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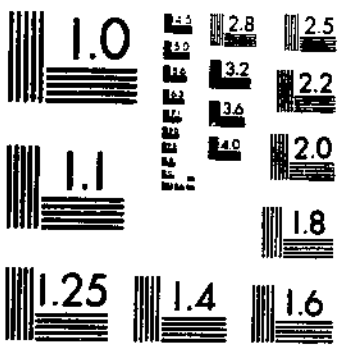


MICROCOPY RESOLUTION TEST CHART
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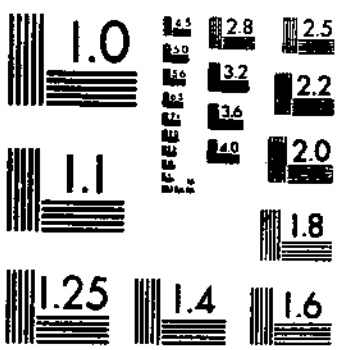


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Experiments in Breeding

# JERSEY CATTLE AT BELTSVILLE

## An Analysis of the Foundation Cows and of the First Outbred Generation

by M. H. Fohrman
and J. B. Parker

Dairy Husbandry Research Branch
Agricultural Research Service

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# Experiments in Breeding
# JERSEY CATTLE AT BELTSVILLE

## An Analysis of the Foundation Cows and of the First Outbred Generation[1]

By M. H. Fohrman and J. B. Parker, *Dairy Husbandry Research Branch, Agricultural Research Service*

## INTRODUCTION

Breeding investigations with dairy cattle were begun by the United States Department of Agriculture in 1917 at the dairy experiment station at Beltsville, Md., as a part of the research program of the Dairy Division of the Bureau of Animal Industry. Subsequently, the responsibility for continuing the breeding research was transferred to the Bureau of Dairy Industry when it was established in 1924, and then to the Dairy Husbandry Research Branch when the Department was reorganized in November 1953.

In 1917, the late B. H. Rawl, Chief of the Dairy Division, conceived the idea of developing scientific information in dairy-cattle genetics by studying the subject directly, through the use of experimental herds of cattle. The object of this experimental work was to afford breeders and dairy farmers a more complete understanding of the laws of heredity as they apply to the breeding of dairy cattle for economical and profitable production of milk and butterfat. It was felt that with a knowledge of genetics as a basis for conducting a breeding program and a successfully demonstrated plan of procedure for applying such knowledge, dairymen would be able to carry on the industry of breeding high-producing dairy cows with greater assurance of success.

At that time, as at present, the dairy-cattle breeding business was hazardous because a high percentage of the female offspring failed to be profitable producers. In later years, as information from dairy-herd-improvement-association herds was accumulated and analyzed, it was found that the cows in these herds were distributed about evenly in three milk-producing classes. One-third earned a profit, another third broke even, and the other third failed to produce enough milk to pay for their keep. This last third could, of course, be identified and disposed of after they were milking; but by that time they represented a considerable capital investment by their owners, only a part of which would be refunded by the butcher.

A business with so large a proportion of failures in its operations could hardly be considered efficient; yet such was the condition of the

[1] Submitted for publication May 13, 1954.

dairy-cattle breeding industry. Later on, when more interest was aroused and bull proving became more popular, the records from dairy-herd-improvement-associations disclosed a similar three-class performance for dairy sires—one-third raising production, one-third about maintaining it, and one-third actually lowering production—as measured by the records of the daughters of a sire when compared with the records of their dams.

That was the situation at the time these breeding experiments were conceived, although at that time the volume of records was not great enough to make it as impressive as later. However, the need for a better breeding procedure was felt. Studies of breeding operations at that time would not supply satisfactory information, as few breeding establishments were following a definite testing program. Record making was largely for advertising purposes and hence was highly selective. Few breeders remained in the business long enough to establish special merit in their cattle.

Studies of information gleaned from the breeders' herds all lacked completeness. Selective testing and shifting environmental conditions in these herds led to erroneous or incomplete conclusions from results based on such information. For these reasons, the Dairy Division inaugurated breeding investigations with herds where environment could be stabilized, testing made all-inclusive, and selection eliminated.

There had always been wide discussion of the relative merits of outbreeding, linebreeding, and inbreeding for improving dairy cattle. Therefore, plans were laid to develop information in the course of these breeding investigations which would give a fair estimate of the importance of the system of mating followed during a program of herd improvement by breeding. One fundamental question to which an answer was to be sought was how to reduce the number of unwanted low-producing females and poor-transmitting males among the progeny of our herds. A reduction from 1 failure in 3 to 1 in 5 would be worth while, and to 1 in 10 would be very good.

It was decided that the most hopeful approach to a solution of this problem would be through the use of proved sires—those which had already demonstrated their transmitting ability through the production performance of their daughters. Producing ability was considered as paramount, since it is the sale of milk and butterfat produced by the herd that makes its maintenance and the owner's income secure. Even the owners of well-advertised breeding herds seldom get more than 10 percent of their gross income from the sale of surplus stock, and this is usually dependent on a satisfactory production performance for the herd.

## BREEDING PROJECTS WITH JERSEY CATTLE

This project was set up at the Beltsville, Md., dairy station in 1918. It contemplated the continuous use of proved sires to concentrate inheritance for high levels of milk and butterfat production. This procedure was predicated on the theory that the valuable sire was one that was relatively homozygous for the hereditary factors controlling high levels of production. Furthermore, if these proved sires all had a similar factorial makeup, the factors for low production that were left in the herd by previous sires would be gradually replaced through the continued use of proved sires for a number of generations.

With the proved sire as the basis for improvement, the projects were mapped so that comparative information would develop on outbreeding, linebreeding, and inbreeding. Proved Jersey sires of three families were used continuously as the program developed.

The plan for the Jersey herd called for three groups of foundation cows, which were bred to three proved sires of well-established Jersey lines or families. The first-generation offspring were an outbred group. These daughters were first mated to their own sires to produce an inbred group. After dropping an inbred daughter the cow was next bred to one of the other unrelated proved sires to produce an outbred daughter for comparison with the previous inbred daughter.

Certain difficulties and hazards constantly threaten the success of even the most carefully planned breeding projects with large animals such as dairy cattle, and it might be well to enumerate them for the benefit of those who are impatient at the slow rate at which results are forthcoming.

There is a constant threat of interference and interruption by outbreaks of disease that may occur in spite of constant vigilance. During this work, infectious abortion, tuberculosis, and mastitis have all been encountered and have taken some toll in passing.

With proved sires brought in at advanced ages there have been delays due to sterility, and accidental losses of important sires have reduced numbers of offspring in some groups.

The fact that the reproduction rate in cattle is slow has made it necessary to undertake the projects with the certainty that results could be attained only after many years.

The maintenance of environmental conditions without change over a long period has been a difficult problem, not only because of changing personnel but also because of a natural desire to utilize the steadily developing knowledge of the factors that influence production. Even the possibilities for the improvement of the experimental procedure which have grown out of this work itself cannot be utilized without reducing the value of the results achieved in the early years of the experiments, as, for instance, the substitution of the 305-day record for the yearly record.

The necessity for upholding the standard of excellence of sires brought in, the sustaining of enthusiasm while awaiting slow-moving results, and the suppression of zeal to push the better and neglect the poorer groups, are all minor factors that need careful watching to maintain parity of opportunity for all generations, since the human element cannot be entirely overlooked where the milking and general care of cattle are concerned.

## PROCEDURE FOR CONDUCTING THE BREEDING PROJECTS

The formulation of procedure for conducting these projects required careful consideration. Once they were launched according to a certain plan there was no possibility of altering the procedure materially without sacrificing the completed part of the work. It is the changing of methods and of environment that most often discounts the value of breeding studies based on results in commercial herds. These changes in herd management are often due to changes in economic conditions.

In order to stand the test of time it was deemed best to make all requirements of procedure moderate. No extreme conditions were established, as these are always difficult to maintain over a period of years, and success depends too often on the skill and enthusiasm of the individual. Moderate requirements can usually be met, even where management personnel is subject to change.

To meet the demands of good experimental procedure it was necessary (1) that no culling or selection of females be practiced after the foundation herds were established, (2) that all female progeny of the various sires be raised and developed without regard to the appearance or producing ability of themselves or their dams, and (3) that the results be based on unselected and unculled groups. The problem was to study inheritance and transmitting ability of all animals in the herd under uniform conditions.

Following the above principle, all the female calves are retained and raised under conditions that should insure satisfactory growth up to producing age. Calves are separated from their dams shortly after birth, placed in small pens in the calf barn, and fed by hand. Whole-milk feeding continues up to 4 weeks, at which time skim milk is substituted. Grain and hay are offered as soon as the calves will eat these feeds. At 6 months of age skim-milk feeding is discontinued. This procedure is general, but the feeding of whole milk is continued longer than 4 weeks if the calf lacks vigor or is retarded by sickness. Corn silage was fed to calves past 6 months of age in the first few years, but for convenience this practice was changed and grain and alfalfa hay now make up the whole ration after skim-milk feeding has been discontinued. The quantity of grain has been varied from time to time and has ranged from 2 to 5 pounds daily for animals 8 to 12 months of age, but sufficient nutrients to afford good growth are fed at all times. The most satisfactory procedure after skim-milk feeding is discontinued is to allow a maximum of 3 pounds of grain daily and free access to alfalfa or mixed hay. It is known that a fairly wide range of rations will insure satisfactory growth.

At a year old, heifers are moved into the herd barns. Silage in winter and pasture in season are then added to the hay and grain ration. First breeding of heifers is in the 15th month, for calving at approximately 2 years of age.

It was determined that the measure of producing ability should be the amount of milk and butterfat produced in 365 days under standardized conditions. When the projects began few breeders were interested in 305-day production because the record was at a disadvantage when compared to the full-year record. The later trend toward the 305-day record and twice-a-day milking was not yet apparent, and herd testing was not even discussed. If the plan were being established today, the 305-day test would probably be adopted, largely because it is a more general practice, and also because it would hasten results by shortening the calving interval. With this background the 365-day record was set up as the standard, and records are made on three milkings daily throughout the period.

The cows are kept in box stalls during the test period. Feeding is based on size of the cow (maintenance), the rate of production of milk, and the butterfat test of the milk. Feeding standards are used to determine the nutritive requirements, based on weight and production at the beginning of each month, and the feeds are adjusted accordingly.

Originally the feeds used were corn silage, alfalfa hay, wet beet pulp, and a grain mixture with a digestible protein content of 18.2 percent. Beginning in July 1933, the digestible protein content of the grain mixture was reduced to 15.5 percent. Also the beet pulp was fed dry and mixed with the grain in the proportion of 1 to 4. This assured greater accuracy in feeding the beet pulp and made the proportion the same for all cows.

Pasture is variable in the Beltsville locality, and as there was no assurance of adequate pasturage from year to year, and also because there is no accurate means of determining the amount of nutrients obtained from pasture when other rations are being fed during the pasture season, the cows have no pasture during their test years. Exercise is permitted in a dry lot. All cows are encouraged to eat hay and silage by offering them slightly more than they will consume, and the grain ration is apportioned to make up the rest of the nutrients required for maintenance and production. No high-powered feeding methods are followed, and no effort is made to pamper individual animals with special feeds. During the test year the cows are bred in the fifth month of lactation.

All cows are put on test at the first calving, if calving is normal, and thereafter they are tested under standard conditions as frequently as our facilities will permit. The object of the first record is to insure a measure of production to be used in the event the cow dies or becomes incapacitated before reaching maturity. If the first parturition is abnormal or something happens to interfere during the first test, another record is begun at the next calving. During the lactation periods when cows are not on standard test they are bred for yearly calving and are frequently used on experimental feeding trials. Facilities do not permit having all animals on test continuously, nor is this deemed necessary in order to determine their producing ability where the testing is done under well controlled and standardized conditions.

All cows were milked by hand until November 1928, when a part of the herd was changed to machine milking. After June 1931 the entire herd was milked by machines, except that most cows are milked by hand during one lactation period after the first. Since January 1950 all cows on test have been milked by hand.

Every effort has been made to provide conditions of environment and management that could be made continuously uniform. The feeding and handling are such as to enable cows to demonstrate differences in their ability to produce, under the environmental level imposed on them. A restrictive or variable environment would defeat the purpose for which the projects were set up. Unfavorable environment will limit the expression of good production inheritance. Production records during test years are made under the supervision of the University of Maryland and in accordance with the rules of the American Jersey Cattle Club.

Records made by cows under 6 years of age when used for comparative purposes are corrected to a mature-age-equivalent basis by use of correction factors, but no other adjustments are made. Records made by cows with blind quarters are noted, but no correction is attempted, because the shrink due to a nonfunctioning quarter cannot be determined definitely. Records for lactations shorter than 365 days are used as made, because the conditions are favorable for a full

year's record and the fault is in the cow. Sickness in cows is noted and they are given proper treatment, but no allowance is made for any nondeterminable loss in production. If the interference is severe the trial is repeated in the next lactation period. Temperature control is not possible with the equipment at Beltsville. No artificial means are used to make the test cows more comfortable during the summer months, though no doubt the high temperatures and high humidity do result in lower production levels for some cows and particularly for those freshening in the spring or early summer months. While all cows are housed under the same conditions, extremes of temperature and humidity affect cows at different periods of their lactations, but no attempt is made to correct for such effects. All abnormalities are recorded and exceptional cases will be discussed individually.

All cows are retained in the herd until they die from natural causes, or are slaughtered for failure to breed, or because they are no longer useful on the projects. Those disposed of are slaughtered on the farm to afford post mortem information and to complete other scientific anatomical studies.

Thus, every effort is made to give each cow, no matter how poor a producer she may be, the chance to produce up to the limit of her inherent capacity. The cow with a capacity production of 350 pounds of butterfat has the same care and management and the same opportunity to produce her maximum, as the cow with a capacity production of 800 pounds. The only controlled variation is the amount of nutrients fed. An attempt is made to feed each cow approximately 10 percent more nutrients than her calculated requirements, in order that a limited production may not be attributed to a limitation of feed. These standardized conditions are designed to give every cow an equal opportunity to produce up to her capacity and undoubtedly the low- to good-producing cow has that opportunity. There may be some exceptionally high producing cows in the herd that would make much higher records if they were milked 4 times a day instead of 3, if they were kept in screened stalls equipped with electric fans during the summer months, and if their appetites were catered to by special feeds. Probably there is a pretty definite ceiling beyond which cows with higher inherent capacity cannot go when handled under the standardized conditions described.

Calves are weighed every 10 days for the first year and monthly thereafter. Body measurements have been made of all animals periodically since 1924, and photographs taken by schedule and in a comparable manner.

Every effort is being put forth to assemble and record complete information that may be useful in interpreting the inheritance of productive ability in all the animals involved in these studies, and to avoid hasty conclusions based on incomplete data.

## DECIDING WHICH RECORDS TO USE

In studying inheritance of milk production the investigator is usually confronted with the problem of determining, in cases where animals have more than one production record, which record most accurately measures the producing ability. Opinion is divided as to whether the highest single lactation period record, an average of all

lactation records, or the lifetime production record should be used to define producing ability. In commercial herds where the sale of milk products is the source of income the animal that has a good lifetime production will be more profitable than the animal that is a good producer for only one or two lactation periods; but where the selection of breeding stock is important or where an analysis of the inheritance of producing ability is sought, it seems essential to use the standard that is most nearly free from interference by environmental factors. Lifetime production may be interfered with by breeding troubles, improper feeding, damage to the udder, or other injuries, none of which has anything to do with inheritance for level of production. Lifetime performance may be as much a measure of good herd management as of inheritance. Very often the cow that has a good lifetime record is one that was fortunate in escaping injury and attacks of disease. Whether these animals possess an inherent resistance to disease or an inheritance for superior constitution or hardiness that enables them to be good producers year after year, is questionable.

Lifetime averages tend to reduce the variability of groups of daughters, and as this is an important point in studying the transmitting ability of sires, it would appear necessary that variance be considered without the modification that averaging would introduce.

The planned procedure in these breeding investigations is to start all cows on test under controlled environmental conditions when fresh with first calf, and to make a second record after the cow has reached the age of mature production. Whenever facilities permit cows are tested in intermediate lactation periods. The mature record would be the best standard for measuring producing ability, if it could be safely assumed that all would go well; but unfortunately some animals die or become sterile before reaching maturity, others suffer injuries or udder damage that may interfere with the full expression of their inherited ability, and still others are started on test during years when difficult calving or other uncontrollable factors interfere with the normal functioning of their milk producing equipment. These latter items furnish the principal reasons for starting cows on test with first calf. The probabilities are greater that the average animal would be sound and normal in her first lactation than at any subsequent lactation period, but even the first lactation period is subject to interference by some of these physiological derangements.

It might be suggested that an average of all records would be a fair compromise, but all animals do not have multiple records, and where only one record can be considered entirely normal the average would interfere with the correct interpretation of the results. The comparison of the average production for a number of lactations for the dam, with the first lactation of the daughter, often proves advantageous to the daughter because of the fact that the dam is very likely to have a letdown in one or more lactations because of injury, disease, or difficulty in calving, and this results in the average being considerably lower than her production for the lactation periods in which she was normal.

The use of heifer records only might be suggested as a satisfactory solution, but under the best of conditions all animals do not calve at the same age, nor do they all calve normally the first time. Furthermore, if slow maturity should be a characteristic of any particular

group, the use of heifer records alone would act to the disadvantage of members of this group.

Age correction factors help to overcome the effect of age differences and their use is warranted in ironing out unavoidable differences in age of first calving and also in making heifer records comparable with mature age records.

After weighing all of the above facts and theories it was deemed best to use the highest records in all cases, either actual mature records or the immature records calculated to maturity, in the statistical analysis of the data. This inherited ability of a cow to produce milk is established at the time of conception. How well this inheritance is expressed by the individual depends on the degree to which environment inhibits its expression. Environment cannot add to the inherited potential but does limit its expression, and when this limiting action is held to a minimum then inherited ability is most fully demonstrated. Therefore, the highest record is the best measure of inherited ability of all animals under uniform environment.

The material that follows is an analysis of the producing, reproducing, and transmitting ability of the foundation cows assembled for this project, and of their progeny sired by the three Jersey bulls used concurrently, The Moose O'Fernwood 137024, Karnak's Noble 4th 115589, and Hood's Sophie's Tormentor 145709. (See First Three Sires Used in the Jersey Breeding Project, p. 15.)

In order to demonstrate any progressive changes which might come about through the use of production-proved sires it would appear to be desirable to analyze the data on a generation basis. There was bound to be some overlapping of generations as the work progressed, since some of the foundation cows were still in the herd when the next battery of sires came into service, and bulls do not all continue serviceable for the same length of time. Reports will be made of the results of the continuous proved-sire breeding on a generation by generation basis, at least until the overlapping of generations becomes too involved to continue in this manner. In the beginning the picture is clear, and this first report is based on the matings of 3 proved sires to the original foundation cows, which have been subdivided into 3 groups.

## THE FOUNDATION JERSEY HERD

In December 1918, 4 Jersey females were purchased in Massachusetts, but only 1 of these and her daughter were used in the Beltsville projects, the others having been sent to a branch station at Jeanerette, La.

In May 1920, 7 females were purchased in New York State and this group was carrying 2 female calves. One of the calves died and the other was added to the foundation group.

In June 1920, 1 cow was purchased in New York, 12 in Maryland, 3 in Massachusetts, and 8 in Maine. The New York cow died and of 4 female calves carried by the other cows, 1 died and the remaining 3 became foundation cows.

A year later 8 females were purchased for another project—4 in Maine, 2 in Massachusetts, 1 in Virginia, and 1 in Connecticut. These 8 females and the 2 female calves they were carrying were used as foundation cows, which makes a total of 46 foundation cows that

were bred to the first 3 bulls on the project. As the work progressed some additional females were added to the original foundation group but they made no contribution to the results reported here.

Three of the cows (Nos. 462, 463, and 464) were born in Oregon but had been used in herds in Maine and Massachusetts. All others were born in the States indicated.

Table 1 lists the foundation cows by Beltsville herd numbers, dates of birth, age at the time the project started, place of purchase, and names and breed registration numbers. They are divided into three groups for the reasons described on page 12.

TABLE 1.—*Females in the Jersey foundation herd*

| Group and herd No. | Date of birth | Age Oct. 1, 1920 | | Where purchased | Name and registration No. |
|---|---|---|---|---|---|
| | | *Yr.* | *Mo.* | | |
| Group 1: | | | | | |
| 403 | Sept. 9, 1916 | 4 | 0 | Massachusetts | Bright Doris of Hillside 406071. |
| 406 | Feb. 8, 1914 | 6 | 7 | New York | Sophie's Jacoba Loretta 314861. |
| 407 | Apr. 12, 1915 | 5 | 5 | do | Jacoba's Loretta Sophie 357535. |
| 408 | May 21, 1915 | 5 | 4 | do | Jacoba of Jersey Lawn 5th 369824. |
| 409 | Sept. 30, 1915 | 5 | 0 | do | Sophie Jacoba Smoky 353399. |
| 410 | Jan. 1, 1917 | 3 | 8 | do | Jacoba's Wonder 385962. |
| 411 | Apr. 17, 1918 | 2 | 5 | do | Jacoba's Dove 431427. |
| 412 | Dec. 30, 1918 | 1 | 9 | do | Jacoba's Ella 435544. |
| 438 | Apr. 1, 1919 | 1 | 6 | Massachusetts | Sophieson Ivanna 404724. |
| 439 | Sept. 12, 1919 | 1 | 0 | do | Sophie's Idyll 465527. |
| 440 | Oct. 16, 1919 | 0 | 11 | do | Sophie's Irina 409447. |
| 454 | Nov. 10, 1920 | | | do | Sophie's Irene Lass 500789. |
| 457 | May 14, 1921 | | | do | Veda's Interested Doris 529084. |
| Group 2: | | | | | |
| 416 | Oct. 11, 1917 | 2 | 11 | Maryland | Independent Kate 418579. |
| 420 | Feb. 25, 1918 | 2 | 7 | do | Maud's Viola Ann 429022. |
| 424 | Apr. 22, 1918 | 2 | 5 | do | Rebecca's Lady Grace 429029. |
| 425 | May 8, 1918 | 2 | 4 | do | Josie's Sultana 429031. |
| 426 | May 8, 1918 | 2 | 4 | do | Golden Jewel's Julia 429030. |
| 427 | May 15, 1918 | 2 | 4 | do | Noble Maid's Lady May 429032. |
| 430 | July 26, 1918 | 2 | 2 | do | Harriet's Jolly Queen 429038. |
| 432 | Aug. 8, 1918 | 2 | 1 | do | Trudie of Hermitage's Sally 459514. |
| 434 | Sept. 15, 1918 | 2 | 0 | do | Lady Maud's Miss Polly 459516. |
| 435 | Nov. 15, 1918 | 1 | 10 | do | Venie of Hermitage's Jean 459517. |
| 436 | Mar. 3, 1919 | 1 | 6 | do | Mable's Mary Jane 457186. |
| 437 | Mar. 10, 1919 | 1 | 6 | do | Jennie's Sultana Gold 457188. |
| 441 | May 20, 1918 | 2 | 4 | Maine | Moonbeam Owl 443945. |
| 442 | Aug. 20, 1918 | 2 | 1 | do | Gussie Owl 450250. |
| 443 | Jan. 18, 1919 | 1 | 8 | do | Interested Creey 464474. |
| 444 | May 21, 1919 | 1 | 4 | do | Interested Annabelle 478368. |
| 445 | May 24, 1919 | 1 | 4 | do | Interested Moy 478369. |
| 446 | July 24, 1919 | 1 | 2 | do | Interested Aza 479079. |
| 447 | Sept. 1, 1919 | 1 | 1 | do | Interested Luna 479080. |
| 448 | Sept. 6, 1919 | 1 | 0 | do | Interested Gara 479081. |
| 449 | Sept. 8, 1920 | | | Maryland | Gamboge's Maud 514096. |
| 453 | Oct. 24, 1920 | | | do | Gamboge's Jean 514098. |
| 455 | Nov. 13, 1920 | | | do | Merton's Gamboge's Polly 514099. |
| Group 3: | | | | | |
| 462 | Mar. 14, 1917 | 3 | 6 | Maine | St. Mawes Lass of Ayredale 392700. |
| 463 | Dec. 15, 1918 | 1 | 9 | Massachusetts | St. Mawes Ruby 436519. |
| 464 | Mar. 4, 1919 | 1 | 6 | do | St. Mawes Olga Flora 440969. |
| 465 | Dec. 31, 1914 | 5 | 9 | Maine | Lyra of Pulpit Rock 367249. |
| 466 | May 3, 1915 | 5 | 4 | do | Victor's Lady Matilda 358502. |
| 467 | Aug. 5, 1916 | 4 | 1 | do | Victorious Hattie 404565. |
| 468 | Feb. 8, 1919 | 1 | 7 | Virginia | Majesty's Princess Cretesia 438853. |
| 469 | July 13, 1918 | 2 | 2 | Connecticut | Majesty's Gamboge Pansy 2d 444539. |
| 475 | Nov. 7, 1921 | | | Maine | Carry-On Lady Letty 541124. |
| 478 | Jan. 24, 1922 | | | Connecticut | Sybil's Fauvic Princess 547240. |

Table 2 gives a summary of the total reproductive performance of foundation cows in the various groups. In addition to the 43 cows included in the table there were 3 more foundation cows, 2 of which (Nos. 430 and 446) died shortly after reaching Beltsville and 1 (No. 453), which was born there, was discarded as a nonbreeder. These 3 animals would have been members of group 2. The 43 cows included in the study averaged 5.5 pregnancies, with some variation

TABLE 2.—*Reproductive performance of foundation cows in the various groups*

| Times pregnant (number) | Group 1 | | Group 2 | | Group 3 | | All groups | |
|---|---|---|---|---|---|---|---|---|
| | Cows | Conceptions | Cows | Conceptions | Cows | Conceptions | Cows | Conceptions |
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| 1 | | | 2 | 2 | | | 2 | 2 |
| 2 | | | 3 | 6 | | | 3 | 6 |
| 3 | | | 3 | 9 | | | 3 | 9 |
| 4 | 3 | 12 | 2 | 8 | 2 | 8 | 7 | 28 |
| 5 | 1 | 5 | 2 | 10 | 2 | 10 | 5 | 25 |
| 6 | 3 | 18 | 2 | 12 | 5 | 30 | 10 | 60 |
| 7 | 3 | 21 | 2 | 14 | 1 | 7 | 6 | 42 |
| 8 | 1 | 8 | 2 | 16 | | | 3 | 24 |
| 9 | 1 | 9 | | | | | 1 | 9 |
| 10 | 1 | 10 | 1 | 10 | | | 2 | 20 |
| 14 | | | 1 | 14 | | | 1 | 14 |
| Total | 13 | 83 | 20 | 101 | 10 | 55 | 43 | 239 |
| Average pregnancies per cow—number | 6.4 | | 5.0 | | 5.5 | | 5.5 | |
| Pregnancies terminated in other herds—do | 16 | | | | 13 | | 29 | |
| Cows died pregnant at Beltsville—do | | | 1 | | 3 | | 4 | |
| Pregnancies terminated at Beltsville—do | 67 | | 100 | | 39 | | 206 | |
| Results of 206 pregnancies terminated at Beltsville: | | | | | | | | |
| Live female calves—number | [1] 25 | | [1] 39 | | 17 | | [2] 81 | |
| Dead female calves—do | 3 | | [1] 3 | | | | [1] 6 | |
| Live male calves—do | 29 | | 37 | | 17 | | 83 | |
| Dead male calves—do | 1 | | 4 | | 1 | | 6 | |
| Aborted female calves—do | | | [1] 4 | | [1] 3 | | [2] 7 | |
| Aborted male calves—do | 7 | | 9 | | 1 | | 17 | |
| Aborted (sex unknown)—do | 3 | | 6 | | 1 | | 10 | |
| Mummified fetus—do | | | 1 | | | | 1 | |
| Total | [1] 68 | | [3] 103 | | [1] 40 | | [4] 211 | |

[1] Includes 2 twins.
[2] Includes 4 twins.
[3] Includes 6 twins.
[4] Includes 10 twins.

between groups 1 and 2. The animals in group 2 were younger on the average when purchased than those in the other groups, which included animals that had already calved once or more. Twenty-nine of the pregnancies were terminated before the cows reached Beltsville, and 4 cows died pregnant. Group 2 animals have the comparative disadvantage of having their entire breeding histories recorded, but some of the animals in other groups had already established some breeding history before they were brought in. This could readily account for the difference in average number of pregnancies between groups.

It took 562 services to establish the 210 pregnancies at Beltsville, an average of 2.68 services per conception. This occurred during a period when the herd was heavily infected with Brucellosis, and in addition during the early stages of the breeding project every effort was made to get cows with calf in order to build up numbers in the first generation. Sex ratio was about even in full-term calves, partly due to the number of pairs of female twins. When sex was determined in aborted fetuses there appeared to be a preponderance of males. The incidence of abortion was abnormally high because an active Brucellosis infection established itself early and was not con-

trolled until the herd was finally divided on a basis of the Bang's test. Five sets of twins recorded were all female twins.

In the early stages of the Jersey breeding project every effort was made to keep the herd on a broad base by obtaining female progeny from as many foundation cows as possible, and for this reason cows were sometimes bred more often than would be practical under commercial conditions. This practice yielded some unusual information on the possibilities of having cows conceive after repeated matings. The individuals which responded on late services also tended to raise the average number of services per conception for the entire population, and in table 3 the breeding performance of the three groups of foundation cows is broken down on a basis of number of animals that conceived on the 1st to the 18th service.

TABLE 3.—*Number and percentage of conceptions by three groups of foundation cows on service indicated*

| Service | Group 1 | | Group 2 | | Group 3 | | All groups | | Cumulative percentage |
|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Percent* | *Number* | *Percent* | *Number* | *Percent* | *Number* | *Percent* | *Percent* |
| 1st | 34 | 50.8 | 58 | 57.4 | 18 | 42.8 | 110 | 52.4 | 52.4 |
| 2d | 11 | 16.5 | 12 | 11.8 | 4 | 9.5 | 27 | 12.8 | 65.2 |
| 3d | 6 | 8.9 | 9 | 8.9 | 4 | 9.5 | 19 | 9.1 | 74.3 |
| 4th | 3 | 4.5 | 10 | 9.9 | 5 | 11.9 | 18 | 8.5 | 82.8 |
| 5th | 4 | 6.0 | 4 | 4.0 | 2 | 4.8 | 10 | 4.8 | 87.6 |
| 6th | 1 | 1.5 | 2 | 2.0 | 3 | 7.1 | 6 | 2.8 | 90.4 |
| 7th | 2 | 3.0 | 2 | 2.0 | 1 | | 5 | 2.4 | 92.8 |
| 8th | 5 | 7.5 | | | 2 | 4.8 | 7 | 3.3 | 96.1 |
| 9th | 1 | 1.5 | 1 | 1.0 | 1 | 2.4 | 3 | 1.4 | 97.5 |
| 11th | | | | | 2 | 4.8 | 2 | 1.0 | 98.5 |
| 12th | | | 1 | 1.0 | | | 1 | .5 | 99.0 |
| 13th | | | 1 | 1.0 | | | 1 | .5 | 99.5 |
| 18th | | | 1 | 1.0 | | | 1 | .5 | 100.0 |
| Total | 67 | | 101 | | 42 | | 210 | | |
| Total number of services | 175 | | 247 | | 140 | | 562 | | |
| Services per conception | 2.61 | | 2.45 | | 3.33 | | 2.68 | | |

The complete breeding performance of the foundation cows was not made at Beltsville, consequently this population may not be entirely typical. Twenty-nine pregnancies had been terminated in the herds where previously owned, before they were assembled at Beltsville. It will be noted that about 75 percent of the pregnancies were established when the cows had been bred 3 times, and more than 90 percent were established when the cows had been bred less than 7 times. There is some difference between groups in the number of services required to establish pregnancy, but this may be accounted for by the fact that in group 3 several cows with good previous breeding histories were introduced into a herd with an active Brucellosis infection. Had the authors followed an arbitrary practice of discarding cows after 6 attempts to settle them, the number of services per conception would have averaged about 2. These data indicate that it would be difficult to make any arbitrary decision based on number of services as to when a cow is definitely sterile.

TABLE 4.—*Production records made by the foundation cows at Beltsville on 3 milkings daily for 365 days (as calculated to a mature-equivalent basis)*

| Herd No. | Milk | Butterfat | | State of origin |
|---|---|---|---|---|
| | *Pounds* | *Percent* | *Pounds* | |
| Group 1: | | | | |
| 403 | 13,280 | 4.95 | 657 | Massachusetts. |
| 406 | 14,034 | 5.40 | 758 | New York. |
| 407[1] | | | | Do. |
| 408 | 14,450 | 5.63 | 814 | Do. |
| 409 | 11,656 | 5.69 | 663 | Do. |
| 410 | 11,352 | 6.45 | 732 | Do. |
| 411 | 12,959 | 5.10 | 662 | Do. |
| 412 | 8,717 | 6.04 | 527 | Do. |
| 438 | 11,485 | 5.61 | 645 | Massachusetts. |
| 439 | 12,901 | 5.88 | 759 | Do. |
| 440 | 16,272 | 5.26 | 855 | Do. |
| 454 | 11,069 | 6.01 | 665 | New York. |
| 457 | 16,813 | 5.31 | 893 | Massachusetts. |
| Average of 12 | 12,916 | 5.61 | 719 | |
| Group 2: | | | | |
| 416 | 12,611 | 5.23 | 659 | Maryland. |
| 420 | 8,422 | 5.44 | 458 | Do. |
| 424 | 12,031 | 5.31 | 639 | Do. |
| 425[1] | | | | Do. |
| 426 | 10,125 | 6.30 | 638 | Do. |
| 427 | 12,195 | 5.39 | 658 | Do. |
| 430[1] | | | | Do. |
| 432 | 8,425 | 5.16 | 434 | Do. |
| 434 | 9,376 | 5.85 | 548 | Do. |
| 435 | 13,676 | 5.44 | 630 | Do. |
| 436 | 12,597 | 5.14 | 647 | Do. |
| 437 | 13,730 | 5.53 | 759 | Do. |
| 441 | 10,079 | 5.61 | 565 | Maine. |
| 442 | 7,824 | 5.59 | 438 | Do. |
| 443 | 9,621 | 4.84 | 465 | Do. |
| 444 | 12,614 | 5.67 | 715 | Do. |
| 445 | 10,999 | 6.06 | 667 | Do. |
| 446[1] | | | | Do. |
| 447[1] | | | | Do. |
| 448 | 13,196 | 4.96 | 655 | Do. |
| 449 | 6,954 | 6.51 | 453 | Maryland. |
| 453[1] | | | | Do. |
| 455 | 10,144 | 4.96 | 504 | Do. |
| Average of 18 | 10,701 | 5.50 | 585 | |
| Group 3: | | | | |
| 462 | 11,486 | 6.07 | 697 | Oregon. |
| 463 | 7,831 | 4.77 | 373 | Do. |
| 464 | 12,884 | 5.85 | 753 | Do. |
| 465 | 8,412 | 4.75 | 400 | Maine. |
| 466 | 11,078 | 5.38 | 597 | Do. |
| 467 | 11,011 | 5.19 | 572 | Do. |
| 468 | 13,080 | 4.88 | 639 | Virginia. |
| 469 | 8,005 | 5.89 | 472 | Connecticut. |
| 475 | 15,758 | 4.78 | 753 | Maine. |
| 478 | 10,571 | 5.48 | 579 | Connecticut. |
| Average of 10 | 11,010 | 5.30 | 584 | |
| Grand average of 40 | 11,443 | 5.48 | 625 | |

[1] No record.

## PRODUCTION RECORDS OF THE FOUNDATION COWS

Table 4 shows the mature-equivalent production records of the foundation cows. All these records were made under the standard conditions at Beltsville on 3 milkings daily for 365 days.

The grouping of the foundation cows is more or less arbitrary, but the 13 cows in group 1 came from 2 herds which, it was felt, had demonstrated a fairly sound breeding program for a number of years. This was substantiated later by the results of systematic testing at Beltsville. The 2 herds from which the 23 cows in group 2 came did not have the same background of a long-time cow-testing program.

The relative producing ability of the two groups is pretty well established by the averages shown in table 4.

Most of the 10 cows in group 3 were brought in for use on another project, and were selected because of their family breeding. They arrived somewhat later than the others and seemed to react more severely to the Brucellosis infection. In addition, some of them were well along in years and it is doubtful if the production records made by some cows in this group are truly representative of their real ability. On the basis of their actual production records, however, they appear to be on a par with group 2, but the authors are inclined to believe that had conditions been the same for all groups they would have averaged close to the group 1 cows. This may be speculative, but it does help to understand more fully the results that will be shown for the progeny of the cows in the different foundation groups.

The mature-equivalent records of the 40 foundation cows averaged 11,443 pounds of milk and 625 pounds of butterfat. Four of the foundation cows were daughters of other foundation cows. These 4 daughters averaged 594 pounds of fat and their dams averaged 635.

Block 2 (table 6) gives a summary of results of $t$ tests on the three groups of foundation cows. A highly significant difference is shown between group 1 and group 2 in both milk and butterfat production, and a significant difference is shown between group 1 and group 3 in butterfat production.

Only 21 of the foundation cows, or about half of the 40 foundation cows with production records, were represented by female progeny in the first generation. Since this division of the foundation cows was entirely random, it might be interesting to determine if there is any wide difference, in milk-and-butterfat production level, between the cows that had project female progeny and those that did not (table 5).

TABLE 5.—*Average mature-equivalent production records of the foundation cows with tested female progeny and of those without female progeny*

| Foundation cows | Foundation cows with tested female progeny | | | | Foundation cows without female progeny | | | |
|---|---|---|---|---|---|---|---|---|
| | Cows | Milk | Butterfat | | Cows | Milk | Butterfat | |
| | *Number* | *Pounds* | *Percent* | *Pounds* | *Number* | *Pounds* | *Percent* | *Pounds* |
| Group 1 | 7 | 12,372 | 5.62 | 690 | 5 | 13,677 | 5.60 | 760 |
| Group 2 | 9 | 10,751 | 5.58 | 596 | 9 | 10,651 | 5.42 | 575 |
| Group 3 | 5 | 9,781 | 5.11 | 501 | 5 | 12,249 | 5.49 | 663 |
| All | 21 | 11,060 | 5.53 | 604 | 19 | 11,865 | 5.48 | 647 |

Coefficients of variability for milk are 19.47 and 21.80, respectively, for the 21 cows with tested progeny and the 19 without tested progeny. The coefficients of variability for butterfat are 20.07 and 20.03, respectively, for the 21 cows and the 19 cows. The difference between the means are not statistically significant, as shown in block 1, table 6.

TABLE 6.—*Production means, standard deviations, and coefficients of variation between various groups of foundation cows and the first-generation progeny*

| Foundation cows | Animals | Production means | | | Standard deviation | | | Coefficient of variation | | | Significant *t* test between [1] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Milk | Butterfat | | Milk | Butterfat | | Milk | Test | Fat | Groups | Milk | Fat |
| Block 1: | *Number* | *Pounds* | *Percent* | *Pounds* | *Pounds* | *Percent* | *Pounds* | *Pounds* | *Percent* | *Pounds* | | | |
| All cows | 40 | 11,443 | 5.48 | 625 | 2,373 | 0.47 | 125.6 | 20.74 | 8.58 | 20.10 | | | |
| Cows with progeny | 21 | 11,060 | 5.53 | 606 | 2,153 | .50 | 121.6 | 19.47 | 9.12 | 20.07 | | | |
| Cows without progeny | 19 | 11,865 | 5.48 | 647 | 2,586 | .44 | 129.6 | 21.80 | 8.01 | 20.03 | | NS | NS |
| Block 2: | | | | | | | | | | | | | |
| Cows in group 1 | 12 | 12,916 | 5.61 | 719 | 2,283 | .44 | 102.9 | 17.68 | 7.84 | 14.31 | 1 & 2 | ** | ** |
| Cows in group 2 | 18 | 10,701 | 5.50 | 585 | 2,000 | .38 | 103.6 | 18.69 | 6.91 | 17.70 | 1 & 3 | NS | * |
| Cows in group 3 | 10 | 11,010 | 5.30 | 584 | 2,505 | .51 | 135.1 | 22.75 | 9.62 | 23.15 | 2 & 3 | NS | NS |
| Block 3: | | | | | | | | | | | | | |
| Cows with progeny (unweighted): | | | | | | | | | | | | | |
| From group 1 | 7 | 12,373 | 5.62 | 690 | 2,459 | .35 | 110.6 | 19.87 | 6.23 | 16.03 | 1 & 2 | NS | NS |
| From group 2 | 9 | 10,751 | 5.58 | 596 | 1,799 | .60 | 95.6 | 16.73 | 10.75 | 16.04 | 1 & 3 | NS | * |
| From group 3 | 5 | 9,781 | 5.11 | 504 | 1,541 | .34 | 108.3 | 15.76 | 6.65 | 21.49 | 2 & 3 | NS | NS |
| Block 4: | | | | | | | | | | | | | |
| Cows with progeny (weighted): | | | | | | | | | | | | | |
| From group 1 | 10 | 12,212 | 5.61 | 680 | 2,076 | .35 | 91.8 | 17.00 | 6.42 | 13.50 | 1 & 2 | NS | NS |
| From group 2 | 10 | 10,938 | 5.59 | 608 | 1,795 | .56 | 97.7 | 16.41 | 10.02 | 16.07 | 1 & 3 | * | ** |
| From group 3 | 7 | 10,079 | 5.20 | 528 | 1,365 | .32 | 97.5 | 13.54 | 6.15 | 18.47 | 2 & 3 | NS | NS |
| All 3 groups | 27 | 11,187 | 5.50 | 614 | 1,949 | .46 | 110.0 | 17.42 | 8.36 | 17.92 | | | |
| FIRST-GENERATION PROGENY | | | | | | | | | | | | | |
| Block 5: | | | | | | | | | | | | | |
| All daughters of 3 sires | 27 | 12,134 | 5.46 | 660 | 2,191 | 0.43 | 112.9 | 18.06 | 7.88 | 17.11 | | | |
| Daughters of Moose | 13 | 12,507 | 5.32 | 661 | 1,958 | .40 | 87.0 | 15.66 | 7.52 | 13.16 | | | |
| Daughters of Tormentor | 4 | 10,855 | 5.61 | 602 | 3,329 | .33 | 156.6 | 30.67 | 5.88 | 26.01 | | | |
| Daughters of Karnak | 10 | 12,162 | 5.60 | 681 | 2,032 | .59 | 126.9 | 16.71 | 10.54 | 18.63 | | | |

[1] NS means not significant; 1 asterisk means significant at the 5-percent level; 2 asterisks mean highly significant at the 1-percent level.

Table 6 was developed to bring together the relationships between the various groups of foundation cows and their progeny in the first generation. The number of animals, the means for milk, butterfat test, and butterfat; the standard deviation for these three items; and the coefficients of variation are shown. The significance and nonsignificance of the differences of the means according to the *t* test are also shown for butterfat and milk where necessary.

Block 1 (table 6) lists these comparisons for the total foundation group. Within this group of 40 foundation cows only 21 had daughters which completed production records. The differences are not statistically significant between the group with project progeny and that without, indicating that there was no bias from this source.

Block 2 (table 6) shows the 40 foundation cows separated into 3 groups. There is a highly significant difference between groups 1 and 2 in both milk and butterfat, and a significant difference between groups 1 and 3 in butterfat. As explained elsewhere in the text, however, the 3 sires were mated to cows in all groups, with the exception of Hood's Sophie's Tormentor, whose daughters were all from group 2 dams.

Block 3 (table 6) shows a breakdown of the 21 foundation dams with female progeny. In this sorting there is no weighting of the dams according to the number of female progeny. Between these groups there was no statistically significant difference with the exception of a significant difference at the 5-percent level between groups 1 and 3 for butterfat.

In block 4 (table 6) there is the same grouping of dams as in block 3, but the dams have been weighted according to the number of female progeny. In this arrangement there is a significant difference between groups 1 and 3 for milk production and a highly significant difference between groups 1 and 3 for butterfat.

Block 5 (table 6) shows the means, standard deviations, and coefficients of variation for the first-generation progeny, first as a group and then by each of the three sires used concurrently. The data in blocks 4 and 5 afford a direct comparison between the 27 dams (weighted) with female progeny and the 27 daughters of the first 3 Jersey sires.

## FIRST THREE SIRES USED IN THE JERSEY BREEDING PROJECT

In discussing the first three sires that were used in the Jersey breeding project, it will be necessary to include the total breeding performance of each sire in order to get a true estimate of his worth. The use of the three sires was not restricted to matings with the foundation cows to produce first-generation outbreds, since the project plans also called for mating each sire to daughters of the other two sires to produce second-generation outbreds and also mating each sire to his own daughters to produce second-generation inbreds. Therefore, the data on the breeding performance of each sire are shown in subsequent tables with a breakdown based on the various generations.

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## THE MOOSE O'FERNWOOD 137024

The Moose O'Fernwood was in service in the herd of R. L. Burkhart at Albany, Oreg., and was purchased when that herd was dispersed. At that time he had 4 daughters that had completed Register of Merit records, and the mature-equivalent average of their records was 721 pounds of butterfat. Other daughters were on test when the herd was sold, where they showed evidence of good-producing ability, but none of them completed a record in the herd to which they were moved.

The Moose O'Fernwood was an Owl-Interest-bred bull, as indicated by his pedigree shown with his picture in figure 1. He was born April 30, 1915, and brought to Beltsville in October 1920, where he was used on the Jersey breeding project until his last successful service on June 20, 1927—at which time he was 12 years 3 months of age.

FIGURE 1.—The Moose O'Fernwood 137024, one of the first three sires used in the Jersey breeding project at Beltsville.

PEDIGREE OF THE MOOSE O'FERNWOOD 137024

| | | | |
|---|---|---|---|
| The Moose O'Fernwood 137024 | The Owl's Duke 89472 | Spermfield Owl 57088 | The Owl PS 2195 HC |
| | | | Spermfield Lassie 129540 |
| | | The Duke's Dorothy 170818 | Thoda's Duke of Portage 41762 |
| | | | Imp. Dorothy's Maid 138109 |
| | Owl's Interested Tones 212122 | Spermfield Owl 57088 | The Owl PS 2195 HC |
| | | | Spermfield Lassie 129540 |
| | | Interested Nutley Tones 188108 | Interested Prince 58224 |
| | | | Nutley's Tones 122809 |

**Table 7 shows the total breeding performance of The Moose O'Fernwood at Beltsville, not only when mated to the 3 groups of foundation cows but also when mated to his own daughters and to daughters of the other 2 sires that were used concurrently in the herd.**

TABLE 7.—*Total breeding performance of The Moose O'Fernwood when used in the Jersey breeding project at Beltsville*

| Females to which The Moose was mated | Cows bred | Cows that conceived | Total conceptions | Average services per conception | Results of conceptions | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | First-generation outbreds | | | | | | |
| | | | | | Females | | Males | | Abortions | | Sex unknown |
| | | | | | Live | Dead | Live | Dead | Female | Male | |
| Foundation cows: | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| Group 1 | 11 | 10 | 29 | 2.34 | [1]13 | 0 | 9 | 1 | 0 | 3 | 4 |
| Group 2 | 3 | 3 | 8 | 2.50 | 3 | [1]3 | 2 | 0 | 0 | 0 | 1 |
| Group 3 | 8 | 7 | 14 | 1.86 | 6 | 0 | 5 | 0 | 0 | [1]3 | 1 |
| Total | 22 | 20 | 51 | 2.24 | [1]22 | [1]3 | 16 | 1 | 0 | [1]6 | 6 |
| | | | | | Second-generation inbreds | | | | | | |
| Daughters of Moose | 15 | 12 | 23 | 3.00 | 4 | 0 | 8 | 0 | 6 | 2 | 3 |
| | | | | | Second-generation outbreds | | | | | | |
| Daughters of Karnak | 2 | 2 | 2 | 1.00 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Daughters of Tormentor | 1 | 1 | 1 | 1.00 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| All females | 40 | 35 | 77 | 2.47 | [1]28 | [1]4 | 24 | 1 | 6 | [1]8 | 9 |

[1] Includes 2 twins.

The disease situation in the Beltsville Jersey herd, as in the early periods in many other newly assembled herds, was critical. Brucellosis was rampant, and many calves were weak at birth and did not survive. Breeding difficulties were a natural aftermath of this situation, and losses due to sterility following abortions were rather heavy. The totals of living female calves, as given in table 7, look substantial, but the project losses are better appreciated when presented in tabular form (table 8).

TABLE 8.—*Early losses of female progeny that were sired by The Moose O'Fernwood*

| Female progeny of Moose | First-generation outbreds | | | | Second-generation inbreds | Second-generation outbreds | Total for all generations |
|---|---|---|---|---|---|---|---|
| | From group 1 cows | From group 2 cows | From group 3 cows | From all 3 groups | | | |
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| Born alive | 13 | 3 | 6 | 22 | 4 | 2 | 28 |
| Losses: | | | | | | | |
| Died as calves | 3 | 1 | 2 | 6 | 2 | | 8 |
| Nonbreeders | 1 | | | 1 | | | 1 |
| Nonbreeders after abortion | 1 | | 1 | 2 | | 1 | 3 |
| Net project females | 8 | 2 | 3 | 13 | 2 | 1 | 16 |

**Table 9 is a listing of birth dates, names and registration numbers, and herd numbers of all the Beltsville daughters of The Moose O'Fernwood, and also the ages of sire and dam when these calves were conceived.**

TABLE 9.—*Female progeny of the The Moose O'Fernwood, and age of parents at time of conception*

| Daughter's herd No. | Date of birth | Daughter's name and registration No. | Herd No. of dam | Foundation group | Age of sire at conception | | Age of dam at conception | |
|---|---|---|---|---|---|---|---|---|
| | | | | | *Yr.* | *Mo.* | *Yr.* | *Mo.* |
| First-generation outbreds: | | | | | | | | |
| 472 | Oct. 25, 1921 | Owlet Jacoba Irene 541121 | 400 | 1 | 5 | 8 | 5 | 3 |
| 473 | Nov. 4, 1921 | Owlet Sophia Lou 541122 | 440 | 1 | 5 | 9 | 1 | 3 |
| 479 | Feb. 15, 1922 | (1) | 420 | 2 | 6 | 0 | 3 | 3 |
| 483 | June 27, 1922 | (1) | 463 | 3 | 6 | 5 | 2 | 10 |
| 493 | Feb. 6, 1923 | (1) | 411 | 1 | 7 | 1 | 4 | 2 |
| 495 | Feb. 26, 1923 | Owlet Sophieson Ivana 602007 | 438 | 1 | 7 | 1 | 3 | 2 |
| 496 | Mar. 6, 1923 | Owlet Gamboge Maud 605381 | 449 | 2 | 7 | 1 | 1 | 9 |
| 612 | Mar. 8, 1924 | (1) | 463 | 3 | 8 | 2 | 4 | 6 |
| 613 | Mar. 29, 1924 | Owlet Sophie Figis 642378 | 440 | 1 | 8 | 2 | 3 | 8 |
| 615 | Apr. 5, 1924 | Owlet Sophie Double Jacoba 650139 | 411 | 1 | 8 | 2 | 5 | 2 |
| 616 | Apr. 11, 1924 | Owlet Sybil Fauvic Maid 650141 | 478 | 3 | 8 | 2 | 1 | 5 |
| 617 | Apr. 13, 1924 | Owlet Sophieson Merry Maid 650142. | 438 | 1 | 8 | 2 | 4 | 3 |
| 621 | May 26, 1924 | Owlet Curry Girl Lady Lotty 650145. | 475 | 3 | 8 | 4 | 1 | 10 |
| 623 | June 28, 1924 | Owlet Hillside Doris 650313 | 403 | 1 | 8 | 5 | 7 | 2 |
| 635 | Feb. 4, 1925 | (1) | 454 | 1 | 9 | 0 | 3 | 6 |
| 636 | Feb. 4, 1925 | Owlet Double Premier Jacoba 686548. | 454 | 1 | 9 | 0 | 3 | 6 |
| 642 | Mar. 26, 1925 | Owlet Premier Jacoba 686551 | 408 | 1 | 9 | 1 | 9 | 1 |
| 644 | May 10, 1925 | Owlet St. Mawes Ruby 693871 | 463 | 3 | 9 | 3 | 5 | 8 |
| 647 | June 18, 1925 | Owlet Sybil Fauvic Princess 693874. | 478 | 3 | 9 | 4 | 2 | 7 |
| 661 | Oct. 25, 1926 | Owlet Lady Grace 758734 | 424 | 2 | 10 | 8 | 7 | 9 |
| 673 | June 20, 1927 | (1) | 438 | 1 | 11 | 4 | 7 | 5 |
| 674 | June 28, 1927 | Owlet Sophie Jacoba Dove 790947 | 411 | 1 | 11 | 5 | 8 | 5 |
| Second-generation outbreds: | | | | | | | | |
| 622 | June 8, 1924 | Owlet Lady Raleigh Sophie 656012 | 474 | | 8 | 4 | 1 | 9 |
| 665 | Jan. 7, 1927 | Owlet Karnak Interest 772005 | 476 | | 10 | 10 | 4 | 3 |
| Second-generation inbreds: | | | | | | | | |
| 640 | Mar. 22, 1925 | (1) | 472 | | 9 | 1 | 2 | 7 |
| 650 | Sept. 24, 1925 | (1) | 486 | | 10 | 3 | 2 | 11 |
| 658 | Aug. 14, 1926 | Double Owlet Sophieson 751611 | 495 | | 10 | 6 | 2 | 8 |
| 684 | Dec. 17, 1927 | Double Owlet Sophie Maid 826422. | 617 | | 11 | 10 | 2 | 10 |

(1) Died at an early age.

All milk and butterfat production records completed by all Beltsville daughters of The Moose O'Fernwood are listed in table 10, along with their mature-equivalent values. The average body weights of the cows while on test are also shown.

TABLE 10.—*Production records of daughters of The Moose O'Fernwood on 3 milkings daily for 365 days*

| Daughter's herd No. | Actual record | | Age when record began | | Mature-equivalent value | | | Average body weight |
|---|---|---|---|---|---|---|---|---|
| | Milk | Butterfat | | | Milk | Butterfat | | |
| | *Pounds* | *Percent* | *Pounds* | *Yr.* | *Mo.* | *Pounds* | *Percent* | *Pounds* | *Pounds* |
| First generation outbreds: | | | | | | | | | |
| 472 | 7,547 | 5.50 | 415 | 2 | 2 | 10,264 | 5.50 | 564 | 876 |
| | 12,276 | 5.21 | 640 | 5 | 3 | 12,644 | 5.21 | 659 | 1,006 |
| 495 | 9,499 | 5.37 | 510 | 2 | 3 | 12,729 | 5.37 | 683 | 893 |
| | 9,543 | 5.30 | 506 | 5 | 7 | 9,734 | 5.30 | 516 | 1,059 |
| 496 | 10,521 | 5.30 | 558 | 6 | 11 | 10,521 | 5.30 | 558 | 1,137 |
| 613 | 7,618 | 5.86 | 447 | 2 | 6 | 9,751 | 5.86 | 572 | 901 |
| 615 | 11,575 | 5.11 | 592 | 5 | 4 | 11,807 | 5.11 | 604 | 1,031 |
| | 10,408 | 5.23 | 523 | 3 | 1 | 12,140 | 5.23 | 633 | 964 |
| 616 | 14,506 | 5.10 | 740 | 5 | 6 | 14,796 | 5.10 | 755 | 1,173 |
| | 6,276 | 5.11 | 321 | 3 | 2 | 7,531 | 5.11 | 385 | 771 |
| 617 | 9,963 | 5.32 | 530 | 5 | 6 | 10,162 | 5.32 | 541 | 898 |
| | 12,289 | 4.77 | 586 | 3 | 8 | 13,880 | 4.77 | 662 | 976 |
| 636 | 11,549 | 4.61 | 533 | 6 | 1 | 11,549 | 4.61 | 533 | 1,136 |
| 642 | 13,742 | 4.41 | 606 | 7 | 5 | 13,742 | 4.41 | 606 | 1,245 |
| | [1] 8,108 | [1] 6.19 | [1] 502 | 3 | 2 | 11,186 | 6.19 | 692 | 1,070 |
| 644 | 12,140 | 5.53 | 672 | 2 | 10 | 15,054 | 5.53 | 833 | 915 |
| | 8,498 | 5.59 | 472 | 2 | 0 | 11,813 | 5.59 | 661 | 811 |
| 647 | 10,585 | 5.47 | 579 | 6 | 3 | 10,585 | 5.47 | 579 | 1,187 |
| 661 | 10,388 | 5.27 | 547 | 7 | 4 | 10,388 | 5.27 | 547 | 1,139 |
| 674 | 7,803 | 5.08 | 401 | 2 | 0 | 11,050 | 5.08 | 561 | 812 |
| | 11,556 | 4.79 | 553 | 2 | 0 | 16,178 | 4.79 | 774 | 923 |
| | 8,880 | 5.21 | 462 | 2 | 5 | 11,544 | 5.21 | 601 | 1,032 |
| Second generation outbreds: | | | | | | | | | |
| 665 | [2] 5,340 | [2] 6.04 | [2] 323 | 2 | 5 | 8,942 | 6.04 | 420 | 903 |
| | 8,959 | 6.03 | 540 | 6 | 2 | 8,959 | 6.03 | 540 | 1,155 |
| Second generation inbreds: | | | | | | | | | |
| 658 | 8,720 | 4.89 | 426 | 2 | 2 | 11,859 | 4.89 | 579 | 700 |
| | 13,123 | 4.93 | 648 | 6 | 2 | 13,123 | 4.93 | 648 | 1,019 |
| 684 | 7,353 | 5.19 | 381 | 2 | 0 | 10,294 | 5.19 | 533 | 978 |

[1] 305-day record, bred too soon.
[2] Following abortion.

Table 11 shows the best mature-equivalent record of each daughter of The Moose O'Fernwood and that of her dam. These records show that on the average his daughters from the foundation cows in group 1 were about equal to their dams, whereas those from the foundation cows in group 2 and group 3 averaged considerably higher than their dams, in both milk and fat. However, there might be some question as to the dependability of the record of foundation cow No. 463 as a true indication of her genetic worth.

TABLE 11.—*Comparison of the best mature-equivalent records of the daughters of The Moose O'Fernwood with those of the dams of the daughters*

| Daughters | | | | Dams | | | | Increase (+) or decrease (−) by daughters over dams | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Herd No. | Milk | Butterfat | | Group and herd No. | Milk | Butterfat | | Milk | Butterfat | |
| | *Pounds* | *Percent* | *Pounds* | | *Pounds* | *Percent* | *Pounds* | *Pounds* | *Percent* | *Pounds* |
| | | | | Group 1: | | | | | | |
| 472 | 12,644 | 5.21 | 659 | 409 | 11,656 | 5.69 | 663 | +988 | −0.48 | −4 |
| 495 | 12,729 | 5.37 | 683 | 438 | 11,485 | 5.61 | 645 | +1,244 | −.24 | +38 |
| 613 | 11,807 | 5.11 | 604 | 440 | 16,272 | 5.26 | 855 | −4,465 | −.15 | −251 |
| 615 | 14,796 | 5.10 | 755 | 411 | 12,959 | 5.10 | 662 | +1,837 | | +93 |
| 617 | 13,880 | 4.77 | 662 | 438 | 11,485 | 5.61 | 645 | +2,395 | −.84 | +17 |
| 636 | 11,186 | 6.19 | 692 | 454 | 11,069 | 6.01 | 665 | +117 | +.18 | +27 |
| 642 | 15,054 | 5.53 | 833 | 408 | 14,450 | 5.63 | 814 | +604 | −.10 | +19 |
| 674 | 11,544 | 5.21 | 601 | 411 | 12,959 | 5.10 | 662 | −1,415 | +.11 | −51 |
| Average of 8 | 12,955 | 5.31 | 686 | | 12,792 | 5.50 | 701 | +163 | −.19 | −15 |
| | | | | Group 2: | | | | | | |
| 496 | 9,751 | 5.86 | 572 | 449 | 6,951 | 6.51 | 453 | +2,797 | −.65 | +119 |
| 661 | 16,178 | 4.79 | 774 | 424 | 12,031 | 5.31 | 639 | +4,147 | −.52 | +135 |
| Average of 2 | 12,965 | 5.33 | 673 | | 9,593 | 5.91 | 546 | +3,372 | −.58 | +127 |
| | | | | Group 3: | | | | | | |
| 616 | 10,162 | 5.32 | 541 | 478 | 10,571 | 5.48 | 579 | −409 | −.16 | −38 |
| 644 | 11,813 | 5.59 | 661 | 463 | 7,831 | 4.77 | 373 | +3,982 | +.82 | +288 |
| 647 | 11,050 | 5.08 | 561 | 478 | 10,571 | 5.48 | 579 | +479 | −.40 | −18 |
| Average of 3 | 11,008 | 5.33 | 588 | | 9,658 | 5.24 | 510 | +1,350 | +.09 | +78 |
| | | | | Daughter of Karnak: | | | | | | |
| 665 | 8,959 | 6.03 | 540 | 476 | 11,531 | 5.90 | 681 | −2,572 | +.13 | −141 |
| Average of 14 | 12,254 | 5.37 | 653 | | 11,559 | 5.53 | 637 | +695 | −.16 | +16 |
| Number of daughters better than dams | | | | | | | | 10 | 5 | 8 |

## KARNAK'S NOBLE 4TH 115589

Karnak's Noble 4th was born June 30, 1913. Like the first sire, he was also purchased when the Jersey herd of R. L. Burkhart at Albany, Oreg., was dispersed in October 1920. At that time, 5 of his daughters in the Burkhart herd had completed Register of Merit records, which averaged 584 pounds of butterfat as compared to their dams' average of 476 pounds. He continued in service on the breeding projects at Beltsville until August 1924, but he was a very uncertain breeder during the last year. He was a Raleigh bred bull, as indicated by his pedigree shown with his picture in figure 2.

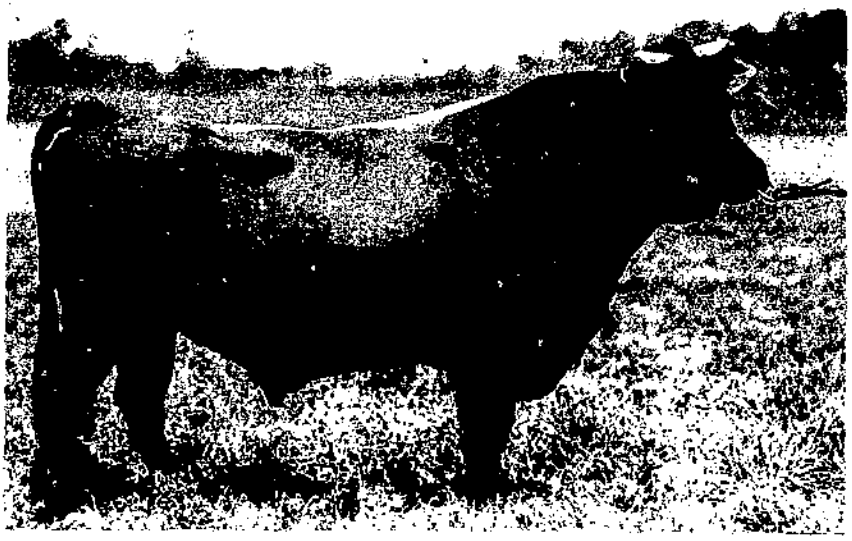


FIGURE 2.—Karnak's Noble 4th 115589, one of the first three sires used in the Jersey breeding project at Beltsville.

PEDIGREE OF KARNAK'S NOBLE 4TH 115589

| | | | | |
|---|---|---|---|---|
| Karnak's Noble 4th 115589 | Karnak's Noble 87952 | Noble of Oaklands 95700 | Blue Belle's Blue Fox 60032 | |
| | | | Lady Viola 228437 | |
| | | Raleigh's Pretty Karnak 232137 | Eminent's Raleigh 69011 | |
| | | | Fontaine's Gold Medal 203630 | |
| | Raleigh's Fair Lady 214022 | Raleigh's Fairy Boy 83767 | Eminent's Raleigh 69011 | |
| | | | Fairy Glen P. S. 9178 HC | |
| | | Golden Leda's Nursie 213954 | Leda's Golden Lad 71148 | |
| | | | Golden Fern's Niece 203634 | |

The total breeding performance of Karnak's Noble 4th in the Beltsville herd is shown in table 12. Two of his daughters failed to conceive to his service, and one conception resulted from matings to daughters of Moose and Tormentor for second-generation outbreds. This terminated in a male calf.

TABLE 12.—*Total breeding performance of Karnak's Noble 4th when used in the Jersey breeding project at Beltsville*

| Females to which Karnak was mated | Cows bred | Cows that conceived | Total conceptions | Average services per conception | Results of conceptions | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | First-generation outbreds | | | | | | |
| | | | | | Females | | Males | | Abortions | | |
| | | | | | Live | Dead | Live | Dead | Female | Male | Sex unknown |
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| Foundation cows: | | | | | | | | | | | |
| Group 1 | 8 | 4 | 6 | 4.00 | 2 | 0 | 3 | 0 | 0 | 0 | 1 |
| Group 2 | 13 | 8 | 15 | 1.53 | 6 | 0 | 5 | 1 | 0 | 2 | 1 |
| Group 3 | 5 | 3 | 4 | 1.25 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 26 | 15 | 25 | 2.08 | 12 | 0 | 8 | 1 | 0 | 2 | 2 |
| | | | | | Second-generation inbreds | | | | | | |
| Daughters of Karnak | 2 | 0 | | | | | | | | | |
| | | | | | Second-generation outbreds | | | | | | |
| Daughters of Moose | 2 | 1 | 1 | 5.0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Daughters of Tormentor | 2 | 0 | | | | | | | | | |
| All females | 32 | 16 | 26 | 2.19 | 12 | 0 | 9 | 1 | 0 | 2 | 2 |

Table 13 lists the female progeny of Karnak's Noble 4th and shows the age of the parents at the time the progeny were conceived.

TABLE 13.—*Female progeny of Karnak's Noble 4th, and age of parents at the time the progeny was conceived*

| Herd No. | Date of birth | Name and registration No. | Herd No. of dam | Foundation group | Age of sire at conception | | Age of dam at conception | |
|---|---|---|---|---|---|---|---|---|
| | | | | | *Yr.* | *Mo.* | *Yr.* | *Mo.* |
| 471 | Oct. 9, 1921 | (1) | 444 | 2 | 7 | 6 | 1 | 8 |
| 474 | Nov. 7, 1921 | Lady Raleigh Jacoba Ella 541123 | 412 | 1 | 7 | 7 | 2 | 1 |
| 476 | Dec. 15, 1921 | Lady Raleigh Interested Fox 541125 | 445 | 2 | 7 | 8 | 1 | 10 |
| 486 | Sept. 3, 1922 | (1) | 418 | 2 | 8 | 5 | 2 | 3 |
| 488 | Oct. 21, 1922 | Lady Raleigh St. Lambert 580874 | 466 | 3 | 8 | 6 | 6 | 8 |
| 491 | Dec. 19, 1922 | Lady Raleigh Annabelle 582185 | 444 | 2 | 8 | 8 | 2 | 10 |
| 492 | Jan. 20, 1923 | Lady Raleigh Lyra St. Lambert 600721 | 465 | 3 | 8 | 10 | 7 | 4 |
| 498 | Apr. 15, 1923 | Lady Raleigh Flying Fox 607730 | 443 | 2 | 9 | 1 | 3 | 6 |
| 501 | June 8, 1923 | Hattie Lambert 615423 | 467 | 3 | 9 | 2 | 6 | 1 |
| 503 | Sept. 28, 1923 | Lady Raleigh Matilda 628489 | 466 | 3 | 9 | 6 | 7 | 8 |
| 506 | Nov. 7, 1923 | Lady Raleigh Sophie Jacoba 628410 | 451 | 1 | 9 | 7 | 2 | 3 |
| 511 | Feb. 23, 1924 | Lady Raleigh Interested Ann 642377 | 444 | 2 | 9 | 11 | 4 | 0 |

(1) Died at an early age.

Two of Karnak's 12 daughters died as calves, but the other 10 completed production records.

Table 14 shows the actual production records of his 10 daughters, and the mature-equivalent value of the records. Table 15 gives a comparison of the best mature-equivalent records of the daughters with those of their dams.

TABLE 14.—*Production records of daughters of Karnak's Noble 4th on 3 milkings daily for 365 days*

| Daughter's herd No. | Actual record | | | Age when record began | | Mature-equivalent value | | | Average body weight |
|---|---|---|---|---|---|---|---|---|---|
| | Milk | Butterfat | | | | Milk | Butterfat | | |
| | *Pounds* | *Percent* | *Pounds* | *Yr.* | *Mo.* | *Pounds* | *Percent* | *Pounds* | *Pounds* |
| 474 | 7,975 | 5.06 | 402 | 2 | 7 | 10,128 | 5.66 | 574 | 907 |
| 476 | 9,299 | 5.90 | 549 | 2 | 10 | 11,531 | 5.90 | 681 | 866 |
| | 11,636 | 5.70 | 663 | 7 | 4 | 11,636 | 5.70 | 663 | 921 |
| 488 | 8,812 | 6.19 | 545 | 2 | 0 | 12,337 | 6.19 | 763 | 912 |
| 491 | 8,391 | 6.44 | 541 | 2 | 2 | 11,412 | 6.44 | 736 | 774 |
| | 11,540 | 6.51 | 752 | 6 | 6 | 11,549 | 6.51 | 752 | 976 |
| 492 | 19,160 | 4.83 | 491 | 2 | 0 | 14,224 | 4.83 | 687 | 844 |
| 498 | 4,784 | 4.93 | 236 | 2 | 8 | 6,028 | 4.93 | 297 | 988 |
| | 8,092 | 4.80 | 388 | 5 | 8 | 8,173 | 4.80 | 392 | 1,024 |
| 601 | 7,862 | 5.94 | 499 | 2 | 5 | 9,831 | 5.94 | 584 | 928 |
| | 12,884 | 6.17 | 794 | 5 | 0 | 13,271 | 6.17 | 818 | 1,042 |
| 603 | 8,508 | 4.85 | 413 | 2 | 11 | 11,060 | 4.85 | 537 | 1,035 |
| | 12,302 | 5.40 | 664 | 5 | 2 | 12,671 | 5.40 | 684 | 1,205 |
| 606 | 10,697 | 5.33 | 570 | 2 | 2 | 14,548 | 5.33 | 775 | 841 |
| | 15,411 | 5.29 | 815 | 6 | 3 | 15,411 | 5.20 | 815 | 1,052 |
| 611 | 8,801 | 5.23 | 460 | 2 | 0 | 12,321 | 5.23 | 644 | 760 |
| | 11,213 | 5.30 | 595 | 6 | 6 | 11,213 | 5.30 | 595 | 1,025 |

TABLE 15.—*Comparison of best mature-equivalent records of the daughters of Karnak's Noble 4th with those of the dams of the daughters*

| Daughters | | | | Dams | | | | Increase (+) or decrease (−) by daughters over dams | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Herd No. | Milk | Butterfat | | Group and herd No. | Milk | Butterfat | | Milk | Butterfat | |
| | *Pounds* | *Percent* | *Pounds* | | *Pounds* | *Percent* | *Pounds* | *Pounds* | *Percent* | *Pounds* |
| | | | | Group 1: | | | | | | |
| 474 | 10,128 | 5.66 | 574 | 412 | 8,717 | 6.04 | 527 | +1,411 | −0.38 | +47 |
| 606 | 15,411 | 5.29 | 815 | 454 | 11,069 | 6.01 | 665 | +4,342 | −.72 | +150 |
| Average of 2 | 12,770 | 5.48 | 695 | | 9,893 | 6.03 | 596 | +2,877 | −.55 | +99 |
| | | | | Group 2: | | | | | | |
| 476 | 11,531 | 5.90 | 681 | 445 | 10,999 | 6.06 | 667 | +532 | −.16 | +14 |
| 491 | 11,549 | 5.51 | 755 | 444 | 12,614 | 5.67 | 715 | −1,065 | +.84 | +37 |
| 498 | 8,173 | 4.80 | 392 | 443 | 9,621 | 4.84 | 465 | −1,448 | −.04 | −73 |
| 611 | 12,321 | 5.23 | 644 | 444 | 12,614 | 5.67 | 715 | −293 | −.44 | −71 |
| Average of 4 | 10,894 | 5.61 | 617 | | 11,462 | 5.56 | 641 | −568 | +.05 | −24 |
| | | | | Group 3: | | | | | | |
| 488 | 12,337 | 6.19 | 763 | 466 | 11,078 | 5.38 | 597 | +1,259 | +.81 | +166 |
| 492 | 14,224 | 4.83 | 687 | 465 | 8,412 | 4.75 | 400 | +5,812 | +.08 | +287 |
| 601 | 13,271 | 6.17 | 818 | 467 | 11,011 | 5.19 | 572 | +2,260 | +.98 | +246 |
| 603 | 12,671 | 5.40 | 684 | 466 | 11,078 | 5.38 | 597 | +1,593 | +.02 | +87 |
| Average of 4 | 13,126 | 5.65 | 738 | | 10,395 | 5.18 | 542 | +2,731 | +.47 | +196 |
| Average of 10 | 12,162 | 5.60 | 681 | | 10,721 | 5.50 | 592 | +1,441 | +.10 | +89 |
| Number of daughters better than dams | | | | | | | | 7 | 5 | 8 |

The increases in milk and butterfat were uniformly higher for daughters from group 1 and group 3 foundation dams. All daughters that produced less than their dams were from group 2 dams.

## HOOD'S SOPHIE'S TORMENTOR 145709

Hood's Sophie's Tormentor was born October 8, 1915, and was purchased from Hood Farm in Massachusetts in March 1921. His period of service in the Beltsville herd was short because he suffered a broken leg and had to be destroyed. At the time of his purchase he had daughters in milk which were producing at a very satisfactory rate, and his selection was based on the performance of these daughters. As indicated by the pedigree, he was a strongly bred Sophie-Tormentor sire. Figure 3 shows his appearance at 5 years 7 months of age.

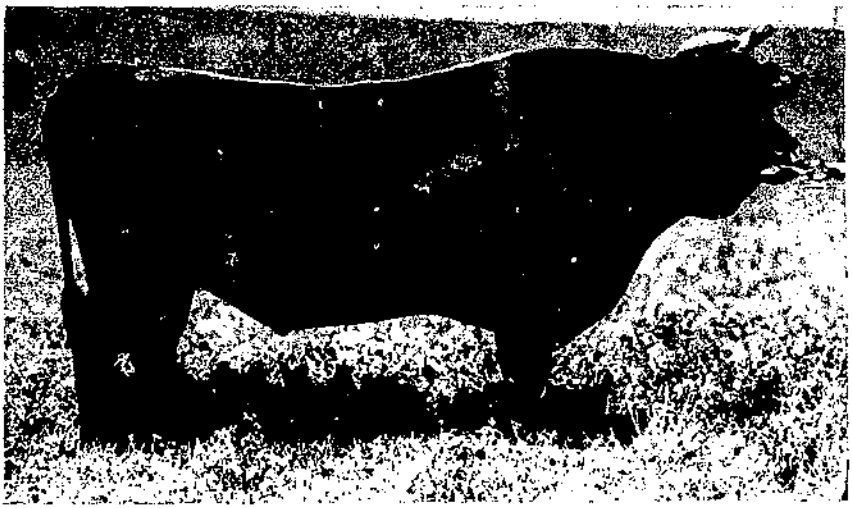


FIGURE 3.—Hood's Sophie's Tormentor 145709, one of the first three sires used in the Jersey breeding project at Beltsville.

PEDIGREE OF HOOD'S SOPHIE'S TORMENTOR 145709

| | | | | |
|---|---|---|---|---|
| Hood's Sophie's Tormentor 145709 | Sophie 19th's Tormentor 113302 | Champion Toreno's Son 104471 | Hood Farm Toreno 60326 | |
| | | | Hood Farm Fox's Piggis 221457 | |
| | | Sophie 19th of Hood Farm 189748 | Perth Hill Farm Chief 62859 | |
| | | | Phil's Seituate 163456 | |
| | Lass 64th of Hood Farm 266735 | Hood Farm Toreno 60326 | Toreno 25204 | |
| | | | Tormentor's Lass 50832 | |
| | | Figgis 27th of Hood Farm 196930 | Hood Farm Pogis 9th 55552 | |
| | | | Osman 4th of Hood Farm 134745 | |

His total breeding performance included 1 unsuccessful service to a group 1 foundation cow, and in addition 12 group 2 cows were bred to him. Ten of these cows completed 15 pregnancies to his service, averaging 1.73 services per conception. The 15 pregnancies resulted in 5 live female calves, 4 live male calves, 1 dead male calf, and 6 aborted fetuses which included 1 pair of female twins. The other

abortions were 2 males and 2 of unidentified sex. Two group 3 cows were bred to him and only 1 conceived. The result was a male calf.

Table 17 lists his female progeny and shows the age of the parents at the time the progeny were conceived.

TABLE 17.—*Female progeny of Hood's Sophie's Tormentor, and age of parents at time of conception*

| Herd No. | Date of birth | Name and registration No. | Herd No. of dam | Foundation group | Age of sire at conception | | Age of dam at conception | |
|---|---|---|---|---|---|---|---|---|
| | | | | | *Yr.* | *Mo.* | *Yr.* | *Mo.* |
| 477 | Jan. 22, 1922 | Milkmaid Mary Jane 547239 | 436 | 2 | 5 | 7 | 2 | 2 |
| 480 | Feb. 28, 1922 | Milkmaid Golden Julia 549603 | 426 | 2 | 5 | 8 | 3 | 1 |
| 490 | Dec. 19, 1922 | Milkmaid Polly 582186 | 455 | 2 | 6 | 6 | 1 | 4 |
| 494 | Feb. 23, 1923 | Milkmaid Golden Jewel 602006 | 426 | 2 | 6 | 8 | 4 | 1 |
| 602 | July 5, 1923 | Viola Milkmaid Venie 620795 | 435 | 2 | 7 | 0 | 3 | 11 |

One of his 5 daughters proved to be a nonbreeder, but the other 4 completed production records. All daughters were from group 2 dams. Their actual production records, and the mature-equivalent values of the records, are shown in table 18. Table 19 shows a comparison of the best mature-equivalent record of each daughter with that of her dam.

TABLE 18.—*Production records of daughters of Hood's Sophie's Tormentor on 3 milkings daily for 365 days*

| Daughter's herd No. | Actual record | | | Age when record began | | Mature-equivalent value | | | Average body weight |
|---|---|---|---|---|---|---|---|---|---|
| | Milk | Butterfat | | | | Milk | Butterfat | | |
| | *Pounds* | *Percent* | *Pounds* | *Yr.* | *Mo.* | *Pounds* | *Percent* | *Pounds* | *Pounds* |
| 477 | 9,109 | 5.43 | 495 | 2 | 2 | 12,385 | 5.43 | 673 | 848 |
| | 10,159 | 5.00 | 508 | 6 | 4 | 10,159 | 5.00 | 508 | 1,024 |
| | 10,220 | 4.98 | 514 | 8 | 6 | 10,320 | 4.98 | 514 | 1,160 |
| 480 | 5,256 | 6.07 | 356 | 2 | 1 | 8,085 | 6.07 | 491 | 826 |
| | 7,923 | 6.01 | 476 | 5 | 3 | 8,161 | 6.01 | 490 | 1,044 |
| 490 | 5,885 | 5.61 | 330 | 2 | 1 | 8,121 | 5.61 | 455 | 836 |
| 602 | 11,063 | 5.32 | 588 | 2 | 3 | 14,824 | 5.32 | 788 | 829 |
| | 12,405 | 5.43 | 673 | 3 | 1 | 12,777 | 5.43 | 693 | 962 |

TABLE 19.—*Comparison of the best mature-equivalent records of the daughters of Hood's Sophie's Tormentor with those of the dams of the daughters*

| Daughters | | | | Dams [1] | | | | Increase (+) or decrease (−) by daughters over dams | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Herd No. | Milk | Butterfat | | Herd No. | Milk | Butterfat | | Milk | Butterfat | |
| | *Pounds* | *Percent* | *Pounds* | | *Pounds* | *Percent* | *Pounds* | *Pounds* | *Percent* | *Pounds* |
| 477 | 12,388 | 5.43 | 673 | 436 | 12,597 | 5.14 | 647 | −209 | +0.29 | +26 |
| 480 | 8,161 | 6.01 | 490 | 426 | 10,125 | 6.30 | 638 | −1,964 | −.29 | −148 |
| 490 | 9,121 | 5.61 | 455 | 455 | 10,144 | 4.96 | 504 | −2,023 | +.65 | −49 |
| 602 | 14,824 | 5.32 | 788 | 435 | 11,676 | 5.44 | 636 | +3,148 | −.12 | +152 |
| Average of 4 | 10,874 | 5.59 | 602 | | 11,136 | 5.46 | 606 | −262 | +.10 | −4 |
| Number of daughters better than dams | | | | | | | | 1 | 1 | 2 |

[1] All dams were group foundation cows.

In Block 5 of table 6 the standard deviations and coefficients of variability for milk and butterfat yields of daughter groups of Moose, Karnak, and Tormentor are listed. Except for the latter sire, who had only 4 daughters, the variation of the daughter groups is less than that of the foundation dams.

## BREEDING PERFORMANCE OF FOUNDATION COWS

There were 46 females in the foundation group under study. Two of the foundation cows (Nos. 430 and 446) died before being bred, 4 others (Nos. 406, 425, 453, and 468) failed to conceive when bred to the first 3 sires (3 of the 4 became nonbreeders, but the fourth was bred successfully to later project sires) and one (No. 447) conceived once, aborted, and became a nonbreeder.

A composite record of the breeding performance of the three groups of foundation cows is shown in table 20. Of 39 female calves born alive, 8 died as calves, 2 proved to be nonbreeders, and 2 others became sterile after aborting; so the 92 pregnancies that were terminated produced only 27 females for project study.

TABLE 20.—*Breeding performance of 3 groups of foundation females when bred to the first 3 project sires*

| Foundation cows | Cows bred | Cows that conceived | Total conceptions | Average services per conception | Results of conceptions | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Females | | Males | | Abortions | | |
| | | | | | Live | Dead | Live | Dead | Female | Male | Sex unknown |
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| Group 1 | 13 | 12 | 35 | 2.63 | [1] 15 | 0 | 12 | 1 | 0 | 3 | 5 |
| Group 2 | 21 | 19 | 38 | 1.82 | 14 | [1] 3 | 11 | 2 | [1] 2 | 4 | 4 |
| Group 3 | 10 | 9 | 19 | 1.68 | 10 | 0 | 6 | 0 | 0 | [1] 3 | 1 |
| Total | 44 | 40 | 92 | 2.10 | [1] 39 | [1] 3 | 29 | 3 | [1] 2 | [1] 10 | 10 |

[1] Includes 2 twins.

## BREEDING AND REPRODUCTIVE PERFORMANCE OF THE DAUGHTERS OF THE THREE JERSEY SIRES

The first 3 sires—Moose, Karnak, and Tormentor—had a total of 33 outbred daughters. These daughters were mated to 18 different sires, but the majority of the matings were to 7 sires. One daughter of Moose and one daughter of Tormentor failed to conceive; the reproductive performance of the other 31 daughters of the 3 sires is shown in table 21.

The 31 daughters of the 3 sires conceived 170 times, 3 died pregnant, and the other 167 pregnancies resulted in 115 living calves, 8 dead calves, 41 abortions, and 3 mummified fetuses. The high incidence of abortion was due to an active Brucellosis infection in the herd during this period. The average of 5.5 conceptions per cow is the same as for the foundation cows.

Table 22 shows the number and percentage of conceptions that occurred at any given service.

TABLE 21.—*Reproductive performance of outbred daughters of 3 Jersey sires*

| Times pregnant (number) | Daughters of Moose | | Daughters of Karnak | | Daughters of Tormentor | | Daughters of all 3 sires | |
|---|---|---|---|---|---|---|---|---|
| | Animals | Conceptions | Animals | Conceptions | Animals | Conceptions | Animals | Conceptions |
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| 1 | 1 | 1 | | | | | 1 | 1 |
| 2 | 2 | 4 | | | | | 2 | 4 |
| 3 | 1 | 3 | 2 | 6 | | | 3 | 9 |
| 4 | 1 | 4 | 3 | 12 | 1 | 4 | 5 | 20 |
| 5 | 5 | 25 | 1 | 5 | | | 6 | 30 |
| 6 | 2 | 12 | 3 | 18 | | | 5 | 30 |
| 7 | 2 | 14 | | | 2 | 14 | 4 | 28 |
| 9 | 2 | 18 | 1 | 9 | | | 3 | 27 |
| 10 | 1 | 10 | | | | | 1 | 10 |
| 11 | | | | | 1 | 11 | 1 | 11 |
| Total | 17 | 90 | 10 | 50 | 4 | 29 | 31 | 170 |
| Average pregnancies per cow—number | 5.4 | | 5.0 | | 7.3 | | 5.5 | |
| Cows that died pregnant—do | 1 | | 2 | | 0 | | 3 | |
| Pregnancies terminated—do | 90 | | 48 | | 29 | | 167 | |
| Results of terminated pregnancies: | | | | | | | | |
| Live female calves—number | | 26 | | 16 | | 15 | | 57 |
| Dead female calves—do | | 1 | | 2 | | 0 | | 3 |
| Live male calves—do | | 32 | | 14 | | 12 | | 58 |
| Dead male calves—do | | 3 | | 2 | | 0 | | 5 |
| Aborted female calves—do | | 11 | | 4 | | 2 | | 17 |
| Aborted male calves—do | | 11 | | 4 | | 0 | | 15 |
| Aborted (sex unknown)—do | | 5 | | 4 | | 0 | | 9 |
| Mummified fetuses—do | | 1 | | 2 | | 0 | | 3 |
| Total—do | | 90 | | 48 | | 29 | | 167 |

TABLE 22.—*Number and percentage of conceptions by daughters of 3 Jersey sires on service indicated*

| Service | Daughters of Moose | | Daughters of Karnak | | Daughters of Tormentor | | Daughters of 3 sires | | Cumulative percentage |
|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Percent* | *Number* | *Percent* | *Number* | *Percent* | *Number* | *Percent* | *Percent* |
| 1st | 39 | 42.8 | 23 | 46.0 | 15 | 51.7 | 77 | 45.3 | 45.3 |
| 2d | 16 | 17.6 | 9 | 18.0 | 5 | 17.2 | 30 | 17.6 | 62.9 |
| 3d | 16 | 17.6 | 4 | 8.0 | 2 | 6.9 | 22 | 12.9 | 75.8 |
| 4th | 8 | 8.8 | 4 | 8.0 | 1 | 3.5 | 13 | 7.6 | 83.4 |
| 5th | 4 | 4.4 | 3 | 6.0 | 3 | 10.3 | 10 | 5.9 | 89.3 |
| 6th | 1 | 1.1 | | | | | 1 | .6 | 89.9 |
| 7th | 1 | 1.1 | 4 | 8.0 | | | 5 | 2.9 | 92.8 |
| 8th | 1 | 1.1 | 1 | 2.0 | | | 2 | 1.2 | 94.0 |
| 9th | 1 | 1.1 | 1 | 2.0 | | | 2 | 1.2 | 95.2 |
| 10th | | | 1 | 2.0 | 1 | 3.5 | 2 | 1.2 | 96.4 |
| 11th | 1 | 1.1 | | | | | 1 | .6 | 97.0 |
| 12th | 1 | 1.1 | | | | | 1 | .6 | 97.6 |
| 13th | 1 | 1.1 | | | | | 1 | .6 | 98.2 |
| 15th | 1 | 1.1 | | | | | 1 | .6 | 98.8 |
| 17th | | | | | 1 | 3.5 | 1 | .6 | 99.4 |
| 21st | | | | | 1 | 3.5 | 1 | .6 | 100.0 |
| Total | 91 | | 60 | | 29 | | 170 | | |
| Total number of services | 252 | | 139 | | 93 | | 489 | | |
| Services per conception | 2.77 | | 2.78 | | 3.36 | | 2.88 | | |

Losses due to abortion served to retard the progress of the breeding experiments and to reduce the size of progeny groups. As a consequence the available animals were retained as long as possible in the herd and every effort was made to breed cows successfully in order to build up numbers of the project. The breeding performance of this group of daughters of the three bulls also showed that sterility cannot be arbitrarily determined by the number of times a cow has been bred unsuccessfully. The results shown in table 22 are quite similar to those for the foundation cows. Almost 76 percent of the pregnancies were on 3 services or less, and about 90 percent on less than 7 services. If no animals had been retained after 6 unsuccessful services, the number of services per conception would be 2. Six pregnancies were achieved after the cows had been bred unsuccessfully 10 times. One conceived on the 17th service and another on the 21st service. Both of these occurred in the Tormentor group and are largely responsible for the average of 3.36 services per conception for this bull's daughters. With 10 services or less, 96.4 percent of the pregnancies had been established.

The daughter group is made up of animals that were all raised and bred initially at Beltsville, in which respect they differ from the members of the foundation-cow group. Data on the early history of the herd indicate that heifers averaged more services per conception when being bred for the first conception than when being bred for subsequent conceptions. Undoubtedly this factor helps to account for the difference in percentage of conceptions on first service in this group, as compared to that of the foundation cows, as well as for the difference in the average number of services per conception for the two groups.

It would appear trite to say that cows that breed most efficiently will produce more calves and remain in the herd longer than cows that breed less efficiently, but it is interesting to see to what extent this was true in a herd where no selection was practiced. The longer calving interval of cows that require four or more services for each conception reduces the number of gestations in an average cow-lifetime, and it may indicate a tendency for earlier sterility than in more efficient cows. However, these data do not afford a basis for concluding that the number of services per conception is a definite measure of shy breeding, as frequently a given animal may be difficult to settle during one breeding period whereas the rest of her breeding history indicates a high degree of breeding efficiency.

Table 23 shows the breeding efficiency of the foundation cows and the outbred daughters of the first three Jersey sires. The animals are divided into 2 groups, the first group being made up of all cows that were pregnant at least once but less than 6 times; the other group is made up of cows that had 6 or more pregnancies. The two sets of animals show a similar result, and both the foundation cows and the daughters in the first group required more than one additional service on the average for conception than those in the second group. For all cows the figure is 3.51 services per conception for cows that had less than 6 pregnancies, and 2.38 services per conception for those that had 6 or more pregnancies.

TABLE 23.—*Breeding efficiency of the foundation cows and the outbred daughters of the first 3 Jersey sires*

COWS THAT CONCEIVED LESS THAN 6 TIMES

| Times conceived (number) | Foundation cows [1] | | | | Daughters of 3 sires | | | | Both groups | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cows | Conceptions | Services | Services per conception | Cows | Conceptions | Services | Services per conception | Cows | Conceptions | Services | Services per conception |
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| 1 | 2 | 2 | 6 | 3.00 | 1 | 1 | 12 | 12.00 | 3 | 3 | 18 | 6.00 |
| 2 | 3 | 6 | 11 | 1.83 | 2 | 4 | 19 | 4.75 | 5 | 10 | 30 | 3.00 |
| 3 | 3 | 9 | 14 | 1.56 | 3 | 9 | 31 | 3.44 | 6 | 18 | 45 | 2.50 |
| 4 | 7 | 24 | 90 | 3.75 | 5 | 20 | 84 | 4.20 | 12 | 44 | 174 | 3.95 |
| 5 | 5 | 24 | 99 | 4.13 | 6 | 30 | 87 | 2.90 | 11 | 54 | 186 | 3.44 |
| Total or average | 20 | 65 | 220 | 3.38 | 17 | 64 | 233 | 3.64 | 37 | 129 | 453 | 3.51 |

COWS THAT CONCEIVED 6 TIMES OR MORE

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 10 | 42 | 120 | 2.86 | 5 | 30 | 74 | 2.47 | 15 | 72 | 194 | 2.69 |
| 7 | 6 | 37 | 75 | 2.03 | 4 | 28 | 88 | 3.14 | 10 | 65 | 163 | 2.51 |
| 8 | 3 | 24 | 60 | 2.50 | | | | | 3 | 24 | 60 | 2.50 |
| 9 | 1 | 9 | 27 | 3.00 | 3 | 27 | 58 | 2.15 | 4 | 36 | 85 | 2.36 |
| 10 | 2 | 10 | 37 | 1.95 | 1 | 10 | 20 | 2.00 | 3 | 29 | 57 | 1.97 |
| 11 | | | | | 1 | 11 | 16 | 1.45 | 1 | 11 | 16 | 1.45 |
| 14 | 1 | 14 | 23 | 1.64 | | | | | 1 | 14 | 23 | 1.64 |
| Total or average | 23 | 145 | 342 | 2.36 | 14 | 106 | 256 | 2.42 | 37 | 251 | 598 | 2.38 |
| Grand total or average | 43 | 210 | 562 | 2.68 | 31 | 170 | 489 | 2.88 | 74 | 380 | 1,051 | 2.77 |

[1] The 43 cows in the foundation group had completed 29 gestations before coming to Beltsville.

## COMPOSITE RESULTS OF MATING THE THREE PROVED JERSEY SIRES TO THE FOUNDATION COWS

The results following the mating of the first 3 proved Jersey sires to members of the 3 groups of foundation cows are shown in table 24.

TABLE 24.—*Average mature-equivalent milk-and-butterfat records of daughters of the 3 Jersey sires, compared with those of their dams*

| Number of daughters | Daughters | | | Foundation dams | | | | Increase (+) or decrease (−) by daughters over dams | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Milk | Butterfat | | Group No. | Milk | Butterfat | | Milk | Butterfat | |
| | *Pounds* | *Percent* | *Pounds* | | *Pounds* | *Percent* | *Pounds* | *Pounds* | *Percent* | *Pounds* |
| 10 | 12,918 | 5.34 | 688 | 1 | 12,212 | 5.61 | 680 | +706 | −0.27 | +8 |
| 10 | 11,300 | 5.55 | 622 | 2 | 10,936 | 5.59 | 605 | +364 | −.04 | +11 |
| 7 | 12,218 | 5.51 | 674 | 3 | 10,079 | 5.20 | 528 | +2,139 | +.31 | +146 |
| All 27 | 12,137 | 5.46 | 660 | All groups | 11,186 | 5.50 | 614 | +951 | −.04 | +46 |
| Number of daughters better than their dams | | | | | | | | 17 | 10 | 18 |

These 3 production-proved bulls sired daughters from all 3 groups of foundation cows that produced more milk and butterfat than their dams, and the 27 daughters averaged 951 pounds more milk and 46 pounds more butterfat. Seventeen daughters produced more milk than their dams and 18 produced more butterfat.

The average milk-and-butterfat records of the daughters of dams in the different groups afford some interesting contrasts and tend to emphasize the assumption that the production records of group 3 dams may not properly express their true worth. Standard deviations for subgroups are all shown in block 4 in table 6. The *t* test indicates a significant difference between groups 1 and 3 for milk and a highly significant difference for butterfat.

## IMMATURE AND MATURE MILK-PRODUCTION RECORDS COMPARED

The best measure of a dairy cow's inherited capacity for milk-and-butterfat production is her mature record. Mature records may be obtained if all cows remain in the herd until they are at least 6 years of age, and if disease, accident, or death does not interfere.

Of the 28 daughters of the first 3 Jersey sires, 17 had mature records and 11 had only immature records. Of the 11 cows with only immature records, No. 474 suffered an eye injury and died while on mature test; No. 488 died before going on mature test; No. 492 developed a bad udder and was not run on mature test; No. 496 aborted twice after reaching mature age and then died of toxic poisoning while on test; No. 613 made a 5-year-old record following 2 previous abortions but no mature record; No. 636 did not complete her mature record; No. 642 died during her mature test; Nos. 490 and 647 failed to respond to machine milking during their mature test and the records were

TABLE 25.—*Individual difference between the immature-age record and the mature-age record (both calculated to a 6-year-age basis) of the daughters of the first 3 Jersey sires*

| Group and daughter No. | Immature record | | | Mature record | | | Increase (+) or decrease (−) by mature record over immature record | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Milk | Butterfat | | Milk | Butterfat | | Milk | Butterfat | | |
| | *Pounds* | *Percent* | *Pounds* | *Pounds* | *Percent* | *Pounds* | *Pounds* | *Percent* | *Pounds* | |
| Group 1: | | | | | | | | | | |
| Average | 11,944 | 5.46 | 647 | | | | | | | [1]. |
| Group 2: | | | | | | | | | | |
| 601 | 9,831 | 5.94 | 584 | 13,271 | 6.17 | 818 | +3,440 | +0.23 | +234 | |
| 616 | 7,531 | 5.11 | 385 | 10,162 | 5.32 | 541 | +2,631 | +.21 | +156 | |
| 603 | 11,060 | 4.85 | 537 | 12,671 | 5.40 | 684 | +1,611 | +.55 | +147 | |
| 615 | 12,110 | 5.23 | 633 | 14,796 | 5.10 | 755 | +2,686 | −.13 | +122 | |
| 665 | 6,942 | 6.04 | 420 | 8,959 | 6.03 | 540 | +2,017 | −.01 | +120 | Immature record made after aborting. |
| 472 | 10,264 | 5.50 | 564 | 12,644 | 5.21 | 659 | +2,380 | −.29 | +95 | |
| 498 | 6,028 | 4.93 | 297 | 8,173 | 4.80 | 392 | +2,145 | −.13 | +95 | Lost 1 quarter. Aborted during mature record. |
| 606 | 14,548 | 5.33 | 775 | 15,411 | 5.29 | 815 | +863 | −.04 | +40 | |
| 491 | 11,412 | 6.44 | 736 | 11,549 | 6.51 | 752 | +137 | +.07 | +16 | Machine milked for mature record. |
| Average | 9,970 | 5.49 | 548 | 11,960 | 5.54 | 662 | +1,990 | +.05 | +114 | |
| Group 3: | | | | | | | | | | |
| 480 | 8,085 | 6.07 | 491 | 8,161 | 6.01 | 490 | +76 | −0.06 | −1 | |
| 476 | 11,531 | 5.90 | 681 | 11,636 | 5.70 | 663 | +105 | −.20 | −18 | Machine milked for mature record. |
| 611 | 12,321 | 5.23 | 644 | 11,213 | 5.30 | 595 | −1,108 | +.07 | −49 | |
| 617 | 13,880 | 4.77 | 662 | 13,742 | 4.41 | 606 | −138 | −.36 | −56 | Aborted during mature record. |
| 644 | 11,813 | 5.59 | 661 | 10,585 | 5.47 | 579 | −1,228 | −.12 | −82 | Immature record made after aborting. |
| 602 | 14,824 | 5.32 | 788 | 12,777 | 5.43 | 693 | −2,047 | +.11 | −95 | |
| 495 | 12,729 | 5.37 | 683 | 10,521 | 5.30 | 558 | −2,208 | −.07 | −125 | Machine milked for mature record. Off feed during mature test. |
| 477 | 12,388 | 5.43 | 673 | 10,320 | 4.98 | 514 | −2,068 | −.45 | −159 | |
| Average | 12,196 | 5.46 | 660 | 11,119 | 5.32 | 587 | −1,077 | −.14 | −73 | |
| Average of 17 in groups 2 and 3 | 11,017 | 5.47 | 601 | 11,564 | 5.44 | 627 | +547 | −.03 | +26 | |

[1] See text.

not considered representative of their producing ability; No. 661 became a nonbreeder and was slaughtered, and No. 674 dropped a dead calf and did not complete her lactation in mature form.

Table 25 shows the individual differences between the immature and mature records for the 17 cows having both types of records (all records calculated to 6-year-age basis). Under Remarks some factors are listed that may have contributed to the variations that occurred between the two sets of records when calculated to a mature equivalent basis. It will be noted that, on the average, these cows on mature test actually produced 26 pounds of fat above their calculated ability on the basis of their immature records. This would indicate that the factors used are fairly conservative. Group 1 is made up of the 11 cows that had no mature records. The other 2 groups are arranged according to the magnitude of the + or — differences between their 2 records.

Correlation surfaces for milk production and butterfat test are shown for the immature and mature records of these 17 cows in tables 26 and 27. The coefficients of correlation were found to be +0.7067 for milk production and +0.7847 for butterfat test. Both of these are highly significant statistically.

TABLE 26.—*Correlation of calculated milk yields on immature and mature tests of 17 cows*

| Milk-yield class of immature records (pounds) | Number of cows whose mature record was in the milk yield class of | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | 15,000 pounds | 14,000 pounds | 13,000 pounds | 12,000 pounds | 11,000 pounds | 10,000 pounds | 9,000 pounds | 8,000 pounds | |
| 14,000 | | 1 | | | | 1 | | | 2 |
| 13,000 | | | | 1 | | | | | 1 |
| 12,000 | | | 1 | | 1 | 2 | | | 4 |
| 11,000 | | | | | 2 | 1 | | 1 | 4 |
| 10,000 | | | | 1 | | | | | 1 |
| 9,000 | | | 1 | | | | | 1 | 2 |
| 8,000 | | | | | | | 1 | | 1 |
| 7,000 | | | | | | 1 | | | 1 |
| 6,000 | | | | | | | 2 | | 2 |
| Total | 1 | 1 | 2 | 3 | 3 | 4 | 3 | 1 | 17 |

TABLE 27.—*Correlation of average percentage of butterfat on immature and mature tests of 17 cows*

| Butterfat test class of immature records (percent) | Number of cows whose mature record was in butterfat-test class of— | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6.4–6.59 per-cent | 6.2–6.39 per-cent | 6.0–6.19 per-cent | 5.8–5.99 per-cent | 5.6–5.79 per-cent | 5.4–5.59 per-cent | 5.2–5.39 per-cent | 5.0–5.19 per-cent | 4.8–4.99 per-cent | 4.6–4.79 per-cent | 4.4–4.59 per-cent | |
| 6.3–6.49 | 1 | | | | | | | | | | | 1 |
| 6.1–6.29 | | | | | | | | | | | | |
| 5.9–6.09 | | | 3 | | 1 | | | | | | | 4 |
| 5.7–5.89 | | | | | | | | | | | | |
| 5.5–5.69 | | | | | | 1 | 1 | | | | | 2 |
| 5.3–5.49 | | | | | | 1 | 2 | | 1 | | | 4 |
| 5.1–5.29 | | | | | | | 2 | 1 | | | | 3 |
| 4.9–5.09 | | | | | | | | | 1 | | | 1 |
| 4.7–4.89 | | | | | | 1 | | | | | 1 | 2 |
| Total | 1 | | 3 | | 1 | 3 | 5 | 1 | 2 | | 1 | 17 |

## HIGHEST MATURE-EQUIVALENT MILK-PRODUCTION RECORDS OF DAUGHTERS AND DAMS COMPARED

It was not possible to make comparisons of first-lactation records of dams and daughters, as most of the foundation cows were purchased and either did not have official first-lactation records or their records were made under different conditions than were set up for this experiment. In only a few cases would it be possible to make such comparisons.

Table 28 gives the distribution of the highest mature-equivalent records of the daughters of the first 3 Jersey bulls, 27 of which are daughters of foundation cows and 1 a second-generation outbred. The coefficient of correlation between dams and daughters in milk yield is +0.4001. Statistically this is significant but not highly significant. This corresponds closely with the results of a study of the first-generation Holsteins and their dams.[2] In that study a similar relationship showed a coefficient of +0.396.

TABLE 28.—*Distribution of daughters of the first 3 Jersey sires and their dams for milk production*

| Milk-production class of daughters (pounds) | Dams in milk-production class of | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16,000 pounds | 15,000 pounds | 14,000 pounds | 13,000 pounds | 12,000 pounds | 11,000 pounds | 10,000 pounds | 9,000 pounds | 8,000 pounds | 7,000 pounds | 6,000 pounds | |
| 16,000 | | | | | 1 | | | | | | | 1 |
| 15,000 | | | 1 | | | 1 | | | | | | 2 |
| 14,000 | | | | | 1 | 1 | | | 1 | | | 3 |
| 13,000 | | | | | | 2 | | | | | | 2 |
| 12,000 | | | | | 2 | 4 | | | | | | 6 |
| 11,000 | 1 | | | | 2 | 1 | 2 | | | 1 | | 7 |
| 10,000 | | | | | | | 1 | | 1 | | | 2 |
| 9,000 | | | | | | | | | | | 1 | 1 |
| 8,000 | | | | | | | 3 | 1 | | | | 4 |
| Total | 1 | | 1 | | 6 | 9 | 6 | 1 | 2 | 1 | 1 | 28 |

Another method of illustrating the comparison of dams and daughters is shown in figure 4. The arrows in this figure show not only the relative production of the individual dams and the daughters of each of the three sires, but also that of the full-sister daughters.

Table 29 shows the variation resulting from the use of the three Jersey sires, when the daughters are compared with the dams arranged into milk-production classes. The extreme variations ranged from a production of 5,812 pounds more milk by 1 daughter than her dam to a production of 4,465 pounds less milk by 1 daughter than her dam. This would indicate considerable heterozygosity in the transmitting ability of the sires and the foundation cows. The arrow charts in figure 4 also lead to the same conclusion.

[2] FOHRMAN, M. H., and GRAVES, R. R. EXPERIMENTS IN BREEDING HOLSTEIN-FRIESIAN CATTLE FOR MILK- AND BUTTERFAT-PRODUCING ABILITY, AND AN ANALYSIS OF THE FOUNDATION COWS AND OF THE FIRST OUTBRED GENERATION. U. S. Dept. Agr. Tech. Bul. 677, 81 pp., illus. 1939.

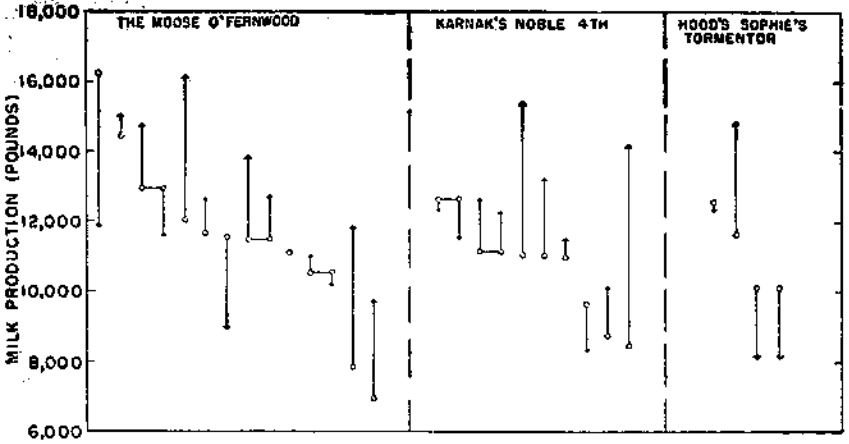



FIGURE 4.—Relation between the milk production records of the daughters of the first three Jersey sires and those of their dams. (Base of arrow indicates the dam's record; point of arrow, the daughter's record.)

TABLE 29.—*Average milk production of daughter-dam pairs, when grouped according to the production class of the dams*

| Milk-production class of dams | Daughter-dam pairs | Average milk production | | Increase (+) or decrease (−) by daughters over dams | Daughters better than dams | Extremes of the difference by which a daughter varied from her dam |
|---|---|---|---|---|---|---|
| | | Dams | Daughters | | | |
| *Pounds* | *Number* | *Pounds* | *Pounds* | *Pounds* | *Number* | *Pounds* |
| 16,000 | 1 | 16,272 | 11,807 | −4,465 | | |
| 14,000 | 1 | 14,450 | 15,054 | +604 | 1 | |
| 12,000 | 6 | 12,629 | 13,129 | +500 | 2 | +4,147 to −1,415. |
| 11,000 | 10 | 11,314 | 12,791 | +1,477 | 9 | +4,342 to −2,572. |
| 10,000 | 5 | 10,482 | 9,805 | −677 | 2 | +532 to −2,023. |
| 9,000 | 1 | 9,621 | 8,173 | −1,448 | | |
| 8,000 | 2 | 8,564 | 12,176 | +3,612 | 2 | +5,812 to +1,411. |
| 7,000 | 1 | 7,831 | 11,813 | +3,982 | 1 | |
| 6,000 | 1 | 6,954 | 9,751 | +2,797 | 1 | |
| Total or average | 28 | 11,199 | 12,024 | +825 | 18 | |

In order to evaluate this in another way, the production averages, mean deviations, standard deviations, and coefficients of variation have been calculated for the three sire groups separately. These data are shown in table 30. Although the group as a whole shows a slight decrease in variability—from 18.6 percent for the dams to 18.2 percent for the daughters—it will be noted that Moose accounts for all of the evidence of homozygosity. The daughters of both Karnak and Tormentor show a much larger variation than their respective dams. This is verified by a study of the arrow charts in figure 4.

There were five sets of full sisters included in these dam-and-daughter comparisons. In two sets both daughters were better than their dams. In 1 set both daughters were poorer than their dam, and in the other 2 sets 1 daughter was better than the dam and the other poorer. The extreme variation was between the 2 daughters of No. 411, with 1 better and 1 poorer than their dam. These daughters were 3,252 pounds apart in milk production. The

others were relatively close. The 2 daughters of No. 438 varied by 1,151 pounds; those of No. 478 by 888 pounds, No. 444 by 772 pounds, and No. 466 by only 334 pounds.

In table 31, the comparison is the reverse of that in table 29. Here the daughters are arranged in 1,000-pound milk-production classes and the comparisons made with their respective dams. The extreme difference in each group is given in the last column. Comparing the highest 14 daughters with the lowest 14, it is found that the highest 14 daughters average 13,766 pounds and the lowest 14 daughters average 10,281 pounds, a difference of 3,485 pounds. The dams of these daughters average 11,686 and 10,713 pounds, respectively, a difference of only 973 pounds.

TABLE 30.—*Variability of the daughters and their dams in milk production by sire groups*

| Group | Average milk production | Mean deviation | Standard deviation | Coefficient of variation |
|---|---|---|---|---|
| | *Pounds* | *Pounds* | *Pounds* | *Percent* |
| 11 dams of Moose daughters | 11,528 | 1,709 | 2,506 | 21.7 |
| 14 daughters of Moose | 12,251 | 1,050 | 2,030 | 16.6 |
| 8 dams of Karmk daughters | 10,440 | 1,143 | 1,319 | 12.6 |
| 10 daughters of Karmk | 12,162 | 1,453 | 1,928 | 15.9 |
| 4 dams of Tormentor daughters | 11,136 | 1,001 | 1,053 | 9.5 |
| 4 daughters of Tormentor | 10,874 | 2,732 | 2,865 | 26.3 |
| All 22 dams | 11,087 | 1,501 | 2,057 | 18.6 |
| All 28 daughters | 12,027 | 1,739 | 2,186 | 18.2 |

TABLE 31.—*Average milk production of daughter-dam pairs, when grouped according to the production class of the daughters*

| Milk-production class of the daughters | Daughter-dam pairs | Average milk production | | Increase (+) or decrease (−) by daughters over dams | Daughters better than dams | Extremes of the difference by which a daughter varies from her dam |
|---|---|---|---|---|---|---|
| | | Daughters | Dams | | | |
| *Pounds* | *Number* | *Pounds* | *Pounds* | *Pounds* | *Number* | *Pounds* |
| 16,000 | 1 | 16,178 | 12,031 | +4,147 | 1 | |
| 15,000 | 2 | 15,292 | 12,760 | +2,472 | 2 | +4,342 to +604. |
| 14,000 | 3 | 14,015 | 11,016 | +3,599 | 2 | +5,812 to +1,827. |
| 13,000 | 2 | 13,570 | 11,248 | +2,328 | 2 | +2,305 to +2,260. |
| 12,000 | 6 | 12,515 | 11,751 | +764 | 4 | +1,503 to −293. |
| 11,000 | 7 | 11,497 | 11,759 | −262 | 3 | +3,982 to −4,465. |
| 10,000 | 2 | 10,145 | 9,644 | +501 | 1 | +1,411 to −409. |
| 9,000 | 1 | 9,751 | 6,954 | +2,797 | 1 | |
| 8,000 | 4 | 8,351 | 10,355 | −2,001 | | −1,448 to −2,572. |

## BUTTERFAT TESTS OF DAUGHTERS AND DAMS COMPARED

The average butterfat test of the daughters of the three Jersey sires was 5.48 percent. The average test of their dams was 5.49 percent on an unweighted basis and 5.51 on a weighted basis. Table 32 shows the distribution of the 28 daughter-dam pairs, according to butterfat test.

The following constants were calculated on the basis of butterfat tests:

The standard deviation for the dams was 0.476; for the daughters, 0.463.
The coefficient of variability for the dams was 8.67; for the daughters, 8.45.
The coefficient of correlation between the dams and daughters was +0.4065.

TABLE 32.—*Distribution of the 28 daughter-and-dam pairs, according to butterfat test*

| Butterfat test of dams (percent) | Number of pairs in which the daughter's butterfat test was— | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6.4 percent | 6.2 percent | 6.0 percent | 5.8 percent | 5.6 percent | 5.4 percent | 5.2 percent | 5.0 percent | 4.8 percent | 4.6 percent | |
| 6.4 | | | | 1 | | | | | | | 1 |
| 6.2 | | | 1 | | | | | | | | 1 |
| 6.0 | | | 1 | 1 | 1 | | 1 | | | | 4 |
| 5.8 | | | 1 | | | | | | | | 1 |
| 5.6 | 1 | | | | | 1 | 3 | | | 1 | 6 |
| 5.4 | | | 1 | | | | 2 | 1 | | | 3 |
| 5.2 | | | 1 | | | 1 | | 1 | | 1 | 4 |
| 5.0 | | | 1 | | | 1 | 1 | 1 | | | 4 |
| 4.8 | | | | | 1 | | | | 1 | | 2 |
| 4.6 | | | | | | 1 | | | 1 | | 2 |
| Total | 1 | | 5 | 2 | 2 | 4 | 7 | 3 | 2 | 2 | 28 |

The coefficient of correlation, while not highly significant, is significant and would indicate some relationship. This is considerably higher than the coefficient of +0.317 found for the first-generation Holstein daughters and their dams.[3]

Figure 5 is an arrow chart picturing the relation of the butterfat test of the dams to that of their daughters. Only a casual observation is needed to show the extreme heterozygosity of both the dams and the daughters of the three sires for butterfat test. A further indication of this is illustrated by the five full-sister groups. The most extreme difference in butterfat test was between the two daughters of dam No. 444. The difference between the 2 daughters was 1.28 percent—or an increase of 0.84 percent by 1 daughter over the dam and a decrease of 0.44 percent by the other daughter below the dam.

Further details of these variations are brought out in table 33. A majority of the daughters showed a decrease in butterfat test as compared to that of their dams. There were 11 cases of increases, 16 of decreases, and 1 was even. On the average, the test of the daughters was only 0.03 percent below that of the dams. If the 28

TABLE 33.—*Average butterfat test of daughters and dams, arranged according to the butterfat-test class of the dams*

| Butterfat test of the dams (percent) | Dam-and-daughter pairs | Average butterfat test | | Increase (+) or decrease (−) by daughters over dams | Daughters better than dams | Extremes of the difference by which daughter varied from her dam |
|---|---|---|---|---|---|---|
| | | Dams | Daughters | | | |
| | *Number* | *Percent* | *Percent* | *Percent* | *Number* | *Percent* |
| 6.5 | 1 | 6.51 | 5.80 | −0.65 | | |
| 6.3 | 1 | 6.30 | 6.01 | −.29 | | |
| 6.0 | 4 | 6.03 | 5.76 | −.27 | 1 | −0.16 to −0.72. |
| 5.9 | 1 | 5.90 | 6.03 | +.13 | 1 | |
| 5.6 | 6 | 5.65 | 5.44 | −.21 | 1 | +0.84 to −0.81. |
| 5.4 | 3 | 5.47 | 5.24 | −.23 | | −0.12 to −0.40. |
| 5.3 | 3 | 5.36 | 5.46 | +.10 | 2 | +0.81 to −0.52. |
| 5.2 | 1 | 5.26 | 5.11 | −.15 | | |
| 5.1 | 4 | 5.13 | 5.48 | +.35 | 1 4 | +0.98 to 0. |
| 4.9 | 1 | 4.96 | 5.61 | +.65 | 1 | |
| 4.8 | 1 | 4.84 | 4.80 | −.04 | | |
| 4.7 | 2 | 4.76 | 5.21 | +.45 | 2 | +0.82 to +0.09. |

[1] 1 daughter had same test as her dam.

[3] See footnote 2.

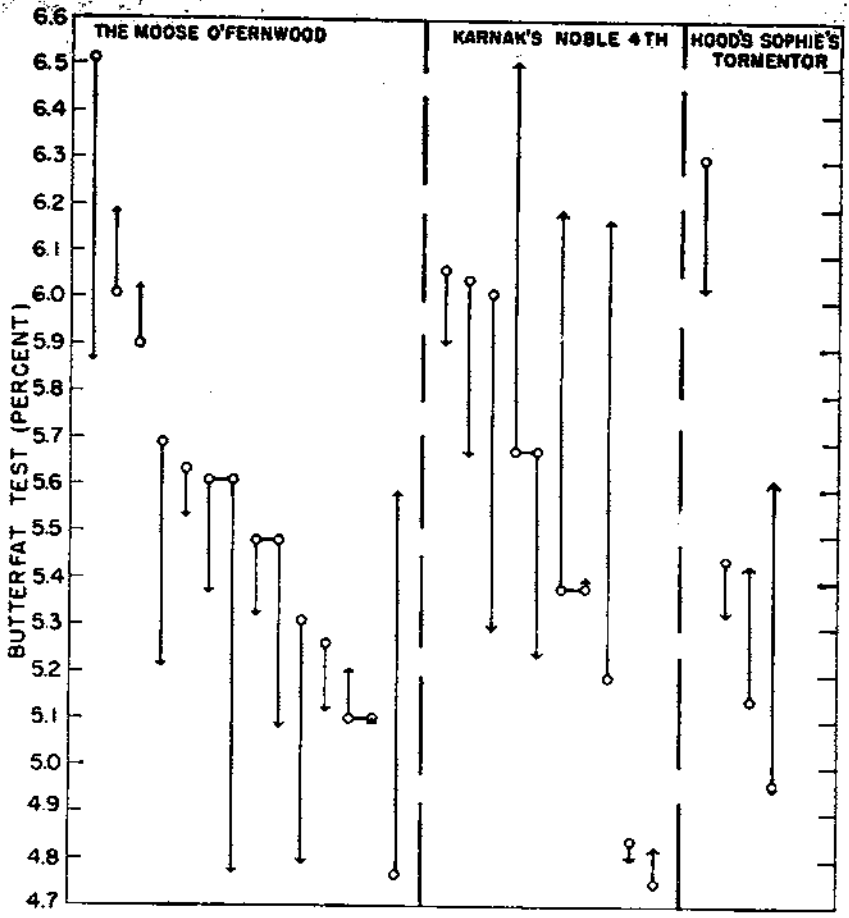



FIGURE 5.—Relation between the butterfat tests of the daughters of the first three Jersey sires and those of their dams. (Base of arrow indicates the dam's test; point of arrow the daughter's test.)

dam-and-daughter comparisons are averaged, from the highest testing dams to the lowest, and divided into 4 groups of 7 comparisons each, an interesting relationship is found. This is shown in table 34.

TABLE 34.—*Relation between butterfat tests of dams and daughters, at different levels of tests of the dams*

| Number of dam-daughter pairs | Average test of dams | Average test of daughters | Increase (+) or decrease (−) by daughters over dams |
|---|---|---|---|
| | *Percent* | *Percent* | *Percent* |
| 7 | 6.12 | 5.85 | −0.27 |
| 7 | 5.62 | 5.42 | −.20 |
| 7 | 5.34 | 5.28 | −.06 |
| 7 | 4.96 | 5.38 | +.42 |

## BUTTERFAT-PRODUCTION RECORDS OF DAUGHTERS AND DAMS COMPARED

The preceding discussions of milk production and butterfat test are based on the assumption that the factors that determine milk yield are inherited independently from those that determine the percentage of butterfat in milk. As butterfat production is a combination of these two sets of factors, and is commonly used to measure the transmitting ability of sires, it will be discussed here.

The butterfat production of the 22 dams ranged from 373 to 855 pounds, a variation of 482 pounds. Their average production on an unweighted basis was 608 pounds; and when each dam's record is used as often as she is represented by a daughter the average was 616 pounds.

The butterfat production of the 28 daughters ranged from 833 pounds to 392, a variation of 441 pounds. The range was somewhat narrower than that of the dams but not greatly so. The average production of the 28 daughters was 656 pounds.

TABLE 35.—*Average butterfat production of 28 daughters and their 22 dams, grouped according to the butterfat-production class of the dams*

| Butterfat-production class of dams (pounds) | Dam-and-daughter pairs | Average butterfat production | | Increase (+) or decrease (−) by daughters over dams | Daughters better than dams | Extremes of the difference by which a daughter varied from her dam |
|---|---|---|---|---|---|---|
| | | Dams | Daughters | | | |
| | *Number* | *Pounds* | *Pounds* | *Pounds* | *Number* | *Pounds* |
| 850 | 1 | 855 | 604 | −251 | | |
| 800 | 1 | 811 | 833 | +19 | 1 | |
| 700 | 2 | 715 | 698 | −17 | 1 | +37 to −71. |
| 650 | 7 | 666 | 677 | +11 | 4 | +150 to −141. |
| 600 | 6 | 642 | 678 | +36 | 5 | +152 to −148. |
| 550 | 3 | 585 | 673 | +88 | 3 | +246 to −38. |
| 500 | 2 | 506 | 515 | +9 | 1 | +47 to −49. |
| 450 | 2 | 459 | 482 | +23 | 1 | +119 to −73. |
| 400 | 1 | 400 | 687 | +287 | 1 | |
| 350 | 1 | 373 | 661 | +288 | 1 | |

TABLE 36.—*Distribution of butterfat production records of 28 daughters and their dams*

| Butterfat-production class of daughters (pounds) | Number of pairs in which the dam's butterfat-production class was— | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 850 pounds | 800 pounds | 750 pounds | 700 pounds | 650 pounds | 600 pounds | 550 pounds | 500 pounds | 450 pounds | 400 pounds | 350 pounds | |
| 800 | | 1 | | | 1 | | 1 | | | | | 3 |
| 750 | | | | 1 | 1 | 2 | 1 | | | | | 5 |
| 700 | | | | | | | | | | | | 0 |
| 650 | | | | | 3 | 3 | 1 | | | 1 | 1 | 9 |
| 600 | 1 | | | 1 | 1 | | | | | | | 3 |
| 550 | | | | | | | 1 | 1 | 1 | | | 3 |
| 500 | | | | | 1 | | 1 | | | | | 2 |
| 450 | | | | | | 1 | | 1 | | | | 2 |
| 400 | | | | | | | | | | | | 0 |
| 350 | | | | | | | | | 1 | | | 1 |
| Total | 1 | 1 | | 2 | 7 | 6 | 5 | 2 | 2 | 1 | 1 | 28 |

The coefficient of variation for the dams is 19.2 percent, and for the daughters 16.7 percent. The coefficient of correlation for the 28 dam-and-daughter pairs is +0.3306. This is not significant. In table 35 these data are grouped to bring out the variations in the daughters' butterfat production at the various levels of production for the dams. Table 36 shows the distribution of these dam-and-daughter pairs. Combining the data into 4 groups of 7 pairs each brings out a significant relationship of the effect of the 3 sires when mated to dams at various production levels. These comparisons are shown in table 37.

TABLE 37.—*Relation between butterfat production of dams and daughters, at different production levels of the dams*

| Number of dam-and-daughter pairs | Average butterfat production of dams | Average butterfat production of daughters | Increase (+) or decrease (−) by daughters over dams |
|---|---|---|---|
| | *Pounds* | *Pounds* | *Pounds* |
| 7 | 730 | 696 | −34 |
| 7 | 656 | 675 | +19 |
| 7 | 609 | 657 | +48 |
| 7 | 471 | 594 | +123 |

## PERSISTENCY OF MILK PRODUCTION BY DAMS AND DAUGHTERS

The method used in measuring persistency of milk production in this study is one proposed by the senior author. It assumes that perfect persistency, or a value of zero, would result if each of twelve 30-day periods in the lactation showed exactly the same production. In applying this method each 30-day production is converted to a percentage of the 360-day total. These percentages are then measured against 8.33 which is the 30-day percentage of even production. The total of the deviations in percentage is the measure of persistency. In actual practice it is necessary only to calculate the plus deviations and double the result.

In this study the foundation cows average 18.50 percent in persistency, whereas the daughters by the 3 sires averaged 18.98 percent. Persistency of the dams, by foundation groups, was as follows:

| | *Percent* |
|---|---|
| Group 1 | 19. 77 |
| Group 2 | 13. 32 |
| Group 3 | 20. 22 |

When the daughters are paired with their respective dams the results are as follows:

| | *Dams, percent* | *Daughters, percent* |
|---|---|---|
| Group 1 | 20. 62 | 18. 52 |
| Group 2 | 12. 99 | 20. 34 |
| Group 3 | 27. 93 | 19. 60 |
| All cows | 18. 50 | 18. 98 |

The numbers are small but there is little indication that the persistency of a dam has any effect on the persistency of the daughter.

## RELATION OF AGE OF PARENTS TO DAUGHTERS' PRODUCING ABILITY

There is no sound basis for assuming that the producing capacity of a cow would be influenced by the age of her parents at the time she was conceived. The correlations resulting from a study of 32 daughters of a Holstein sire verified that conclusion, being +0.016 for age of sire and 0.0 for the age of dams.[4]

Table 38 shows the data for the 28 Jersey daughters of 3 sires grouped according to age of the parents. The surprising part of this phase of the study was the correlations resulting. The correlation coefficient for age of sire at time of conception and butterfat production of the daughters was +0.1796; and for age of dam at time of conception and butterfat production of the daughters, the correlation coefficient was +0.4344. Statistically this latter correlation is significant, yet an analysis of the data indicates that by chance 1 dam in the 9-year group had a daughter in the 800- to 850-pound class, and 3 daughters below the 500-pound class were from the younger dams. It will be of interest to see the results when larger numbers of animals are available for this study.

TABLE 38.—*Effect of age of parents at the time of conception on the average butterfat production of daughters*

| Age class of sire (years) | Sire's daughters | Sire's average age | Average butterfat production of the daughters | Age class of dams (years) | Dams' daughters | Dams' average age | Average butterfat production of the daughters |
|---|---|---|---|---|---|---|---|
| | *Number* | *Months* | *Pounds* | | *Number* | *Months* | *Pounds* |
| 5 | 3 | 68 | 607 | 1 | 4 | 19 | 562 |
| 6 | 1 | 78 | 455 | 2 | 5 | 29 | 675 |
| 7 | 5 | 87 | 660 | 3 | 6 | 42 | 608 |
| 8 | 7 | 101 | 681 | 4 | 3 | 50 | 615 |
| 9 | 9 | 112 | 678 | 5 | 3 | 64 | 692 |
| 10 | 2 | 130 | 657 | 6 | 2 | 76 | 790 |
| 11 | 1 | 137 | 601 | 7 | 3 | 91 | 715 |
| | | | | 8 | 1 | 101 | 601 |
| | | | | 9 | 1 | 109 | 833 |
| Total or average | 28 | 101 | | Total | 28 | 52 | |

## STUDIES OF BODY-WEIGHT DATA

Weights of all animals in the herd have been recorded since the start of this project. Calves are weighed as soon after birth as possible. Thereafter they are weighed at 10-day intervals during the first year, and the weight for the calf at 1 year of age is the average of 3 weights centering on the first birth anniversary. All females over 1 year of age are weighed on the first 3 days of each month as long as they remain in the herd. The average of these three weighings is used as the weight of the animal for the age nearest to the dates on which the weighings are made. Cows on production tests are weighed in the middle of each month.

[4] See footnote 2.

Live weight is the most generally used and most easily applied standard for measuring body size; it is also useful in determining physical condition and response to feed and is necessary for calculating rations for cows on experiments of various kinds. Weight data on live animals gathered in a herd where management practice is standardized will, of course, reflect the results of such management. Growth tables derived from such a source have some value as a basis for comparison but, because the management practice influences the results, they serve as a true standard only for the herd from which they are derived, or for herds under similar management.

Table 39 shows the average weights of the daughters of the first 3 Jersey sires at monthly intervals to 1 year of age, and at 6-month intervals to 10 years of age.

TABLE 39.—*Average weights of the daughters of Moose, Karnak, and Tormentor at ages indicated*

| Age | Moose | | Karnak | | Tormentor | | All daughters | |
|---|---|---|---|---|---|---|---|---|
| | *Number* | *Pounds* | *Number* | *Pounds* | *Number* | *Pounds* | *Number* | *Pounds* |
| At birth | 18 | 60 | 10 | 54 | 5 | 47 | 33 | 56 |
| *Months* | | | | | | | | |
| 1 | 17 | 76 | 10 | 71 | 5 | 69 | 32 | 73 |
| 2 | 17 | 104 | 10 | 93 | 5 | 89 | 32 | 98 |
| 3 | 18 | 136 | 10 | 124 | 5 | 122 | 33 | 130 |
| 4 | 18 | 177 | 10 | 161 | 5 | 161 | 33 | 170 |
| 5 | 18 | 222 | 10 | 203 | 5 | 210 | 33 | 214 |
| 6 | 18 | 269 | 10 | 248 | 5 | 257 | 33 | 261 |
| 7 | 18 | 312 | 10 | 298 | 5 | 307 | 33 | 307 |
| 8 | 18 | 344 | 10 | 333 | 5 | 315 | 33 | 341 |
| 9 | 18 | 379 | 10 | 365 | 5 | 379 | 33 | 375 |
| 10 | 18 | 413 | 10 | 398 | 5 | 417 | 33 | 409 |
| 11 | 18 | 447 | 10 | 427 | 5 | 451 | 33 | 442 |
| *Yr. Mo.* | | | | | | | | |
| 1 0 | 18 | 473 | 10 | 463 | 5 | 479 | 33 | 471 |
| 1 6 | 18 | 606 | 10 | 589 | 5 | 606 | 33 | 601 |
| 2 0 | 17 | 774 | 10 | 739 | 5 | 758 | 32 | 761 |
| 2 6 | 17 | 820 | 10 | 825 | 4 | 801 | 31 | 820 |
| 3 0 | 17 | 879 | 10 | 907 | 4 | 893 | 31 | 889 |
| 3 6 | 16 | 919 | 10 | 943 | 4 | 865 | 30 | 920 |
| 4 0 | 14 | 961 | 10 | 914 | 4 | 876 | 28 | 932 |
| 4 6 | 14 | 983 | 10 | 936 | 4 | 939 | 28 | 960 |
| 5 0 | 14 | 1,002 | 10 | 974 | 4 | 971 | 28 | 988 |
| 5 6 | 14 | 1,021 | 9 | 957 | 4 | 975 | 27 | 993 |
| 6 0 | 13 | 1,070 | 9 | 1,017 | 4 | 1,025 | 26 | 1,045 |
| 6 6 | 13 | 1,094 | 8 | 1,007 | 4 | 1,092 | 25 | 1,066 |
| 7 0 | 12 | 1,073 | 6 | 1,015 | 4 | 1,023 | 22 | 1,048 |
| 7 6 | 8 | 1,123 | 5 | 962 | 1 | 1,113 | 17 | 1,073 |
| 8 0 | 7 | 1,096 | 3 | 981 | 3 | 1,054 | 13 | 1,060 |
| 8 6 | 4 | 1,087 | 2 | 980 | 3 | 1,061 | 9 | 1,057 |
| 9 0 | 3 | 1,051 | 1 | 1,009 | 3 | 1,111 | 7 | 1,069 |
| 9 6 | 3 | 982 | 1 | 952 | 3 | 1,129 | 7 | 1,041 |
| 10 0 | 3 | 1,033 | 1 | 905 | 3 | 1,075 | 7 | 1,041 |

One effect of herd management is expressed in the decreasing magnitude of monthly gains after skim-milk feeding is discontinued. The practice is to feed skim milk to the age of 6 months, and the gains for the fifth and sixth months exceed those of the seventh or any succeeding month. Another effect is reflected in the small gain registered in the 13th month. The practice is to keep heifers in the calf barn until they reach the age of 1 year, when they are shifted to the herd barn. This sudden change of environment evidently retards the rate of gain until the animal adjusts itself to the new conditions.

In the study of the daughters of the Holstein sire Denton Colantha Sir Rag Apple an analysis of the maximum weights reached was cor-

related with the weights at birth, at 1 year of age, at 2 years of age, and at 2 years of age when pregnant.[5] Similarly the same relationships were studied for the first generation of Jersey daughters. These relationships are shown in table 40.

TABLE 40.—*Relation of the maximum weight of daughters of Moose, Karnak, and Tormentor, to the weight at birth, 1 year of age, 2 years of age, and 2 years of age when pregnant*

| Age, and weight (pounds) | Number that reached a maximum weight of— | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | 1,300 pounds | 1,250 pounds | 1,200 pounds | 1,150 pounds | 1,100 pounds | 1,050 pounds | 1,000 pounds | |
| At birth: | | | | | | | | |
| 70 | | | 1 | | | | | 1 |
| 65 | 1 | | | 1 | | | | 2 |
| 60 | 1 | 1 | | 3 | | | 1 | 6 |
| 55 | 1 | 1 | 2 | 1 | | 3 | | 8 |
| 50 | | | 2 | 1 | 1 | 2 | | 6 |
| 45 | | 1 | | 1 | 1 | | 1 | 4 |
| Total | 3 | 3 | 5 | 7 | 2 | 5 | 2 | 27 |
| At 1 year: | | | | | | | | |
| 550 | | 1 | | | | | | 1 |
| 500 | 2 | 1 | 2 | 1 | | 1 | | 7 |
| 450 | 1 | 1 | 2 | 4 | | 2 | | 10 |
| 400 | | | 1 | 2 | 2 | | 2 | 7 |
| 350 | | | | | | 2 | | 2 |
| Total | 3 | 3 | 5 | 7 | 2 | 5 | 2 | 27 |
| At 2 years: | | | | | | | | |
| 900 | | | | 1 | | | | 1 |
| 850 | | | 1 | | | | | 1 |
| 800 | 1 | 2 | | | | 2 | | 5 |
| 750 | 1 | 1 | 1 | 1 | 1 | | | 5 |
| 700 | 1 | | 3 | 4 | 1 | 1 | | 10 |
| 650 | | | | 1 | | 1 | 1 | 3 |
| 600 | | | | | | 1 | 1 | 2 |
| Total | 3 | 3 | 5 | 7 | 2 | 5 | 2 | 27 |
| At 2 years when pregnant: | | | | | | | | |
| 900 | | | | 1 | | | | 1 |
| 850 | | | 1 | | | | | 1 |
| 800 | 1 | 2 | | | | 1 | | 4 |
| 750 | 1 | | 1 | 1 | 1 | | | 4 |
| 700 | | | 1 | 3 | | 1 | | 5 |
| 650 | | | | | | 1 | 1 | 2 |
| Total | 2 | 2 | 3 | 5 | 1 | 3 | 1 | 17 |

On this basis, that is, relation of maximum weight to weight at birth, at 1 year of age, at 2 years of age, and at 2 years of age when pregnant, the correlation coefficients were +0.2943, +0.5831, +0.4197, and +0.4282, respectively. The correlation at 1 year of age is highly significant and that at 2 years of age is significant.

After this part of the study was made, the question arose as to the significance of the maximum weight of the animal. Consequently the first three relationships were computed on the basis of the average weights of the animal during her mature test year. These relationships are shown in table 41. The resulting ratios are +0.3549, +0.8117, and +0.7656, respectively, and, as can be seen, are significantly higher. It would appear that the average weight of the animal during her mature test year is a far better base weight than the maximum weight that might have been reached at some time during the animal's lifetime.

[5] See footnote 2.

TABLE 41.—*Relation of the average weight of daughters of Moose, Karnak, and Tormentor, during their mature test year to the weight at birth, at 1 year of age, and at 2 years of age*

| Age and weight (pounds) | Number that reached average weight on mature test of— | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | 1,000 pounds | 1,150 pounds | 1,100 pounds | 1,050 pounds | 1,000 pounds | 950 pounds | 900 pounds | 850 pounds | |
| At birth: | | | | | | | | | |
| 60 | 1 | 1 | 1 | | 1 | | | 1 | 5 |
| 55 | | 1 | 1 | | 1 | 1 | | | 4 |
| 50 | | | | 1 | 2 | | 1 | | 4 |
| 45 | | | | | 2 | 1 | | | 3 |
| Total | 1 | 2 | 2 | 1 | 6 | 2 | 1 | 1 | 16 |
| At 1 year: | | | | | | | | | |
| 550 | 1 | | | | | | | | 1 |
| 500 | | 2 | 1 | | | | | | 3 |
| 450 | | | 1 | 1 | 2 | 1 | | | 5 |
| 400 | | | | | 3 | 1 | | 1 | 5 |
| 350 | | | | | 1 | | 1 | | 2 |
| Total | 1 | 2 | 2 | 1 | 6 | 2 | 1 | 1 | 16 |
| At 2 years: | | | | | | | | | |
| 800 | | 2 | | 1 | 1 | | | | 3 |
| 750 | 1 | | 2 | | 1 | | | | 4 |
| 700 | | | | 1 | 4 | 1 | | | 6 |
| 650 | | | | | | 1 | | 1 | 2 |
| 600 | | | | | | | 1 | | 1 |
| Total | 1 | 2 | 2 | 1 | 6 | 2 | 1 | 1 | 16 |

TABLE 42.—*Effect of stage of lactation and gestation on average mature weight of daughters of the first 3 Jersey sires*

| Range in age | Average weight of cows that were not pregnant and in milk | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 to 100 days | | 101 to 200 days | | 201 to 300 days | | Over 300 days | | | |
| | *Number* | *Pounds* | *Number* | *Pounds* | *Number* | *Pounds* | *Number* | *Pounds* | *Number* | *Pounds* |
| 5 years to 5 years 11 months | 71 | 989 | 42 | 1,014 | 17 | 1,036 | 7 | 1,029 | | |
| 6 years to 6 years 11 months | 73 | 1,015 | 44 | 1,042 | 12 | 1,104 | 5 | 1,080 | | |
| 7 years to 7 years 11 months | 35 | 1,029 | 24 | 1,045 | 5 | 1,101 | 4 | 1,148 | | |
| 8 years to 8 years 11 months | 18 | 1,068 | 8 | 1,073 | 9 | 1,048 | 5 | 1,087 | | |
| 9 years to 10 years | 18 | 1,023 | 4 | 1,019 | | | | | | |
| Total | 215 | 1,014 | 122 | 1,034 | 43 | 1,066 | 21 | 1,078 | | |
| | Average weight of cows that were pregnant | | | | | | | | | |
| | 1 to 75 days | | 76 to 150 days | | 151 to 225 days | | 226 days and over | | | |
| 5 years to 5 years 11 months | 46 | 958 | 43 | 953 | 44 | 1,014 | 31 | 1,064 | 301 | 999 |
| 6 years to 6 years 11 months | 36 | 1,041 | 42 | 1,040 | 41 | 1,052 | 32 | 1,128 | 285 | 1,049 |
| 7 years to 7 years 11 months | 22 | 1,015 | 37 | 1,069 | 37 | 1,108 | 26 | 1,148 | 199 | 1,077 |
| 8 years to 8 years 11 months | 21 | 1,025 | 26 | 1,055 | 20 | 1,065 | 14 | 1,130 | 121 | 1,064 |
| 9 to 10 years | 18 | 998 | 18 | 1,015 | 16 | 1,076 | 10 | 1,131 | 84 | 1,039 |
| Total | 143 | 1,007 | 186 | 1,024 | 158 | 1,059 | 113 | 1,121 | 981 | 1,040 |

**To show the effects of pregnancy on body weights of mature Jersey animals, the weight data for the period when the animals were from 5 to 10 years of age were assembled as shown in table 42. This age period covers the span of adult life after the maximum effects of the growth stimulus have been spent or retarded.**

A total of 981 weights were used and they average 1,040 pounds. The table shows two categories, cows that were in milk and not pregnant and cows that were pregnant. Most of the weights on pregnant cows were taken while they were still milking, except those in advanced pregnancy. The 401 weights of cows fresh and not pregnant average 1,029 pounds, the 580 weights of pregnant cows average 1,047 pounds. The weights of the nonpregnant milking cows show a steady increase as lactation progresses, which is not due to pregnancy as these cows were not in calf. Of the 580 weighings of pregnant cows, 309 were made of cows carrying calves 1 to 150 days. They average 1,016 pounds, while the 271 weights of cows pregnant more than 150 days average 1,085 pounds. The increase in weight with advancing pregnancy is also shown by the breakdown in the table.

Table 43 shows the weight data on a comparable basis for the daughters of the three Jersey sires and their dams. Because many of the foundation cows were not in the herd at the early ages, the number of comparisons at these ages is less than in older groupings. It will be noted in the table that the daughters, on the average, were heavier at corresponding ages than their dams. The bottom line in the table shows a summation of all weights taken at 6 years of age and over. The daughters averaged 1,071 pounds and the dams 1,008 pounds.

Maximum weights are available for 24 dam-and-daughter pairs, the average being 1,141 pounds for the dams and 1,183 pounds for the daughters, with 14 daughters heavier than their dams.

TABLE 43.—*Average weights of the daughters of the first 3 Jersey sires and of their dams at various ages*

| Age | Dam-and-daughter pairs | Daughters | Dams | Daughters heavier than dams |
|---|---|---|---|---|
| | *Number* | *Pounds* | *Pounds* | *Number* |
| Birth | 7 | 55 | 61 | 5 |
| 90 days | 7 | 122 | 122 | 4 |
| 180 days | 7 | 245 | 250 | 4 |
| 270 days | 7 | 350 | 348 | 3 |
| 1 year | 7 | 458 | 453 | 4 |
| 1 year 3 months | 8 | 521 | 508 | 6 |
| 1 year 6 months | 8 | 582 | 577 | 3 |
| 2 years | 15 | 741 | 717 | 8 |
| 2 years 6 months | 21 | 816 | 807 | 12 |
| 3 years | 22 | 880 | 858 | 13 |
| 3 years 6 months | 22 | 915 | 900 | 12 |
| 4 years | 21 | 923 | 898 | 10 |
| 4 years 6 months | 21 | 962 | 903 | 12 |
| 5 years | 22 | 987 | 942 | 13 |
| 5 years 6 months | 23 | 996 | 953 | 13 |
| 6 years | 21 | 1,047 | 1,002 | 11 |
| 6 years 6 months | 22 | 1,075 | 1,015 | 12 |
| 7 years | 19 | 1,066 | 1,023 | 12 |
| 7 years 6 months | 13 | 1,084 | 078 | 8 |
| 8 years | 9 | 1,057 | 1,034 | 6 |
| 8 years 6 months | 6 | 1,101 | 082 | 5 |
| 9 years | 5 | 1,093 | 1,024 | 4 |
| 9 years 6 months | 5 | 1,097 | 1,008 | 3 |
| 10 years | 5 | 1,103 | 995 | 5 |
| Average of all weights taken at 6 years and over | | 1,071 | 1,008 | |

Table 44 shows the relation between the birth weight of the daughters and the maximum weight of the dams. Although a significant relationship is shown for the first-generation Holsteins,[6] indicating that heavier cows tended to give birth to heavier calves, a similar relationship is not indicated for the Jerseys. This may be because of limited numbers, but the coefficient of correlation is only +0.1233.

The lower half of table 44 shows the distribution for the relationship between the maximum weight of dams and daughters. Here again no significant correlation resulted. The coefficient was +0.1503.

TABLE 44.—*Relation of birth weights and maximum weights of daughters of first 8 Jersey sires to the maximum weight of their dams*

| Weights of daughters (pounds) | Number of dams whose maximum weight was— | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | 1,250 pounds | 1,200 pounds | 1,150 pounds | 1,100 pounds | 1,050 pounds | 1,000 pounds | 950 pounds | 900 pounds | |
| At birth: | | | | | | | | | |
| 70 | | | | | | 1 | | | 1 |
| 68 | | | | | | | | | 0 |
| 66 | | | | | | | | | 0 |
| 64 | 1 | | 1 | | | | | | 2 |
| 62 | | 2 | 1 | | | 1 | | | 4 |
| 60 | 1 | 1 | | | | | | | 2 |
| 58 | 2 | | | | | 1 | | | 4 |
| 56 | | | | 1 | 1 | 1 | | | 3 |
| 54 | | 1 | | | | | | | 1 |
| 52 | | | | | | | | | 0 |
| 50 | | 1 | | | | 2 | | 1 | 4 |
| 48 | | | | 1 | | | | | 1 |
| 46 | | | | | | | | | 0 |
| 44 | | 1 | 1 | | | | | | 2 |
| Total | 4 | 6 | 3 | 2 | 2 | 6 | 0 | 1 | 24 |
| Maximum weight: | | | | | | | | | |
| 1,300 | 1 | | 2 | | | | | | 3 |
| 1,250 | | 1 | 1 | | | 1 | | | 3 |
| 1,200 | 1 | | | | 1 | 2 | | 1 | 5 |
| 1,150 | 2 | 3 | | | | | | | 5 |
| 1,100 | | | | 1 | | 1 | | | 2 |
| 1,050 | | 1 | | 1 | 1 | 1 | | | 4 |
| 1,000 | | 1 | | | | 1 | | | 2 |
| Total | 4 | 6 | 3 | 2 | 2 | 6 | 0 | 1 | 24 |

Table 45 shows the distribution for precalving weight of the dams and the birth weight of the daughters. Again no significant relationship was shown. The resulting coefficient was +0.1624.

## RELATION OF BODY WEIGHT TO BUTTERFAT PRODUCTION

While the daughters of the first three Jersey sires were on yearly official test, they were weighed the 1st and 15th of each month. The average of the 24 weights is used as the weight during the test year. The 28 daughters had 50 such official test periods and the relation between these weights and actual butterfat production is shown in table 46. The resulting coefficient of correlation is +0.4167. This is identically the same relationship found in the corresponding study of the first-generation Holsteins. This included the effect of age on both size and butterfat production, but some rather extreme variations do occur within each weight group.

[6] See footnote 2.

TABLE 45.—*Comparison of birth weight of daughters and precalving weights of dams*

| Birth weight of daughters (pounds) | Number of dams whose precalving weight was— | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | 1,150 pounds | 1,100 pounds | 1,050 pounds | 1,000 pounds | 950 pounds | 900 pounds | 850 pounds | |
| 70 | | | | | 1 | | | 1 |
| 68 | | | | | | | | 0 |
| 66 | | | | | | | | 0 |
| 64 | 1 | 1 | | | | | | 2 |
| 62 | | 2 | 1 | | 1 | | | 4 |
| 60 | 1 | 1 | | | | | | 2 |
| 58 | 2 | | 1 | 1 | | | | 4 |
| 56 | | | | 1 | 2 | | | 3 |
| 54 | | | 1 | | | | | 1 |
| 52 | | | | | | | | 0 |
| 50 | 1 | | | 1 | 1 | | 1 | 4 |
| 48 | | | | 1 | | | | 1 |
| 46 | | | | | | | | 0 |
| 44 | | 1 | 1 | | | | | 2 |
| Total | 5 | 5 | 4 | 4 | 5 | 0 | 1 | 24 |

In table 47 this same information is sorted into two different categories; on a weight basis, and on a butterfat basis. The relationship would have been considerably higher if the range in butterfat production of the cows in the two medium weight groups had not been so great. In the 900-pound-weight group the range in butterfat production was from 300 to 750 pounds, and in the 1,000-pound-weight group the range was 350 to 800 pounds.

TABLE 46.—*Relation of the body weight of daughters of first 8 Jersey sires to their actual butterfat production*

| Daughters' weight (pounds) | Number of records by daughters whose butterfat production was— | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 800 pounds | 750 pounds | 700 pounds | 650 pounds | 600 pounds | 550 pounds | 500 pounds | 450 pounds | 400 pounds | 350 pounds | 300 pounds | |
| 1,200 | | | | 1 | 1 | | | | | | | 2 |
| 1,100 | | | 1 | | | 2 | 4 | | | | | 7 |
| 1,000 | 1 | 1 | | | 2 | 3 | 3 | 2 | 1 | 1 | | 13 |
| 900 | | 1 | | 3 | | 1 | 2 | 1 | 2 | 1 | 1 | 12 |
| 800 | | | | | | 1 | 3 | 3 | 2 | 1 | 1 | 12 |
| 700 | | | | | | | 1 | 1 | 1 | | 1 | 4 |
| Total | 1 | 2 | 1 | 4 | 3 | 8 | 13 | 7 | 6 | 2 | 3 | 50 |

TABLE 47.—*Relationship between the body weight of the daughters of the first 8 Jersey sires and their butterfat production, and vice versa*

| | Ranked according to weight class | | | Ranked according to butterfat-yield class | | | |
|---|---|---|---|---|---|---|---|
| Weight class (pounds) | Records | Average weight | Average butterfat production | Butterfat class | Records | Average butterfat production | Average weight |
| | *Number* | *Pounds* | *Pounds* | *Pounds* | *Number* | *Pounds* | *Pounds* |
| 1,200 | 2 | 1,225 | 635 | 800 | 1 | 815 | 1,052 |
| 1,100 | 7 | 1,153 | 573 | 700 | 3 | 762 | 1,064 |
| 1,000 | 13 | 1,035 | 564 | 600 | 7 | 652 | 1,040 |
| 900 | 12 | 932 | 553 | 500 | 24 | 516 | 999 |
| 800 | 12 | 848 | 476 | 400 | 13 | 451 | 889 |
| 700 | 4 | 767 | 437 | 300 | 5 | 342 | 869 |
| Total or average | 50 | 998 | 534 | | 50 | | |

# PARENTAL EFFECTS ON SEX RATIOS OF PROGENY

In studies of breeding and reproductive performance, the question has often arisen as to the influence of the parents on the sex ratios of the progeny. The data available from the Jersey breeding experiment have been studied with a view to providing an answer to this question.

In the first phase of the study 31 dams, each having 4 or more progeny of known sex were divided into 2 groups—the first group being made up of the 17 dams whose progeny were more than 50 percent female and the second group being made up of the 14 dams whose progeny were less than 50 percent female. Table 48 shows the sex ratios in the offspring of the 31 dams in relation to the sex ratios in the offspring of the 51 daughters of these dams.

TABLE 48.—*Sex ratios in offspring of 31 dams and in the offspring of 51 daughters of the dams*

| Groups of dams | Dams in group | Dams' offspring | | | Daughters of the dams | Daughters' offspring | | |
|---|---|---|---|---|---|---|---|---|
| | | Males | Females | | | Males | Females | |
| | *Number* | *Number* | *Number* | *Percent* | *Number* | *Number* | *Number* | *Percent* |
| Dams with 50 percent or more female progeny | 17 | 45 | 69 | 60.5 | 32 | 95 | 92 | 49.2 |
| Dams with less than 50 percent female progeny | 14 | 51 | 30 | 35.7 | 19 | 43 | 42 | 49.4 |
| Total | 31 | 99 | 99 | 50.0 | 51 | 138 | 134 | 49.3 |

The progeny of the 17 dams was 60.5 percent female and that of the 14 dams was 35.7 percent female, but each group of daughters of these dams had progeny consisting of about 49 percent females. These data, while limited in scope, seem to indicate that the sex ratio of the progeny of a cow is not influenced by the sex ratio of the progeny of her dam.

In the next phase of the experiment, the sequence of sex in calves from the daughters of the first three Jersey sires was studied. Pregnancies that terminated where sex could not be determined were considered as interruptions to the sequence. Table 49 summarizes the 2-, 3-, and 4-calving sequences.

TABLE 49.—*Sex of calves born in sequence to daughters of the first 3 Jersey sires* [1]

| Sequence of 2 calvings | | Sequence of 3 calvings | | Sequence of 4 calvings | |
|---|---|---|---|---|---|
| Sex | Number | Sex | Number | Sex | Number |
| MM | 32 | MMM | 12 | MMMM | 3 |
| | | | | MMMF | 3 |
| | | MMF | 8 | MMFM | 3 |
| | | | | MMFF | 2 |
| FF | 30 | FFF | 14 | FFFF | 5 |
| | | | | FFFM | 6 |
| | | FFM | 9 | FFMF | 3 |
| | | | | FFMM | 2 |
| MF | 33 | MFM | 15 | MFMM | 5 |
| | | | | MFMF | 6 |
| | | MFF | 11 | MFFF | 4 |
| | | | | MFFM | 3 |
| FM | 37 | FMF | 15 | FMFF | 6 |
| | | | | FMFM | 6 |
| | | FMM | 13 | FMMM | 7 |
| | | | | FMMF | 1 |
| Total | 132 | | 97 | | 65 |

[1] M indicates male calf, F indicates female calf.

TABLE 50.—*Relation of the age of parents at the time of conception to the sex of the offspring of the daughters of the first 3 Jersey sires*

| Age of dam (years) | Number of offspring of each sex [1] when age of sire was— | | | | | | | | | | | | | | | | | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 year | | 2 years | | 3 years | | 4 years | | 5 years | | 6 years | | 7 years | | 8 years | | 9 years | | 10 years | | 11 years | | 12 years | | | |
| | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F |
| 1 | | 3 | 2 | | | 2 | | | | 2 | 1 | 1 | 3 | 1 | | 1 | 2 | 1 | 3 | 2 | 1 | | | | 12 | 13 |
| 2 | 1 | | 1 | 2 | | | | | | | | 3 | 1 | 2 | | 3 | | 3 | 1 | 1 | 4 | 1 | 1 | | 9 | 15 |
| 3 | 1 | 1 | 3 | 3 | 4 | 1 | | | | | | | 2 | 2 | 2 | | | 1 | | | 2 | | | | 14 | 8 |
| 4 | | | 1 | 3 | 2 | | | 1 | | | 1 | 2 | 3 | | 1 | 1 | | 3 | | 2 | | | | | 8 | 12 |
| 5 | 1 | | 1 | 1 | 2 | 1 | | 2 | 1 | | 1 | | 2 | 1 | 2 | 2 | 4 | 1 | | | | | | | 14 | 8 |
| 6 | 1 | | | 1 | | | | 1 | | 2 | | 1 | | 3 | 3 | 1 | | | | | | | | | 4 | 9 |
| 7 | | | | | | 1 | | | | | | | 2 | | 1 | 1 | | 1 | 3 | | | | | | 6 | 3 |
| 8 | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | | | | 2 | 3 | | | 5 | 5 |
| 9 | | | | | | | | | | | | | | | | 1 | 2 | 1 | | 1 | | | 1 | | 3 | 3 |
| 10 | | | | | | | | | | | | | | | | 1 | | | 2 | | | | | | 2 | 1 |
| 11 | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | |
| Total | 4 | 4 | 8 | 10 | 8 | 5 | | 4 | 1 | 4 | 3 | 7 | 14 | 10 | 10 | 12 | 9 | 11 | 9 | 6 | 9 | 4 | 3 | | 78 | 77 |

[1] M indicates male; F, female.

In 62 of the 132 sequences of 2 calvings, both calves were of the same sex and in 70 sequences the calves were of different sex. Male followed male 32 times, female followed male 33 times, female followed female 30 times, and male followed female 37 times.

In the 3-calving sequences, 12 were all males and 14 all females. The sexes alternated in 30 sequences. In 17 sequences, 2 calves of the same sex were followed by a calf of the other sex; and in 24 sequences a calf of one sex was followed by 2 calves of the other sex.

In the 4-calving sequences, 3 were all males and 5 were all females. In 12 sequences the sexes alternated, and in 8 additional sequences there were 2 males and 2 females. The remaining 37 sequences had 1 calf of one sex and 3 calves of the other sex. Sequence of sex of calves according to these data is entirely random.

Table 50 shows the effect of the age of the parents at time of conception on sex of the progeny. In this table all conceptions, including those resulting in dead calves and abortions where sex was determined, are counted.

For all conceptions resulting in male progeny, the sire's age at time of conception averaged 6 years 5 months. For all conceptions resulting in female progeny, the sire's age was 6 years 10 months. The male progeny were from dams averaging 5 years 10 months of age, and the female progeny were from dams averaging 5 years 1 month of age. This is exactly opposite to the results found in the study of the first-generation Holsteins [7] and would seem to indicate that, as might be expected to be shown with sufficient numbers, age of parents is no factor in determining the sex ratios of the progeny.

When the data are condensed as in table 51, they show an interesting relationship. Only one group (sires over 6 years of age mated to females under 6 years) shows more female than male progeny.

TABLE 51.—*Relation of the age of parents at time of conception to the sex of the offspring*

| Sire-age groups | Number of offspring of each sex [1] when age of dam was— | | | | | |
|---|---|---|---|---|---|---|
| | Under 6 years | | 6 years and over | | Total | |
| | M | F | M | F | M | F |
| Sires under 6 years of age | 25 | 22 | 12 | 9 | 37 | 31 |
| Sires 6 years of age and over | 32 | 40 | 34 | 23 | 66 | 63 |
| Total | 57 | 62 | 46 | 32 | 103 | 94 |

[1] M indicates male; F, female.

## SOME EFFECTS OF INBREEDING

The Moose O'Fernwood was bred to 15 of his own daughters in order to produce an inbred generation. Twelve of the 15 daughters conceived to his service for a total of 23 pregnancies and averaged 3.09 services per conception. The 23 pregnancies resulted in 4 living female calves, 8 living male calves, and 11 abortions. The abortions included 6 females, 2 males, and 3 fetuses of undetermined sex. Only two inbred daughters lived to complete production records.

[7] See footnote 2.

**Their names and registration numbers are listed in table 9 and their production records in table 52.**

TABLE 52.—*Production records of 2 inbred daughters of The Moose O'Fernwood* [1]

| Herd No. | Actual production | | | | | Mature-equivalent value | |
|---|---|---|---|---|---|---|---|
| | Milk | Butterfat | | Age | | Milk | Butterfat |
| | *Pounds* | *Percent* | *Pounds* | *Yr.* | *Mo.* | *Pounds* | *Pounds* |
| 658 | 8,720 | 4.89 | 426 | 2 | 2 | 11,859 | 579 |
| | 13,123 | 4.93 | 648 | 6 | 2 | 13,123 | 648 |
| 684 | 7,353 | 5.19 | 381 | 2 | 0 | 10,204 | 533 |

[1] Both inbred daughters produced less milk and butterfat than their outbred dams.

The 2 inbred daughters that survived conceived 11 times to 27 services (5 times on the first service, 2 times on the second, 2 times on the third, once on the fifth, and once on the seventh).

One of the 2 inbred daughters died while carrying a male fetus, and the other 10 pregnancies resulted in 4 female and 6 male calves.

Karnak's Noble 4th was bred to 2 of his daughters a total of 10 times but no conceptions occurred.

Hood's Sophie's Tormentor died before any of his daughters reached breeding age.

## SONS OF THE FIRST THREE JERSEY SIRES

During their period of service in the Beltsville herd, the first 3 Jersey bulls sired 29 outbred sons, as listed in table 53.

Table 54 shows the average production of the daughters of each of the 11 sons of Moose and the 3 sons of Karnak that were proved, also the records of the dams of the daughters.

Nine of the 29 bulls died or were disposed of before they reached breeding age. One bull was placed in service in a State college herd and is not included in table 54. The other 7 bulls went to herds where records were not kept over long enough period to determine their transmitting ability.

In some cases proof of the sire was brought in from two herds. Most of these bulls were proved in herds handled under ordinary dairy-farm conditions and with a few exceptions the cows were milked twice daily. Record information was gathered by a personal visit and the production records were recalculated and summarized from the cooperators' cow-testing association books and from the private herd records of one large institution. Conditions under which both the daughters and their dams were tested were as comparable as those usually found in herds of this kind. The records analyzed cover a long enough period to offset seasonal variations. Most of the daughters and dams were in the herds long enough to provide production records for two or more lactation periods; however, the highest mature-equivalent record was used in the comparison.

On the average the 151 daughters of these 14 sires produced 436 pounds more milk than their dams, 94 of the 151 daughters being better producers than their dams. The percentage of butterfat was increased 0.13 percent, and 89 of the 151 daughters were better than the dams. In total butterfat production, the daughters averaged 33 pounds higher than the dams, and 102 of the 151 daughters were better than their dams.

TABLE 53.—*Sons of Moose, Karnak, and Tormentor from foundation cows*

SONS OF MOOSE

| Herd No. | Date of birth | Name and registration No. | Herd number of dam | Foundation group | Age of sire at conception | Age of dam at conception |
|---|---|---|---|---|---|---|
| | | | | | *Yr. Mo.* | *Yr. Mo.* |
| 517 | Nov. 1, 1921 | Jacoba's Premier Moose 207681 | 408 | 1 | 5 9 | 5 8 |
| 518 | Dec. 1, 1921 | Sophie's Premier Moose 207682 | 438 | 1 | 5 10 | 1 11 |
| 527 | Jan. 26, 1922 | Jacoba's Moose 210081 | 411 | 1 | 5 11 | 3 0 |
| 532 | Apr. 1, 1922 | Jacoba's Wonder's Moose 217375 | 410 | 1 | 6 2 | 4 5 |
| 536 | July 29, 1922 | Rebecca's Moose 220946 | 424 | 2 | 6 6 | 3 6 |
| 537 | Aug. 11, 1922 | St. Mawes Owl Interest 220947 | 464 | 3 | 6 6 | 2 8 |
| 543 | May 1, 1923 | Jacoba's Smoky Moose 230872 | 409 | 1 | 7 3 | 6 10 |
| 544 | May 28, 1923 | Jacoba's Tormentor Moose 231767 | 410 | 1 | 7 5 | 5 8 |
| 563 | May 22, 1924 | Sophie's Jacoba Smoky's Moose 242237. | 409 | 1 | 8 3 | 7 10 |
| 568 | Dec. 4, 1924 | The Moose of St. Lambert 252893 | 467 | 3 | 8 10 | 7 7 |
| 571 | Feb. 21, 1925 | The Moose of Olga Lad 252894 | 464 | 3 | 9 0 | 5 2 |
| 576 | May 24, 1925 | The Moose of King George 255039 | 421 | 2 | 9 4 | 6 4 |
| 579 | June 28, 1925 | The Moose of St. Mawes 255041 | 462 | 3 | 9 5 | 7 6 |
| 580 | June 29 1925 | The Moose of Jacoba 255042 | 411 | 1 | 9 5 | 6 5 |
| 700 | July 6, 1926 | Irene's Premier Moose 271704 | 411 | 1 | 10 5 | 7 5 |
| 701 | Aug. 13, 1926 | The Moose of Olga St. Mawes 273191. | 462 | 3 | 10 6 | 8 8 |

SONS OF KARNAK

| | | | | | | |
|---|---|---|---|---|---|---|
| 524 | Jan. 7, 1922 | Karnak Noble Interest 210080 | 443 | 2 | 7 9 | 2 2 |
| 528 | Feb. 1, 1922 | Karnak Noble Owl 210082 | 442 | 2 | 7 10 | 2 8 |
| 531 | Mar. 1, 1922 | (1) | 411 | 2 | 7 11 | 3 0 |
| 538 | Oct. 5, 1922 | Karnak's Hillside Torono 222218 | 403 | 1 | 8 6 | 5 5 |
| 547 | Oct. 22, 1923 | (2) | 412 | 1 | 9 6 | 4 0 |
| 548 | Oct. 24, 1923 | Karnak's Interested Noble 236074 | 457 | 1 | 9 6 | 1 8 |
| 549 | Oct. 27, 1923 | Karnak's Noble Eminent Fox 239833. | 424 | 2 | 9 7 | 4 9 |
| 551 | Nov. 2, 1923 | (2) | 448 | 2 | 9 7 | 3 5 |

SONS OF TORMENTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| 523 | Dec. 26, 1921 | Sally's Tormentor Noble 210079 | 432 | 2 | 5 6 | 2 8 |
| 525 | Jan. 8, 1922 | Lady May's Tormentor Noble 210671. | 427 | 2 | 5 6 | 2 11 |
| 529 | Feb. 4, 1922 | (1) | 435 | 2 | 5 7 | 2 6 |
| 539 | Jan. 4, 1923 | Tormentor Ouwlogge Majesty 227443. | 409 | 3 | 6 6 | 3 8 |
| 542 | Feb. 28, 1923 | (1) | 132 | 2 | 6 8 | 3 10 |

[1] Died at an early age.
[2] Sold Mar. 18, 1924.

TABLE 54.—*Average of the highest mature-equivalent production records of the daughters of each of 14 sons of Moose and Karnak, and of the dams of those daughters, made in herds of cooperating individuals and institutions* [1]

| Son's herd No. | Daughter-dam pairs | Daughters | | | Dams | | | Increase (+) or decrease (−) by daughters over dams | | | Daughters equal or better than dams in— | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Milk | Butterfat | | Milk | Butterfat | | Milk | Butterfat | | Milk | Test | Butterfat |
| 11 sons of Moose: | *Number* | *Pounds* | *Percent* | *Pounds* | *Pounds* | *Percent* | *Pounds* | *Pounds* | *Percent* | *Pounds* | *Number* | *Number* | *Number* |
| 517 | 11 | 9,917 | 5.32 | 512 | 9,564 | 5.13 | 469 | +353 | +0.19 | +43 | 6 | 7 | 7 |
| 527 | 6 | 6,252 | 5.26 | 326 | 5,665 | 5.15 | 292 | +587 | +.11 | +34 | 4 | 4 | 4 |
| 537 | 6 | 7,702 | 5.41 | 415 | 6,499 | 5.32 | 337 | +1,203 | +.09 | +78 | 6 | 3 | 6 |
| 544 | 7 | 8,744 | 5.07 | 429 | 11,056 | 3.95 | 432 | −2,312 | +1.12 | −7 | 2 | 7 | 4 |
| 563 | 7 | 6,362 | 5.19 | 318 | 5,922 | 4.78 | 281 | +440 | +.41 | +37 | 4 | 5 | 6 |
| 571 | 6 | 12,849 | 5.39 | 690 | 13,632 | 5.39 | 733 | −783 | .00 | −43 | 2 | 3 | 3 |
| 576 | 11 | 10,357 | 4.67 | 471 | 10,233 | 4.37 | 440 | +124 | +.30 | +31 | 7 | 7 | 8 |
| 579 | 5 | 5,400 | 5.27 | 294 | 5,496 | 4.80 | 245 | −96 | +.47 | +49 | 2 | 4 | 4 |
| 700 | 13 | 8,288 | 5.03 | 404 | 7,957 | 5.02 | 390 | +331 | +.01 | +14 | 7 | 8 | 5 |
| 701 | 24 | 7,172 | 5.27 | 376 | 6,913 | 5.31 | 367 | +259 | −.04 | +9 | 13 | 10 | 17 |
| 720 [2] | 22 | 8,381 | 4.92 | 401 | 7,529 | 4.79 | 352 | +852 | +.13 | +49 | 16 | 14 | 16 |
| Total or average | 118 | 8,312 | 5.12 | 417 | 8,084 | 4.94 | 390 | +228 | +.18 | +27 | 69 | 72 | 80 |
| 3 sons of Karnak: | | | | | | | | | | | | | |
| 538 | 8 | 8,769 | 4.59 | 388 | 6,441 | 4.72 | 292 | +2,328 | −.13 | +96 | 7 | 4 | 8 |
| 548 | 14 | 8,760 | 5.16 | 444 | 7,885 | 5.24 | 407 | +875 | −.08 | +37 | 10 | 7 | 8 |
| 549 | 11 | 7,938 | 4.96 | 399 | 7,218 | 4.96 | 356 | +720 | .00 | +43 | 8 | 6 | 6 |
| Total or average | 33 | 8,488 | 4.96 | 415 | 7,313 | 5.02 | 362 | +1,175 | −.06 | +53 | 25 | 17 | 22 |
| All 14 sons: Total or average | 151 | 8,351 | 5.09 | 417 | 7,915 | 4.96 | 384 | +436 | +.13 | +33 | 94 | 89 | 102 |

[1] The dam-and-daughter comparisons in this table are based on the highest mature-equivalent production record made by each dam and daughter under the testing conditions in the herd of the cooperator. All records were made on 2 milkings a day, with the exception of those by the daughters (and dams) of bull No. 571, which were made at Beltsville under standardized conditions of 3 milkings a day for 365 days. In most of the cooperating herds it was the practice to milk for 305-day lactation periods, but the herd where bull No. 517 was in service was on Herd Test and a few records of the dams and daughters were for 365 days.

[2] Bull No. 720 is an inbred son of Moose, being out of a daughter of Moose.

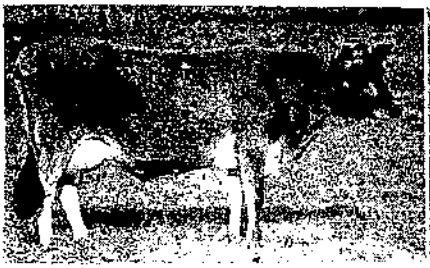
## BREED TYPE OF THE DAUGHTERS OF THE THREE SIRES

The camera was used for recording the appearance and type of the experimental animals. As soon as convenient after the projects were started a routine procedure was established for photographing the animals periodically throughout their lifetime. The details of the procedure have been given by Fohrman elsewhere.[8] This systematic picture taking affords a means for comparing animals of the same or different generations at various age intervals. Unfortunately some of the foundation cows had passed their prime before the photographic recording was begun, and pictures are not available for the daughters at the same ages or stages of lactation. For this reason not all dam-and-daughter pictures shown here are strictly comparable.

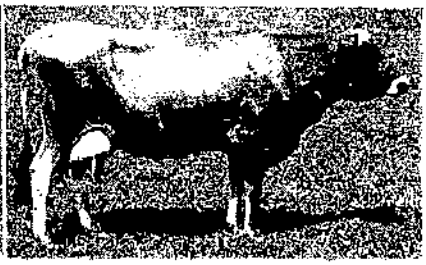
Pictures of the 28 daughters of the first 3 Jersey sires and their dams are shown in figures 6 to 12, inclusive. The pictures of the dam are on the left and where a dam has more than one daughter only one picture of the dam is shown. The illustrations carry the herd number and the highest production record of each individual.

[8] FOHRMAN, M. H. USE OF THE CAMERA IN STUDYING THE GROWTH AND DEVELOPMENT OF DAIRY ANIMALS. U. S. Dept. Agr. Dept. Cir. 371, 22 pp., illus. 1926. Available in most agricultural libraries, also for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents a copy.

**DAMS** **DAUGHTERS OF MOOSE**

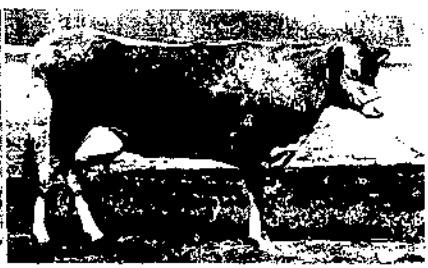


No. 408—Milk, 14,450 lbs; Fat 5.63%, 814 lbs.



No. 642—Milk, 15,054 lbs; Fat 5.53%, 833 lbs.

No. 409—Milk, 11,656 lbs; Fat 5.69%, 663 lbs.



No. 472—Milk, 12,644 lbs; Fat 5.21%, 659 lbs.

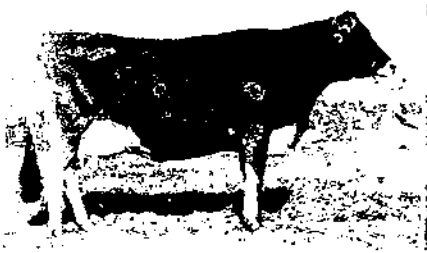
No. 411—Milk, 12,959 lbs; Fat 5.10%, 662 lbs.

No. 615—Milk, 14,796 lbs; Fat 5.10%, 755 lbs.

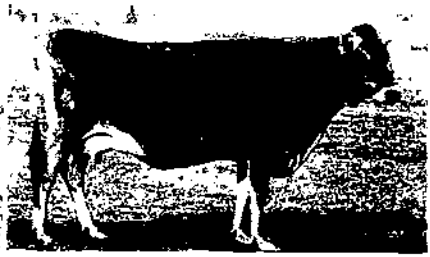
No. 674—Milk, 11,544 lbs; Fat 5.21%, 601 lbs.

FIGURE 6.—Comparative breed type of four daughters of The Moose O'Fernwood and their dams.

**DAMS** **DAUGHTERS OF MOOSE**



No. 424—Milk, 12,031 lbs; Fat 5.31%, 639 lbs.



No. 661—Milk, 16,178 lbs; Fat 4.79%, 774 lbs.

No. 495—Milk, 12,729 lbs; Fat 5.37%, 683 lbs.

No. 438—Milk, 11,485 lbs; Fat 5.61%, 645 lbs.

No. 617—Milk, 13,880 lbs; Fat 4.77%, 662 lbs.

No. 448—Milk, 16,272 lbs; Fat 5.26%, 855 lbs.

No. 613—Milk, 11,807 lbs; Fat 5.11%, 604 lbs.

FIGURE 7. Comparative breed type of four daughters of The Mouse O'Fernwood and their dams.

**DAMS** **DAUGHTERS OF MOOSE**

No. 483—Milk, 7,831 lbs; Fat 4.77 %, 373 lbs. No. 644—Milk, 11,813 lbs; Fat 5.59 %, 661 lbs.

No. 449—Milk, 6,954 lbs, Fat 6.51 %, 453 lbs. No. 496—Milk, 9,751 lbs; Fat 5.96 %, 572 lbs.

No. 454—Milk, 11,089 lbs; Fat 6.01 %, 665 lbs. No. 636—Milk, 11,185 lbs; Fat 6.19 %, 692 lbs.

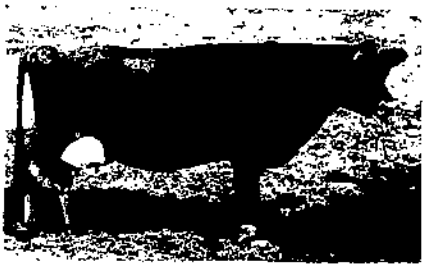
No. 476—Milk, 11,531 lbs; Fat 5.90 %, 681 lbs. No. 665—Milk, 8,959 lbs; Fat 6.03 %, 540 lbs.

FIGURE 8.—Comparative breed type of four daughters of The Moose O'Fernwood and their dams.

**DAMS**

**DAUGHTERS OF MOOSE**

No. 478—Milk, 10,371 lbs; Fat 5.48%, 579 lbs.



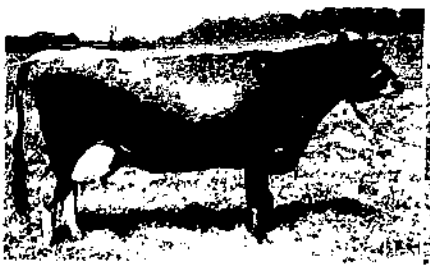
No. 616—Milk, 10,162 lbs; Fat 5.32%, 541 lbs

No. 647—Milk, 11,050 lbs; Fat 5.08%, 561 lbs.

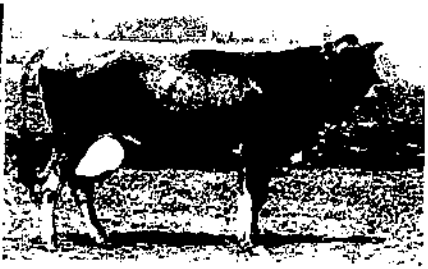
**DAUGHTERS OF KARNAK**

No. 412—Milk, 8,717 lbs; Fat 6.04%, 527 lbs

No. 474—Milk, 10,128 lbs; Fat 5.66%, 574 lbs.



No. 465—Milk, 8,412 lbs; Fat 4.75%, 400 lbs.

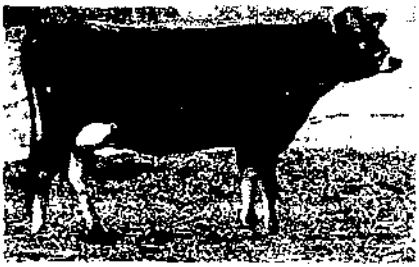


No. 492—Milk, 14,224 lbs; Fat 4.83%, 687 lbs.

FIGURE 9.—Comparative breed type of two daughters of Tlie Moose O'Fernwood and two daughters of Karnak's Noble 4th and their dams.

**DAMS** **DAUGHTERS OF KARNAK**

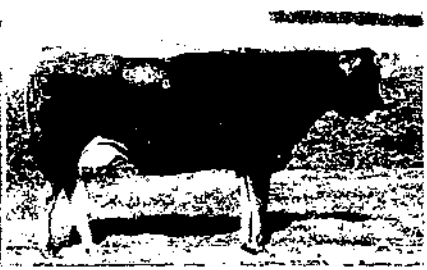
No. 466—Milk, 11,078 lbs; Fat 5.38 %, 597 lbs.



No. 468—Milk, 12,337 lbs; Fat 6.19 %, 763 lbs.

No. 503—Milk, 12,071 lbs; Fat 5.40 %, 684 lbs.

No. 443—Milk, 9,621 lbs; Fat 4.84 %, 465 lbs.



No. 498—Milk, 8,173 lbs; Fat 4.80 %, 392 lbs.

No. 445—Milk, 10,999 lbs; Fat 6.06 %, 667 lbs.

No. 476—Milk, 11,531 lbs; Fat 5.80 %, 641 lbs.

FIGURE 10.—Comparative breed type of four daughters of Karnak x Noble 4th and their dams.

**DAMS**

**DAUGHTERS OF KARNAK**

No. 491—Milk, 11,549 lbs; Fat 6.51%, 752 lbs

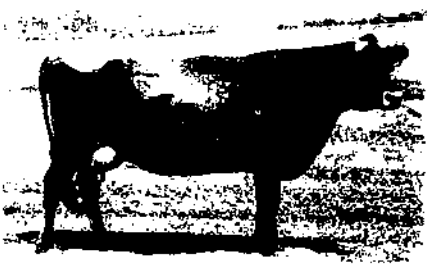
No. 444—M[illegible], 12,614 lbs; Fat 5.87%, 715 lbs.

No. 611—M[illegible], 12,321 lbs; Fat 5.23%, 644 lbs.

No. 454—M[illegible], 11,[illegible]9 lbs; Fat 6.[illegible]1%, [illegible]5 lbs

No. 806—M[illegible], 13,411 lbs; Fat 5.29%, 815 lbs.

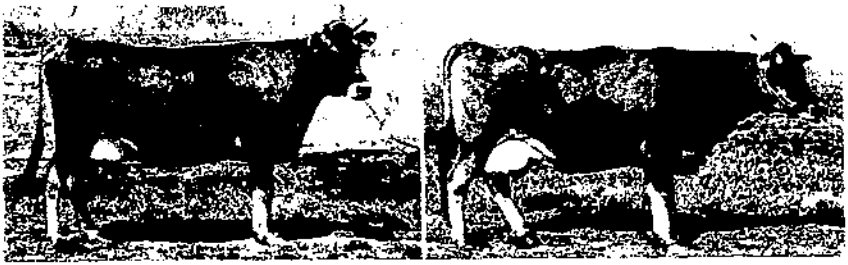
No. 467—M[illegible], [illegible] lbs; Fat 5.[illegible]%, 572 lbs



No. 601—M[illegible], 13,271 lbs; Fat 6.17%, 818 lbs.

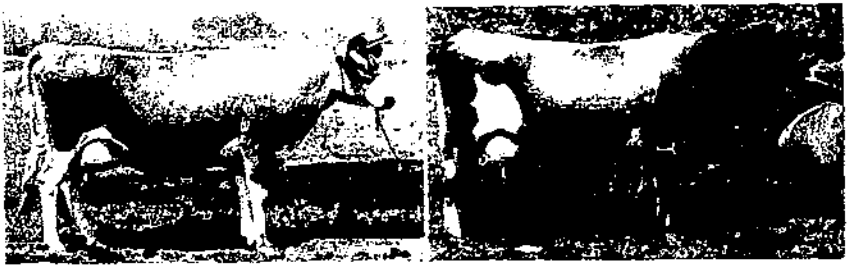
FIGURE 11. Comparative breed type of four daughters of Karnak's Noble 4th and their dams.

**DAMS** **DAUGHTERS OF TORMENTOR**



No. 426—Milk, 10,125 lbs; Fat 6.30%, 638 lbs. No. 480—Milk, 8,095 lbs; Fat 6.07%, 491 lbs.

No. 435—Milk, 11,676 lbs; Fat 5.44%, 636 lbs. No. 602—Milk, 14,824 lbs; Fat 5.42%, 788 lbs.



No. 436—Milk, 12,597 lbs; Fat 5.14%, 647 lbs. No. 477—Milk, 12,388 lbs; Fat 5.43%, 673 lbs.

No. 455—Milk, 10,144 lbs; Fat 5.0%, 514 lbs. No. 450—Milk, 8,121 lbs; Fat 5.61%, 455 lbs.

FIGURE 12.—Comparative breed type of four daughters of Hood's Sophie's Tormentor and their dams.

Of the 28 dam-and-daughter pairs, 7 were considered equal by a panel of graders on the basis of type when estimated from pictures.[9] Eleven daughters were poorer by 13 type grades than their dams. Ten daughters were better by 19 type grades. On this basis there was a slight increase in the average type grade of the daughters as compared with that of their dams.

When the 28 daughters are divided into sire groups, 14 daughters of Moose are about even with their dams in type, 4 were considered even, 4 were better by 6 type grades, and 6 were poorer by 7 grades.

The 10 daughters of Karnak showed a definite improvement in type as compared to their dams. One daughter was rated equal to her dam, 3 were poorer by a total of 4 grades, and 6 were better by a total of 13 grades.

The 4 daughters of Tormentor were from 4 high rating dams. Two of the daughters were rated equal to their dams in type and 2 were poorer by 3 grades.

## FURTHER DEVELOPMENT OF THE JERSEY BREEDING PROJECT

The preceding discussion has dealt with completed work in the Jersey breeding project. The foundation females and all daughters of the first three Jersey sires have gone from the herd and a final analysis has been made of their records. The project has progressed materially beyond this point and in order to afford the reader some idea of the progress of the work, table 55 has been prepared to show the sires that have been used to produce the first-, second-, and third-generation groups, and the average production of the daughters in each group. Results of detailed studies of succeeding generations are now being prepared for publication.

TABLE 55.—*Sires used to produce the first-, second-, and third-generation groups and the average production of the daughters in each group*

| Sires | Daughters | | | | | |
|---|---|---|---|---|---|---|
| | Born | With records | Now in herd | Average production | | |
| | | | | Milk | Butterfat | |
| | *Number* | *Number* | *Number* | *Pounds* | *Percent* | *Pounds* |
| First 3 sires: | | | | | | |
| Karnak's Noble 4th 115389 | | | | | | |
| The Moose O'Fernwood 137021 | 28 | 28 | 0 | 12,021 | 5.18 | 656 |
| Hood's Sophie's Tormentor 115703 | | | | | | |
| Second 3 sires: | | | | | | |
| Oxford May's Int Owl 205417 | | | | | | |
| Sophie's Torono 23rd 167335 | 37 | 37 | 0 | 12,652 | 5.54 | 694 |
| Tiddledywink's Raleigh 158391 | | | | | | |
| Third 3 sires: | | | | | | |
| Marston's Interested Owl 231782 | | | | | | |
| Sophie's Phoenix 222590 | 31 | 31 | 0 | 13,996 | 5.50 | 763 |
| Raleigh's Dorothy's Senator 203990 | | | | | | |

[9] The type grades used by the panel were the six official grades recognized by the American Jersey Cattle Club, viz., Excellent, Very Good, Good Plus, Good, Fair, and Poor.

## SUMMARY AND CONCLUSIONS

A description and general discussion of the Jersey breeding project is presented. Detailed information is included on the foundation herd of Jersey females, with some analysis of genetic differences found in various groups, and complete records of production and reproduction of the individual animals.

The 44 foundation cows were bred to 3 Jersey sires, which were used concurrently and which represented 3 popular families at that time. These families were Raleigh, Sophie Tormentor, and Owl Interest. Of the 44 foundation cows, only 25 had living female progeny by the first 3 Jersey sires. Forty foundation cows made records that averaged 11,443 pounds of milk and 625 pounds of butterfat when calculated to a mature basis. The other four had no production records nor progeny. The 21 foundation cows with female progeny made records that averaged 11,060 pounds of milk and 606 pounds of butterfat, calculated to a mature basis.

The basis for the selection of the first three Jersey bulls, Hood's Sophie's Tormentor, Karnak's Noble 4th, and The Moose O'Fernwood, is reviewed.

The 50 records made by the 28 daughters of the first 3 Jersey sires have been analyzed. Made under the controlled environmental conditions, the first-calf records of 17 daughters (calculated to maturity) and their mature records are closely correlated. The average butterfat percentage is also closely related on first and mature tests of the same cows.

The 27 first-generation outbred daughters of the first 3 sires had records that averaged 12,137 pounds of milk, 660 pounds of butterfat, with a butterfat test of 5.46 percent. This is an increase of 951 pounds of milk and 47 pounds of butterfat over the average production of their dams. Study of the milk and butterfat producing ability of the daughters of each of the three sires indicates considerable heterozygosity in both the sires and the dams. A major part of the average increase in butterfat production is due to the daughters of Karnak's Noble 4th. The data indicate a definite lowering of the variability in the production of the progeny. One second-generation outbred daughter of Moose is included in his proof.

Tables of live weights are included to show the rate of growth, variations in growth, and effects of pregnancy and parturition on body weight. The average birth weight of the 33 daughters of the first 3 Jersey sires was 56 pounds, and their average mature weight was 1,047 pounds. Some correlation was found between body weight and butterfat production.

The breeding and reproductive performance of the daughters of the first three Jersey sires is given. The daughters averaged 2.88 services per conception.

Fourteen sons of Moose and Karnak were proved in herds of cooperating institutions and dairy farmers. The 151 daughters of these sons averaged 436 pounds more milk, 33 pounds more fat, and 0.13 percent higher test than their dams.

Comparative pictures are used to show the type and conformation of the foundation cows and the daughters studied in this publication.

A statement of the present status of the breeding project, with a table of production averages on the incompleted groups, is included.

# END