It is reasonable therefore to expect that the greatest triumphs in breeding are yet to come.

Selection Covers the Whole Art of Breeding.—The art of breeding may in a sense be said to be epitomized in the one word selection, since it involves a consideration of every peculiarity of form and the application of every established principle of practice. While more attention must be given to those peculiarities of form that are important, no feature thereof can be overlooked. Even fancy points must not be lightly passed over as long as they are included in the standard of excellence, and in fact as long as they have any traditional significance such as may affect market values. It is pre-supposed that the principles of practice referred to are correct, since sometimes practices prevail widely that tend to lower the level of attainment in breeding. The practice of breeding from sires too immature, which is of this character, is all too prevalent at the present time.

Considerations Included in Selection.—Selection in breeding includes the following among other considerations: 1. The breed in its relation to adaptation. 2. The choice of animals with reference to a standard of excellence. 3. The consideration of pedigree. 4. Individual merit in the animal. 5. Special care in the choice of sires. 6. Allowing no animals to come within the flock or herd which are liable to transmit undesirable characters, however excellent in themselves. 7. The unsparing elimination of all undesirable animals. And 8, Judicious mating. These various features pertaining to selection will in turn be further considered.

Selection and Adaptation.—When determining which breed or class of animals may be advantageously introduced into any particular locality, the character of the surroundings and the natural capabilities of the country should be most carefully considered, and that breed or class should be chosen which these natural conditions will best maintain. Any mistake in the choice thus made will hinder success, and in proportion to the degree of the mistake, even though the work in other respects should be judiciously carried on. Amateur farmers are much prone to allow what may be termed fancy preferences to lead them in this matter without giving due weight to the question of adaptation to the conditions. They overlook the fact that intrinsic merit is one thing and adaptation another, and that inherent suitability to some conditions may mean inherent unsuitability to other conditions. Hereford cattle have been found eminently adapted to the Southwestern ranges of the United States, hence, they should be freely grown there rather than on the arable farm where both milk and meat are wanted. Some other breed as Shorthorns and Red Polls, which are more suitable for meeting this combined need, should be kept on the arable farm rather than on Southwestern ranges. Southdown sheep are small in body and active in limb. Lincolns are large and massive. The former therefore may prove profitable on upland and broken pastures of sparse production on which the latter would fail, and the latter may prove more profitable than the former on rich levels.

Illustrations could be multiplied indefinitely. The attempt to maintain animals under conditions unadapted to their needs is likely to lead to failure, as shown in the results of the effort to improve Cheviot sheep while on their native pastures by crossing them with Leicester rams. The cross thus made created a tendency to increased size. The tendency thus created was not well sustained by the pastures, hence, eventually, the progeny of this cross were found inferior to pure Cheviots and it had to be abandoned. It would of course be possible in some instances to so change the animals that their necessities would in time conform to the conditions of environment. But why engage in so perilous and profitless a work when breeds exist adapted to all the varied conditions that may arise?

Selection and Standards.—In breeding pure breds as intimated in Chapter II. the standard must conform to that which truly represents the breed whether that standard is drawn up by an association or not. Any distinct variation from the recognized standard, especially in the foundation animals, is likely to lead to similar variation in the progeny, and any distinct variation in the choice of sires is likely to lead to modification of type. While distinct variation is thus to be shunned, it is not to be shunned to the exclusion of what may be termed outstanding individuality in individuals, especially when that individuality is of the character of improvement. For instance, more than average fullness in the Hereford thigh should be welcomed, though marked fullness there is more characteristic of the Shorthorn.

In breeding grades the breeder has much more latitude. He can fix his own type. But it must first be clearly defined in his own mind, and in fixing it due recognition should be given to useful qualities and to the needs of the market. Progress will be more rapid and success more pronounced when the foundation animals are possessed of similarity rather than of divergent characters. For instance, when selecting foundation animals for a Shorthorn herd, unification or resemblance in the progeny will be more complete when the foundation females have similarity of type rather than divergence in the same. But even when such dissimilarity does exist, prepotent males may ere long produce unification.

Selection in Pedigree.—In the absence of pedigree there can be no certainty in transmission except in the case of animals of known purity of breeding. For instance, early in the nineteenth century, Southdown sires were used in the formation of certain breeds as the Hampshire and the Oxford. They were so used because of the known prepotency which they possessed, although at that time pedigrees as such were not kept of the breed. But for many generations previously Southdowns had been bred pure. They had, what may be termed, unwritten pedigrees. The relation between certainty in transmission and purity of breeding has been shown in Chapter III. But even when pedigree is present, transmission may be of a character far from desirable, as has been witnessed in very many instances. Such transmission however is not to be charged up against pedigree as such, but rather to pedigree linked with inferiority, the result of improper breeding. It follows therefore that selection in pedigree is more important than pedigree in itself. The best pedigree is that which has the largest number of animals in it distinguished for high merit. But this definition should be modified by the further proviso, that the value of the pedigree is enhanced by excellence in the near rather than in the remote ancestry. (See p. 273.) The little attention that is given to pedigree in the choice of sires is costing the United States millions of dollars every year.

Selection and Individual Merit.—No selection of any kind is admissible in breeding that is not possessed of at least fair individual merit, even though it should be selection based on the best pedigrees that exist. High individual merit means the possession in a marked degree of the useful qualities essential to the breed. Opinion differs as to the relative value of individual merit and pedigree. The tendency has been to exalt pedigree over individual merit. In discussing this question, the character of the pedigree should be most carefully considered. If it is possessed of no other merit than its length, then unquestionably individual merit is more important than pedigree, for transmission cannot then be of a high order. If, however, the pedigree has in it many animals noted for individual merit, then pedigree becomes relatively more important, since the transmission may resemble the near ancestors quite as much as the parent.

This explains the fact not infrequently observed, that some sires which never won prizes themselves, because of want of the requisite individual merit, have begotten animals noted for a successful show yard career. If the choice must be made between individual merit and pedigree, the former should be given the first place, since the danger is always imminent, that a pedigreed animal inferior in its individuality will transmit its own qualities to the progeny rather than those of its ancestors which may have been superior. In choosing breeding animals the aim should be to combine high individual merit and excellence in pedigree. The most suitable animals for breeding, therefore, are those possessed of the best pedigrees and also the highest individual merit.

Selection and the Sire.—Special care should be exercised in the choice of the sire, since he is likely to exert an influence on the stud, breed or flock, equal to the sum of the influence exerted by all the females of the same, when as male and female they stand on an equal plane with reference to breeding and individuality. In this comparison it is presupposed that but one sire is used in the stud, herd or flock. If, however, the male should be superior in both these respects, the influence which he exerts on the progeny is likely to be proportionately superior to that of the conjoined influence exerted by the females of the same. It will be as much superior to the sum of the influence exerted by all the females, as the individuality of the sire conjoined with his prepotency exceeds the same in each individual female.

It is thus apparent, that the statement so often repeated, that the male is half the herd may not tell the whole truth. He may indeed be much more than half the herd, especially when he is pure bred and the females are mixed in breeding. The most important qualities in the male in addition to good lineage and high individuality, are masculinity, bodily vigor and prepotency. Masculinity and bodily vigor so far evidence the presence of prepotency. (See p. 107.) Observation has shown that both, as a rule, tend to accentuate the impressiveness, that is to say, the prepotency of the sire.

Selection and Undesirable Transmission.—Selection should most rigidly exclude the admittance of animals into the herd that are liable to admit undesirable characters, notwithstanding their individual excellence. Such are animals in whose near ancestry have been shy breeders, indifferent performers, and those which have evidenced a tendency to certain forms of disease. Shy breeding will influence profitable returns adversely in addition to the disappointment which it brings, and it is certainly transmissible even to the extent of becoming a herd trait. A dairy cow may have great beauty of form, but she is low in milk production. She also comes of an ancestry indifferent in milk production. Her beauty of form should not entitle her to a place in the breeding herd, since she is not likely to produce good milkers. The exclusion of animals as breeders which have evidenced a tendency to certain forms of disease should be most rigid, as, for instance, horses with tendencies to spavin, cattle with leanings to tuberculous diseases, sheep affected with goitre and swine whose limbs are weak. The germs of undesirable qualities thus admitted may crop out for generations, howsoever judicious the breeding may be that follows their admittance.

Selection and Unsparing Elimination.—The selection of breeding animals should be of that character which will rigidly and persistently eliminate all animals possessed of undesirable characters. It should extend:—

1. To all animals below the average in essentials as to form, otherwise a high average of excellence can never be reached, nor if reached could it be maintained. There will be that lack of resemblance to one another that should not obtain between animals of the same pure breed.

2. To all such animals as are poor feeders and indifferent producers. The first will not give a profitable return for the food fed, and transmission from them would also be undesirable.

3. To all shy breeders whether male or female, and to those deficient in fecundity. Non-breeders are simply a bill of expense and shy breeders are unprofitable in proportion as they fail to breed regularly. When more than one may be produced at a birth the profits are proportionate to the numbers

produced up to the limit of capability to produce and nurse properly young animals not below the normal standard.

4. To those which have shown themselves lacking in prepotency. Lack of prepotency in the male would be far more serious than deficiency in the same in the female. Especially would this be true in the breeding of grades. (See Chapter XXVI.) But in the breeding of pure breds prepotency in the female also is of much value. The elimination of unprepotent males should be most unsparing, since to breed from them may result in much loss.

5. To those among pure breds possessed of color markings which are highly objectionable. Such would be color markings which bar from registry in pure breds, and color markings which seriously discount the selling value of animals, though they may not bar them from registry. Such would be Shorthorn males white in color. This course should be adopted though the animals should be possessed of high merit, since the power of fashion with reference to fancy points is stronger to compel rejection than the power of good individuality linked with objectionable color markings is to overcome such prejudice.

6. To all who have passed the meridian of best usefulness through old age, unless in the case of breeding animals of rare value. Such dams are more costly to keep, are not so likely to produce animals of high individual merit as at an earlier age, and are not so likely to nourish them so well during the nursing period.

7. To those animals which give indications of abnormal tendencies. Even though these tendencies should be inherently unobjectionable in themselves,

their elimination should be of the most unsparing character. Such would be the absence of horns in any of the horned breeds, unless the accidental variation thus manifested were to be utilized in producing a hornless breed. How much more then would it be fitting to eliminate all such variations as are objectionable in themselves. All such animals should be sent quickly to the block. They ought not to be sold as breeders. The ethics of the golden rule would forbid such sales.

Selection and Judicious Mating.—Animals should be so mated that their mutual weaknesses will be likely to be corrected, and with that object in view they should be selected accordingly. For instance, suppose a herd of Tamworth swine becomes unduly lengthy in the barrel or coupling, and that they are also too long of limb. The proper selection of a male to correct these defects would mean choosing one with requisites of form bearing in the opposite direction, and so of all mating. Where points are weak in one sex they should be strong in the other. The eventual outcome will be an equilibrium in development. In small herds or flocks such mating may be impossible in practice, for a time at least, when a marked diversity exists in the females, since in such herds or flocks it is usually impracticable to keep but one male. The evening up process in such herds therefore will be more prolonged, and while it progresses, the elimination of undesirable variations should of course be continued. It may also be mentioned that violent crosses should be avoided. For the fuller discussion of this question as also the whole question of mating see Chapter XXX.

CHAPTER XXV.

CROSS BREEDING.

Cross breeding may be so conducted under certain limitations that it will become a source of profit while in other instances, under different conditions, it will be a source of loss. Again, it may be so conducted as to prove a stepping stone to improvement, while in yet other instances it may lead to retrogression. It will be the object in this chapter to so investigate the question that some at least of the benefits to be derived from cross breeding under suitable conditions may be pointed out, and likewise some of the evils that flow from injudicious cross breeding, that the breeder may be enabled to shun them.

Definition of the Term Cross Bred.—In the highest and strictest use of the term it may be said that a cross bred is the progeny of two distinct breeds. For instance, suppose the Hereford and Shorthorn breeds are crossed, and then only Hereford or Shorthorn sires were used for a number of generations, the progeny would still be cross breds. Ultimately they would of course become possessed of all the essential characteristics of Herefords, or Shorthorns, according as the sires were chosen from the one or the other of these breeds. Still, they would not be recognized as pure. The term may also be applied and with some propriety to the progeny of animals possessed in various degrees of the blood chiefly of but two breeds. For instance, suppose a high grade Hereford and a high grade Shorthorn are mated the progeny is called a cross bred. The term cross bred is also frequently applied, though improperly, to the progeny of animals from two different families or tribes within the same pure breed. Suppose that Booth and Bates cattle are mated, the mating is spoken of as a cross, which in reality it is not in the sense of crossing breeds. It is only a cross in the sense of crossing families or tribes within a breed, which in reality is not a cross. In the proper use of the term there cannot be a cross in the absence of alien blood. But, for convenience, and because of the want of a more specific word, the terms crossing, making a cross, out breeding and cross breeding are frequently applied to the mating of those different families and tribes.

Cross Breeding and Early Improvement.—Cross breeding was a favorite method of seeking improvement in animals before the time of Bakewell. In fact it would probably be correct to say that it was one of the chief means by which improvement was sought. The door for practicing it among pure breds stood then wide open, as it was before the age of herdbooks. The advent of these have probably forever closed that door. The idea probably grew out of the observed fact, which is true, that increased vigor was imparted by it, and in many instances individual improvement. It would not be correct to say that all cross breeding brings renovating power any more than it would be correct to say that all cross breeding brings individual improvement, but in many instances it does both.

The instances in which it will effect improvement, or the opposite, cannot certainly be predicted beforehand. This question is one of the great deeps in which the investigator still flounders. The probable results must rest on experience. When cross breeding was carried on without any definite plan, these early breeders found the results were usually disappointing in the end. So it is to-day and so it will be always. Yet the fact is to be recognized that the abundant crossing practiced by those early breeders, especially in Great Britain, gave to many of the animals of the eighteenth century a plasticity of constitution that prepared them for the quick improvement which followed, and which was sought, on what may be termed the Bakewell system already outlined. (See page 2.)

Three Methods of Cross Breeding.—Three methods of cross breeding have been adopted, viz.: 1. Continuing to interfuse the blood of two breeds indefinitely; 2, Making the results of the first series of crosses the basis of a new breed; and 3, introducing the cross for a time to remedy some particular defect, or to secure some desirable quality.

The first of these methods has not proved satisfactory. Experience in practicing it has shown that the results, like the swing of a pendulum, are first forward and then backward. They do not advance beyond a certain level. Such breeding tends to produce variation, and variation that is vexatiously variable and uncertain.

Nor can it be said that the second method has proved a great success, where a regard has not been had to a most rigorous selection in the progeny. Such a selection is imperative, since the tendency to variation is always accelerated by cross breeding. When however such crossing has been judiciously done, and the selection following has been rigid and wise, great service has been rendered, as the history of many of the improved breeds will show that have been evolved from composite materials.

The third method has been turned to good account more especially in the improvement of grades. For instance, when improved mutton qualities were sought in the Hampshire breed, these were obtained through Cotswold crosses, and when the wool of the Shropshire was to be lengthened, this also was effected through Cotswold crosses. Suppose one is breeding a grade flock of sheep and he finds they are losing size. He may introduce an outcross from some larger breed. Having made the cross he may at once return to the old line of breeding. For instance, suppose that a breeder of grades has high grade Shropshires that are degenerating in size and also in the length of the wool staple, by introducing an Oxford Down cross he will increase both the size of the progeny and the length of the fleece. Having made the improvement he can at once go on breeding from Shropshires, if that is the sheep which has shown itself reasonably well suited to his conditions. When such crosses are made, preference should be given to those breeds which will effect improvement with the least change as to form and color in the progeny. In the illustration given above the Oxford Down cross would be preferable to the Lincoln, for the reason just given. In effecting such change in high grade Leicesters the Lincoln cross would seem preferable to the Oxford Down.

Cross Breeding and Improvement.—Cross breeding has rendered invaluable service in the formation of new breeds. But few breeds of cattle, sheep and swine have been evolved during the recent centuries

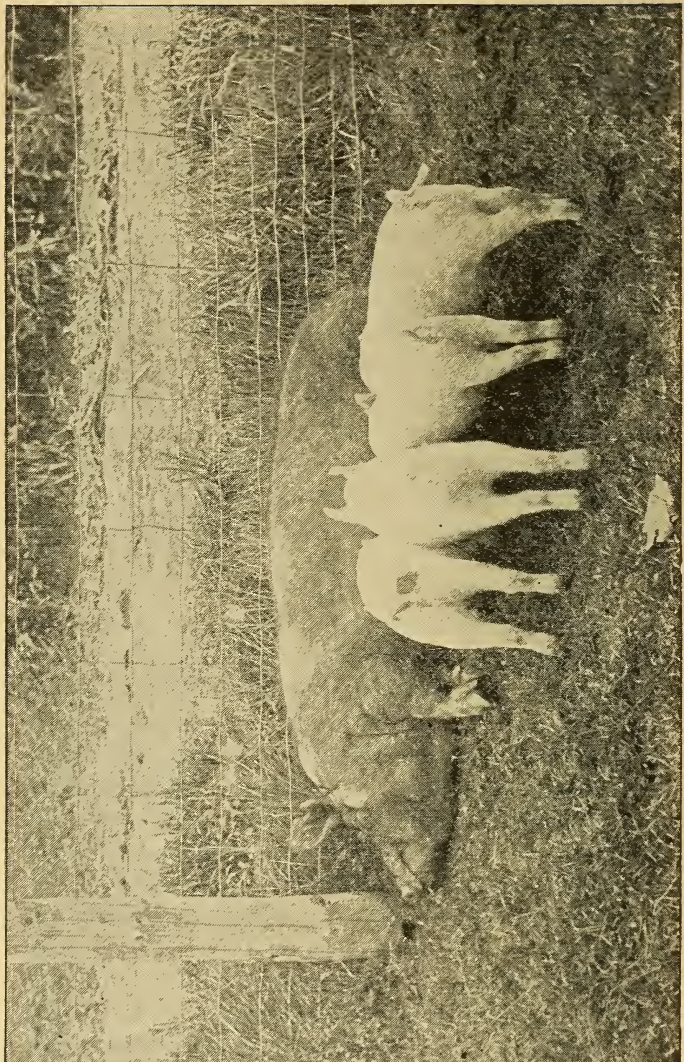

FIG. 11. PIGS OF THE LARGE IMPROVED YORKSHIRE-BERKSHIRE CROSS.
(Illustrating the greater potency of the sire.)
The property of the Minnesota University Experiment Station, 1901.

without resorting to more or less of crossing in the foundation animals and for a few generations subsequently. In this way among the breeds of sheep the Hampshire Downs and the Oxford Downs were evolved and among swine the Poland Chinas and Duroc Jerseys. Some, however, of the old breeds, as Galloway cattle and Leicester sheep, would seem to have been improved entirely by selections within the breed. Cross breeding has also rendered great service in the improvement of old breeds, as shown in the improvement effected in certain of the long-wooled breeds by the use of Leicester sires. But all this was done before the period of public registration. Records shut off the possibility of attempting to bring renovation in this way. The benefits that are to be secured from cross breeding in the future will of necessity be confined to grade stocks. On this principle, in the new breeds that will yet be evolved, cross breeding must cease as soon as public records come to be kept.

When cross breeding is resorted to in the formation of new breeds, a most careful regard must be had to selection in the animals produced by the earlier crosses, and indeed by all the crosses. Those animals with undesirable variations must be most rigidly eliminated. Uniformity will be hindered or facilitated in proportion to the fidelity shown in such elimination. The judicious inbreeding of these for a time will also further intensify and render permanent the improvement, although the two systems are apparently the opposite. (See Chapter X.)

Cross Breeding and Undesirable Variations.—Where two distinct breeds are crossed when the animals have about equal powers of transmission, there is frequently a tendency to produce undesirable variations, more especially when the work is carried further than the first cross. The reasons for this cannot be fully given in the present state of our knowledge. The fact has been recognized that the original characters common to both are likely to be made more dominant, and special characters, that is, characters secured by improvement, are likely to be obscured. In other words the tendency is toward retrogression. The greater the contrast of the two breeds, the stronger is the tendency frequently to obscure the best characters of each, and also to restore the original characters of each. It is not surprising therefore that the introduction of alien blood has in many instances given a tendency to reversion. Let it be observed, however, that it is when the breeds have about equal prepotency that these results are most marked. It would seem like unto a war of blood elements for the mastery, with the curious result that atavic tendencies are strengthened. When one breed so crossed is decidedly the more prepotent, the atavic tendencies are proportionately obscured.

Crossing a New Upon an Older Breed.—When the attempt is made to engraft the characters of a composite though a distinct breed upon one that is more ancient, it may be necessary first to weaken the dominant characters of the latter by intercrossing it with some other breed or type, and then crossing the composite breed upon the progeny. Composite here is but another name for new, for the newer breeds are all composite. It is this newness which gives a less prepotency than that possessed by the ancient breeds. To illustrate: Suppose it were desired to engraft Oxford Down characters upon the Merino, the process would be hastened by first diluting the Merino blood by crossing upon Merino some other breed, and then following with the Oxford Down cross. The process would probably be further hastened by first crossing one distinct breed on the pure Merino, as the Southdown, and then on other pure Merinos another distinct breed, as the Shropshire, next intercrossing the cross breds from each, and then following up with a succession of Oxford Down crosses. The tendencies to reversion to Merino characteristics would thus be more quickly removed than by making a succession of straight Oxford Down crosses at the first. The reasons will be apparent. The more ancient breed, the Merino, has greater power to resist change. This is owing to the greater accumulation of dominant characters within it, and to the more complete incorporation of these in the system as a whole. When the potency of Merino blood has been weakened, as indicated, the way is paved for the blood of the newer breed, the Oxford Down, to assert its supremacy.

Crossing for Increased Size.—When the attempt is made to improve the size of an established breed either in the pure or high graded form, by crossing upon it a larger breed, a due regard must be had to improved conditions of keep, that is to say, to furnishing increased food supplies, since the tendency to increase in size will demand more liberal feeding and very probably somewhat modified conditions of exercise and protection from exposure. When these are not forthcoming the disturbance in the equilibrium of the system may result disastrously. The tendency to increased size calls for the consumption of more food, and if the pastures do not furnish it, unless supplemented in some way, the tendencies thus imparted to the system in the direction of increased size results in deranged growth, which means unsatisfactory growth. Thus it is, that mistakes grievous in character have been made in the attempt to secure increased size.

The last condition of the breed thus crossed has been found greatly inferior to the same when crossing began. Thus it was, that attempts to improve the Cheviots by crossing the larger Leicester upon them failed, and likewise the attempts to improve the Black-faced Highland sheep by crossing them with the Cheviots. Because of this, the attempt should not be made to introduce on to the ranges, or on to rugged and ungenerous pastures where animals must gather their own food during much of the year, those breeds in which the standard of size cannot be readily maintained by the natural conditions.

Crossing Females to be Sent to the Block.—Cross breeding may sometimes be resorted to when seeking progeny from the females of a breed, which, along with their dams are to be fed for the block. Illustrations are furnished by the Black-faced Highland and Cheviot breeds of sheep, at least in many instances, when the ewes are to be put upon the market the following season. The ewes thus drafted are frequently driven down to lower pastures. They are then crossed with rams of a larger breed, and along with their progeny are in due time sent to market. The same plan may some day be adopted with aged females from the American ranges. It would also be legitimate to select such ewes at a younger age and breed thus from them yearly, until they are finally disposed of. It is at least questionable if, in ordinary farm practice, cross breeding should be carried much further than has been outlined above.

This statement, however, has some limitations. Exceptions to it are found in those instances already referred to in which one outcross may be introduced for a specific purpose and also in the case of high grade Dorset sheep, when the object is to combine the property of producing in the autumn with a more perfect mutton form than that possessed by the Dorset. But, let it be observed, that the general principle thus laid down does not apply to improvement through grading, which is discussed in the following chapter. The distinction between these should be carefully preserved.

Cross Breeding on the Ordinary Farm.—Cross breeding should not be commonly practiced by the breeder in his ordinary operations for the reasons, 1, that it would too much tend to destroy the identity of breeds; 2, the results are frequently very uncertain; 3, it would render pure bred females less capable of again breeding true to type; and 4, it would probably result in financial loss generally. These several results to which it leads will be further discussed below.

Cross Breeding and Breed Identity.—That the crossing of pure bred animals would destroy breed identity needs no demonstration, since animals thus crossed could not be registered. And such crossing, if it became general, would prove fatal to records. These are supported by all the breeders of pure bred stock in America. They are considered indispensable to the maintenance of a high standard of excellence. Such breeding, therefore, would run counter to focused opinion from all the breeders of pure breds on the continent, if not indeed in the world. It would prove fatal to the integrity of breeds. Even though the immediate results from such a cross were an improvement, they would eventually prove disastrous, since sooner or later such crossing would tend to the disposal of all the material from which such crosses could be made.

Such a contingency once threatened the Aberdeen Angus breed when the Shorthorn Aberdeen Angus cross was so popular in Scotland many years ago. Had the integrity of the Aberdeen Angus breed been destroyed at that time, the results would have proved calamitous to the live stock interest. Such crossing would also be fatal to that potency for improving grades which in so marked a degree is possessed by animals of the pure breeds. The reasons for this have already been given. (See p. 31.) In fact such crossing would just be undoing the great grand work which the builders of pure breeds have done.

Cross Breeding and Uncertainty in Results.—As already intimated, the results from cross breeding are frequently very uncertain. In some instances the outcome is an improvement on either ancestor, owing to what may be termed an affinity in dominant characters. Such are the results frequently obtained from crossing Galloways upon West Highland cattle. This affinity would seem to bring along with it renovating power. Such renovating power would seem to be in a sense inherent, as the outcome of a cross. In some instances it would be striking, as when vigorous Tamworth swine are crossed upon the Poland China swine of the corn belt. But in the present state of our knowledge, such improvement cannot be certainly assured before it has been demonstrated by actual test.

In other instances the progeny is inferior to either ancestor, owing to what may be termed antagonism in dominant characters, which begets a tendency to reversion. Such would seem to be the outcome when Herefords are crossed upon Galloways. Why there should be affinity in some instances in dominant characters and want of affinity in others is one of those deep questions in breeding that cannot be measured by the measuring lines of to-day. Some of the probable results from crossing may, however, be prejudged beforehand, as, for instance, when the more robust Simmenthaler animal is crossed upon the more refined Jersey, increased vigor will assuredly result. Again when the Jersey is crossed upon the Holstein, an increase in butter fat in the milk may be confidently looked for, and when the Holstein is crossed upon the Jersey an increase in the milk product may be looked for with equal confidence. But whether the blending will result in all round improvement or in general retrogression cannot be confidently prejudged beforehand in the absence of previous experience. Since many of the results of crosses yet untried cannot with any degree of certainty be foretold, there are always some elements of hazard present except when the crossing is based on the determinations of previous experience.

Cross Breeding and Type.—Cross breeding renders pure bred females less capable of again breeding true to type when bred again to males of the breed to which they belong. This is owing to the influence of one impregnation on succeeding ones, as shown in Chapter XIV. The value of such females for future breeding would, therefore, be so far impaired. But there may be instances in which such breeding would be legitimate, as when females were to be thus bred repeatedly to males of another breed because of the excellence of the results obtained.

Cross Breeding and Financial Results.—Cross breeding, unless in the exceptions already given, would be more likely to result in financial loss than in financial gain. The pure progeny of any one of the pure breeds that may be crossed, should have a greater money value than the cross bred progeny of the same. This at least is true of them, as long as they are capable of breeding in good form. If this were not true there would not be sufficient reasons for maintaining the breed in the pure form. If the day ever comes in the history of any breed, when, in the pure form, the value of the average animal is worth no more than that of the average cross bred from the same, the argument for maintaining such a breed in its purity would be gone. If it were not true that pure breds are usually more valuable than their cross bred progeny pure breeds would be wiped out of existence, and this would of course react disastrously upon live stock production.

CHAPTER XXVI.

IMPROVEMENT THROUGH GRADING.

The improvement of live stock through grading is a matter of much moment to those engaged in breeding grade stock, and this includes the great mass of the farmers. It would be no exaggeration to say that through this process alone, in less than half a dozen generations the value of the live stock on the continent of America could be improved at least from 25 to 50 per cent., providing a sufficient number of pure bred sires of the various pure breeds could be secured for service, and this general improvement would of course be accompanied by a gradual increase in purity of breeding, so that by the time half a dozen generations and probably a less number had been produced through using pure bred sires from some pure breed, it would not be possible to distinguish the animals thus graded from pure breds of that breed, because of the closeness of the resemblance in form and also in qualities.

A Grade Defined.—A grade strictly speaking is the offspring of a pure bred and an animal of common or mixed breeding. Either the male or female may be pure, but in practice the male is usually pure and the female of mixed blood. The reasons for breeding thus will be apparent when it is remembered that to mate pure females with males of mixed blood would be to lessen the value of the offspring. Nor could a sufficient number of females be secured for such breeding. But the term grade is also applied to the offspring of two animals of common or mixed breeding. Such a use of the term, however, should not be confounded with the use of the term cross bred, sometimes used in a sense nearly but not quite similar.

It is not easy to give to a nicety all the shades of distinction that appertain to the use of these terms as they have been applied in the past. Strictly speaking, however, it is necessary, that in breeding grades, one ancestor shall be pure and the other of mixed breeding. Whereas, in breeding cross breds both ancestors are pure. But in a looser sense the parents of cross breds may each possess the blood elements of two breeds the same in kind, although it is not necessary that they shall possess these in the same degrees, whereas each of the parents of grades may be possessed of the blood elements of more than two breeds. To state the question more briefly cross breds may sometimes mean the progeny of cross breds, and grades may sometimes mean the progeny of grades. A grade, therefore, may contain any percentage of the blood of one breed less than one hundred.

A High Grade Defined.—A high grade is an animal of mixed breeding, in which the blood of a pure bred largely predominates. To obtain this marked predominance in pure blood elements, it must possess at least three or four crosses of the same, and may possess any number beyond this. In all leading essentials it may be practically equal to a pure bred, but it cannot be recorded. In stamina it may be superior to a pure bred, owing to the renovating influence which the judicious blending of blood seems to bring with it. This explains why, in fat stock contests, high grade animals are usually the winners when shown against pure breds.

Object in Breeding Grades.—The object in breeding grades is to secure a higher average of excellence among common stocks, hence it is frequently spoken of as grading up. This object is usually sought through the use of pure bred males upon females of common or mixed breeding, since to use sires of common or mixed breeding upon pure bred females, as shown above, would be breeding down rather than up. Such breeding would not only be foolish, but it would also be in a sense impracticable, owing to the relatively small number of the females that could be obtained for such breeding.

Benefit from Up-Grading.—The great advantage in grading up lies in the ingrafting of the characteristics of a superior breed upon an inferior one, for the purpose of improving the latter. The improvement is due to the superior qualities of the males used. This superiority has reference not only to individual qualities, but also in degree even greater to the superior power which such a parent has to transmit such qualities to the offspring. But the improvement thus secured cannot be maintained unless accompanied by suitable care and management. For instance suppose that a choice pure bred male is mated with common females, a tendency to improved form will be begotten in the progeny. If this tendency is not sustained by liberal feeding, the promised improvement will not be realized. Along with this tendency to improved form may be transmitted less ability to withstand the more or less hard conditions to which the dams may have been subjected. If no improvement is made in these conditions, then improvement is not likely to be made, much less maintained, in the progeny. Improved blood, therefore, without suitable care and feeding, will not effect the improvement looked for by those who introduce it.

Plan to Follow in Up-Grading.—The plan to be adopted in up-grading would be substantially as follows:—

1. Decide upon the breed to be chosen for effecting improvement, that is to say, decide upon the breed from which the sires shall be chosen. The influences that should determine such choice are such as environment, the present and prospective market demands, the intrinsic merit of the breed and the preferences of the individual. On no account should a breed be introduced into unsuitable environment when kept for the profit that is in it. Such would be the introduction of Lincoln sheep on to mountain pastures, or Shorthorn cattle on to the soils low in productive power. When the present and prospective market demands favor animals of a certain size and breed, as they sometimes do, the profits should be greater than could be obtained from breeds for which there was less demand. At the present time this would lead to the selection of dark faced rams of the Down breeds in preference to Merino rams when seeking to grade up mutton sheep. The breed should also be possessed of much intrinsic merit, as shown by its previous history, and if the choice of the breed is in the line of the preferences of the individual, more interest will naturally be taken in its development.

2. Choose pure sires of high individuality from the same breed as frequently as they may be wanted,

Such choosing will be sufficiently frequent to avoid in-and-in breeding. If the sires were line bred and wisely chosen, uniformity in the animals that are being graded up would be attained more speedily, but those not skilled in the art of breeding would be more likely to succeed by choosing wholly unrelated sires.

3. Cross the first sire chosen upon females of common or mixed breeding, since such material is not costly, and continue to use the sires thus chosen from generation to generation, upon the selected females of the progeny. The blood elements in the foundation females, though a factor of some importance, is not so important as form in the same. For instance, when grading up a flock of sheep for mutton uses, if the foundation females should be largely of Merino blood, the process will be slower than if they possessed mainly the blood of some of the mutton breeds. But it is important that they shall have as good form as the average of the class furnishes, otherwise, the grading up will cover a longer period than is really necessary. The stocks therefore which constitute the foundation females should be selected when practicable and selection should be made from each generation of the progeny, always rejecting those below a certain standard.

High Grade Sires not Suitable.—The practice of using high grade sires to effect improvement is to be discouraged, where good pure breds can be obtained at reasonable rates, as dominant characters in them have been so little intensified that the results are likely to be variable. The strong temptation to introduce such a sire into the stud, herd or flock should be resisted, notwithstanding any individual excellence which he may possess, but such a sire when prepotent, and in rare instances those sires are, is to be preferred to a pure bred of inferior individuality. The latter may reproduce his own individuality on the offspring.

Zigzag Grading to be Shunned.—What may be termed zigzag grading ought not to be practiced. Such grading means a frequent change in the breed from which the sires are chosen. The results from such a course of breeding will be increasingly variable and uncertain, the longer that it is pursued. Suppose a pure Shropshire sire has been crossed upon grade ewes of mixed breeding, the progeny will be possessed of much resemblance to the Shropshires in form, appearance and qualities. Improvement has been made in a certain direction, that is to say, in the direction of Shropshire characteristics. Suppose that a Lincoln cross follows. Improvement in the line of Shropshire characteristics is arrested, and diverted in the direction of Lincoln characteristics. Increase in size will follow, and in the length of the fleece, but the latter will have lost in density, and the fiber of the muscle will be somewhat less fine in the grain. It may be found that the size is too great for the pastures to sustain, and a Southdown cross is next introduced. There will then follow a decrease in size and in the length and weight of the fleece, but it will be finer and the same will be true of the fiber of the muscle. A Shropshire cross follows, and there is further modification in the direction of the results obtained from the first cross. It is very evident, therefore, that such crossing, which is simply zigzag crossing, cannot secure any stable or permanent results. It is simply advancing and receding, achieving and undoing. The individuals who follow it, and their name is legion, sail in a circle. Those thus engaged carry on a never ending experiment without being able to make any substantial or permanent progress.

Up-Grading and Mingled blood Elements in Females.—When breeding grades the more mingled the blood elements in the females, the more marked will be the improvement in the progeny, since their power to resist change weakens with the increase of diversity in the blood elements. This conclusion is the logical outcome of the opposite idea, viz., that the longer the period that the animals have been bred pure the greater power they have when mated to transmit their properties to the progeny, that is to say, their power to transmit these properties increases with the diversity of the blood elements in the females, and each such additional diverse blood element tends to weaken the power to resist change on the part of the females, since it tends further to disunite the resisting power to change in these blood elements, rather than to unite them. In other words, in the first instance, unity of action and consequently potency of action increases with increased purity of blood, and in the second instance separate and independent action, and consequently weakened action, increases with increasing diversity in the blood elements. Diversity in blood elements, therefore, may be a positive advantage in females when the effort to improve them through upgrading begins. Suppose that high grade Merino sheep in one instance are to be improved for the block through up-grading, and in another instance sheep with blood elements very diverse are to be similarly improved, the sires in both instances being chosen from the same pure breed, the object will be attained more quickly with the latter than with the former.

The present condition, therefore, of the common stocks of the country render them susceptible of rapid improvement through grading. But the fact should not be overlooked, that up-grading will be more quickly accomplished when the females to be graded are already possessed of blood elements the same in kind as those from which the males are chosen, and it will be facilitated proportionately to the degree in which these are possessed by the said females. For instance, females of mixed blood with more or less of Shropshire blood elements, can be graded up more quickly through using Shropshire males than if such elements were not present.

Up-grading and a Lessened Ratio of Improvement.—When improvement is sought through up-grading, the more marked is the improvement relatively which is effected by the first cross, and the ratio of improvement lessens with each succeeding cross. This fact has been noticed by the most casual observers. The explanation is not difficult. To illustrate: Suppose females much mixed in their blood elements are to be graded up through the use of pure Galloway sires of good individuality. When the work of improvement begins the difference in the blood elements, that is, in properties and characteristics may be fitly represented by 100, on the supposition that the females have in them no Galloway blood. Careless observers would say that the progeny from the first mating would inherit properties from each parent that would be represented by 50. This, in reality, is not true. Each animal of the progeny would inherit more than 50 per cent. of the properties of the sire and less than 50 per cent. of the properties of the dam. The excess in the properties inherited from the sire would be equal to the excess in the transmitting power of the male as compared with that of each female. In other words it would equal the preponderance in the transmitting power in the male to effect change over that of each female to resist change. The power of the male to transmit properties would be much greater than that of each female, because of his marked purity of breeding and high individual excellence. Let the number 75 represent the properties inherited from the sire in each of the progeny, then 25 will represent the properties inherited from the dam. The progeny will therefore resemble the sire very much more closely than the dam. It could not be otherwise, because of the excess in properties inherited from the sire as compared with those inherited from the dam.

Now suppose that an equally prepotent pure Galloway sire is chosen for mating with the female progeny begotten by the first mating, the difference in properties between this sire and each female will be represented by 25, whereas at the beginning it was represented by 100. In other words, a gap or difference in properties represented by 25 is to be bridged over. The change effected by the second sire therefore cannot be so great relatively as that effected by the first, since the difference in blood elements, that is to say, in properties, is only one fourth of what it was at the beginning. The chance therefore for improvement is proportionately narrowed. Let the number 15 represent the essentially Galloway properties inherited from the sire in the second instance, then 10 will represent the resistant properties to assimilation inherited from the dam. The difference in properties between pure Galloways and the progeny of the second mating will therefore be represented by 10. The progeny in this instance will more closely resemble the Galloways than that from the first mating, but the increase in resemblance will be much less relatively than in the first instance. It could not be otherwise. It is very evident, therefore, that by the time the fourth or fifth Galloway sire had been thus used in up-grading, the difference in properties between the animals thus graded and the pure Galloways would be imperceptible. They would be possessed essentially of the characteristics of pure Galloways, but, of course, they could not be recorded as the rules for the registration of Galloways now stand.

In this way common animals thus graded by using successively pure bred males from any breed, can speedily be graded up to the level of that breed in individuality, and they will probably excel it in average vigor. This level, as has been shown, may be attained through a very limited number of crosses when the work is judiciously done. The number of these crosses will depend, first, upon the preponderance of prepotency in the sires; second, upon the judgment used in selecting and mating; and third, upon the management.

Up-Grading and Retrogression.—The opinion has gained currency, that, while a first cross in grading is likely to effect marked improvement, succeeding crosses are not so likely to effect further improvement, and in many instances they are not likely to maintain the standard of improvement obtained in the first cross. This opinion is doubtless based on observation, but such observation has led to erroneous conclusions as to the true cause of such retrogression as will be shown below. Where the work is properly done, such results from up-grading would be impossible, though they might easily arise from cross breeding under certain conditions as has been shown. (See Chapter XXV.)

When Retrogression May Follow.—In the attempt to up-grade, even though pure bred sires are used, retrogression may follow in the second and succeeding crosses. It may follow when the blood elements have been strong on the side of the dam, as well as on the side of the sire. To illustrate: Suppose the attempt is made to change the American Merino whose blood is almost pure into the mutton type by crossing upon it some of the more recently established of what may be termed the composite mutton breeds, as the Hampshire Down. The powers of the Merino in that case may be stronger to resist change than those of the Hampshire Down to effect it. If so there will be a tendency to reversion in the second and probably in some of the succeeding crosses. Such an instance, however, is more nearly allied to cross breeding than to up-grading. It may also follow when the changes effected are not in keeping with the conditions of environment, and when the animals suffer from neglect. Such would be the result from the attempt to introduce a coarse-wooled mountain breed into a hot climate and to engraft upon the same the characteristics of a very fine wooled breed. If the progeny from pure sires were subjected to conditions less favorable than the breed from which the sires chosen were accustomed to, there may also be retrogression. (See p. 319.)

Up-Grading and Sustenance.—Grading with a view to increase the size and quality must be accompanied with liberal sustenance, otherwise, such increase in size and also in fattening properties would be a source of weakness, owing to the disturbance that would arise in the equilibrium of the system. The increased impulse in both directions unsupported by the necessary food supplies, would lead to retrogression. Because of this, many of the ranchmen of the American Western ranges have been forced to abandon such crosses. (See p. 320.)

Excluding Grades from Record.—The wisdom of excluding all grades from the American stud, herd, and flock records which are intended to guard the interests of the pure breeds is, at least, questionable. Such exclusion is eminently wise when applied to animals with a limited number of crosses, owing to tendencies in them to atavic transmission, but, in continuous up-grading, a time comes when the elements of the common blood originally possessed by the dams become so small a factor as to have no appreciable influence. Thus barring the door of admittance to every form of grades, howsoever excellent in themselves, tends to discourage up-grading of the highest order.

The only advantage that those who improve through grading can look for is increased market values consequent upon individual improvement, whereas, could they record such grades after a sufficient number of crosses additional value would be given to them as soon as admitted to registry, that is, as soon as they were recognized as pure breds. The additional benefit would also follow that comes from the infusion of vigorous alien blood. Such blood is forever excluded by the rules of the American Live Stock Association Records as they now stand. The average individual excellence of Shorthorns in

Great Britain is at least equal to that of the average of the same in the United States, and yet at no time during the period of recording Shorthorns in that country have more than five crosses from pure Shorthorn sires been necessary to secure registration in the English Shorthorn herdbook. In a country where the common stocks are inferior, the number of pure bred crosses to admit to registry should be more than five, but that number could be fixed upon that would furnish a reasonably sure guaranty of good individuality in the animals admitted. The bars that guard the herd records may never again be thus lowered in this country, but, if such should prove to be the case, the price thus paid for the exclusion of alien blood with its renovating power will probably be a dear one.

CHAPTER XXVII.

FORMING NEW BREEDS.

Much difference of opinion prevails as to the wisdom of trying further to multiply breeds, or as to the necessity for such multiplication. Some intelligent breeders are of the opinion that too many breeds already exist, and that the needs of the country would be better served by utilizing to a greater extent the blood of the more important and popular of these, the others being allowed to drop out of existence. Such a view would seem to be extreme. It may be true that some breeds or sub-breeds do exist which so closely resemble one another in form and appearance, that there would seem to be no good reasons why they should not be blended to form one breed, as was the case with the cattle of Norfolk and Suffolk when the Red Polls were evolved as one distinct breed. This is certainly true of some of the types of Delaine Merinos as now bred in this country, yet the fact remains, that the breeds which we now have exist because they have been found useful, and many of them exist because they have been found useful under conditions in which no other breed would have been found equally useful.

Changed conditions create new necessities, so that it is by no means certain that the necessity for further evolution in breeds does not exist even in these United States. No breed has yet been evolved that has complete adaptation to much of the range country and at the same time to the demands of the markets. Such adaptation will not be complete until the necessity for introducing rams from abroad into that country will not exist. Here then is a field for the profitable evolution of more than one breed or type. Again, the practice of dehorning recently introduced is prompting experimenters to try to remove the horns from some of the existing breeds of cattle. Some of these are doing so by the aid of alien blood, and if they succeed the result will be the production of a new breed. If a breed of hornless sheep were evolved with all the distinct characteristics of the Dorsets, except the horns, it is probable that they would supersede the latter. The time therefore has not yet arrived when this country would not be made richer by the forming of some new breeds of live stock.

Considering the Necessity for New Breeds.—While there would seem to be room for some new breeds or sub-breeds in this country, the reasons for calling them into existence should be most carefully considered, before such a work is undertaken. The simple desire to introduce something different would not be a sufficient reason for evolving a new breed. It should not be attempted before the necessity is felt for a breed which will more completely meet the needs of certain conditions than any breed now in the country. The process is tedious and will of necessity involve more or less outlay. Unless the breed so produced is distinctly superior in some respects, and for some important uses to those now existing, nothing will have been gained.

Few Men Competent to Evolve New Breeds.—The men who are fully equipped for such a work are rare. More rare are they than legislators in the highest legislative body in the nation. To carry such a work to a successful completion, requires the exercise of a rare combination of talents. It calls for great judgment in selecting the foundation materials and in the elimination of animals with undesirable variations . It requires a correct and far-reaching knowledge of the principles that govern breeding. And it calls for the exercise of perseverance without any limit. That but few persons possess these requisites in a marked degree is evident from the small number relatively of those who have made a success of evolving a new breed in proportion to the number of those who have failed. Of the many who have engaged in such a work, but few have so far perfected the same as to render it abiding.

The Time Required in Breed Formation.—The formation of a breed usually requires not less than the work of an ordinary lifetime. In some instances successive lives have been expended in establishing and improving a breed, before it attained any marked prominence. And the same is true of the establishment of a type within a breed. But the length of time required will depend largely on the materials used and the method pursued. The greater the diversity of the foundation materials used and the less close the breeding from these, the longer will be the period which the work will cover. Affinity and antagonism in blood elements in different breeds has already been referred to. (See p. 323.) This should be well understood regarding the materials chosen for the evolution of breeds.

Forming Breeds Through the Influence of Natural Conditions.—Distinct breeds may originate largely through the influence of the conditions to which they have been subjected in the locality which came to be the abiding home of the breed. The influence of these natural conditions was of course further accentuated by selection. The more or less divergent foundation stocks come at length to assume distinctiveness of type which becomes permanent. Such has been the origin doubtless of several of the breeds of cattle and also other classes of domestic animals found in Great Britain. The type which they assumed would be greatly influenced by environment. (See Chapter XXVIII.) The gap between the cattle of the Shetland Islands and those of Galloway is now very great, and yet it is possible that both came from the same aboriginal race. Selection alone could be made to modify form, color and other characteristics, more especially as the supplies of food increased. Crossing may also have exerted an influence, owing to the frequency of raiding in the early centuries of the modern era. Through these influences the mixed stocks of the range if undisturbed by crossing would in time assume fixed characters in harmony with the environment on that particular part of the range. Such doubtless would not be the very best way of forming new breeds in the range country, but it would be one way of accomplishing such an end.

Forming Breeds Through Crossing Followed by Selection.—In some instances breeds have been formed by indiscriminate and promiscuous crossing for a time, followed by a period of careful selection. Such was the origin of that excellent breed of swine, the Poland China. The promiscuous crossing gave a plasticity to the system which the later molders of the breed turned to good account in giving to it uniformity of type and high excellence of form. Such a system of breed forming is of necessity slow. The evolution of the breed covered more than three quarters of a century when it might have been as fully completed in less than half the time through crossing with more of definiteness of purpose. The story of the evolution of some of the breeds of swine in Britain is very similar. The first crosses made are frequently tentative. The results, if satisfactory, encourage others to do likewise. Thus it is that breed modification may extend to the breeders over a large area before the effort is made to secure definiteness in breed characteristics.

Forming Breeds Through Selection and In-and-in Breeding.—In other instances improvement has been made by a rigid selection within a type or breed, aided by in-and-in breeding. The improvement thus secured has been carried still further by accompanying it with improved methods of feeding and care. In evolution of this character, not many foundation animals were chosen at first, but they were possessed of the desired characteristics in a high degree. Such has been the origin of some of the best breeds that now exist, notably the Leicester breed of sheep, the blood of which has been so freely used in improving other breeds and also in forming some of these. The foundation animals being the outcome of variation that reaches around rather than backward would necessarily be few. The in-and-in breeding of these and their descendants for a time speedily fixed those variations. The rigid selection that usually has accompanied such breeding tended still further to secure uniformity, and the liberal food supplies carried the desired variation to a higher level.

No system of breed evolution is so rapid, since the tendency to variation is less markedly present than when alien blood has been used in making the foundation crosses. Strictly speaking such a system is more one of breed improvement than of breed formation. Because of this, it has been oftener resorted to in evolving types than in forming breeds. Since Bakewell's time all the noted improvers of breeds have followed this plan. The Colling Bros., the elder Booth, Thomas Bates, and Benjamin Tompkins are prominent in the list of such improvers.

Forming Breeds to Render Permanent Some Feature of Variation.—Some breeds have been established to render permanent a distinct feature of variation that has been considered valuable. Such, doubtless, were the facts all known, was the origin of the polled races of cattle, as there are good reasons for believing that their progenitors at one time were all horned. The distinctive feature in these instances was the absence of horns. Foundation animals that were hornless were doubtless secured at first by spontaneous variation. Careful breeding and selection did the rest. In other instances the desired feature belonged to animals of alien blood, and the characteristics of a superior breed have been engrafted upon it. The original branch of Polled Durham cattle furnishes an illustration of breed forming by this method, and the more recently formed branch of the breed further referred to below furnishes an illustration of the same by the other method previously referred to.

When the attempts were first made to breed Polled Durhams, pure Shorthorn sires were crossed upon muley cows which more or less resembled Shorthorns in their essential characteristics. Only the hornless progeny and such as were possessed of form and characteristics essentially Shorthorn were retained for breeding. These were mated and the selecting and eliminating process continued until hornlessness and other desirable qualities were fixed. As more than one breeder was pursuing the same line of experimentation the necessity for in-and-in breeding of the closest kind was not so necessary since it was possible for the various breeders who engaged almost simultaneously in the work to secure males to head their herds that were unrelated and also hornless. The other branch of the Polled Durham tree came from absolutely pure Shorthorn ancestry, the foundation animals being the unlooked for outcome of spontaneous variation. The method of engrafting the characters of a superior breed upon foundation blood more or less alien brings along with it a vigor that is distinctly advantageous, but it requires a longer time to secure uniformity in type than is called for by the other system.

Forming Breeds Through Males from Another Breed.—In yet other instances breeds have been formed by using, for a time more or less limited, males from another breed with certain desirable characteristics not possessed by the females of the foundation stocks. In this way these characteristics would be secured in the progeny, and this method of breeding would be continued until they had become so fixed that its further continuance would be no longer necessary; sires would then be chosen from within the new breed. But in some instances it has been found necessary again to resort to an occasional outcross of sires from the breed which furnished the sires at the first. The Cotswold breed of sheep as they now are, were thus evolved, sires having been chosen from the Leicester breed. The Hampshire Downs were also produced in this way by the use of Southdown sires, with the difference that now and then through the evolution period ewes were occasionally chosen from the native foundation stocks.

Leading Principles in Forming New Breeds.—From what has been said above, it will be very evident that in forming new breeds careful attention must be given: 1. To a most rigid and careful selection of the foundation animals chosen and also of the progeny of these. 2. To in-and-in breeding in a greater or lesser degree, whenever the work is to be accomplished within a reasonably limited period. And 3. To some out-crossing at certain stages of the work. The degree to which these principles should be applied will vary with the nature of the work to be done. They will be further enlarged upon below.

Selecting Foundation Animals.—In forming breeds, selection has reference mainly to the choice of foundation animals possessed of the characteristics sought in a marked degree and most of all in the choice of males. The choice of these therefore will be very limited and to secure them may involve much labor. The necessity for the utmost care in selecting such sires will be apparent because of the first great law of breeding. (See Chapter III.) It has also a regard to the continued elimination of all but the most desirable specimens as to form and quality. Undesirable specimens will appear in proportion as prepotency is wanting in the males, and also in proportion as it is present in the females possessed of undesirable variations. (See Chapter IX.) Unification and stability in properties will be secured in proportion as the elimination of animals with undesirable variations is rigid and severe, and it is greatly necessary that it shall be rigid and severe in the choice of males from within the new breed. Judicious selection will at once discard all sires deficient in prepotency of the kind sought, as soon as such deficiency has been discovered, howsoever excellent the said males may be in other respects. When crosses have been introduced selection must be specially rigid, owing to the great tendency in cross breds to atavic transmission. (See p. 317.) The influence which the character of the selection has in accelerating or retarding the work of breed formation is thus very apparent.

Artificial Characters and Selection.—The characters secured through selection may be fitly termed artificial characters, since they are created. They can only be secured in the greatest perfection by the most persistent effort in the systematic accumulation of slight variations in the desired direction. Such variations, as a rule, are only slight, hence the importance of carefully using them as stepping stones toward further variation in the same direction. They can only be retained or further developed by breeding from those animals in which they are most apparent, and they can only be engrafted upon animals of no particular breeding by persevering in the same method of carrying on the work for a longer or a shorter period.

Forming Breeds and In-and-in Breeding.—In-and-in breeding has been resorted to more or less in the formation and establishment of all the newer breeds, and for the purpose of securing and unifying, the more speedily, uniformity and prepotency of the kind sought. But it has been practiced in degrees which vary much, by the molders of these breeds. With some of them the motto was to breed for a time from animals of the closest affinities and possessed of the requisite qualities, while that of others was to breed from the best, regardless of relationships. Bakewell's practice furnishes an example of the first and that of Hugh Watson, of Keillor, an example of the second. The latter course is probably the less dangerous, although much slower than the former. The respective merits of the two systems will be influenced by the degree of the inherent vigor possessed by the foundation animals and also by the degree to which alien blood is present or absent. The greater the vigor of the foundation stocks, the closer the degree of the in-and-in breeding that may be practiced, and the longer the period during which it may be so practiced without injury to the animals. And the more diverse and numerous, as a rule, the alien blood elements in the foundation stocks, the closer also may be the in-and-in breeding, because of the renovating power which the commingling of alien blood elements usually brings along with it. The time when breeding thus closely should be discontinued and the degree of such discontinuance call for the exercise of much discrimination on the part of the breeder.

Artificial Variations May Become Latent.—If the hereditary transmission of desirable variations were not intensified by in-and-in breeding, they would to a greater or lesser extent become latent, owing to the preponderance in the more stable characters of the original type. The more concentrated the dominant blood elements in the foundation animals the more likely are these to revert to the original type when breeds are being formed. This constitutes one real difficulty in forming breeds when the effort is made to engraft new characters on animals possessed essentially of the blood elements of some ancient breed. And the more highly artificial the variation, the more likely is it to be obscured. In other words, the more that the variation is unlike the characters possessed by the original materials from which the breed is evolved, the more likely is such a result to follow. Without close breeding such characters might be inherited, but if so, it would only be inheritance more accidental than stable. True, persistent selection would eventually enable the molders to reach the goal, but not nearly so quickly. In breed formation as in other things, why would it not be much wiser to reach a given point by traversing one side of a triangle rather than by traversing the two sides of the same?

Breed Forming and Out-Crossing.—In forming breeds out-crossing is usually effected by the introduction of males possessed of the desired qualities, and chosen from unrelated or not closely related families within the breed. In forming new breeds such out-crossing may not be possible, owing to the smallness of the number of the foundation animals. In such instances, if an outcross is introduced it would have to be from unrelated blood brought in from some one of the breeds or strains from which the foundation animals were drawn. To make it from a breed wholly alien would probably make too violent an outcross. And it should be drawn from that breed or strain which will furnish it in that form best calculated to effect the purpose sought. The chief object of such an outcross is to impart additional stamina to the breed, as soon as any indications of the necessity for so doing are apparent. The time at which the outcross or outcrosses must be introduced will depend, to some extent, on the close and prolonged character of the in-and-in breeding. The outcross should be introduced in a tentative and cautious way, as increased stamina accompanied by retrogression in desirable form would be purchased at too high a price.

CHAPTER XXVIII.

THE INFLUENCE OF ENVIRONMENT.

The environment, that is to say the surroundings of animals, is all powerful in the influence which it exercises upon their development. This alone may swell out enormously the proportions to which the animals develop, or it may even dwarf them into pigmies though of the same breed. The influence of environment is all too little considered by the many when sitting in judgment on the choice of a breed. It is one thing that a breed shall suit the personal preferences of the individual, and quite another thing that it shall suit the conditions of environment.

Environment Defined.—Environment, as intimated above, has reference to the influences which the surroundings have upon live stock. These influences include climate, pastures, and food supplies for winter and summer. Strictly speaking they also include every feature of management even in its minutest details. There is virtually no limit to the extent to which these may be made to modify the type of the animal and to qualify its powers of usefulness. These various influences except that last mentioned will be further discussed. To enlarge upon the influence of the various features of management would not be opportune in a work of this nature.

The Influence of Climate.—Climate affects: 1, the constitution of animals. 2, the character of the coat and 3, through these their general usefulness.

Of course it affects these in varying degrees, according as it is rigorous, temperate or hot. The degree of the humidity or the want of this also exerts a qualifying influence. These various features of the influence of climate will be further enlarged upon.

Influence of Climate on the Constitution.—The influence of climate upon the constitution of animals is very decided. The extent of this influence is of course greatly modified by the degree of the exposure. They are hardy, first, in proportion to the rigors of the climate, and, second, to the degree to which they are exposed to it. The hardiest breeds of domestic animals therefore are found on the northern and southern extremes of the north and south temperate zones respectively, that is to say, when they are not artificially protected during much of the year. It would also be correct to say, that but for the unartificial conditions under which animals are reared in the torrid zone, they would there be the least hardy. But animals may be raised in a cold climate and, notwithstanding, be lacking in hardihood, owing to the extremely artificial conditions under which they are reared. This explains why cattle reared in cold latitudes fall an easy prey to tuberculous diseases when unduly confined to stables too warm and unventilated. But while hardihood is a valuable quality, the fact should not be overlooked that it is only of practical value when it is linked with productivity.

An animal may be possessed of hardihood in a marked degree and yet such hardihood may not be accompanied by an abundant flesh production, nor may the flesh when produced be of a sufficiently high character to make it desirable. It may also be deficient as a milk producer. Likewise the character of the coat may not rank high as in the case of some of the hardy breeds of goats and sheep. Constitution, therefore, of which hardihood is the core is a question of degree. The razorback swine of the south are infinitely hardier than the delicate over refined swine not unfrequently found in the corn belt. Likewise they are hardier than the swine of the northern states fed on a balanced ration, and yet the latter are more desirable and more valuable than either. That degree of constitution, therefore, that is consonant with the highest productivity in the broad sense of the term is sufficient, and it will vary with the object for which the animals are kept. More hardihood is wanted in the cattle kept under semi-range conditions than on the arable farm, and in those kept on the open range than in those kept under semi-range conditions.

Accommodating Breeds to Climatic Conditions.—All breeds of domestic animals have some power to accommodate themselves to changed climatic conditions, but some breeds have this power in a much greater degree than others. So it is with plants. Experience has shown that one variety of wheat, for instance, will have greater power, at least for a term of years, than any other variety to accommodate itself to the various conditions of soil and climate found in any one state or even in a group of states that may be contiguous. The reasons for this greater power of accommodation in plants or in animals cannot all be given now, and possibly they never can be so given. It would seem reasonable to say that this greater power of accommodation in some breeds may arise, in part at least, from a greater plasticity in materials of the entire organism. This at least in some instances would seem to arise from the influence of composite blood in the ancestry not too remote. This may account in part for the high adaptation of Shropshire sheep to changed conditions.

Greater resistance to violent climatic changes may, therefore, be looked for on the part of old established breeds that have long been habituated to certain characteristics of climate than on the part of breeds more recently formed. The fact is significant in this connection, that the Anglo-Saxon race so composite in blood elements in the ancestry, have been the greatest colonizers in the world. But size is also an important factor in acclimatizing power. As a rule the medium and even the smaller breeds may be successfully distributed over wider areas than the larger, and this again is influenced by production.

The Influence of Climate on the Coat.—Climate materially affects the character of the coat. This has already been discussed to some extent. (See Chapter XIX.) It was there shown that a cold climate thickened the coat of animals, and tended to make it finer, that a hot climate tended to make it open and coarse, that a dry climate tended to make it short, and that a moist climate tended to make it long. It was also shown that these influences were modified by other conditions, as heredity, food, digestion, sunshine and protection. It may be added that the influences thus exerted are probably relatively greater in degree with those classes of live stock that are heavily covered, as sheep. It is only natural that it should be so, since the longer the covering and the more dense, the greater relatively is the bulk and superficies to be affected.

The Influence of Climate Upon Utility.—Through the influence of climate upon the constitution and coat of animals their utility is materially affected. A change from a climate extreme in heat or cold to one temperate is usually favorable to higher development. For instance, if an animal is taken from a very cold climate to one temperate, while hardihood in the sense of ability to endure may be lessened, yet, under proper care it will not be lessened so as to interfere with utility. Utility is almost certain to be increased since less of the food is wasted in the fight with rigors of climate. The coat may be made less dense, but there will probably be more than compensation in the increased length of the same. This when the coat is manufactured means added value. On the other hand a change from a hot climate to one temperate strengthens the constitution, and thickens and lengthens the coat. It holds good therefore that a change from a climate extreme in heat or cold to one temperate is usually favorable to higher development, while a change from a temperate climate to one of extremes is usually unfavorable to development. But in sitting in judgment on this question, the effect of other influences should not be overlooked.

Influence of the Pastures.—The character of the pastures influences: 1. The size of the animals. 2. The relative development of certain parts of the body. 3. The quality of the flesh and fleece, and, 4, The health of the animals. These influences will be further considered separately.

The Influence of Pastures on Size.—The influence of the pastures upon the size of animals is all-important. In its relation to adaptation in breeds this influence should never be overlooked. As a rule, the more sparse the pastures, the smaller the breed which they will maintain. This arises, first, from the less quantity of food required to maintain a small animal; second, from the less effort required by the same to carry about its less ponderous body in search of food; and third, from the greater ease with which in consequence it travels over the relatively large area to gather the food of each meal. In consequence small breeds can oftentimes maintain themselves in the pink of condition when large breeds of the same species would go on short supplies and would consequently fare badly. When heavy breeds are put upon sparse pastures they deteriorate not only in size but also in useful qualities.

In the future "battle of the breeds," this fact will always enable the small breeds to win out under such conditions. These, therefore, will never be supplanted by those larger in their own proper domain, and failure will never cease to be written on the work of those who attempt to supplant them with breeds too large, unless increased productivity in the pastures accompanies increased size in the animals. The reverse is also true. Rich pastures and especially those level in character tend to make small breeds larger when grazed upon them, hence it is usually considered more profitable to stock such pastures with breeds that are already large. But while large breeds cannot be maintained on sparse pastures without supplementary food, it does not follow that a small breed will not prove profitable on rich pastures. Southdown sheep may prove highly profitable on the best of pastures. Again, pastures intermediate in character are best adapted to sustain animals intermediate in size and this fact should be duly regarded when choosing breeds to put upon these. But climate exercises a powerful influence upon size, as well as pastures.

As a rule the extremes of heat and cold affect size adversely. The latter is more antagonistic to size than the former, especially when linked with irregular and insufficient food supplies. Because of this, the smallest specimens of any breed are found in the distant north. The largest and most perfect of these are found in temperate regions. Hence it is, that the largest breeds of cattle, sheep and swine have not usually been found so well adapted to the conditions of the southern states as to those further north. But to this there may be some exceptions. The larger breeds suffer more relatively from the summer heat when carrying around their heavier bodies while getting food through grazing.

Pastures and Special Development.—The character of the pastures exercises no small measure of influence on what may be termed special development, that is, development of certain parts of the body. When the pastures are rugged there is an increase of development in the fore parts of the body. The muscles of the forearm and certain other parts of the front quarter being much used in climbing are made strong. There is also decrease more or less in the development of the hind parts of the same, notwithstanding that the muscles of the thighs remain large. But too much should not be made of such decrease since so much depends upon the degree of the climbing.

The relations also between the relative proportions of bone and flesh are more or less altered by the character of the pastures. Those deficient in lime cannot maintain a sufficiency of bone, hence, breeds reared upon them are certain to deteriorate in size and in other useful qualities, notwithstanding that the grasses may be abundant. Such are some of the pastures of the upland regions of some of the south-eastern states. Kentucky has long been famed not only for the abundance of its blue grass pastures springing out of a soil rich in lime, but also for the robust development in form and limb of the animals which feed on these. The pastures of the downs in the south of England, which are short and sweet and greatly nutritious, produce an abundance of flesh but without any excess in bone.

The Influence of Pastures on Flesh and Fleece.—The finer the pastures the finer the grain of the flesh produced. Pastures coarse in character produce flesh coarse in fiber though it may be abundant. What are known as chalk soils are proverbial for the fine quality of the flesh which they produce. The greater the variety of the pastures and the more numerous the aromatic plants which they contain, the more highly flavored is the meat. In this fact is found one explanation of the high character of the meat of the mountain breeds of sheep and also of the cattle that feed upon the slopes of the mountains. The same is true of meat grown on certain of the western ranges. These pastures, however, are usually less succulent than those of the mountains and the meat in consequence is less juicy.

The richer and the more succulent the pastures, the more superior the quality of the wool which they produce in sheep. Such pastures stimulate the circulation concerned in the nourishment of the wool and also the action of the glands which lubricate it. As a result the fiber of the wool is strengthened, its length is increased, its luster is improved, the yolk in it is ample. Its appearance externally and especially when the fleece is opened is healthy and attractive. The fact is also significant that usually a short staple of wool and denseness in the same are oftenest found on pastures short and fine, and more length of staple and less density upon pastures more rank and coarse. But caution should be exercised in weighing these questions, lest too much stress shall be laid upon the influence of pastures on the wool rather than on that of breeds and breeding.

Pastures and Health in the Animals.—Good health in domestic animals as in the human family is affected by their surroundings. Low pastures affect adversely the health of nearly all the breeds of sheep, even though these should be drained. They do so for the reason, first, that in them parasites so fatal relatively to sheep are much prone to breed in low lands, and second, that it is more in consonance with the nature of sheep to graze upon undulating slopes and uplands. Some large breeds of sheep, however, as the Lincoln and Romney Marsh breeds are reared on just such low lands, but these are contiguous to the sea and, because of the saline nature of the rains resulting from proximity to the sea, parasites do not abound in these pastures. Pastures wet and undrained affect adversely the health of nearly all classes of domestic animals but not equally. They injure sheep more than other animals, and swine less. In fact sheep cannot prosper when confined to such pastures even though located near the sea. But it would scarcely be correct to say the same of swine, since they love to wallow in moist and wet places in hot weather. But even swine will thrive better on drained pastures if they can at the same time have access to such waters. Stagnant waters, especially during the season of hot weather, are injurious to animals as they usually become a refuge for parasites of various kinds and in time they become more or less befouled by droppings from the animals which drink from them.

The Influence of Food Supplies in Winter.— An abundance or scarcity of food supplies in winter, the character of the same as to variety, the relative coarseness and fineness of the fodders, and the degree of the aroma, influence development similarly to the presence or absence of these in the pastures. Abundance in winter foods tends, of course, to promote development. Scarcity in the same retards it. Variety is appetizing and because of the influence which it exercises on increased consumption is favorable to growth. Variety also generally tends to produce a more perfect balance in the ration. Coarseness in the fodder tends to produce coarseness of fiber in the flesh. Fineness in the same exerts an opposite influence. Aroma in the fodder by making it more appetizing increases consumption of the same and in this way promotes development. It also exerts a favorable influence on the flavor of the flesh which it produces. Succulence in the winter food and also nutrition up to a certain degree influence favorably development, fecundity and productivity generally. (See Chapter XVII.) The flavor of the milk produced is also much influenced by the food fed. Certain foods, as turnips and rutabagas, tend to produce odors more or less offensive in the milk. The same is also true of certain pastures in summer, as rape or rye. Such taint however may usually be prevented by allowing the animals to partake of such foods only within a limited period after each milking.

The Influence of Shelter in Winter.—Suitable shelter in winter intensifies all the influences of suitable winter feeding that have been mentioned above. It is sufficient when the animals, according to their kind, are kept in comfort. The degree of the shelter necessary varies much with various classes of animals. Sheep and horses not at work require less shelter relatively than cattle and swine, since the former are much protected by the fleece and the latter tend to neutralize the influences of cold by the abundant exercise which they take. Swine require shelter greater in degree than horses, cattle or sheep, since nature has furnished them with a less dense covering than is possessed by the animals just named. Humidity or dryness in the climate also exercises an important influence on the degree of shelter necessary.

A moist climate with much rainfall in winter calls for more protection relatively than a dry climate with lower temperatures, and more of winter sunshine. Exposure to cold rains or sleet storms is specially harmful to all kinds of domestic animals. When unduly exposed to these their development will be correspondingly hindered and also the profit from keeping them. Winter shelter is excessive when it so impairs vigor and hardihood as to hinder future development, and when it interferes with profitable returns. Sheep especially are susceptible to injury from too close confinement in winter. The stamina of many excellent dairy herds has also been injured in the same way. Good health in animals is no sooner injured by such treatment than profits diminish.

The Influence of Shelter in Summer.—Shelter in summer furthers development and productivity and chiefly for the reason that it keeps the animals so sheltered from discomfort and worry. It is sufficient when the animals according to their kind are kept in comfort. The chief influences to be guarded against are first, annoyance from flies, and second, undue exposure to sunshine. The unrest caused by flies is sometimes very great, so great that growing animals otherwise well cared for, make but little progress during the fly season, unless protected from flies. The bite or sting of the fly causes the unrest.

Two modes of protection have been adopted. By the first, some substance usually liquid, offensive because of its odor, and in some instances more or less destructive to the flies is applied, as by spraying or sponging. By the second, the animals are kept in sheds or stables sufficiently ventilated and the windows of which are darkened. The second method is the most effective. Flies shun the darkness. But it is only applicable to studs, herds and flocks, limited in numbers. The weak points about external applications are, first, their cost, and second, the short duration of the period during which they protect without renewal. The person who will introduce an external application, cheap and easily prepared, that will be greatly destructive to flies and not injurious to the live stock and that will not call for renewal oftener than once or twice a week, is sure of an earthly immortality.

The method most commonly adopted in protecting from excessive sunshine is to give the animals access to the shade of groves or trees growing singly or in clumps. Because of this, pastures amply furnished with such shade and also supplied with running streams are greatly desired by the keepers of stock. But while shade from trees is good that from darkened sheds is better and especially when of the basement character, since basement stables are cooler, and they also protect from flies.

Environment and Adaptation.—From what has been said it will be clearly evident that environment exercises a marked influence on adaptation. The degree therefore of the success in planting any breed in a certain locality will depend very largely on environment in relation to the natural adaptation of the breed. With environment ill adapted to the needs of the breed, it can scarcely be made profitable. And just here it may be added that, in placing breeds, it has been found that more satisfactory results have been obtained where they have been planted in localities with a producing power rather beyond than short of the requirements of the same. In other words, animals more readily accommodate themselves to conditions in advance of their exact needs than to those that fall short of the same, and on the broad principle, perhaps, that accommodation in the line of expansion is usually more easy than accommodation in the line of contraction.

CHAPTER XXIX.

CASTRATION AND SPAYING.

Castration and spaying, that is to say, removing the testicles in the one case and the ovaries in the other, have long been practiced. It cannot now be known when or how these practices first came to be introduced, since both have been practiced for a period so long that the dim and distant past will never disclose the period when they were first introduced. From the very nature of the operation and the results flowing therefrom, it is probable that castration was practiced at an earlier period than spaying. It would be discovered sooner because more easily discovered, and the necessity for it would be more apparent because of the less need for as many males as females to sustain reproduction.

Castration Defined.—By castration is meant the artificial removal of the testicles in males. Among the objects sought by such removal the following are prominent: 1. To render them incapable of reproduction so that careful selection for breeding purposes may be easily possible. And 2. To secure more profitable returns when growing them for meat. In nature selection in the males is made on the ground of physical strength. It is simply an illustration of the survival of the fittest. But when man selects he improves upon nature by giving careful attention to other features of form in addition to those which constitute strength, and he is enabled to do so by rendering undesirable males incapable of begetting, by castrating them. The argument has been brought against castration, that since nature produces about an equal number of males and females, it was intended that they should be mated accordingly, but the answer is also found in the domain of nature, since, when animals are not under the guidance of man, generation comes through only a limited number of males, and as has been pointed out, because of their physical strength. The reason why returns are more profitable from castrated than from uncastrated animals as viewed from the standpoint of meat and labor are considered below.

The Principal Benefits From Castration.—The following are chief among the beneficial influences that follow castration: 1. It promotes absolute development. 2. It hinders undue development of the parts less valuable as food. 3. It tends to cause the energies of the system to concentrate in a much greater degree upon the development of those parts of the body suitable for food. 4. It cheapens the cost of producing meat. 5. It prevents the production of meat possessed of an offensive taint. 6. It usually corrects all tendencies to viciousness. And 7. It promotes the ease with which the animals may be managed. These respective benefits will be further considered.

Castration and Absolute Development.—Castration promotes absolute development by arresting that division of the energies of the system necessary to the development of the generative organs. The organs of generation and the generative function are as much a matter of growth as any other part of the system. If left undisturbed, therefore, they draw upon the energies of the system for sustenance. When the testicles are removed, and usually they are at an early age, such drafts cease. The sustenance, therefore, which would otherwise be required for such development is left free to assist in developing the system as a whole. The relative amount of nutrition called for in developing and sustaining the generative functions is a factor that cannot be determined with precision, but it is thought to be considerable. Practical stockmen claim that castrated animals require considerably more feed to develop them than those uncastrated. How much more food is thus required does not appear to have been made a matter of experimentation. They also claim that the difference is greater relatively after that period is reached when the generative functions become sufficiently developed to beget or to conceive. Castration also aids in securing that quietness of disposition in consonance with the highest possible development. After reproduction becomes possible the animals become less restful; especially is this true when the females are in heat. The highest possible development, therefore, is hindered in proportion as such restlessness exists. A quicker maturity is therefore possible in the castrated animals and in all probability a greater absolute weight.

Castration and Arrested Development.—Castration hinders undue development of certain of the parts less valuable as food. In the uncastrated animal there is relatively large development of the head; of bone throughout the system, including horn; of neck, hide and hair, and of some other parts of little or no value as food. The meat value of the head is trifling. Bone is in a sense offal and therefore discounts the value of the dressed carcass in proportion as it is excessive. The relative market value of the neck and breast, always abundantly developed in uncastrated animals, is low compared with that of certain other parts of the carcass. The discrimination, therefore, in the meat markets against uncastrated animals which have passed a certain age is not fanciful, but is grounded on the best of reasons. The extent of such discrimination against the carcass of uncastrated lambs from nine to twelve months old in the New York markets during recent years has run from 10 to 20 per cent. of the value of the entire carcass. The older the animals become the greater is the discrimination against uncastrated males in all markets. In the case of aged boars it is in some instances considerably more than 50 per cent. No sooner has castration been effected than undue development of the parts named ceases entirely or is arrested in a marked degree.

Castration and Useful Development.—Castration not only favors increase in absolute development, and hinders undue increase in the development of the parts that are less valuable, but it also promotes relative development in parts that are most valuable. It does so by enabling the energies of the system to act more in concert in promoting useful development. Nutrition that would otherwise be used in developing the less valuable parts of the system is thenceforth diverted to the development of the system as a whole, hence a more perfect development of the more useful parts is secured than would be possible under the opposite conditions. The energies of the system utilized in developing and sustaining the generative organs and function in uncastrated animals would also be devoted, in part at least, to the development of the more useful parts of the system in castrated animals.

And the waste of energy consequent upon that greater degree of unrest that characterizes uncastrated animals would, instead of being dissipated to no purpose, act in the same direction. With these forces thus acting in conjunction, the value of the entire carcass could not but be considerably enhanced, first through suppression in the less valuable parts of the carcass, and second, through increase in the more valuable parts.

Castration and Cheapness of Production.—That castration at the proper age cheapens the cost of production in meat will be evident from what has been said above regarding its influence, first, on absolute development, second, in arresting development, and third, in promoting useful development. It has been shown: 1. That it insures in a greater or a less degree of immunity from that restlessness which hinders flesh development in proportion as it is present. 2. That it insures the production of meat superior to what it would otherwise be by suppressing development in the less valuable parts, and by promoting it in those more valuable. And 3. That it secures a greater return in quantity. The conclusion therefore is self-evident, that castration materially cheapens the cost of production in meat, even without taking into account the greater ease with which castrated animals are managed, as shown below. When to this is added the increased value of such meat on the block, the importance of giving due attention to castration will be abundantly evident.

Castration and Taint.—Castration hinders the production of meat with that taint which is sometimes imparted to it from activity in the generative functions. When the reproductive organs have become sufficiently developed to insure generation, they sometimes give to the meat more or less of a peculiar taint. This taint is imparted to it or at least accentuated through activity in the generative functions. It is not easily described. When present in a marked degree, it is discernible both through the organs of taste and smell. It has some resemblance to musk. When referring to it, it is common to speak of the meat as being "strong," but such language is very indefinite. The taint is more marked in well matured animals, at the special seasons for service, and in proportion to the frequency with which the animals are used in service. Such taint is entirely absent before the males are capable of begetting, and it usually increases with the age of the animal. While it is present only in a slight degree and frequently not at all at certain seasons of the year, it is markedly present during the mating season. Activity in the generative functions and the reflex influence of the same on the system as a whole is probably the cause. To lessen this taint, aged males are frequently bled to death by a slow and gradual process. In other instances they are subjected to the hazard of castration before the final fattening process.

Castration and Viciousness.—Castration usually corrects all tendencies to viciousness, at least it does so generally in no small degree. The influence which it thus exerts upon the spirit and temper of the animal is even greater than that which it exercises upon development. But when done at a comparatively early period, the immediate results are not so apparent since a sufficient age has not been reached to manifest in any striking way the characteristics of temperament. The influence thus exercised is always of a softening character, and so patent is it that after castration the element of danger from males previously pronouncedly vicious in character is almost wholly eliminated. Thus it is that in horses and oxen kept for labor, castration is almost universally practiced. The animals are thereby also rendered more useful, since, in addition to an increased mildness of temper, they are also possessed of more reliability in the line of obedience. This greater tractability is doubtless owing, in part, to the complete elimination of the unsettling influences arising from sexual desire. It has been noticed that castration enhances fidelity even in the dog. In the absence of castration it would scarcely be possible to manage animals kept for labor without the hazard of many accidents to those engaged in handling them and in some instances the loss of life.

Castration and Ease in Managing Animals.—Castration promotes the ease with which animals may be managed. 1. They are more easily restrained by fences. With uncastrated males on one side of a fence and females of the same species in heat on the other side, no ordinary fence would suffice to prevent stallions or bulls from breaking through it. The habit once learned would not readily be forgotten. 2. Males and females may be kept together when necessary in the pasture, or in the feed lot or feed yard. In the absence of castration it would be necessary to keep males and females in distinctly separate inclosures, otherwise mating would be promiscuous and this would be fatal to the further improvement of live stock. While such measures would be expensive and difficult of accomplishment in summer they would also be still more expensive and difficult of accomplishment in winter. 3. The animals are more submissive to restraints put upon them and this will hold true whatsoever the character of the restraints. It is evident therefore that castration makes the entire management of animals much easier in every way that it would otherwise be.

The Beneficial Effects of Early Castration.—The beneficial effects from early castration are usually, if not indeed always, proportionate to the nearness to the birth period when it is done. It is usually deemed advisable, however, to allow all young animals to remain uncastrated for at least a week from the time of birth. Time is thus given to the young animal to safely adjust itself to the new conditions of its being before anything is done that will even temporarily weaken the action of the vital forces. When castration is done early there is then practically no undue development of the parts less valuable as meat. (See page 364.) Nor are the energies of the system diverted from building up the true meat-producing form. The best age therefore at which to castrate meat making animals is when they are young.

The most satisfactory results are obtained when swine are castrated while yet on the dam and even when not yet one month old. The same is also true of lambs. Calves may also be best castrated under the age of a month, whether reared on the dam or by hand. But it is not to be understood that results seriously unsatisfactory will follow if the animals are allowed to reach a greater age before they are castrated. When preserving only the choicest of the males as sires, it is frequently necessary to defer castration until the animals are so far developed that the ultimate form which they will assume can be pretty certainly known. Thus it may be necessary sometimes to defer castration in meat making animals until that period is closely approached when they become capable of begetting. Since colts are not grown for meat, it is usual to defer castrating them until they have reached the age of several months or even a year, and partly for the reason, that time is thus given for the development of that spirit and nerve so essential to the usefulness of the horse.

Castration and Advancing Age.—The danger attendant upon castration increases with the advancing age of the animal. This is owing, in part at least, to the greater violence of the shock produced upon the system. At maturity the forces of the system have become so set in their action, that to thus divert any part of them thus suddenly produces serious disturbance to the whole system, and so serious in occasional instances as to result in the death of the animal. Such a result may also be owing in part to the decreased activity of the functions which sustain the system generally, including those concerned in the repair of the injured parts. Thus it is that the repair of injured parts is increasingly difficult as the birth period is receded from.

Spaying Defined.—By spaying is meant the removal of the ovaries in females. The objects sought in spaying are, first, to render females incapable of breeding, and second, to render them more capable of being easily fattened. In many instances it may not be desirable to keep females for breeding because of undesirable form or because of excess of numbers. In such instances, therefore, the goal of these is the block and at an early age. If not spayed as soon as these animals become capable of breeding, they are notably restless during the period of heat, and are also at such times more or less of a disquieting factor to the animals with whom they feed. Such disquietude is unfavorable to flesh production. When the ovaries are removed the energies of the system that were previously concentrated on building up and sustaining those parts concerned in generation are diverted to the production of meat. Beyond these advantages no others that are very marked would seem to be secured, since spaying does not arrest the development of the less useful parts as castration does in males.

Spaying More Difficult than Castration.—Spaying is a more delicate operation than castration. It is also more difficult and it is attended with more of hazard. That it is a more difficult operation to perform will be manifest from its nature, the ovaries being not so readily accessible to the operator. The greater difficulty of the operation increases the liability that it will not be performed with the necessary precision, hence the increased hazard. Spaying should not be done therefore unless by a properly instructed operator. This does not mean that no one save a professional man should do this work, for non-professional men have in many instances been pronouncedly successful in the same, but that no one should attempt it who has not been carefully instructed as to how it should be done, and that none should engage extensively in the work until they have first proved their fitness for the same by the success that has previously attended efforts restricted in their scope. Nor should spaying ever be done unless some distinctive advantage is to be expected from it that will more than make up for the temporarily arrested development that immediately follows the operation.

Spaying Less Necessary than Castration.—The necessity for spaying females in localities where stall feeding is practiced and where early maturity is sought is not so great as for castrating males. In such localities males kept for service are not usually allowed to run at large with the females, hence the latter are easily preserved from becoming pregnant. The early maturing of animals has also shortened the period required for their development, and in proportion as this period has been shortened, the necessity for spaying has been lessened. Nevertheless, it may be advantageous in pastoral countries where fencing and building materials are not plentiful. The same is true and even in a greater degree of open ranges where the animals run at large during all or nearly all the year. Under such conditions it would scarcely be practicable to prevent them from becoming pregnant in any other way than through spaying.

Animals With Imperfect Procreative Organs.—Animals with but one testicle and one ovary are quite capable of begetting and conceiving as the case may be when the development of one or the other of these is perfect. Young males greatly prized because of their lineage have been frequently rejected as sires because of the absence or imperfect development of one testicle, when, at the same time, they would beget surely and with much potency. The objection, however, remains, that on the principle of the first great law of breeding, the offspring might inherit in some degree the tendency to such development. In some instances males possess the power to beget when the only testicle developed is wanting in complete development. In other instances they cannot beget. Of course animals of this class should not be kept for breeding where the defect is known. It should also be remembered that it is not wise to allow a male with but one testicle, though ill-developed, to run at large with females, even though incapable of begetting. Such an animal disturbs them more or less and such disturbance is prejudicial in proportion as it is present.

CHAPTER XXX.

MATING ANIMALS.

The question of mating animals properly is not well understood by the many. Nor is it surprising that it is so, since it virtually involves the application of every principle concerned in selection. (See p. 303.) That it is not better understood is unfortunate for live stock interests, since, without a proper knowledge of mating animals so as to eliminate defects, a high standard of attainment cannot be reached when breeding them.

One Chief Object in Mating.—In mating animals one chief aim should be so to pair them as to correct in the progeny what is deficient in either parent or in both. For example: if one parent is weak in the hind flank the other should be strong there. Or, should one parent be unduly long of limb the other should be more than ordinarily short of limb. It may not be possible in practice to always choose animals thus when mating them, for the reason that when a number of types are found in one herd on the side of the females, to mate them thus would involve the purchase of as many males as there were different types among the females. Such conditions are frequent when the materials are brought together to found a herd. It is a result that is generally the outcome of inexperience, or of lack of knowledge on the part of those establishing herds. It does not follow that the types chosen are inferior, but simply that they are different.

Under the circumstances therefore, where one male will suffice in a stud, herd or flock, it is greatly important that the said male shall be a typical specimen of the kind of animals which it may be desired to breed. If the same plan of breeding is continued from year to year, in a few generations the diversity in type in the foundation females will disappear in the progeny. Such mating may not at the first conform fully with the principle of so mating animals, male and female, that each parent shall help the defects of the other in the progeny, but it is the nearest approach that can be made to it in practice when only one male can be kept for service. It is of course different when several males are so kept, for then there is more latitude in the choice of the male that shall be paired with each female.

Defects that Belong to Both Parents Intensified.—When the same defect belongs to both parents, it will almost certainly be intensified in the offspring. Breeding on such lines should be sedulously avoided, since, first, it will tend to perpetuate in animals that which is faulty in type. Such breeding would be a mistake, viewed from the standpoint of financial gains, and serious in proportion as the defect is relatively serious. And second, the danger would exist that the longer such breeding was practiced the more difficult would it be to correct the evil.

How to Correct Characteristic Defects.—When any defect is so common that it may be looked upon as a characteristic of the herd or flock, rather than an accidental variation, it is greatly important that a prepotent sire shall be chosen possessed of characteristics that are likely to remedy the defect. If such a defect is an original trait of the species, it may stubbornly resist such correction. Examples are found in the attempts that have been made to remove lightness of thigh in the Hereford, over-nervousness in the Ayrshire and the white color in Shorthorns.. After many years of careful breeding some Herefords are yet a little light in the thigh. Ayrshires are yet in some instances over-sensitive, and the white color in Shorthorns is still more or less frequent. Usually, however, some progress will be made in correcting such defects each successive mating with prepotent sires.

Mating and Compactness in the Sires.—In breeding or mating animals when there is a difference in male and female, as such, as to compactness, it is considered preferable to have the male the more compact of the two. This, by many good breeders, has come to be recognized as a principle that should apply in the selection of males and females for breeding. It rests first in the fact that the compact form is associated more or less closely with vigor of constitution, which is considered more important relatively in the male. In this way the careful choice of males may be made a safeguard in protecting constitutional vigor, and it should never be lost sight of when selecting them. It rests, second, in the fact that the body of the female ought to be more roomy relatively than that of the male, so that in the process of generation the well developed fœtus within the former will not press too much on the space occupied by and belonging to certain other organs of the body. The relation is also close between the large, roomy barrel in the female and free milk production after the young have been brought forth. And such females breed more regularly and are more reliable as breeders than those of the blocky type. But care should be taken not to press these distinctions too far, nor can they be applied in equal degree with all classes of live stock.

Mating Females Unreliable as Breeders.—When the breeding powers of the female are unreliable, it is important that she shall be mated with a vigorous male. Such mating will be more certain to insure conception. And if the male is possessed of mixed or alien blood, conception in the female, it is thought, is more assured. Whether such a result is to be attributed to the simple fact that such blood is alien is yet an open question. Mixed blood especially is frequently associated with greater individual vigor than blood long bred without any admixture of alien blood. But the effort thus to improve the breeding powers of females unreliable as breeders will not avail, unless care is taken at the same time to maintain the system in such a condition as will be favorable to conception, by feeding food eminently suited to such an end, and by giving all the exercise practicable under the circumstances. It may even be advantageous to insist upon enforced exercise, as, for instance, using such a female upon a tread power. Such exercise with mares kept for breeding is more easily controlled than with females of other classes of animals.

Restoring Power to Beget in Males.—When the begetting powers of valuable males have become impaired to the extent of being unable to procreate, they may in some instances be restored. The measures that favor such restoration will depend upon the nature of the loss in begetting power. Usually, however, they will include the following: 1. Giving the liberty of a pasture. Such liberty is usually very helpful when the animals have previously been more or less confined.

2. Enforcing exercise by labor. Bulls especially may be managed thus in winter when pastures are not accessible. 3. Reducing the system gradually by feeding foods less concentrated. Gradual reduction is recommended, since sudden changes tend to disturb yet further rather than to correct derangement in the system of animals. 4. Feeding a small quantity of ground wheat or of some other food well capable of nourishing the procreative powers. The effectiveness of these measures will be considerably dependent upon the cause of the impotency. If it has arisen simply from the want of exercise or from excessive feeding as in fitting for the shows, the hope of restored power to beget may be cherished. If on the other hand organic derangement has been the cause, the hope of restoration is much weakened.

Females Irregularly in Heat.—It will not avail to have females served which manifest the breeding impulse at irregular periods. The recurrence of those periods in mares, cows, ewes, and sows is at intervals of twenty-one days. Their duration is usually from two to three days. And their regular occurrence at such intervals is a pretty sure indication of healthy action in the organs concerned in generation. On the other hand when the periods of heat come at other times they bring with them evidence of derangement in the breeding organs. And the evidence is strong in proportion as the irregularity is marked. If such derangement cannot be corrected by treatment of one kind or another, conception cannot take place.

Females too Frequently in Heat.—When females manifest the breeding impulse every few days and go about the pastures restless and continually disturbing the other animals of the herd, they should be sent to the block. Sometimes such instances occur in herds of cows. The individual thus affected will roam about the pastures disturbing the other animals of the herd and lowing more or less. These manifestations indicate such derangement of the reproductive functions as ordinarily resist remedial measures. To have such animals served is simply to waste to no purpose the energies of the male. The disquietude which such an animal may cause in a herd may soon lead to serious loss, hence it should at once be removed and made ready for the block. And since it may not fatten readily because of the unrest which characterizes it, there may be wisdom in sending it directly to the block, even though at an apparent sacrifice.

Sudden Changes of Condition Unfavorable to Breeding.—When animals have been pampered by high feeding, sudden changes of condition are unfavorable to regular breeding. For instance, when they have been forced into high flesh as for the show ring, they are more likely to breed if kept in a fairly high condition of flesh subsequent to having been exhibited than they would be if the condition of flesh was suddenly reduced. While reduction of flesh at such a time will probably prove favorable to breeding, it ought to be a gradual reduction such as follows a reduction in the carbonaceous food elements and an increase in succulence in the food given. A uniform condition of what is termed as being in good flesh and even high flesh is more favorable to regular breeding than marked alternations in condition. This partly explains why some herdsmen succeed in getting show animals to breed with no little reliability while others fail. Nor should the fact be overlooked, that when there is a necessity for feeding carbonaceous foods, those of this class that are succulent will be much more favorable to conception and generation than if the succulent element were lacking. (See p. 208.)

Violent Crossing or Mating Defined.—Violent crossing or violent mating may relate: 1. To the mating of animals dissimilar in species. The mating of the ass and the mare illustrates such mating. 2. To the mating of animals of the same breed but of lines of blood or of families unrelated, and differing much in type. For instance, if in breeding Aberdeen Angus cattle a line bred female of the Pride family were mated with a male of some obscure family and essentially of a different type, though of the same breed, such crossing may be spoken of as violent crossing. 3. It may further relate to the mating of animals between whom there is great disparity in size, even though of the same species, as, for instance, mating a ponderous Clydesdale stallion with a Cleveland bay mare. Such crosses are not desirable as will be shown below, and consequently should be avoided unless a definite purpose is to be served by making them.

Mating Different Species.—Such mating is unfavorable to continued reproduction, as witnessed in the total inability of the jack to beget, and the almost total inability of the hinny to breed. The jack, as is well known, is the male progeny of the ass and the mare. The hinny is the female progeny of the horse and the ass. Both crosses are made with a view to unite certain good qualities possessed by both species in the progeny. The former is the favorite cross. The jack has much more size and speed than the ass, and linked with such increase in size and speed, is much of the patience, fortitude and endurance of the ass, along with ability to thrive on fare which would not maintain the horse in good form. But this combination of qualities cannot be thus perpetuated by breeding from the progeny. Nature has erected a barrier between the species which is unquestionably intended to protect the same. Because of this, man cannot break down such barriers with impunity. Hence it is that efforts to perpetuate the progeny resulting from the union of the buffalo male with Galloway cows has not heretofore been successful.

Mating Dissimilar Types.—The great objection to crossing or mating types that are dissimilar, arises from the danger of producing undesirable variations. Good qualities secured by generations of careful breeding may thus be sacrificed in a single cross. Outcrossing within a breed may sometimes be necessary as previously shown (see p. 133) but whenever done it ought to be done cautiously and in a tentative way at the first. Since, however, types long bred in line and in consequence weakened in stamina, may in some instances be renovated and improved in this way, such crossing or mating should not be too pronouncedly discriminated against.

Mating Animals Differing Much in Size and Shapes.—Mating or crossing animals between whom there is great disparity in size is not desirable. Trouble may arise at parturition, especially when the male is larger than the female, not so much from the absolute size of the young animals when born, as from peculiarities in development. It is at least questionable if the size of the fœtus when fully developed is affected by the size of the male or by the amount of the male element of generation present at the time of impregnation. That would seem to be controlled almost entirely, if not indeed entirely, by the extent to which the fœtus is nourished by the female during the period of intra-uterine development. This may be contrary to the popular view, but is it not sustained by the facts? After parturition, however, there can be no question but that size is affected by inheritance from both parents, and it is also true that form is influenced by the male parent as well as by the female. And because of this, peculiarities of form may arise, which, as a direct result of certain kinds of mating give trouble at the time of birth. When the disparity in size is very marked it has been noticed that more difficulty is found in obtaining form that is desirable than when the mating is of an opposite character.

Service Soon After Parturition.—It is not considered good practice to serve females, as sows for instance, within a few days of the date of parturition. This practice has been followed by some breeders who have the sow served within two to four days of the birth of the pigs. Such breeding would incur the hazard: 1. That the vigor of the female would be injured by overtaxing; 2, that the litter she was feeding would not be so generously fed; and 3, that the fœtus of the future litter would also be deprived of that nourishment necessary to insure desirable development. Sows will not always accept service at such a time, but when they do, the machinery of the vital forces is being driven too rapidly. During the nursing period it is difficult in any case to prevent reduction in the condition of the sow. When the tax is put upon her of sustaining such a family, and of nourishing the fœtus at the same time while in process of development, the burden must unduly tax the energies of the sow. The litter she is nursing cannot but in some degree fall short of the sustenance that they would otherwise get from the sow, and the litter in embryo, as intimated, is also deprived of a full measure of sustenance. It would not be long possible to maintain sufficient vigor in swine where such a method of breeding was generally practiced. Nor is it necessary in sows even where two litters are produced in a year, for this result can be accomplished though the mating of the sow should be deferred for two months from the date of the birth of the young pigs.

When two crops of lambs in one year are exacted of ewes in a climate where the winter is stern and long, it is very doubtful if sufficient size and stamina in the same can be maintained. It may be different, however, in mild climates. Nor do experienced stockmen care to have cows served the first time they come in heat after having produced a calf. If the cows are well sustained this frequently takes place in about six weeks from the time of parturition. They claim that conception is less certain than when the mating is longer deferred. But when mares are to raise colts every year, it is necessary that they shall again be mated a few days subsequently to the birth of the foal. The favorite time is nine days after the foal has been born. If such mating is to be commended in the mare, why should it be condemned in the sow? The conditions are different. The mare has eleven months to grow the fœtus, the sow has less than four. The mare can nurse the foal for half a year and more, the sow has only a few weeks in which to nourish her litter. The drain, therefore, on the system of the former in producing her young is much less relatively than on the system of the latter.

Overtaxing Prior to Mating.—When the energies of the animal have been overtaxed, or when animals have been violently exercised just before mating, the danger of failure in conception is more imminent. These facts should be given due recognition when animals are to be mated. The reference here is not so much to energies reduced through severe and prolonged labor as to the overtaxing of the same during the period of heat. Where females are to be taken a long distance to be mated, they should either be carted, led or driven slowly. Violent exercise at such a time is quite unfavorable to conception. And after females have been mated it is equally important that they shall not be allowed or required to take violent exercise.

APPENDIX A.

PERIOD OF GESTATION IN DOMESTIC ANIMALS.

The average duration, approximately, of the period of gestation in domestic quadrupeds may be given as stated below:

The Ass	365 days.	The Sow	113 days.
" Mare	330 "	" Dog	63 "
" Cow	282 "	" Cat	50 "
" Sheep	149 "	" Rabbit	30 "
" Goat	149 "	" Guinea Pig	21 "

The average duration, approximately, of the period required in hatching the eggs of the various domestic breeds of fowls may be set down as follows:

The Goose	30 days.	The Guinea Hen	26 days.
" Turkey	29 "	" Hen	21 "
" Duck	29 "	" Pigeon	18 "
" Peahen	28 "		

The extremes in the duration of the period of gestation in the mare, the cow, the ewe and the sow may be set down as follows:

The Mare	295 days to	370 days.
" Cow	265 "	300 "
" Ewe	145 "	154 "
" Sow	110 "	118 "

The extremes in the duration of the period of incubation in the various classes of domestic fowls named below may be given as follows:

The Goose	27 days to	33 days.
" Turkey	26 "	30 "
" Duck	26 "	32 "
" Peahen	28 "	30 "
" Guinea Hen	25 "	26 "
" Pigeon	16 "	20 "

It is not intended that the figures given above will cover every possible variation that may occur, but that they fix the limits beyond which extremes occur but rarely in the period included in gestation and incubation respectively.

Observations.—1. There is unquestionably some relation between the size of the various classes of animals and the duration of the periods covered by gestation and incubation respectively. While the period during which the female elephant carries her young may be given as from twenty to twenty-three months, that during which the female sheep carries hers is approximately five months, and while the period of incubation with geese may be given as thirty days, with hens it is only twenty-one days. And this relation would seem to hold true, in some degree at least, between the larger and smaller breeds of the same species.

2. It is probably true that early maturity exercises some influence on the period covered by gestation and incubation, the early maturing breeds coming into existence in a somewhat shorter period than those which mature later.

3. In the process of incubation it has been noticed that eggs from the smaller species of fowls hatch rather more quickly when incubated under fowls of a larger species, owing, it is thought, to the greater heat which descends from their bodies.

4. The opinion is prevalent that males take a somewhat longer period to mature in embryo than females, and it would seem to be true, but further evidence is necessary before the correctness of the opinion can be looked upon as established.

5. The influences that lead to the great varia-

tions noticed in the period of gestation in animals of the same species are by no means clearly understood, but it will doubtless be correct to say that they include size, heredity, bodily vigor, food and climate, and, in some instances, disease.

6. The influences that tend to produce variation in the period covered by incubation in the same class of fowls, include size, heredity, freshness or staleness in the eggs, atmospheric changes and disturbances, and attention or inattention on the part of the sitters.

APPENDIX B.

READING AND WRITING PEDIGREES.

As intimated in Chapter XXII, there are essentially but two systems of writing pedigrees. An example of each is now submitted with the necessary explanations. The pedigree of an in-and-in bred animal will also be submitted.

Writing Pedigrees by the first System.—The example which follows represents a fictitious pedigree made out and ready for entry in the Dominion Short-Horn Herd Book. It is made out on an entry form furnished by the secretary of the Dominion Short-Horn Breeders' Association. The entry form of this association has been chosen because of its comprehensiveness, which brings along with it the opportunity to make explanations more full and complete. Owing to the great volume of business done by many of the American associations, they publish only as much of the pedigree as makes it practicable to trace it readily, hence, the entry forms only call for such information as will enable the secretary to record the

DOMINION SHORT-HORN HERD BOOK

(Formerly Canada and British American Short-Horn Herd Books)

FORM OF ENTRY

For Regulations, Price and Instructions for Making Entries, see Other Side of Entry Form

Name of Animal.	Sex.	Color.	Date of Birth.	If Previously Recorded and What Book.
Jessamine, 2nd.	Female.	Red Roan.	May 3rd, 1900.	*Vol*............... *Page*..............

		Post Office.	Province.
Bred by	John Anderson	Woodburn	Ont.
Second Owner	John Riley	Hamilton	"
Third Owner	Samuel Gray	Rochester	State of Minnesota

Vol......*page*......*of dam.*

Signature of Owner of Service Bull: John Anderson.

Date of Service: August 3rd, 1899.

							Nos. of Sires.		
							Dominion H.B.		English H.B.
					Got by Bolivar (Imp.)	=	....	=	(75418)
Dam	Jessamine	=	6306	=	by Conrad	=	10314	=	(73411)
2 d	Rosebud	=	5211	=	by Camperdown	=	9607	=	(70316)
3 d	Violet	=	4306	=	by Risingham	=	8204	=	(65342)150611
4 d	Dewdrop	=	3511	=	by Attila	=	7444	=	(60028)
5 d	Pansy	=	2681	=	by Hotspur	=	6339	=	(52754)
6 d	Daffodil	=	1911	=	by Leonidas	=	6216	=	(30206)
7 d	Arabella, 5th	=	1605	=	by Regulus	=	5408	=	(25612)
8 d	Arabella, 4th	=	1412	=	by Pompey	=	4511	=	(12306)
9 d	Arabella, 3rd	=	1310	=	by Plato	=	2104	=	(9457)
10 d	Arabella, 2nd	=	900	=	by Cicero	=	1011	=	(6316)
11 d	Arabella, (Imp.)	=	....	=	by Hannibal	=	986	=	(2103)
12 d		=	....	=	by Hospodar	=	99	=	(610)
13 d		=	....	=	by Hubback	=	....	=	(319)

☞ If a cow, give the facts as to all calves on the other side of this sheet.
If the dam or sire has been sent for record and not yet printed, state when sent and by whom—Sire sent 3rd June, 1900, by J. Anderson.

I, being the breeder, HEREBY DECLARE that the foregoing pedigree is, to the best of my knowledge and belief, true, and I make this declaration after having taken all available means to satisfy myself that it is correct.

Date . . . . 10th January, 1901. (Here Sign) . . . . John Anderson.

New By-Laws.—That all animals shall in future be registered within 24 months of birth, or if not so registered penalty fees shall be charged for their registration. (See other side.)

N.B.—All pedigrees shall be signed by the breeder, or, in case of death, by a proper representative. The breeder of an animal is the owner of the dam at time of service.

animal. As previously intimated, the blank entry forms are furnished, on application, by the secretary of the association. Usually no charge is made for them, but to this there are some exceptions.

Explanations.—The following explanations are given in the hope that they will enable those not familiar with pedigrees the more readily to understand the facts stated and the relation which they bear to one another.

1. Observe the record signs of the numbers. The American record number is written without any sign. The English record number is enclosed in round brackets, and the Canadian record number is preceded and followed by the sign of equality. Thus in the fourth sire, Risingham, the American record number is 150611, the English record number (65342), and the Canadian=8204=. The tendency in the United States is to write the record number without associating with it any sign.

2. The facts relating to ownership signify that John Anderson bred Jessamine 2d, that he sold her to John Riley, and that she was sold by John Riley to Samuel Gray before the application was made by John Anderson to have Jessamine 2d registered. Otherwise the fact of the sale to Samuel Gray could not have been mentioned.

3. Bolivar (75418), the sire of Jessamine 2d, as his record number implies, is recorded in the English Shorthorn Herd Book, and the fact of his importation is stated by the use of the abbreviated word (imp.) Conrad=10314=is the sire of Jessamine=6306=, and he too was imported, though the fact is not of necessity stated, since he is recorded in the English

Herd Book. Camperdown=9607=is the sire of Rosebud=5211=, and each sire preceding in the ancestry is in turn the sire of the dam which stands to the left and opposite to it. No two of these sires are of necessity related to one another, although some of them may be related.

4. Jessamine=6306=, it will be observed, is the dam of Jessamine 2d, and Rosebud=5211=is the dam of Jessamine=6306=. This order in relationship is observed down to the end of the list of the dams. The female ancestry of Jessamine 2d, therefore, are given in an unbroken succession, tracing back to Arabella, which was imported, and since the name Arabella appears so many times in the earlier female ancestry, Jessamine 2d would be said to be of the Arabella family.

5. As nothing more is stated in the pedigree regarding the sires than the name and pedigree number, if further information is desired with reference to the pedigree of any one of them, it may be obtained by noting the record number and referring to the volume which contains it. The record numbers included in any volume of the herd book are usually stated on the back of the same. For instance, to obtain the pedigree of Risingham, which is recorded in the American, English and Canadian shorthorn herd books respectively, it would be necessary to refer to the volume in one of the aforementioned records which has in it the record number assigned to Risingham.

6. As nothing more is stated in the pedigree regarding the dams than the name and number of the sire and the respective names of the ancestry in the dams, to obtain the full pedigree it will be necessary

to consult the herd book, as in the case of the sire. But since numbers are not assigned to the dams in the American or English herd books the pedigrees can only be found by referring to the index of the respective volumes issued by the association which has recorded the dam whose pedigree is sought, and since several of the recorded dams may have the same name, the search for the pedigree becomes frequently a labored work. But in nearly all records numbers are assigned to the dams as well as to the sires.

Observations.—1. Because of the labor involved in looking up a pedigree in the records of some of the live stock associations, and since in some of these pedigrees are only recorded in the abbreviated form, it will be found advantageous in such instances to have a private record which contains a complete pedigree of every animal purchased or bred upon the farm. Such a record would be most convenient for reference.

2. In preparing pedigrees for private or sale catalogues, it is customary to append historical facts to the same. These are given in the form of footnotes, and they are such as relate to the performance of the animals in production, or action, and winnings in the show ring.

Writing Pedigrees by the Second System.—The illustration given below of writing pedigrees by the second system, represents the pedigree of an animal that has already been recorded. But the system and method of making out the pedigree of an animal not yet recorded would be the same except that the number of the said animal could not be stated. It reads as follows:—

- PRIMEVAL 4812
  - Viscount 2177
    - Bonny Boy 1097
      - Imp. Fernwood Royal 645
        - Presto P. S. 14 P. S.
        - Imp. Countess of Fernwood 1464 14 lbs. 12 oz.
      - Imp. Bonnie Lassie of Fernwood 1485 8000 lbs. milk at 2 years old
        - Excelsior P. S. 11 P. S.
        - Bonnie Lassie 1st 225 F. S. 25 qts. daily.
    - Imp. Countess of Fernwood 1464 14 lbs. 12 oz.
      - Duke F. S. 74
        - St. Andrews 1st 1 F. S.
      - Fleurie de Terte 1136 G.H.B. 14 lbs. 10 oz.
        - Dorman Guernsey 15 lbs. 12 oz.
  - Benjamin's Primrose 7820
    - Benjamin 1931, Champion Bull at Wis. State Fair, 1892, '94, '96, '97, '98, and 1st prize at Trans-Mississippi Exp'n, 1898
      - Jeweler XVI 1274 1st prize Wis. State Fair
        - Jeweler 117 Sold for $1500
        - Imp. Lilly of Castel 846 15 lbs. butter
      - Tricksey 1760 2 lbs. 7¾ oz. in one day; sweepstakes Wis. State Fair '88
        - Champion II 130 F. S.
        - Lady Bird 604 F. S.
    - Fair Lad's Primrose 3244
      - Fair Lad II 75
        - Imp. Fair Lad 71
        - Imp. Patty 150
      - Primrose of Lehigh II 1523
        - Fair Lad II 75
        - Primrose of Lehigh 1416

Nov. 29th, 1896.
Geo. C. Hill & Son,
Rosendale, Wis.

Explanations.—1. The preceding pedigree is that of the noted prize winning Guernsey Bull Primeval 4812, which was bred by George C. Hill & Son, Rosendale, Wis. The date of birth was Nov. 29th, 1896. Primeval was for three years at the head of the Guernsey herd of the Wisconsin Live Stock Company, located at Stanley, Wis. The last fact stated does not appear in the pedigree nor do any facts relating to the winnings of Primeval in the show ring. But these and any number of facts desired pertaining to any of the animals in the pedigree could be appended in the form of footnotes.

2. Observe the plan of the pedigree. It gives the ancestry on the side of both sire and dam with equal fullness, where the names of these can be obtained. They can always be so obtained except in the case of some animals of the foundation stock. The sire of Primeval 4812 is Viscount 2177, and his dam is Benjamin's Primrose 7820. The sire of Viscount is Bonny Boy 1097 and the dam Countess of Fernwood 1464. The sire of Benjamin's Primrose is Benjamin 1931, and the dam Fair Lad's Primrose 3244. Similarly the relationship of each sire and dam in the ancestry is shown, the sire always being written at the top of the bracket and the dam at the bottom of the same.

3. Certain facts are given with reference to the history and performance of several of the animals in the pedigree. Countess of Ferndale 1464 is shown to have been imported by the abbreviated word "Imp" prefixed to her name. It is further indicated that she gave 14 lbs. 12 oz. of butter in seven days, the time for brevity's sake being implied rather than stated.

The prizes won by Benjamin 1931, or at least some of them, are given. It is recorded of Bonnie Lassie, of Fernwood 1485, that she was imported and that in the two-year-old form she gave 8000 pounds of milk in one year, the time being implied rather than stated. Facts are given regarding the performance of Tricksey 1760 at the pail and in the show ring, and divers facts are similarly stated regarding certain other animals in the pedigree.

4. The letters "G. H. B." indicate the Guernsey Herd Book as distinguished from the American Guernsey Herd Book. The letters "F. S." indicate foundation stock, and the letters "P. S." pedigree stock.

Observations.—1. By the above system it is possible to give certain facts regarding each animal in the pedigree if sufficiently meritorious, but it should be remembered that such facts become relatively less valuable with increasing remoteness in the ancestry. The tendency now is to confine the facts stated in the pedigree to performance and to state historical facts in the form of footnotes.

2. The more complete lineage of any animal in the pedigree may be obtained by consulting the volume of the herd book in which such animal is recorded. This can be ascertained from the number of the animal.

Pedigree Representing Close In-and-in Breeding.—For the pedigree given below, which names the ancestors of the closely in-and-in bred Jersey Two Hundred Per Cent 33592, the author is indebted to Mr. Thomas J. Hand, of New York City. It represents in full the ancestry for three generations:—

Two Hundred Per Cent. 33592.	One Hundred Per Cent. 16590.	StokePogis 5th 5987.	Stoke Pogis (846 E.H.B.) 1259 Imp.
			Marjoram 3239, Imp. with Stoke Pogis.
		Leclair's Marjoram 36355.	Stoke Pogis, as above.
			Marjoram, " "
	Leclair's Marjoram 36355.	Stoke Pogis (846 E. H. B.)	Young Rioter (751 E.H.B.) by Rioter (746) Dauncey's.
			Essay, by Young Rioter
		Marjoram 3239.	Dr. Syntax (240 E.H.B.)
			Magnet, by The Gipsy (354 E.H.B.)

Observations.—1. In the seven male ancestors given in the three generations, the blood of Stoke Pogis (846 E. H. B.) appears directly or in his sons five times. It also appears twice in the dams. In the seven female ancestors the blood of Marjoram 3239 likewise appears five times, and it also is present in two of the seven sires.

2. The results of such in-and-in breeding must speedily lead to disaster, as shown in Chapter X.

INDEX.