HEREDITY
IN THE DOG

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No other animal serves so many widely different purposes or has been so plastic in man's hands as the dog. Those characteristics by which dogs differ most from other domestic animals and which make them especially useful to man are largely of a psychological nature such as intelligence and willingness to cooperate. This can be especially appreciated by one who has watched a trained sheep dog working a quarter or half mile away from his master, yet obeying every signal that his master gives.

Partly because of their original inheritance and adaptability and partly because of the great variability that has resulted from centuries of selection, dogs today serve man as hunters, retrievers, guards, companions, aides in war, herders of livestock, police aides, guides, draft animals, entertainers in sports and shows, subjects in medical and scientific investigations, scavengers, fur bearers, and in case of necessity as food. Many of these uses can be subdivided and doubtless others might be given.

The range in size is so great that some animals in the largest breeds weigh 100 times as much as other normal individuals of the smallest breeds. An Irish Wolfhound standing on his hind legs can often look over the head of a tall man, while some full-grown Chihuahuas may stand comfortably on one's outstretched palm. Not only in size but in form, physique, temperament, aptitude, and intelligence there is great variation. Long, short, wide, narrow, tall, squat, slender, chunky, graceful, awkward, excitable, placid, robust, delicate, intelligent, stupid, friendly, savage, affectionate, self-contained, dignified, ridiculous, ugly, and beautiful are terms that might be aptly applied to different breeds and individuals. Figure 1 illustrates some of the wide variations in type.

In many of the breeds there is a so-called “standard” size, but there also may be a small or “toy” size, and sometimes a giant size. There are varieties with smooth, wire-haired, curly, long, stand-off, or corded coats. Some breed standards permit all colors, others certain vari-

1 A stand-off coat is a long profuse coat with the hair standing straight out from the body as in the Pomeranian and Chow. A corded coat is a coat of long curly hair matted together in the form of long ropelike cords as in the corded poodle.

Figure 1.—Variation in body form, type of coat, and color patterns as shown by some popular breeds of dogs in the United States. A, Pointer; B, German Shepherd; C, Toy Poodle; D, Bulldog; E, Dachshund; F, Pekingese; G, Cocker Spaniel; H, Chow; I, Scottish Terrier; J, Fox Terrier; K, Greyhound; L, St. Bernard. (C, D, and L by courtesy of G. Howard Watt, Inc.)
ations in color, and others only a single color or color pattern. Later in this article the causes for much of this variation will be discussed.

ORIGIN AND DOMESTICATION OF THE DOG

It is certain that doglike animals existed on the earth thousands of years ago. The origin of the dog (*Canis familiaris*), however, is not known. There is considerable speculation as to whether dogs originated from such present-day wild species as wolves, jackals, and dingoes, with which they will interbreed (fig. 2), or from other forms now extinct.

Quite probably they trace to more than one of these sources. It has often been supposed that the fox, which has many doglike characteristics, was one of the ancestors of the dog. However, few, if any, authentic cases of successful crosses between these two species are known, although numerous unsuccessful attempts to cross them have been reported. Accordingly, it appears improbable that the fox has played a very large part in the ancestry of our present dogs.

Students of the antiquity of the dog, Studer (57, 58), Breuil (7), Elliot (15), Osborn (46), Allen (2), von Stephanitz (54), and Clark (10) are agreed that dogs were domesticated before any of the other animals, but how long ago they do not know. In Europe bones of dogs have been found associated with the remains of men who invaded Europe at the close of the Paleolithic or Old Stone Age, and at the beginning of the Neolithic or New Stone Age. Since earlier remains of dogs have not been found in Europe, apparently they were brought to that continent by the pre-Neolithic peoples and were probably already partially domesticated, serving possibly as scavengers and guards and for food. This makes it seem probable that the dog was first domesticated in Asia at an even earlier date. Somewhat more recent evidence of domestication has been left us in the form of crude pictures carved by prehistoric man (fig. 3) showing dogs used in the chase (8, 35).

\[\text{Figure 2.—Hybrid from a German Shepherd dog and a female wolf. (Photograph by courtesy of John Gans and Fachschaft für Deutsche Schäferhunde after von Stephanitz (54).)}\]
DOGS

DOGS AS FARM ANIMALS

Dogs have held an important place in agriculture and rural life for centuries. Probably they have been most important to the American farmer in guarding property, herding livestock, contributing to the sport and the larder of the master when he goes hunting, helping exterminate vermin, and as companions and pets. While it is im-

Figure 3.—Prehistoric rock tracing representing reindeer, a horse in a boat, men, and dogs. Cut in the quartz at Masseberg, Skee Parish, Bohuslän. Height, 5 feet; width 12½ feet. (Courtesy of Cassell & Co., London, after Leighton (35).)

possible to estimate the value of these services, one can hardly imagine a cheaper or more efficient guard service for the farm than that furnished by a good watchdog, and if the same animal serves in other ways, as it often does, one can be sure that its value considerably exceeds the cost of keeping it. The value of dogs as companions, especially where people lead rather isolated lives, as they sometimes do in certain agricultural districts, is often underestimated. And what other animal gives the growing boy, either on the farm or in the city—or the growing girl, for that matter—as good an opportunity

JUST as some outstanding advances in other scientific fields—advances of very great value to humanity—have been made with the help of dogs, so their use in certain fields of genetic research seems to offer the most practical means of attacking some very important but difficult problems, notably those connected with the inheritance of psychological characteristics. Because they show so wide a range of intelligence, aptitudes, and temperament, and can be handled easily dogs appear to be better adapted to studies of this kind, especially with our present limited methods of measurement, than any other animal. Aside from the possibility of improving one of our most useful animals through such studies, there is the still more significant possibility of adding materially to knowledge of mammalian genetics, especially the inheritance of psychological traits—a field in which relatively little progress has been made.
to learn self-control and consideration through the care and control of his pet?

According to an old saying, there is no good flock without a good shepherd and no good shepherd without a good dog. There are without doubt some exceptions to this, but there is no doubt that a trained herding dog is a great help and under some conditions indispensable in handling livestock. Many farmers enjoy hunting so that good hunting dogs are found on many farms. If one were to estimate the percentage of the 6,812,350 farms in the United States that have at least one dog from the sample of which he has personal knowledge, it would certainly be very high.

PRESENT STATUS OF GENETIC RESEARCH ON THE DOG

Although dogs have been domesticated for many centuries and have been successfully molded into many forms adapted to man’s uses by the processes of heredity and selection, most of the breeds we know today have originated in comparatively recent time, and up to within a few years ago there had been very little, if any, breeding work with dogs that could be considered of a scientific nature.

However, there is a considerable store of scientific information concerning various aspects of the dog. Anatomists, physiologists, and psychologists have found the dog an excellent subject, especially in connection with medical research, for studying mammalian characteristics. In fact the diet, physiology, and temperament of dogs make them indispensable for certain types of experiment. Some of the outstanding advances in physiology, psychology, and medicine have been made with the help of dogs, as for example the work on conditioned reflexes by Pavlov (48) and much of the fundamental information on artificial respiration, and the control of diabetes and pernicious anemia (9).

In addition to the gain for humanity that has resulted from these experiments, dogs have been used, of course, in the study of their own disorders. The control of hookworm following the work of Hall (19) and of distemper resulting from the investigations of Dunkin and Laidlaw (13, 14, 30, 31, 32, 33), who were provided with funds by the Field Distemper Council in Great Britain, has been made possible by the use of a relatively small number of dogs in the laboratory.

Although the results obtained in some of these researches indicate that the dog would serve as an excellent subject in the study of certain aspects of mammalian genetics, few systematic attempts have been made to obtain information on inheritance in this animal. However, many reports dealing with various aspects of the genetics of the dog have been published. The characters reported in these papers will be considered in this article in the following order: (1) Cytological (concerned with the chromosomes in the cell), (2) psychological, (3) morphological (concerned with form and structure), and (4) color.

Investigators are in disagreement as to the number of chromosomes in the dog. Thus Malone (40) has reported the number in the body cells as being 21 and 22 in the male and female, respectively; Minouchi, according to Oguma and Kakino (44), has reported 78 chromosomes in the body cells of both the male and the female; Painter (47)

* 1935 census figures.
has reported the number to be about 50, probably 52; while other investigators have found intermediate numbers (29).

**Mental Characteristics and Temperament**

In the study of mental characters psychologists have been able to measure various abilities of dogs such as the speed with which they form conditioned reflexes or immediate reactions to a given situation constantly repeated; their powers of discrimination with regard to visual objects and sounds of different kinds; their ability to make delayed responses to stimuli; and their ability to solve problems such as the opening of a box to get food or finding their way out of a maze or labyrinth. Since most such measurements are difficult to make accurately and require considerable time and expense, practically no information exists on the variation in these abilities among dogs of the various breeds and strains or on the mode of their inheritance.

Some information has been collected regarding the inheritance of certain aptitudes in dogs, as is shown in the appendix. For example, both Marchlewski (41) and Whitney (64) have reported that the aptitude for hunting with the head carried high appears to be dominant to the aptitude for hunting with the head carried low when certain strains or breeds of dogs are crossed. Although the list given seems impressive, it presents information on relatively few of the great variety of aptitudes possessed by dogs and most of the conclusions are based on a few observations only and have not been completely confirmed.

One of the best studies of temperament in dogs and the practical application of genetic principles to breeding dogs with superior abilities is that of Humphrey and his associates in producing and training dogs for leading the blind, and for police and army service, at Fortunate Fields, Switzerland (reported by Humphrey and Warner (22)). The tests used were largely subjective judgments by the trainers and while it was apparently impossible for them to determine the exact mode of inheritance of most of the characters, they were able by assuming that certain of these characters were largely controlled by a few major genes to make marked progress in producing superior animals.

**Body Characteristics**

In addition to mental traits, such body characters of the dog as conformation, functioning of internal organs, fertility, and resistance to disease play an important part in his usefulness. The body characteristics that have been studied genetically are listed in the appendix. Of particular interest in this connection is the work being carried on in this country by Stockard (55) and his associates at the Cornell University Medical College on the genetics of modified endocrine secretion and of associated form patterns—such as head shape—among dog breeds. (See the reported findings of Stockard and Vicari in the appendix.)

Although the color of the animal is a body character, it is so easily differentiated from other characters that it seems best to consider it separately. The third part of the list (p. 1337) gives the color characters in dogs for which information concerning the mode of inheritance has been reported.
On the whole, where more than one investigator has reported on the inheritance of a color factor, the results have been similar or the differences can be reasonably well accounted for. There appear to be marked similarities between color inheritance in dogs and that in rodents and in other carnivora (18), which makes some of the conclusions appear reasonable even where the evidence from dogs themselves is rather scant. No cases of proved linkage have been reported. There is, however, fairly good evidence that there are a number of allelomorphic (alternative) series of genes that affect color in the dog. These have been summarized briefly in table 2 in accordance with what seems to be the best evidence available. Some genes exhibit multiple effects, such as those caused by the gene for dominant irregular spotting, which in addition to affecting the coat color produces defective sight and hearing, frequently a reduction in general vigor, and sterility in the female (pp. 1333, 1936, and 1339).

Probably the greatest contribution of the science of genetics to practical breeding has been the formulation of a definite system of inheritance. This system furnishes the basis for a rational approach to breeding problems. However, at present it is difficult, for several reasons, to make specific recommendations on many practical problems confronting the dog breeder—the breeder's aims are extremely diversified; the dogs themselves exhibit such tremendous variations; there are not nearly enough known facts on inheritance in dogs to solve most of the problems of practical importance; and many practical men have not yet familiarized themselves with general genetic principles. (The discussion of these principles in introductory articles in this Yearbook will probably be found helpful in this connection.) This emphasizes the need for encouraging research on inheritance in dogs and for organizing breeders so that they can obtain information with regard to specific problems and can at the same time contribute to the knowledge of inheritance in dogs from their own records.

One method of encouraging improvement in the animals themselves would be to offer prizes at dog shows on the basis of the breeding record of an animal instead of almost wholly on the basis of its individual appearance or performance. Genetics has very definitely shown that in many instances the appearance of an animal is not a reliable basis for judging its value as a breeder. Its real breeding value depends on its ability to pass on desirable characters and combinations of desirable characters to its descendants. Because of the effect of dominant genes, the appearance of an animal may give no hint of the presence of recessive genes for quite opposite characters, more or less covered up by the dominants. Thus a short-legged dog may carry the gene for normal legs, which would show up in some of his descendants if they received the same recessive gene from the other parent. Similarly, a black dog may carry the gene for liver color. (See pp. 1334 and 1337.)

Not only individual genes but the particular combination of genes that an animal inherits also determines its appearance or performance. Since most animals are very mixed in their inheritance, they are capable of transmitting a large number of different combinations of genes to their offspring. For example, a dog of intense agouti or wild gray color without white spots may carry the genes for dilute coat color, for nonagouti, and for piebald white spotting. When this dog
was mated with an animal of similar mixed genetic composition, one would expect, if agouti, intense coat color, and absence of piebald white spotting are considered to be completely dominant,\(^4\) to get puppies of eight different types so far as appearance is concerned, provided enough puppies are produced: (1) Intense agouti without white spots, (2) intense agouti with white spots, (3) intense nonagouti without white spots, (4) dilute agouti without white spots, (5) dilute agouti with white spots, (6) intense nonagouti with white spots, (7) dilute nonagouti without white spots, and (8) dilute nonagouti with white spots. These 8 types could represent as many as 27 different combinations of genes, considering only the characters mentioned. Examples of the effects of certain combinations of genes for color are given in the appendix (p. 1343). In many cases there are no data on the results to be expected from given combinations.

This illustrates the fact, well known to geneticists, that often the only way to judge what an animal does carry in its inheritance is by a sufficiently extensive progeny test.

Genetic studies indicate that color, type of hair, length of legs, form of head and body, and many other characters can be transferred from one breed to another by cross-breeding. It is undoubtedly by cross-breeding followed by selection that much of the variation in dogs has come about. New mutations—sudden changes in the germ plasm, later passed on in inheritance—were undoubtedly transmitted to different breeds by cross-breeding and greatly increased the number of types. The large number of types in turn allowed great leeway for selection and the development of still different forms. Many mutations are decidedly disadvantageous to the animals possessing them—so much so that under wild or primitive conditions they may not survive. Under the conditions of domestication, however, many of the mutant types not only survive, but may be superior for certain of man's uses. For example, certain inherited characters possessed by the Russian Wolfhound give him greater speed than the wolf so that he is useful for hunting wolves. On the other hand it is doubtful whether the Russian Wolfhound could compete successfully with the wolf in the wild state because he possesses certain other inherited characters that would put him at a disadvantage, such as a less well-developed sense of smell and a type of intelligence that is not quite so well adapted to self-preservation as that of the wild animal. Reports (5, v. 1, p. 38) of dogs that have returned to the wild state—feral dogs—indicate that their descendants are often wolflike in form.

**MEASURING THE ABILITY OF DOGS IN COMPETITION**

If one were to undertake a comprehensive genetic program on the inheritance of many of the characters that make dogs useful, a system of measurements of these characters would have to be worked out so that accurate comparisons could be made. At the present time dogs are used in competitive trials of various kinds, out of which certain measurements have been developed. Generally, however, these tests are of a sporting nature and chiefly measure the ability of the animal to win over its opponents under the particular conditions of the trial.

\(^4\)Dominance probably would not be complete in all cases so that it might be possible to subdivide some of the phenotypic classes.

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Often they measure several distinct characteristics. Thus a winning combination must generally include a strong desire on the part of the dog to succeed, excellent morphological and psychological adaptability, a high degree of coordination of physical and mental powers and often a high degree of intelligence, and perfect cooperation between the dog and his trainer or handler. While such things are often only crudely differentiated or measured in competitive trials, nevertheless, such trials have been a very important factor in the development of breeds especially suited to certain types of competition. The following brief descriptions are given to illustrate what has been done in this connection as well as because of their general interest to dog breeders.

**Track and Sled Racing**

Dog racing has been on the increase in the United States since the devising of a mechanical rabbit for the dogs to chase. The first track using this invention was opened in 1919 in California. In 1935 meets were held in Arizona, Arkansas, California, Florida, Massachusetts, Minnesota, New York, Ohio, Oregon, Pennsylvania, Texas, and Washington. American racing records taken from the All Sports Record Book (42) are given in table 1.

<table>
<thead>
<tr>
<th>Distance (mile)</th>
<th>Dog</th>
<th>Time</th>
<th>Place and date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>Damon Runyan</td>
<td>25</td>
<td>Miami, Fla., 1927.</td>
</tr>
<tr>
<td>1/4 1/2</td>
<td>Swift and Sure</td>
<td>26%</td>
<td>Milwaukee, Wis., 1927.</td>
</tr>
<tr>
<td>Futurity</td>
<td>Karl Kelly</td>
<td>28</td>
<td>New Orleans, La., 1927.</td>
</tr>
<tr>
<td>Do.</td>
<td>Domestator</td>
<td>29%</td>
<td>West Jefferson, Ohio, 1931.</td>
</tr>
<tr>
<td></td>
<td>Oh Boy</td>
<td>31%</td>
<td>Miami, Fla., 1924.</td>
</tr>
<tr>
<td></td>
<td>Altair Drain</td>
<td>38%</td>
<td>New Kensington, Pa., 1930.</td>
</tr>
<tr>
<td>3/4</td>
<td>Midnight Joe</td>
<td>45%</td>
<td>Miami, Fla., 1925.</td>
</tr>
<tr>
<td>3/4</td>
<td>Red Skipper</td>
<td>52%</td>
<td>Belmont, Calif., 1932.</td>
</tr>
</tbody>
</table>

These records are not quite so fast as the best time reported for running horses on oval tracks—three-eighths of a mile in 33 1/3 seconds, seven-sixteenths of a mile in 39 seconds, and one-half mile in 46 1/3 seconds. Mick the Miller, a British dog, considered the world’s fastest Greyhound, has a record of 600 yards (a little less than three-eighths of a mile) in 34 seconds, which compares very well with the best running-horse record for approximately the same distance. Perhaps a clearer idea of how fast this dog was traveling may be gained from stating the rate as an average of 36 miles per hour for a distance of 600 yards.

According to Menke (42), Mick the Miller is said to be the most intelligent of greyhounds and showed uncanny ability in getting clear of “jams” in the running of races, thus giving him undisputed passage-way. From 1929 to the end of 1931 he won $50,000 in purses and numerous cups and trophies. He was 9 years old in 1935, retired and quartered at Walton-on-Thames for breeding purposes even though his exact ancestry was unknown. The increase of track racing in this country has resulted in the importation of thousands of Greyhounds.
Another form of racing requiring a very different type of dog is dog-sled racing. The most famous of these races are run in Canada and Alaska—for example, the Eastern International Dog Sled Derby run annually over a 120-mile course at Quebec; the Hudson Dog Sled Derby (generally called The Pas Derby) run over a 200-mile course from The Pas, Manitoba, to Flin Flon and return; and the All-Alaska Dog Race at Nome. Similar races have been run in New Hampshire, in upper New York State, and from Winnipeg, Manitoba, to St. Paul, Minn. As the races are run on scheduled dates regardless of the weather, there is considerable variation in the time required by the winning teams. Thus, over the 200-mile course at The Pas Derby the time has varied from 24 hours 51 minutes in 1922 to 37 hours in 1929. Alaska’s Borden marathons run over a course of 26 miles 385 yards, has been won in time varying from 1 hour 50 minutes 27 seconds to 3 hours 35 minutes. Albert Campbell, a Cree Indian, drove his team of six dogs 522 miles in 118 hours 16 seconds to win the Red River International Derby from Winnipeg, Manitoba, to St. Paul, Minn. Rules governing the contests vary with regard to the number of dogs allowed per team, whether the race must be run in laps, and other points.

Because of their remarkable strength and endurance, Huskies have been very successful in these dog-sled races. These dogs are the result of crossing Eskimo dogs, which probably have considerable wolf inheritance, with such breeds as Great Dane, Newfoundland, or German Shepherd. It may well be that at least a part of their superiority in strength and endurance is an expression of hybrid vigor. Deerhounds have been used in recent years in crosses with the Eskimo dogs, but though the offspring are big, rugged animals, it is said that temperamentally they are more of a hunting-dog than of a sled-dog type and so are not such useful draft animals as some of the other cross-breds. Greyhounds are also said to have been tried in crosses with the Eskimo dogs. The offspring have superior speed but lack the ability to withstand the severe climatic conditions under which the sled races are often run. Today it is hard to find pure Eskimo dogs in the North as the Eskimos themselves prefer the stronger cross-breds.

HUNTING AND HERDING FIELD TRIALS

Field trials for dogs are now widely held in the United States and in some other countries, notably England, to test the ability of bird dogs such as Setters and Pointers. These trials are actual hunting contests in which the dogs are scored by judges for their ability to locate the birds by scent, to point in the direction of the game, to hold the point until the hunter fires at or flushes the birds, to retrieve the game when crippled or killed, to cover a large area both rapidly and efficiently, and to demonstrate endurance, tractability, style, and perseverance. Generally the competition is divided into three classes, puppy, derby, and all-age, the division depending on the age of the dog. Contestants are run either singly or in pairs. Similar trials are also being run for Retrievers and Spaniels. In these, the animals must work both on land and in the water and more
attention is paid to retrieving the game and less to pointing. Field trials with Foxhounds, Bloodhounds, and other types of sporting dogs, as well as ratters, are sometimes held, and there seems to be a growing interest in them.

One of the effects of these trials has been a decided tendency to develop two strains within some of the breeds involved, one being bred to meet the requirements of field trials and the other to meet bench-show requirements of the fancier or the standard set up by the breed association. In the first strain, mental aptitudes and physique are stressed, and in the second, body conformation and color. A good example of this is to be found in English Setters, in which the Llewellin strain has been very successful in the field, while the Laverack strain has been most noted on the bench.

The herding of sheep by dogs goes back to prehistoric times, though, of course, organized sheep dog trials such as are held today in a number of countries to determine the ability of the dogs in competition are of comparatively recent origin. In Germany organized trials were held about the beginning of the present century. In 1873 the first sheep dog trial was held in Wales. Since the World War, these trials have become very popular in Great Britain and are also held on a large scale in Australia. In the United States for the last 9 years a sheep dog contest has been held annually in New England and exhibitions are given at a number of fairs and livestock shows.

So far the trials in the United States have been of the type held in Great Britain. One dog is run at a time and is directed entirely with whistles and gestures by the master. Scores are given for the manner and style with which the dogs handle the sheep. Trials are held in a meadow, with the sheep being liberated at one end while the dog and shepherd enter at the other. The dog is then sent out to gather in the sheep, which he must bring to the shepherd. Then he must drive them through a number of hurdles and finally into a small pen in the open field. In some contests the dog is also required to cut out or "shed" a certain number of marked sheep from the flock. All of this must be done within a certain time limit, without hurrying the sheep, and always with complete obedience to the shepherd's commands.

Practically all the dogs entered in the contests in Great Britain or the United States are Border or Working Collies. These dogs generally have long black and white coats and are somewhat smaller than the Collies seen at dog shows. Their heads also are somewhat broader and shorter than those of the show Collies, which have been selected for long, flat, narrow-type skulls. Scotch and English shepherds train their dogs not to bite the sheep but only to bluff them, while in Germany, where the dog must often protect the crops from the sheep, the shepherds train the dogs to grip the sheep if necessary. Border Collies seldom bark, which is an advantage under the conditions prevailing where they ordinarily are used. In brush country, however, a barking dog can be heard by the sheep when he cannot be seen and is thus often more successful in his work than a quiet one. In some countries, the sheep must be protected from wolves and other wild animals so that large and powerful dogs are needed. Because of these differences in requirements and training, it is not to be expected that
the more than 40 varieties of herding dogs, including such varied breeds as the German Shepherd, Aftscharaka, Kelpi, Puli, Old English Sheepdog, Komondor, Bundas, Riesenschnauzer, etc., can compete satisfactorily in trials designed for the Border Collie alone.

In former years some breeds of dogs were bred to fight each other in the pit or arena or, as in bullbaiting, to fight a bull. This kind of competition has largely been outlawed, and the fighting breeds—Bull Terriers, Bulldogs, and Boxers—are now kept largely as companions and guards.

Some of the recent dog shows have been featuring a new type of contest called an obedience trial in which prizes are awarded on the obedience of each animal to a number of commands. Poodles have been outstandingly successful in these competitions.

Dog Shows

Of the organized competitive activities connected with dogs, the dog shows attract the most interest. In 1935 there were, according to Menke (42), 2,760 bench shows in the United States, with 200,000 entries and 1,000,000 paid admissions. No one knows how many dogs there are in the United States, though a rough estimate would be between 10,000,000 and 12,000,000. There were registered with the American Kennel Club in the single year of 1935, 72,000 dogs that were eligible for shows.

The largest dog show in the United States, the Westminster Dog Show held in Madison Square Garden, New York, N. Y., had a record in 1935 of 2,837 entries with 85 breeds represented. This was the fifty-ninth Westminster Dog Show held under the auspices of the American Kennel Club and it drew entries from all over the world.

As is the case with other domestic animals, the dogs that can win highest honors in competition either in field trials or bench shows, usually attract the breeders, and dogs that can transmit their ability to win soon become the foundation animals of a strain or breed. Thus the sires Gladstone and Count Noble, which produced 25 and 30 field-trial winners, respectively, are to be found in the ancestry of most field-type English Setters in the United States. Dog shows also have been one of the most potent influences on breeding in the last half century. By fostering the adoption of breed standards and the use of these in judging they have kept before dog breeders fairly definite aims to be attained. They have also been a most efficient medium for advertising those animals that, in the opinion of the judges, were the best in their respective breeds and have helped to spread information and interest in dog breeding. The standards, of course, have often been largely influenced by changing fashions and frequently have little or no relation to utility.

On the whole this use of bench-show or field-trial winners as breeders has made for progress, although the overwhelming emphasis on individual performance has also sometimes perpetuated and spread through the breeds defects carried by the foundation stock. The ideal condition for the progress of the breeds would be to place the emphasis on breeding records, which should include all the offspring of a given animal instead of the winners only or at best the offspring
without serious defects. Thus breeders would have a progeny test that would indicate the real genetic constitution of a given animal.

The American Kennel Club (3), under whose auspices most of the dog shows are held, included descriptions and standards of 102 breeds of dogs in their book Pure-Bred Dogs published in 1935. These breeds, together with their color, size, and principal uses, for the most part as given in Pure-Bred Dogs, have been listed in table 3. This table clearly indicates the variety of dogs in the United States. It is impossible, however, to give an adequate amount of detail, and for more complete information the readers should consult the American Kennel Club’s publication.

POSSIBILITIES OF FURTHER GENETIC RESEARCH WITH DOGS

The improvement of dogs along certain practical lines by the use of a knowledge of inheritance appears to offer definite promise for the future. Thus the relative number of German Shepherd dogs that are suitable as guides for the blind or for police or army work can be greatly increased by means of selective breeding and the application of genetics as has been demonstrated at Fortunate Fields (22). Also, working ability can be successfully combined to a considerable extent with show form according to the results obtained by the same organization.

Superior hunting dogs may be bred for certain conditions as was done by Adametz (see Iljin (25)), who crossed English Pointers to German Pointers to produce a rapid-working dog that could stand the heat on the steppes of Moravia.

Improved physical and disciplinary traits can probably be secured from certain crosses. Iljin (25) states that in several regions of the Union of Soviet Socialist Republics German Shepherd dogs and Doberman Pinschers are crossed for that purpose.

The histories of a large number of the present breeds as given by the American Kennel Club (3) indicate that they originated from matings between animals of two or more breeds made purposely to combine certain desirable characteristics in one strain.

Doubtless many abnormalities or defects, such as cryptorchidism, cleft palate, reduced larynx, certain types of periodic eczema, etc., can be eradicated or controlled through breeding as indicated by the work of Koch (28). Studies on the inheritance of resistance to infectious diseases with other species of animals, as the mouse, rabbit, guinea pig, and chicken (see Hill (20) for a review of the subject) would indicate that it may be possible to develop strains of dogs with high resistance to certain of the infectious diseases, such as distemper.

In addition to the improvements that might be made in the dogs themselves, undoubtedly studies of the inheritance of various characters in dogs would aid in a better general understanding of mammalian genetics.

That dogs have been used extensively in anatomical, physiological, and psychological research, as already indicated, but to a very limited extent in genetic research is probably due to a number of reasons. (1) Research workers in the fields mentioned have been able to utilize dogs from city pounds and cheap animals of nondescript breeding,
whereas in making a genetic analysis a large number of animals would have to be produced from specific matings. (2) In studying the inheritance of certain characters, notably psychological traits, for the study of which dogs are especially good subjects, methods of measuring many of the characters must first be perfected before genetic studies will be very fruitful. In the last analysis, however, probably the principal reason why less attention has been paid to genetic research with the dog has been the feeling that results promising greater immediate economic gain were to be had in other fields.

Yet within a single species dogs show so wide a range of intelligence and temperament that they are better adapted for studies of the inheritance of these characters with the crude methods now available than other species in which the differences are less marked, such as guinea pigs, rats, mice, rabbits, and poultry. Dogs also reproduce with reasonable rapidity and would not be so expensive to maintain in sufficient numbers under laboratory conditions as horses, cattle, sheep, goats, and swine. Thus the use of dogs as subjects in certain fields of genetic research appears to offer the most practical means of attacking certain very important problems.

The Bureau of Animal Industry has just initiated a project to study the inheritance of intelligence and associated characters in farm animals with especial reference to the influence of such characters upon performance and production. Dogs are being used in the early phases of these studies because they probably exhibit a greater range in temperament and in intelligence than most animals; different breeds have been developed for widely different purposes and some of them have important agricultural uses.

In this project dogs of several breeds of different temperament will be subjected to certain tests to determine the range and type of intelligence and their suitability for various purposes, especially for the herding of sheep. Crosses also will be made between breeds and similar tests will be made on the offspring of the first generation and later generations following the cross. One of the breeds being studied is the Puli. Four individuals of this breed (fig. 4) were recently imported...
by the Department from Hungary. These dogs are noted in their native country for their sheep-herding ability. Studies on this breed and its hybrids from crosses with several other breeds are now under way.

From these experiments facts will be secured on (1) the degree to which intelligence is inherited, (2) the manner of its inheritance, and (3) the influence of intelligence, temperament, and certain other psychological traits upon certain special aptitudes of the dog. The experiments will also furnish fundamental information on the type of temperament and psychological traits that are needed in dogs for special purposes. Furthermore, information will be secured on the relation of various types of temperament to such things as feed utilization, appetite, management, and growth. The results obtained from these experiments are expected not only to furnish information on these functions in dogs but also to be of value in pointing the way for further investigations of this nature with other farm animals.

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(68) Wright, S.

APPENDIX

Characters in Dogs, the Inheritance of Which Has Been Studied by Various Research Workers

Mental Aptitudes

<table>
<thead>
<tr>
<th>Characters and breeds</th>
<th>Investigator</th>
</tr>
</thead>
<tbody>
<tr>
<td>High head carriage of the English Pointer appears to be dominant to low head carriage of some strains of the German Pointers (a).</td>
<td>Marchlewski (41).</td>
</tr>
<tr>
<td>High head carriage of bird dogs is dominant to low head carriage of Bloodhounds and Foxhounds (a).</td>
<td>Whitney (64).</td>
</tr>
<tr>
<td>Quiet style of hunting of the English Pointer appears to be dominant to the yelping style of some strains of the German Pointer (a).</td>
<td>Marchlewski (41).</td>
</tr>
<tr>
<td>Trail barking of hounds is dominant to still trailing of various breeds of mute trailers (a).</td>
<td>Whitney (63, 64).</td>
</tr>
</tbody>
</table>

*It must be emphasized that many of the conclusions are tentative and that the phenotypic or outward expression of a character may in some cases differ decidedly as a result of differences in the environment or of various combinations and interactions of the gene or genes involved.

Letters in parentheses indicate: (a) Author's statement, no data given, (b) conclusions drawn from small sample, (c) studbook records.
Mental Aptitudes—Continued

Characters and breeds

Water-going propensity of the Newfoundland and bird dogs is dominant to lack of it in hounds (a).

Bird-hunting aptitude of bird dogs is imperfectly dominant to lack of it in hounds and other breeds (a).

Higher grades of pointing instinct appear to be incompletely dominant to lower grades in crosses of English Pointers and German Pointers (a).

The "backing" instinct is dependent on specific genes in crosses between English and German Pointers and strains of the same (a).

The active, almost nervous, temperament of the English Pointer is incompletely dominant to the more lethargic temperament of the German Pointer.

A factor inhibiting liveliness appears to be present in dogs. Thus the offspring of German Shepherd × Siberian are rarely lively. However, the situation is complicated as shown by the fact that the offspring of Doberman Pinscher × German Shepherd or of Doberman Pinscher × Airedale Terrier are often excitable (a).

Disposition showed a tendency toward segregation in the offspring from a cross of a very gentle and timid Old English Sheepdog to a playful aggressive Scotch Collie (b).

Auditory undersensitiveness appears to be incompletely dominant to oversensitiveness in German Shepherd dogs. Probably more than one factor is involved.

Tactual (body) undersensitiveness appears to be incompletely dominant to tactual oversensitiveness in German Shepherd dogs. Probably more than one factor is involved.

Both auditory and tactual sensitiveness appear to be associated with sex. Relatively more males are undersensitive and more females oversensitive than would be expected by chance.

Energy, distrust, willingness, and trailing willingness appear to be inherited, but evidence is not conclusive (a).

Body Characters Other than Color

Narrow pointed head of the sheep dog is dominant to the broad dished type of the Pointer (a).

Elongated type of head in the Greyhound is dominant to the Bulldog and Pug types of skull formation.

Wide form of skull and lower jaw is dominant to narrow (as studied in the German Shepherd and crosses between the dog and the wolf) (a).

Head shape of the Boston Terrier and French Bulldog gives intermediate head shape when crossed with Dachshunds. Multiple factors are involved, some dominant and some recessive (a).

Head shape of English Bulldog is incompletely dominant to head shape of the Basset Hound (a).

"Brick"-shaped head of the Airedale Terrier is incompletely dominant to the type of the Doberman Pinscher (a).

Bulldog type of head is dominant to the head type of the Doberman Pinscher (a).

Short crown is dominant to long crown (a).

Head length shows intermediate type of inheritance (a).
DOGS

Body Characters Other than Color—Continued

The orbital angle is the angle formed by the intersection of a plane across the eye socket with a horizontal plane across the top of the skull. It appears to be controlled by at least two factors in crosses between the German Shepherd dog and wolf. In the F₁ animals the angle is intermediate but closer to the dog type.

The form of the zygomatic process and maxillary angle (cheekbone and angle at its anterior end) appears to be controlled by at least two factors. Crosses were between the German Shepherd and the wolf. The F₁ animals were intermediate but closer to the wolf type.

Rotundity of the bullae ossea or ear bladders appears to be controlled by at least two factors in crosses between the German Shepherd dog and the wolf. The F₁'s were intermediate.

Nonribbedness of the ear bladders appears to be controlled by at least two factors. Crosses between German Shepherd and wolf. F₁ intermediate but closer to wolf type.

Cheekbone breadth appears to be controlled by at least two factors. Blending type of inheritance.

Length of muzzle and head shape intermediate in offspring of normal-nozed Schnauzer-Dachshund × short-nosed Pekingese. Results from backcrosses indicate that the broad skull and greatly shortened muzzle of the Pekingese results from a single factor (b).

Defective sight is associated with merle dilution (p. 1461) in the homozygous condition in Collies and with albinism in Pekingese.

Double nose is inherited apparently as an incomplete dominant in Siberians, Boxers, and Boxer × Bulldog (a).

Normal palate is a simple dominant to various types of cleft palate frequent in dogs with short skulls. The defect is due to a disturbance of the pituitary growth hormone (a).

Normal larynx is dominant to reduction and narrowing of the larynx in Skye Terriers (a).

Pitch and timbre of the voice appear to be inherited, but there has been no analysis (a).

Yapping bark appears to be dominant to hound drawl (a).

Normal number of teeth is dominant to missing teeth in German Shepherds. Probably more than one factor is involved (a).

Deafness is associated with homozygous merle dilution in Collies and with extreme white spotting in Great Danes and Bull Terriers.

Small ear size of Alsatian appears to be dominant to large ear size of the Pointer (a).

Triangular type of ear in English Pointer is dominant to the larger lobed type ear of the German Pointer (a).

Hanging or pendant ear carriage appears to be incompletely dominant to erect ears in Pointer × Alsatian and Ceylon Hairless × Dachshund.

Investigator
Iljin (26).
Do.
Do.
Do.
Do.
Wriedt (67).
Mitchell (43); Pearson, Nettleship, and Usher (49, pt. 2, pp. 460–520).
Iljin (25).
Koch (28).
Do.
Ilijin (25).
Whitney (63).
Humphrey and Warner (22).
Pearson, Nettleship, Usher (49); Mitchell (43).
Marchlewski (41).
Do.
Plate (51), Marchlewski (41).
Body Characters Other than Color—Continued

Characters and breeds

Ear carriage appears to be generally due to three allelo-
morphs with the following relationships suggested:

\[ H^e \text{ semierect}, H^l \text{ lop}, h^e \text{ erect.} \]

\[ H^e \text{ completely dominant to } H \text{ or } h. \]

\[ H \text{ incompletely dominant to } h. \]

\[ H^e H^l - H^e h^e - H^l h^e \text{ semierect Collie type.} \]

\[ H H^l - \text{ lop.} \]

\[ h h^e - \text{ semierect.} \]

\[ h h - \text{ erect.} \]

There is also an independent semierect type of ear car-
rriage as in the Russian Wolfhound, and an indepen-
dent lop-eared type recessive to erect ear. No infor-
mation is given on this last type (a).

Erect ear carriage seems to be partly dominant to
faulty ear carriage in German Shepherds and prob-
bly depends on multiple factors (a).

Narrow chest is dominant to broad chest (a).

Development of chest is intermediate in inheritance in
crosses of English and German Pointers (a).

Dewlap in the German Pointer is dominant to lack of it
in the English Pointer (a).

Body form in cross-breds from Doberman Pinscher ×
Rottweiler is intermediate.

Body and trunk form of St. Bernard is dominant to that
of Dachshund (b).

Body and leg form showed segregation in a cross of Old
English Sheepdog with Scotch Collie (b).

Short tail or absence of tail is due to several factors
apparently not related to sex (b).

Short tail is dominant or incompletely dominant to
long tail in Schipperke, and Belgian or Brussels
Griffons.

Form and posture of the tail appear to be inherited in
addition to length (a).

Homzygous short tail is lethal (a).

Normal tail of Dachshund is dominant to screw tail of
Boston Terrier or French Bulldog. Two factors ap-
pear to be involved (a).

Screw tail does not appear to be linked with bull-shai)ed
head in crosses of the Boston Terrier or French Bull-
dog with Dachshund and in crosses of the English
Bulldog with the Basset Hound (a).

Normal tail of the Basset Hound is a simple dominant
over screw tail of English Bulldog (a).

Normal tail is a simple dominant to screw tail in the
French Bulldog. Screw tail is apparently based on
defective functioning of the growth hormone of the
anterior lobe of the pituitary (a).

Short legs of Dachshund, Basset Hound, Scottish Ter-
rrier, etc., are incompletely dominant to normal long
legs of Saluki, Bull Terrier, French Bulldog, English
Bulldog, Schnauzer, Fox Terrier, and other normal-
legged breeds.

Catlike compact foot of the English Pointer appears to
be incompletely dominant to open harelike foot of
German Pointer (a).

Closed foot appears to be dominant to open foot in Ger-
man Shepherd (a).

Short foot appears to be dominant to long foot in Ger-
man Shepherd (a).

Humphrey and Warner (22).

Iljin (25). Marchlewski (41).

Iljin (25).

Marchlewski (41).

Iljin (25). Little (38).

Vilmorin. (See Wriedt (66)); Iljin (25).

Stockard (55).

Koch (28).

Lang (34); Stockard (55); Wriedt (67).

Marchlewski (41).

Humphrey and Warner (22).

Do.

Do.

Do.
Supernumerary (fifth) toe on the hind feet appears to be inherited in various breeds. Mode of inheritance has not been determined (a).

Short hair (S) is due to a single gene almost completely dominant to long hair (s) in the Newfoundland X Pointer, Belgian or Brussels Griffon, and Dachshund.

Investigator Iljin (35); Lang (34); Anker (4); Iljin (25); Little (38).

Figure 5.—Haired and hairless Mexican dogs from the same litter. (Photograph by courtesy of the Journal of Heredity, after Stockdale (1).)

Rough or wire hair (R) appears to be due to a single gene incompletely dominant to smooth short hair (r) in Belgian or Brussels Griffons, Dachshunds, and Ceylon Hairless dog X Dachshund. The R series (R—r) interacts with the S series (S—s) to give the following phenotypes:

RS and Rs = wire
RS = short
rs = long.

In a cross of Old English Sheepdog with Scotch Collie, type of coat showed segregation with the additional appearance of short smooth coat. This indicates a more complex genetic basis for the inheritance of length of coat than shown above (b).

Investigator Plate (51); Anker (4); Iljin (25); Little (38).

Gates (16).
Body Characters Other than Color—Continued

Hairlessness (fig. 5) is due to a single gene incompletely dominant to normal hair in Mexican, Ceylon, African, and Egyptian hairless dogs and Ceylon Hairless × Dachshund. The gene appears to be lethal in the homozygous state and to be associated with defective teeth and often with a slender, greyhoundlike body conformation in the heterozygous individuals.

Cryptorchidism is inherited in many breeds. Normal descent of the testes is a simple dominant to cryptorchidism in breeds having pronounced head shortening and screw tail; apparently cryptorchidism is caused by defective functioning of the anterior lobe of the pituitary (a).

Thyroid size is relatively larger in the offspring of Dachshund crossed to Boston Terrier than in either parent (a).

Relative size of thyroid in the German Shepherd is incompletely dominant to relative thyroid size of the Basset Hound (a).

Differences in structure of the thyroid found in various breeds appear to be inherited in Mendelian fashion (a).

The greater power of destruction of uric acid with the formation of allantoin found in most dogs appears to be dominant to the decreased ability reported in specimens of the Dalmatian breed (b).

Death of certain motor and sympathetic neurones in the lumbar region of the spinal cord causing weakness and paralysis of the hind legs and in the males chronic dilation of blood vessels to the erectile tissue appears to be caused by multiple genes. The hypothesis that three dominant genes must be present in order that the character be expressed is suggested by Stockard. This condition was observed by Stockard in crosses between St. Bernard and Great Dane, and between Bloodhound and Great Dane. It has been reported at times in purebred St. Bernards and Great Danes.

Estrual weakness † occurs as a dominant to its absence in many breeds of dogs. The defect is due to deficient functioning of the follicular hormone (a).

One rut during the year is dominant to two ruts during the year in cross-breds from the wolf and dog (a).

A pleiotropic gene in the Dunker breed (dominant irregular spotting) affects color, eyes, general vigor, and the reproductive cycle in the female.

Hyper trophy of the vaginal mucosa during heat, often leading to prolapse of the vagina, is probably dominant to the normal condition. It is especially frequent in families showing cryptorchidism and cleavage malformations and is apparently due to the imperfect functioning of the follicular hormone, the production of which is controlled by the sex hormone of the anterior lobe of the pituitary (a).

Inherited periodic exzema is probably a simple dominant to its absence. Indications are that it is due to a thyroid disturbance (a).

Tendencies toward certain diseases, as cataract, whistling asthma, several forms of epilepsy, and recurrent inflammation of the eyes, appear to be inherited (a).

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‡ The lack of readiness for copulation in the presence of normal morphological estrual phenomena.

Investigator [Stockdale] (1); Plate (51, 52); Letard (36).

Koch (28).

Vicari (60).

Do.

Onslow (45).

Stockard (56).

Koch (28).

Iljin (26).

Wriedt (66).

Koch (28).

Do.

Iljin (25).
**DOGS**

**Color Inheritance**

Characters and breeds

Color (C) appears to be a simple dominant to imperfect albinism (c^) in the offspring of colored and albino Pekingese and in the progeny from albino Pekingese × black Pomeranians (Wright, using the data of Pearson, Nettleship, and Usher). Inconsistencies in the data are probably due to the interaction of other genes.

White coat with dark nose and eyes of white Pomeranian (c^) appears to be a dominant allelomorph of partial albinism (c^) (Cornaz albino, very pale grayish coat with pale-blue eyes appearing red in some lights) in the Pekingese (b).

The basic gene for color (C) is dominant to (c') which dilutes red to yellow (found in the Siberian) and to partial albinism (c^) found in the Samoyede (a).

Intense color is incompletely dominant to a factor causing partial albinism (nearly white coat with grayish black nose and dark eyes) found in the Samoyede dog. In the heterozygous state recessive red is reduced to pale chamois while black is not affected (b).

Black (B) is a simple dominant to brown or liver (b) in Pointers, Cocker Spaniels, Dachshunds, Doberman Pinschers, Newfoundland × Pointer, and in crosses of wolf and German Shepherd dog.

Yellow (A^v), wild gray color (A) and black and tan spotting (a^t) appear to form an allelomorphic series. A^v restricts the distribution of black and is incompletely dominant over a^t. A^v and a^t are found in the Belgian or Brussels Griffon (b).

Sable is dominant to nonsable in Collies. It is due to a single gene (A^v) allelomorphic to the recessive bicolor or black and tan (a) and is in the agouti series. It is dominant to agouti or wild gray color (A) of the German Shepherd. Mitchell reports the following relationships:

- \( A^vA^v = \) clear yellow sable.
- \( A^v a^t = \) varies from almost a clear yellow to dark sable apparently governed by modifiers.
- \( A = \) agouti.
- \( A^aA^a = \) sable.

Dominant black and tan (A^t), wild color (A), self-color (a), and recessive black and tan or liver and tan spotting (a^t) appear to form an allelomorphic series with dominance in the order given from crosses of Doberman Pinscher with a wolf, and Doberman Pinscher crossed to wild colored German Shepherds.

Wild gray, self-color, and black and tan appear to be present in an allelomorphic series in crosses of wolf and German Shepherd dog with dominance in the order given.

Dominant yellow and its allelomorph brindle are epistatic to all other color pigmentation except dominant black, common in Great Danes, sheep dogs, and certain breeds of terriers; also probably in the Bulldog and Mastiff, practically absent from breeds of Russian and French origin. (In the light of other evidence, it may be questioned whether dominant yellow and brindle are allelomorphs.)
Color Inheritance—Continued

Characters and breeds

Rear cases black is hypostatic to dominant yellow but
epistatic to brown (chocolate) and recessive yellow.
It is also recessive to wild or wolf-gray color. Occurs
in Irish Setters, Dachshunds, Liptaks, shepherd, and
pastoral dogs (b).

Self-color (T) is dominant to bicolor (black and tan)
in the Basset Hound and Dachshund. In combina-
tion with B=black and E=extension the (T-t)
series gives:

\[ B^T T = \text{self-black}, \quad B^T e = \text{black and tan}. \]
\[ B^t e T = \text{self-tan, red with black nose}. \]
\[ B^t e e = \text{red and lemon with black nose}. \]

Ibsen states bicolor is not in the agouti series but does
not give evidence. (In the light of other evidence
this may be questioned.)

Solid color in incompletely dominant to bicolor (black
and tan, brown and tan, red and lemon) in Cocker
Spaniels, Doberman Pinschers, Collies, Gordon Setter
× Irish Setter.

Dominant red is dominant to black and tan in Dachs-
hunds.

Yellow or red is epistatic to black and brown in Dachs-
hunds.

Red of Irish Terrier (probably \( A^2 \)) is a simple
dominant to black and tan of Fox Terrier or Welsh
Terrier.

Black and tan may be related to black in the following
three ways:
1. The recessive factor by which it differs may
   be identical with factor by which red differs
   from black. A subsidiary factor is neces-
sary to modify a red into black and tan.
2. Black and tan may be due to an allelomorph
   of the extension series.
3. Black and tan may be due to a factor inde-
   pendent of the extension series.

Reddish brown (B) is epistatic to black (A) (except
\( A^ABb\) = black) in Dachshunds and Ceylon Hairless
crossed to Dachshund. Plate suggests the following:

\[ A^A B B = \text{dark red}. \]
\[ A^A B B \text{ and } a a B B = \text{light red}. \]
\[ A^A B b \text{ and } a a B b = \text{yellow}. \]
\[ A^A B B, A^A b b \text{ and } A a b b = \text{black}. \]
\[ a a b b = \text{brown (c)}. \]

Red appears to cover up the presence of agouti or “hare
coloring” in the wire-haired Dachshund (e).

Agouti is dominant to black and tan or brown and tan
in the wire-haired Dachshund (e).

The more extensive tan markings in the Gordon Setter
are partially dominant to the lesser tan markings
(a).

Dominant black is epistatic to all other types of pig-
ment formation and probably is an allel in the exten-
sion series. It is found in Pointers, Setters, Great
Danes, Spaniels, and in some of the terriers, as the
Fox Terrier (b).

Extension of black pigment (E) is dominant to restric-
tion of black pigment; i.e., yellow (e) in Pointers (c).

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\(10\) The symbol \( T \) used by Ibsen and Anker is not the same as that used in table 2 where bicolor is placed
in the agouti series and \( T \) is used as the symbol for the ticking series.
DOGS

Color Inheritance—Continued

Characters and breeds

**Black (E)** is dominant to brindle (E') and to red or fawn (e). Brindle (E') is dominant to red or fawn (e) in Great Danes and Greyhounds. Little and Jones, and Warren suggest that they form a triple allelomorphic series (e).

Brindling appears to be dominant to the lack of it in Irish Wolfhounds and Great Danes (e).

Black or liver is a simple dominant to red (ee) (a).

Black appears to be dominant to tan or red in the Doberman Pinscher.

Black and liver are dominant to recessive yellow present in Pointers, and frequently in English Setters (a).

Dirty-white belt, yellow-brown belt of medium intensity, and bright-yellow belt in wild gray hair appear to be determined by triple allelomorphic genes in crosses of the wolf and German Shepherd dog. Dominance tends to be in the order given but is very weak between the first two.

Grayish-white dappling, light-yellow dappling, red dappling, appear to be present in an allelomorphic series in crosses of wolf and German Shepherd dog. Dominance is in the order given.

Intense coat color is a simple dominant to a factor diluting black coat color to blue and red to fawn or lemon in Cocker Spaniels, Great Danes, Doberman Pinschers, and Greyhounds. In Greyhounds, Warren found some evidence indicating the factor diluting red was not the same as the one diluting black.

The rough hair gene appears to dilute the coat colors, especially yellow, in Belgian or Brussels Griffons.

Intense pigmentation of hair, ball of foot, claws, and skin in hairless dogs (D) is incompletely dominant to dilute pigmentation of same (d) in crosses of the Ceylon Hairless dog × the Dachshund.

Dominant irregular white spotting harlequin pattern, often associated with wall eye and in extreme white individuals with deafness, is reported to be a simple dominant to the absence of such spotting in Cocker Spaniels, Great Danes, Old English Sheepdogs, Dalmatians, and possibly Bull Terriers. Though reported as a dominant, most individuals affected appear to be heterozygous. Iljin reports that this spotting pattern does not show when present in yellow or lemon hounds.

Dominant irregular spotting (merle dilution—fig. 6) often associated with wall eye is reported to be due to a single gene dominant to the absence of such spotting in the merle Collie, dappled Dachshund, and Norwegian Dunker Hound. In the heterozygous condition it produces irregular dark spots on a lighter pigmented ground color. With yellow or sable animals, however, its presence is often difficult to detect unless it has affected the eyes. In the homozygous condition it produces pale-gray or yellow spots on a white coat and generally defective sight and hearing. Mitchell suggests the above pattern is produced by the same gene as the harlequin pattern except that in the latter case there is an independent modifying gene which dilutes the ground color to white.
Collies showing the effects of the genes $V-v$ for dominant spotting (merle dilution): A, Normal black and tan Collie ($vv$); B, blue merle Collie ($Vv$), which happens to have both eyes normal, but often one or both eyes will be wholly or partly of a pale bluish-white color—“wall-eyed”; C, merle Collie with defective sight and hearing ($VT$). Since blue merles or sable merles are mixed ($Vv$), they will not breed true when mated together. (Photographs by courtesy of the Journal of Heredity, after Mitchell (43).)

Figure 6.
Color Inheritance—Continued

Characters and breeds

Self-color (S) is dominant to piebald white spotting (s) in hounds, sheep dogs, Doberman Pinschers, Great Danes, Cockeer Spaniels, Newfoundland × Pointer, Ceylon Hairless × Dachshund, Airedale × Fox Terrier, and wolf × German Shepherd dog. It appears to be subject to modifying genes causing it to range from a very little white on the coat to practically entirely white animals. The lesser degrees of piebald white spotting appear to be dominant to the greater degrees. Haldane attributes this variation to three allelomorphic factors, $s_1$, $s_2$, and $s_4$. Wriedt suggests $Ss$ animals are generally solid color except for small white markings on chest and toes.

Self-color with white on chest and toes completely dominant over markings in Newfoundland × Pointer.

Dominant white (W) is dominant to color (w). It occurs in the Russian Shepherd and sometimes in the Syrian (a).

Colored coat (W') appears to be a simple dominant to white coat (w') in Collies. Heterozygous animals (W'w') often have more prominent white markings than those free of the factor. These white Collies have dark eyes and nose. As a rule there is some color on the head (a).

Tricolor is caused by a combination of black and tan (bicolor, $a^b$) and piebald white spotting (s) in hounds and Collies.

Pigmented point in the midst of a white area on top of the head usually dividing the pigmented auricular regions behaves as a dominant to the lack of it in Pointers (a).

Self-color of ear appears to be dominant to white spots on the ear. In the heterozygous condition there are a few white hairs on the ear (a).

Ticking or roan (fig. 7) is a simple dominant to the lack of it in Cocker Spaniels, Setters, Pointers, and Foxhounds. It does not show except on white, and heavier grades appear to be dominant to the lighter grades.

Nonsilvering appears to be a simple dominant to silvering in Doberman Pinscher (a).

Eye color showed segregation in a cross of a dark brown-eyed Old English Sheepdog with a light brown-eyed Scotch Collie with the additional appearance of "wall eye."

Dark eyes appear to be dominant to lighter colored ones in Cocker Spaniels and German Shepherds (a).

Brown or yellow eyes (Y) appear to be dominant to blue eyes (y) (a).

Normal eyes (P) appear to be dominant to ruby eyes ($p^r$) (a).

Wall eye is associated with merle dilution in Collies, Old English Sheepdogs, Shetland Sheepdogs, Dappled Dachshunds, and Norwegian Dunker Hounds, and with irregular black and white spotting in harlequin Great Danes, Dalmatians, and Bull Terriers. The nose is always the same color as the footpads in Cocker Spaniels.

The colors (black, blue, red, fawn, white, brindle, or white spotting) do not appear to be linked with sex in Greyhounds.

None of the colors appear to be linked with sex in the Dachshund.

Investigator

Lang (34); Wright (68); Little and Jones (39); Wriedt (65); Plate (31); Warren (61); Haldane (18); Marchlewski (41); Iljin (24, 25, 26); Hirschfeld (31); Mitchell (43).

Lang (34).

Iljin (25).

Mitchell (43).

Iljin (24).

Barrows and Phillips (6); Wright (68); Whitney (62); Marchlewski (44).

Gates (16).

Barrows and Phillips (6); Humphrey and Warner (22).

Gates (16).
Figure 7.—Foxhounds showing the absence and presence of ticking, colored hairs intermingled with white hairs on those portions of the body that would otherwise be white: A, Foxhound bitch without ticking (t); B, Foxhound dog with ticking (Tt). Eight of the fifteen offspring from the above animals were ticked. (Photographs by courtesy of the Journal of Heredity, after Whitney (62).)
**Table 2. Alleloomorphic color series in the dog**

<table>
<thead>
<tr>
<th>Series</th>
<th>Gene symbol</th>
<th>Phenotypic effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>C</td>
<td>Basic factor for color.</td>
</tr>
<tr>
<td></td>
<td>c^e</td>
<td>Dilutes red to yellow (found in Siberians) may be Cc^e.</td>
</tr>
<tr>
<td></td>
<td>c^e</td>
<td>Partial albinism, white coat, dark eyes and nose as in Samoyede and white Pomeranian.</td>
</tr>
<tr>
<td></td>
<td>c^e</td>
<td>Partial albinism, slightly colored coat, blue eyes appearing red in reflected light, albino Pekingese.</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>Factor for black.</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
<td>Dominant yellow or sable.</td>
</tr>
<tr>
<td></td>
<td>a</td>
<td>Self-color, black or mongouti.</td>
</tr>
<tr>
<td></td>
<td>a^l</td>
<td>Bi color, black and tan, liver and tan, red and yellow.</td>
</tr>
<tr>
<td>E</td>
<td>E</td>
<td>Dominant black.</td>
</tr>
<tr>
<td></td>
<td>e</td>
<td>Partial extension of black pigment.</td>
</tr>
<tr>
<td></td>
<td>e'</td>
<td>Nonextension of black pigment, red or recessive yellow.</td>
</tr>
<tr>
<td>I</td>
<td>I</td>
<td>Dirty-white belts in wild gray hair.</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td>Yellow-brown (medium intensity) belts in wild gray hair.</td>
</tr>
<tr>
<td></td>
<td>i'^n</td>
<td>Clear-yellow (intense) broad belts in wild gray hair.</td>
</tr>
<tr>
<td>Ii</td>
<td>I;</td>
<td>Gray-white dapples.</td>
</tr>
<tr>
<td></td>
<td>i'^n</td>
<td>Light-yellow dapples.</td>
</tr>
<tr>
<td></td>
<td>i'^n</td>
<td>Red dapples.</td>
</tr>
<tr>
<td>D</td>
<td>D</td>
<td>Intense color.</td>
</tr>
<tr>
<td></td>
<td>d</td>
<td>Dilutes black to blue and possibly red to fawn or yellow.</td>
</tr>
<tr>
<td>V</td>
<td>V</td>
<td>Dominant spotting dilutes the coat and often the eye, nose, and footpads except for irregular pigmented areas, as in the merle Collie and harlequin Great Dane (apparently effected by modifiers).</td>
</tr>
<tr>
<td></td>
<td>v</td>
<td>Self-color (in the absence of other genes for spotting).</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
<td>Self or solid color.</td>
</tr>
<tr>
<td></td>
<td>s</td>
<td>Pale white markings (there may be other alleles in this series).</td>
</tr>
<tr>
<td>W'</td>
<td>W'</td>
<td>Dominant white in Russian Shepherd dog and sometimes in the Siberian.</td>
</tr>
<tr>
<td>W</td>
<td>W</td>
<td>Colored.</td>
</tr>
<tr>
<td></td>
<td>w</td>
<td>Colored.</td>
</tr>
<tr>
<td></td>
<td>w'^n</td>
<td>White coat as found in Collies (possibly an allelomorph of S or s with a modifier).</td>
</tr>
<tr>
<td>T</td>
<td>T</td>
<td>Lack of ticking or roaning.</td>
</tr>
<tr>
<td></td>
<td>t'^n</td>
<td>Ticking or roaning on white (there may be other alleles in this series).</td>
</tr>
<tr>
<td>S_i</td>
<td>S_i</td>
<td>Nonsilvering.</td>
</tr>
<tr>
<td></td>
<td>s_i</td>
<td>Silvering.</td>
</tr>
<tr>
<td>Y</td>
<td>Y</td>
<td>Brown or yellow eye color.</td>
</tr>
<tr>
<td></td>
<td>y</td>
<td>Blue eye color.</td>
</tr>
<tr>
<td>P</td>
<td>P</td>
<td>Normal eye (greenish reflection).</td>
</tr>
<tr>
<td>P_r</td>
<td>P_r</td>
<td>Ruby eye (red reflection).</td>
</tr>
</tbody>
</table>

1 In general dominance within the series is in the order given. There is a divergence of opinion and lack of certainty with regard to the existence of some of the above genes and also with regard to the allelomorphic relationships (see list (pp. 1331–1341) and discussion in the text). The symbols have been changed in some cases from those used by the original investigator.

2 Possibly the same as the I series; the different phenotypic effect may be due to different gene combinations.

**Formulas for Some of the Most Common Colors and Color Patterns in Working Dogs (Homozygous Individuals)**

<table>
<thead>
<tr>
<th>Genetic formula</th>
<th>Phenotypic appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCAABBDDDDEESS</td>
<td>Wild gray.</td>
</tr>
<tr>
<td>CCAabbDDDDEESS</td>
<td>Black.</td>
</tr>
<tr>
<td>CCAabbDDDEESS</td>
<td>Liver.</td>
</tr>
<tr>
<td>CCAaBBddEESS</td>
<td>Blue.</td>
</tr>
<tr>
<td>CCAaBBDeeppESS</td>
<td>Brindle.</td>
</tr>
<tr>
<td>CCAaBBDeeSS</td>
<td>Yellow, black nose.</td>
</tr>
<tr>
<td>CCAaBBDeeSS</td>
<td>Yellow, brown, or light colored nose.</td>
</tr>
<tr>
<td>CCA'a'BBDDDEESS</td>
<td>Black with tan markings.</td>
</tr>
<tr>
<td>CCA'a'bbDDDEESS</td>
<td>Liver with tan markings.</td>
</tr>
<tr>
<td>CCA'a'BBddEESS</td>
<td>Blue with tan markings.</td>
</tr>
<tr>
<td>CCAaBBDDDEESS</td>
<td>Black with white spots.</td>
</tr>
<tr>
<td>CCAaBBDDDeSS</td>
<td>Liver with white spots.</td>
</tr>
<tr>
<td>And generally</td>
<td>White—Thus c^d^d and W'^ are epistatic to, or cover up the action of the other genes given.</td>
</tr>
</tbody>
</table>

11 From Iljin (55) with slight modifications. He included in working dogs the following breeds: Doberman Pinscher, German Shepherd, Airedale Terrier, Rottweiler, Giant Schnauzer, Boxer, Siberian, shepherd dog of southern part of the Union of Soviet Socialist Republics. Because of the phenomenon of dominance, heterozygous individuals will often appear similar to homozygous ones; however, segregation may show up among the offspring of the former. Since there are many genes affecting color, animals heterozygous for at least some of them are quite common even among purebred dogs.
## Table 3.—Color, weight, and most important uses of breeds of dogs recognized by the American Kennel Club

**GROUP 1, SPORTING DOGS**

<table>
<thead>
<tr>
<th>Breed</th>
<th>Principal colors</th>
<th>Weight</th>
<th>Principal uses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Females</td>
<td>45–50.</td>
</tr>
<tr>
<td><strong>Pointer</strong></td>
<td>White with liver, black, or lemon markings, solid black or liver.</td>
<td></td>
<td>Pointing and retrieving game birds; retrieving.</td>
</tr>
<tr>
<td></td>
<td>Solid liver, liver and white spotted, liver and white spotted and ticked, liver and white ticked.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Short-haired German Pointer.</strong></td>
<td></td>
<td></td>
<td>Pointing and retrieving game birds; companions.</td>
</tr>
<tr>
<td><strong>Chesapeake Bay Retriever.</strong></td>
<td>Dead-grass color, dark brown to faded tan.</td>
<td>65–75.</td>
<td>Retrieving, especially ducks.</td>
</tr>
<tr>
<td><strong>Curly-coated Retriever.</strong></td>
<td>Black or liver.</td>
<td>60–70.</td>
<td>Retrieving game, land or water.</td>
</tr>
<tr>
<td><strong>Flat-coated Retriever.</strong></td>
<td></td>
<td>60–70.</td>
<td>Do.</td>
</tr>
<tr>
<td><strong>Golden Retriever.</strong></td>
<td>Rich golden, Golden chestnut or mahogany red.</td>
<td>65–68.</td>
<td>Retrieving and gun dogs.</td>
</tr>
<tr>
<td><strong>Labrador Retriever.</strong></td>
<td>Generally black.</td>
<td>55–65.</td>
<td>Retrieving and gun birds; companions.</td>
</tr>
<tr>
<td><strong>English Setter.</strong></td>
<td>Black, white and tan, black and white, blue belton, lemon and white, lemon belton, orange belton, liver and white, liver belton, solid white.</td>
<td>55–70.</td>
<td>Retrieving game, especially birds; retrieving.</td>
</tr>
<tr>
<td><strong>Gordon Setter.</strong></td>
<td>Black with tan markings.</td>
<td>50–65.</td>
<td>Do.</td>
</tr>
<tr>
<td><strong>Irish Setter.</strong></td>
<td>Golden chestnut or mahogany red.</td>
<td>50–65.</td>
<td>Do.</td>
</tr>
<tr>
<td><strong>Brittany Spaniel.</strong></td>
<td>Liver and white or orange and white. Often with roan ticking.</td>
<td>18–24.</td>
<td>Finding game, especially birds; retrieving.</td>
</tr>
<tr>
<td><strong>Clumber Spaniel.</strong></td>
<td>Lemon and white, orange and white.</td>
<td>18–24.</td>
<td>Finding game, especially birds; retrieving.</td>
</tr>
<tr>
<td><strong>Cocker Spaniel.</strong></td>
<td>Solid black, red, or liver. Above colors with white on chest.</td>
<td>18–24.</td>
<td>Finding game, especially birds; retrieving.</td>
</tr>
<tr>
<td><strong>English Springer Spaniel.</strong></td>
<td>Any color except red and white, and lemon and white.</td>
<td>Average 45.</td>
<td>Average 42.</td>
</tr>
<tr>
<td><strong>Field Spaniel.</strong></td>
<td>Solid black, liver, golden liver, mahogany red, roan, or the above with tan over the eyes and on cheeks, feet, and pasterns.</td>
<td>35–50.</td>
<td>Finding game, especially birds; retrieving.</td>
</tr>
<tr>
<td><strong>Irish Water Spaniel.</strong></td>
<td>Deep pure liver without white.</td>
<td>35–45.</td>
<td>Retrieving ducks.</td>
</tr>
<tr>
<td><strong>Sussex Spaniel.</strong></td>
<td>Rich golden liver.</td>
<td>35–45.</td>
<td>Finding game, especially birds in heavy cover.</td>
</tr>
<tr>
<td><strong>Welsh Springer Spaniel.</strong></td>
<td>Dark rich red and white.</td>
<td>33–40.</td>
<td>Finding game, especially birds in rough country with heavy cover; retrieving; companions.</td>
</tr>
<tr>
<td><strong>For more complete descriptions and histories of the various breeds see the American Kennel Club (3) from which most of this information was taken. An approximate weight to give the reader some idea of the size of the breed has been added, where possible, for those breeds having no official weight range in the breed standard. Dogs of all breeds are used as companions to at least some extent, even though that use is not listed for each breed in the table. The group classification is that used by the American Kennel Club. It is realized that in some respects this classification is not consistent with respect to the uses and characters of certain breeds. However, it would be difficult to make a classification that would not be subject to similar criticism, also the above classification appears to meet the needs of breeders fairly well.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>The belton color is produced by an intermingling of colored and white hairs in the coat.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>No published weights.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 3.—Color, weight, and most important uses of breeds of dogs recognized by the American Kennel Club—Continued

**GROUP 2. SPORTING DOGS (HOUNDS)**

<table>
<thead>
<tr>
<th>Breed</th>
<th>Principal colors</th>
<th>Weight</th>
<th>Principal uses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td><strong>Afghan Hound</strong></td>
<td>Black and tan, black, golden.</td>
<td>Pounds</td>
<td>Pounds</td>
</tr>
<tr>
<td><strong>Basset Hound</strong></td>
<td>Generally black, tan or white, or a combination of these.</td>
<td>25-40</td>
<td>25-40</td>
</tr>
<tr>
<td><strong>Beagle</strong></td>
<td>Black, tan, black and tan, black and white, tan and white, black and tan and white.</td>
<td>(9)</td>
<td>(9)</td>
</tr>
<tr>
<td><strong>Bloodhound</strong></td>
<td>Black and tan, red and tan, tawny, sometimes with small amounts of white.</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td><strong>Dachshund</strong></td>
<td>Solid red (tan) of various shades, black with tan points, chocolate with tan points.</td>
<td>5-35</td>
<td>5-35</td>
</tr>
<tr>
<td><strong>Scottish Deerhound</strong></td>
<td>Dark blue gray, darker and lighter grays, brindles, yellow and sandy red, red and fawn.</td>
<td>85-110</td>
<td>75-95</td>
</tr>
<tr>
<td><strong>American Foxhound</strong></td>
<td>Black, tan, black and tan, black and white, tan and white, black and tan and white, often ticked.</td>
<td>50-60</td>
<td>50-60</td>
</tr>
<tr>
<td><strong>English Foxhound</strong></td>
<td>Black, tan, black and tan, black and white, tan and white, black and tan and white.</td>
<td>60-80</td>
<td>60-80</td>
</tr>
<tr>
<td><strong>Greyhound</strong></td>
<td>Black, blue, brindle, red, fawn, white and above colors with white.</td>
<td>65-70</td>
<td>65-65</td>
</tr>
<tr>
<td><strong>Harrier</strong></td>
<td>Black, tan, black and tan, black and white, black and tan and white, black and tan and white, sometimes of a blue mottled color.</td>
<td>About 50</td>
<td>About 50</td>
</tr>
<tr>
<td><strong>Norwegian Elkhound</strong></td>
<td>Gray with black tips to the long covering hairs, somewhat lighter on under part of body.</td>
<td>About 60</td>
<td>About 60</td>
</tr>
<tr>
<td><strong>Otterhound</strong></td>
<td>Blue and white, grizzle or sandy, black and tan.</td>
<td>Up to 65</td>
<td>Up to 65</td>
</tr>
<tr>
<td><strong>Saluki</strong></td>
<td>Cream, fawn, red, grizzle and tan, black and tan, white and chestnut, tricolor (black, white and tan), solid black.</td>
<td>About 70</td>
<td>About 70</td>
</tr>
<tr>
<td><strong>Whippet</strong></td>
<td>Black, blue, red, white, fawn, gray, brindle, and combination of these with white.</td>
<td>10-28, average 20.</td>
<td>10-28, average 20.</td>
</tr>
<tr>
<td><strong>Irish Wolfhound</strong></td>
<td>Gray, brindle, red, black, pure white, fawn.</td>
<td>Minimum 120.</td>
<td>Minimum 120.</td>
</tr>
<tr>
<td><strong>Russian Wolfhound</strong></td>
<td>White usually predominating marked with lemon, tan, brindle, gray, or black.</td>
<td>75-105</td>
<td>55-90</td>
</tr>
</tbody>
</table>

*No published weights.*
Table 3.—Color, weight, and most important uses of breeds of dogs recognized by the American Kennel Club—Continued

**GROUP 3. WORKING DOGS**

<table>
<thead>
<tr>
<th>Breed</th>
<th>Principal colors</th>
<th>Weight</th>
<th>Principal uses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td>Alaskan Malamute.</td>
<td>Wolfsish gray or black and white. Caplike or mask-like marking on face.</td>
<td>65-85</td>
<td>50-70</td>
</tr>
<tr>
<td>Belgian Sheepdog.</td>
<td>Long-haired variety, black. Short-haired variety, brindled fawn with black, mask.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bouviers de Flandre.</td>
<td>From fawn to black through pepper and salt, gray and brindle.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boxer.</td>
<td>Fawn and brindle with mask, white with black, fawn or brindle markings.</td>
<td>About 50</td>
<td>About 50</td>
</tr>
<tr>
<td>Briard.</td>
<td>Black, black with some white hairs, dark and light gray, tawny, and combinations of gray and tawny.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bull-Mastiff.</td>
<td>Any shade of fawn or brindle.</td>
<td>115</td>
<td>100</td>
</tr>
<tr>
<td>Collie (rough).</td>
<td>Black and tan with white frill and collar, sable with white markings, white, blue merle.</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Collie (smooth).</td>
<td>Black and tan with white markings, sable with white markings.</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Doberman Pinscher.</td>
<td>Black, brown, or blue with rust-red sharply defined markings.</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td>Eskimo.</td>
<td>Black, white, black and white, wolf gray, blue gray, all shades of tan or buff and all combinations of these colors.</td>
<td>65-85</td>
<td>50-70</td>
</tr>
<tr>
<td>German Shepherd.</td>
<td>Various shades of gray, black, black and tan, brindle, brown, white marking permitted.</td>
<td>About 55</td>
<td>About 55</td>
</tr>
<tr>
<td>Great Dane.</td>
<td>Brindled, fawn, blue, black, harlequin.</td>
<td>120-160</td>
<td>100-130</td>
</tr>
<tr>
<td>Great Pyrenees.</td>
<td>White or principally white with markings of badger, gray, or tan.</td>
<td>100-125</td>
<td>90-115</td>
</tr>
<tr>
<td>Kuvasz.</td>
<td>Pure white.</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Mastiff.</td>
<td>Silver fawn or dark fawn brindle, with muzzle, ears, and nose black.</td>
<td>About 170</td>
<td>About 170</td>
</tr>
<tr>
<td>Newfoundland.</td>
<td>Dull jet black, white and black or bronze.</td>
<td>140-150</td>
<td>110-120</td>
</tr>
<tr>
<td>Old English Sheepdog.</td>
<td>Gray, grizzle, blue or blue merled, with or without white markings in varying amounts.</td>
<td>About 65</td>
<td>About 65</td>
</tr>
<tr>
<td>Rottweiler.</td>
<td>Black with tan or brown markings.</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>

1 No published weights.
### GROUP 3. WORKING DOGS—Continued

<table>
<thead>
<tr>
<th>Breed</th>
<th>Principal colors</th>
<th>Weight</th>
<th>Principal uses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samoyede</td>
<td>Pure white, white and biscuit, cream</td>
<td></td>
<td>Watchdogs; companions; sled dogs and herding reindeer in Siberia.</td>
</tr>
<tr>
<td>Giant Schnauzer</td>
<td>Pepper and salt colored or similar equal mixtures, pure black or black and tan</td>
<td></td>
<td>Police service; guards; formerly cattle driving.</td>
</tr>
<tr>
<td>Shetland Sheep-dog</td>
<td>Sable, black, blue, merle, marked with varying amounts of white and tan</td>
<td>7-10</td>
<td>Watchdogs; sheep herding; companions.</td>
</tr>
<tr>
<td>Siberian Husky</td>
<td>White, black, gray, with white and black markings</td>
<td>54-64</td>
<td>Guards; companions; rescue work at the Hospice of St. Bernard.</td>
</tr>
<tr>
<td>St. Bernard</td>
<td>Red, light or dark brindle, with white markings</td>
<td>170-210</td>
<td>Watchdogs; companions; driving cattle.</td>
</tr>
<tr>
<td>Welsh Corgis (Cardigan)</td>
<td>Red (sable, fawn, or golden), brindle, black and tan, black and white, blue merles</td>
<td>18-25</td>
<td></td>
</tr>
<tr>
<td>Welsh Corgis (Pembroke)</td>
<td>Any color other than pure white</td>
<td>18-24</td>
<td>Companions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP 4. TERRIERS</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Airedale Terrier</td>
<td>Head and ears tan, except for dark markings on each side of the skull, legs up to thighs and elbows tan; body, black or dark grizzle.</td>
<td>40-45</td>
<td>Guards; hunting; herding livestock; police and army service; companions.</td>
</tr>
<tr>
<td>Bedlington Terrier</td>
<td>Dark blue, blue and tan, liver, liver and tan, sandy, sandy and tan.</td>
<td>24</td>
<td>Pets; formerly used on badgers, foxes, otter, etc.</td>
</tr>
<tr>
<td>Border Terrier</td>
<td>Red wheaten, grizzle and tan, or blue and tan.</td>
<td>13-15½</td>
<td>Sporting terrier; bolt-foxes.</td>
</tr>
<tr>
<td>Bull Terrier</td>
<td>White.</td>
<td>12-60; average, 50.</td>
<td>Guards and companions; formerly for dog fighting.</td>
</tr>
<tr>
<td>Cairn Terrier</td>
<td>Any color except white, dark muzzle, ears and tail tip desirable.</td>
<td>14</td>
<td>Pets; killing vermin; formerly for bolt-foxing, foxes, and vermin.</td>
</tr>
<tr>
<td>Dandy Dinmont Terrier</td>
<td>Pepper or mustard (dark bluish black to light silvery gray or reddish brown to pale fawn).</td>
<td>14-24</td>
<td>Watchdogs; companions; hunting and killing vermin.</td>
</tr>
<tr>
<td>Smooth and Wire-haired Fox Terrier</td>
<td>Predominately white, black, tan or black and tan markings.</td>
<td>14-18</td>
<td></td>
</tr>
<tr>
<td>Irish Terrier</td>
<td>Bright red, red wheaten, golden red.</td>
<td>27</td>
<td>Companies; hunting small game and vermin; house dogs; army service.</td>
</tr>
<tr>
<td>Kerry Blue Terrier</td>
<td>Light to dark blue</td>
<td>33-38</td>
<td>Watchdogs; companions; hunting; shepherd dogs.</td>
</tr>
<tr>
<td>Lakeland Terrier</td>
<td>Blue, blue and tan, black and tan, red, mustard, wheaten, grizzle and black.</td>
<td>Not over 17</td>
<td>Watchdogs; companions; hunting small game and vermin.</td>
</tr>
<tr>
<td>Lhasa Terrier</td>
<td>Golden, sandy, honey dark grizzle, slate, smoke parti-color, black, white or brown, dark tips to ears and beard an asset.</td>
<td>About 14</td>
<td>Watchdogs; companions; and pets.</td>
</tr>
</tbody>
</table>

*No published weights.*
Table 3.—Color, weight, and most important uses of breeds of dogs recognized by the American Kennel Club—Continued

GROUP 4. TERRIERS—Continued

<table>
<thead>
<tr>
<th>Breed</th>
<th>Principal colors</th>
<th>Weight</th>
<th>Principal uses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pounds</td>
<td>Pounds</td>
</tr>
<tr>
<td>Manchester Terrier</td>
<td>Black and tan</td>
<td>14-22</td>
<td>14-22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12-22</td>
<td>12-22</td>
</tr>
<tr>
<td>Miniature Schnauzers</td>
<td>Pepper and salt or similar equal mixtures, light or dark, including red pepper, pure black, black and tan.</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Standard Schnauzers</td>
<td>All pepper-and-salt colored or similar mixtures; pure black or black and tan.</td>
<td>About 20</td>
<td>About 18</td>
</tr>
<tr>
<td>Scottish Terrier</td>
<td>Steel or iron gray, brindled or grizzled, black, sandy, or wheaten.</td>
<td>18-20</td>
<td>18-20</td>
</tr>
<tr>
<td>Sealyham Terrier</td>
<td>All white or with lemon, tan or grizzled markings on head and ears.</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>Skye Terrier</td>
<td>Dark or light blue, or gray or fawn with black points.</td>
<td>16-20</td>
<td>14-18</td>
</tr>
<tr>
<td>Welsh Terrier</td>
<td>Black and tan or black grizzled and tan.</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>West Highland White Terrier</td>
<td>Pure white</td>
<td>15-19</td>
<td>13-17</td>
</tr>
</tbody>
</table>

GROUP 5. TOY DOGS

<table>
<thead>
<tr>
<th>Breed</th>
<th>Principal colors</th>
<th>Weight</th>
<th>Principal uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chihuahua, short- and long-coated.</td>
<td>Any color, solid or marked or spashed.</td>
<td>1-6</td>
<td>1-6</td>
</tr>
<tr>
<td>English Toy Spaniel:</td>
<td></td>
<td></td>
<td>Pets; ratters.</td>
</tr>
<tr>
<td>King Charles or Black and Tan.</td>
<td>Black with tan markings.</td>
<td>9-12</td>
<td>9-12</td>
</tr>
<tr>
<td>Ruby</td>
<td>Chestnut red.</td>
<td>9-12</td>
<td>9-12</td>
</tr>
<tr>
<td>Blenheim</td>
<td>White with bright rich chestnut or ruby red markings, evenly distributed in large patches, spot on forehead.</td>
<td>9-12</td>
<td>9-12</td>
</tr>
<tr>
<td>Prince Charles or Tricolor.</td>
<td>White with black and tan markings.</td>
<td>9-12</td>
<td>9-12</td>
</tr>
<tr>
<td>Griffon: Brussels (wired-haired).</td>
<td>Reddish brown, a little black at whiskers and chin.</td>
<td>Small-sized, not over 7; large-sized, not over 12.</td>
<td>Do.</td>
</tr>
<tr>
<td>Belgian (wired-haired).</td>
<td>Black and redish brown mixed black mask and whiskers.</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>Brabancones (smooth-haired).</td>
<td>Reddish brown, black with redish brown markings.</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>Italian Greyhound.</td>
<td>All shades of fawn, red, mouse, blue, cream and white.</td>
<td>Lightweight, 8 and under; heavyweight, over 8.</td>
<td>Do.</td>
</tr>
<tr>
<td>Japanese Spaniel.</td>
<td>Black and white, all shades of red and white.</td>
<td>Lightweight, 7 and under; heavyweight, over 7.</td>
<td>Do.</td>
</tr>
<tr>
<td>Maltese</td>
<td>Pure white</td>
<td>Not over 7; under 3, ideal.</td>
<td>Do.</td>
</tr>
</tbody>
</table>
### TABLE 3.—COLOR, WEIGHT, AND MOST IMPORTANT USES OF BREEDS OF DOGS RECOGNIZED BY THE AMERICAN KENNEL CLUB—CONTINUED

#### GROUP 5. TOY DOGS—CONTINUED

<table>
<thead>
<tr>
<th>Breed</th>
<th>Principal colors</th>
<th>Weight</th>
<th>Principal uses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td>Mexican Hairless</td>
<td>Skin generally slate gray, sometimes mottled with flesh-colored spots.</td>
<td>About 14</td>
<td>About 14</td>
</tr>
<tr>
<td>Pappillon</td>
<td>Unicolor—any pure color.  Two-colored—any color, with white.  Tricolor—any two colors with white.</td>
<td>Less than 9</td>
<td>Less than 9</td>
</tr>
<tr>
<td>Pekingese</td>
<td>Red, fawn, black, black and tan, sable, brindle, white and particolored well defined, black masks and spectacles desired.</td>
<td>Maximum 14</td>
<td>Maximum 14</td>
</tr>
<tr>
<td>Pinscher (miniature.)</td>
<td>Lustrous black with tan, rust red or lemon markings, solid yellow, solid red or stag red, solid brown or brown with red or yellow markings, solid blue or blue toned with red or yellow markings.</td>
<td>5-10</td>
<td>5-10</td>
</tr>
<tr>
<td>Pomeranian</td>
<td>Black, brown, chocolate, red, orange, cream, orange sable, wolf sable, beaver, blue, white, and particolored colors.</td>
<td>Lightweight, not exceeding 7; heavy-weight, over 7.</td>
<td>Lightweight, not exceeding 7; heavy-weight, over 7.</td>
</tr>
<tr>
<td>Pug</td>
<td>Silver or apricot fawn, with dark mask, black.</td>
<td>14-18</td>
<td>14-18</td>
</tr>
<tr>
<td>Toy Manchester Terrier or Toy Black and Tan Terrier.</td>
<td>Jet black with rich mahogany-any tan markings.</td>
<td>About 7</td>
<td>About 7</td>
</tr>
<tr>
<td>Toy Poodle</td>
<td>Any solid color.</td>
<td>Under 12</td>
<td>Under 12</td>
</tr>
<tr>
<td>Yorkshire Terrier</td>
<td>Dark steel blue with tan markings.</td>
<td>2 1/4-13</td>
<td>2 1/4-13</td>
</tr>
</tbody>
</table>

#### GROUP 6, NONSPORTING DOGS

<table>
<thead>
<tr>
<th>Breed</th>
<th>Principal colors</th>
<th>Weight</th>
<th>Principal uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulldog</td>
<td>Red brindle, other brindles, solid white, solid red, fawn, or fawn, piebald.</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Chow Chow</td>
<td>Any clear color, usually red, black, or blue.</td>
<td>55-60</td>
<td>55-60</td>
</tr>
<tr>
<td>Dalmatian</td>
<td>Ground color, pure white with small black or liver-colored spots scattered over the entire animal.</td>
<td>35-50</td>
<td>35-50</td>
</tr>
<tr>
<td>Keeshonden</td>
<td>Wolf gray.</td>
<td>About 40</td>
<td>About 40</td>
</tr>
<tr>
<td>Poodle</td>
<td>Any solid or even color.</td>
<td>Large, over 20; miniature, 12-20.</td>
<td>Large, over 20; miniature, 12-20.</td>
</tr>
<tr>
<td>Schipperke</td>
<td>Solid black.</td>
<td>Up to 18</td>
<td>Up to 18</td>
</tr>
</tbody>
</table>