THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report

of

Committee on Thesis

The undersigned, acting as a Committee of the Graduate School, have read the accompanying thesis submitted by Gordon Lewis Flack for the degree of Master of Science. They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science.

W. H. Peters
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Date May 18-1922

10-20 5M

THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report

of

Committee on Examination

This is to certify that we the undersigned, as a committee of the Graduate School, have given Gordon Lewis Flack final oral examination for the degree of

Master of Science.

We recommend that the degree of

Master of Science

be conferred upon the candidate.

W. H. Peters
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Date May 8-1922

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CORRELATION BETWEEN SHOWYARD WINNINGS AND INBREEDING AND OUTBREEDING

A THESIS

PRESENTED TO THE FACULTY

IN THE

GRADUATE SCHOOL

OF THE

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IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF MASTER OF SCIENCE

BY

GORDON L. FLACK

1922

CONTENTS

INTRODUCTION

The production of livestock has always been one of the leading industries in the United States, contributing on the average thirty-five percent to the total income derived from the agricultural resources.

The magnitude of the livestock industry has brought about the keenest of competition in the sale of the livestock and the livestock products on the market, with the result that the organization for the slaughtering of livestock and the distribution of the product is very firmly established and effectively operated. In addition to an efficient organization through which to market, the producer's profit depends primarily upon the economy of production and the quality of the animal produced.

Economy of production and quality of product are dependent largely upon the efficiency of the animal in the utilization of feeds in converting them into a highly specialized type that is particularly suitable to the fulfillment of some specific market demand. This efficiency in the animal is secured first by breeding those of the desired type and characteristics, and secondly by the use of suitable feeds and economic methods of feeding and management. Proper feeding methods have been quite definitely established by scientific investigation and experimental demonstration but the principles of breeding have not been subjected so thoroughly to scientific research or experiment. Through attention to the forces of heredity present in every animal used for breeding purposes, it should be possible to make the livestock industry more profitable because the value and usefulness of animals depends primarily upon the heritage they receive from their ancestors.

The known facts about heredity as applied to livestock breeding have not been clearly comprehended, therefore great uncertainty of method in practice has prevailed. The practice followed by some prominent breeders of mating together animals closely related or inbreeding, has been condemned by other successful breeders who have followed outbreeding or the mating together of unrelated animals. In order to justify the acceptance of one or other of these methods, the purpose of this thesis is to study that phase of animal breeding having to do with the principles of inbreeding and of outbreeding.

The practice of inbreeding has had a very important part in the formation of most of our modern breeds of livestock. Inasmuch as inbreeding has been used in the formative period of the breeds so formed to secure excellence and uniformity, can it be used with the breeds to maintain excellence and uniformity without sacrificing vigor and prolificacy.

Using the International Live Stock Show, Chicago, as a measure of excellence and uniformity, the investigation made for the purpose of this study has been directed to establishing a relationship between showyard winnings and inbreeding and outbreeding.

Because of the large amount of time required to trace pedigrees, detailed pedigree study has been limited to the Shorthorn and the Hereford breeds of cattle. These breeds were selected because they are the two most important breeds of beef cattle and a large amount of constructive breeding has been done with them by American breeders.

Literature and experimental evidence relative to the subject of inbreeding is also reviewed.

ANALYSIS OF THE PROBLEM OF MEASURING INBREEDING

(a) Practice of Inbreeding

The effect of inbreeding on the progeny is a much discussed problem of theoretical biology and of practical breeding. It has been alternately maintained on the one hand that inbreeding is the most pernicious and destructive procedure which could be followed by the breeder, and on the other hand that without its powerful aid most of what the breeder has accomplished in the past could not have been gained, and that it offers the chief hope for further advancement in the future.

In the breeding of all of the domestic animals, inbreeding has been practiced in many instances to a very marked degree. The material recorded in the books of registration far exceeds in amount and in diversity any which could possibly be obtained experimentally on the same forms of life. Aside from a relatively small amount of definite experimental data, one's judgment in the matter is finally formed on the basis of his interpretation of the vast accumulation of material comprised in the recorded experience of the breeders of registered livestock.

(b) Coefficient of Inbreeding.

In developing a general measure of the intensity of inbreeding we may start from the conception that the inbred individual possesses fewer different ancestors than the maximum possible number.(1)

Besides this factor account must be taken of the generation or generations in which the reduced number of different ancestors is found and the extent to which these generations are removed from the individual

or generation under consideration. In other words the two factors which must be included in a general measure of the intensity of inbreeding are (a) the amount of ancestral reduction in successively earlier generations, and (b) the rate of this reduction over a specified number of generations.(1)

Both of these demands are met by taking as a measure of the intensity of inbreeding in any generation, the proportionate degree to which the actually existent number of different ancestral individuals fails to reach the maximum possible number and by specifying the location in the series of the generation under discussion.(1)

The degree of inbreeding involved will, therefore, be measured by the expression:

$$Zn = 100\left(\frac{Pn + 1 - qn + 1}{Pn + 1}\right)$$

Where Pn + 1 denotes the maximum possible number of different individuals involved in the mating of the n + 1 generation, qn + 1 the actual number of different individuals involved in these matings. Zn being called the coefficient of inbreeding.(2)

If the value for Z for successive generations in the ancestral series be plotted to the generation numbers as a base, the points so obtained will form a curve which may be designated as the curve of inbreeding.(2)

The coefficient of inbreeding Z is the percentage of the difference between the maximum possible number of ancestors in a given generation and the actual number realized in the former. The coefficient may have any value between 0 and 100. When there is no breeding of relatives whatever, its value for each generation is 0. As the intensity of the inbreeding

increases the value of the coefficient rises.(2)

Illustration of continued brother and sister breeding.(3)

The breeding of Brother and Sister Out of Brother and Sister continued for a series of generations.

Coefficients of inbreeding, Z_o, Z_1, Z_2 and Z_3. (4)

For Z_o - P = 2

q = 2

Thus $\frac{100\ (o)}{2} = 0\ \%$

In the same way - $Z_1 = \frac{100(4 - 2)}{4} = 50\ \%$

$$Z_2 = \frac{100(8 - 2)}{8} = 75\ \%$$

$$Z_3 = \frac{100(16 - 2)}{16} = 87.5\ \%$$

Expressed verbally these results are: In the last two ancestral generations X is 50 percent inbred; in the last three generations it is 75 percent inbred; and in the last four generations it is 87.5 percent inbred.

Values of the successive coefficients of inbreeding (Zo to Z15) in the case of the most intense inbreeding possible (Brother and Sister out of Brother and Sister Continued) are, (5)

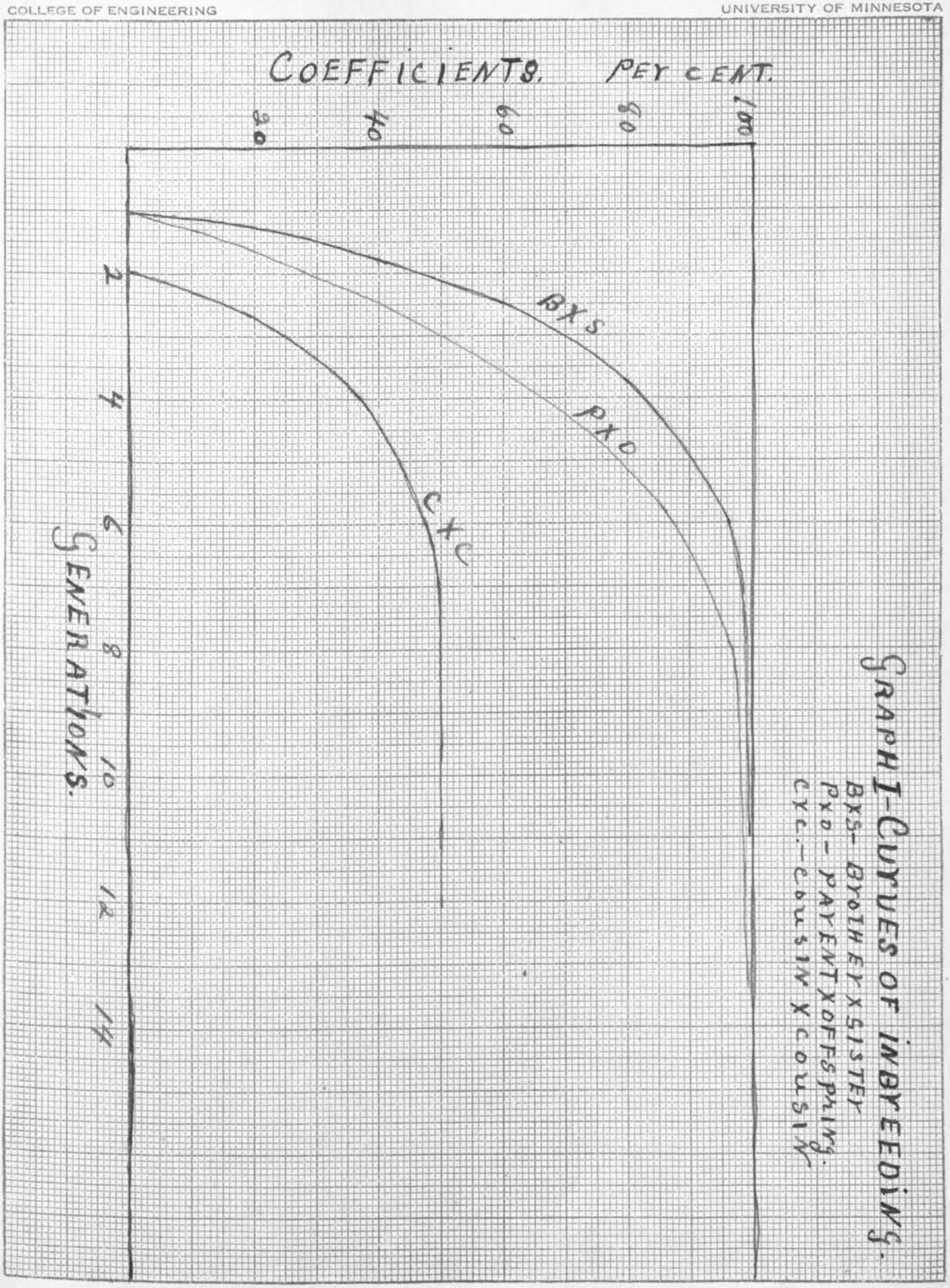
Coefficient of Inbreeding	Ancestral Generation included	Numerical value of coefficient
Zo	1	0
Z1	2	50
Z2	3	75
Z3	4	87.5
Z4	5	93.75
Z5	6	96.875
Z6	7	98.4375
Z7	8	99.21875
Z8	9	99.609375
Z9	10	99.8046875
Z10	11	99.90234375
Z11	12	99.951171875
Z12	13	99.9755859375
Z13	14	99.98779296875
Z14	15	99.993896484375
Z15	16	99.9969482421875

From this table it is apparent that while the narrowing or exclusion of the possible different source lines of descent proceeds very rapidly in

the first few generations of Brother and Sister breeding, only relatively little change is made by further generations of this sort of breeding. Thus in seven generations of Brother and Sister breeding all but 1.5 percent of the potentially different ancestral blood lines will have been eliminated. After sixteen generations of this sort of breeding, a number easily attainable in ordinary breeding experiments, an individual so bred can by no chance possess more than $\frac{3}{1000}$ of one percent of the different lines of ancestral descent which are theoretically possible. This table strongly suggests that if in an experiment to test the influence of inbreeding, no particular effect is observed during ten generations of Brother and Sister breeding, it is extremely improbable that any effect will be produced by a further continuation of the same method of breeding. If an apparent effect should suddenly appear some time later than the tenth generation the case would need the most careful scrutiny to determine whether the observed effect had really been due to the inbreeding rather than to some unsuspected cause.(5)

The values for the Z's in Table I are maxima; no particular coefficient of inbreeding can have a higher value than that given in the table. It is not possible, for example, so to breed any animal (having an obligate bisexual type of reproduction) that its pedigree on analysis will give $Z3 > 87.5$ percent. Maximum values for the coefficient of inbreeding are obtained when continuous Brother and Sister mating is involved.(6) Graph I.

The measure of the comparative amount or degree of inbreeding, considering the pedigree as a whole, is given by the area included by the particular inbreeding curve under discussion as compared with the corresponding area of the maximum (Brother and Sister) curve. (7)



GRAPH I-CURVES OF INBREEDING.
BXS- BROTHER X SISTER
PXO - PARENT X OFFSPRING.
CXC.- COUSIN X COUSIN

The proportion of the actual inbreeding during a number of generations to the highest possible inbreeding in the same number of generations then offers a fairly good measure for the total inbreeding. This proportion can be found by determining the proportion of the area included by the actual inbreeding curve in percentage of the area included by the maximum inbreeding curve.(8)

The formula for the total inbreeding coefficient is then the following: (9)

$$Z\,T\,n = \frac{100\ E\ \frac{Zn}{Z1}}{F\ Tn}$$

Where E denotes summation of all values between the inclusive limits indicated.

F Tn is the total area of the maximum Brother and Sister curve up to and including the n + 1th generation, since these successive values are constant they may be tabled once for all. (10)

Values of F Tn. The inclusive area of the Maximum Inbreeding Curve.(10)

Ancestral Generation	n	F Tn
2	1	50
3	2	125
4	3	212.5
5	4	306.25

(c) Coefficient of Relationship

The pedigree of an individual consists of two halves; one of these halves is made up of the sire and his ancestors, the other of the dam and her ancestors. It is plain that the values of the coefficients of inbreeding for a particular pedigree are composed of the following elements: (11)

(1) The occurence of the same individual animals more than once on the sire's side of the pedigree only.

(2) The occurence of the same individual animals more than once on the dam's side of the pedigree only.

(3) The reappearance of animals which appear first on one side of the pedigree, on the other side. If only (1) and (2) are to be found in the pedigree it means that the sire and dam are totally unrelated. On the other hand, the occurence of (3) means that sire and dam are in some degree related and that a portion of the observed inbreeding arises because of that fact. The coefficients of inbreeding in and of themselves, tell nothing about what proportionate part has been played by these three elements in reaching the final result. It is a matter of great importance to have information on this point because of its genetic significance.

An individual may be inbred in ten generations to within two-tenths of one percent as intensely, measured by the coefficients of inbreeding, if his sire and dam are in no way related, as he would be if his sire and dam were brother and sister. But clearly the germinal constitution of the individual produced would, except by most remote chance, be quite different in the two cases. The values of coefficient of relationship for a particular

pedigree evidently furnish a rough index of the probability that the two germ plasms which unite to form an individual are alike in their constitution. Thus in reaching a numerical measure of the degree of inbreeding it is not sufficient to consider coefficients of inbreeding alone. The coefficients of relationship must be taken into account.(12)

The degree, intensity or closeness of the relationship is in general, proportional to the number of different ancestors which the two individuals have in common; out of the whole number they might possibly have in common. The degree or amount of relationship is numerically measured by relationship coefficients, one for each ancestral generation. The coefficients are calculated in two slightly different ways according to whether they are being evaluated in connection with inbreeding coefficients or independently.(13)

The coefficient of relationship indicates the number of ancestors common to both pedigrees of the two individuals whose relationship is being measured in proportion to the total maximum number of different ancestors in the two pedigrees taken together in the generation in question.(14)

When the relationship between the sire and dam of an inbred individual is being measured the formula is: (15)

$$Kn = \frac{100\ (Pn + 1 - qn + 1) - (sZn - 1'sP1 + dZn - 1'dPn)}{Pn + 1}$$

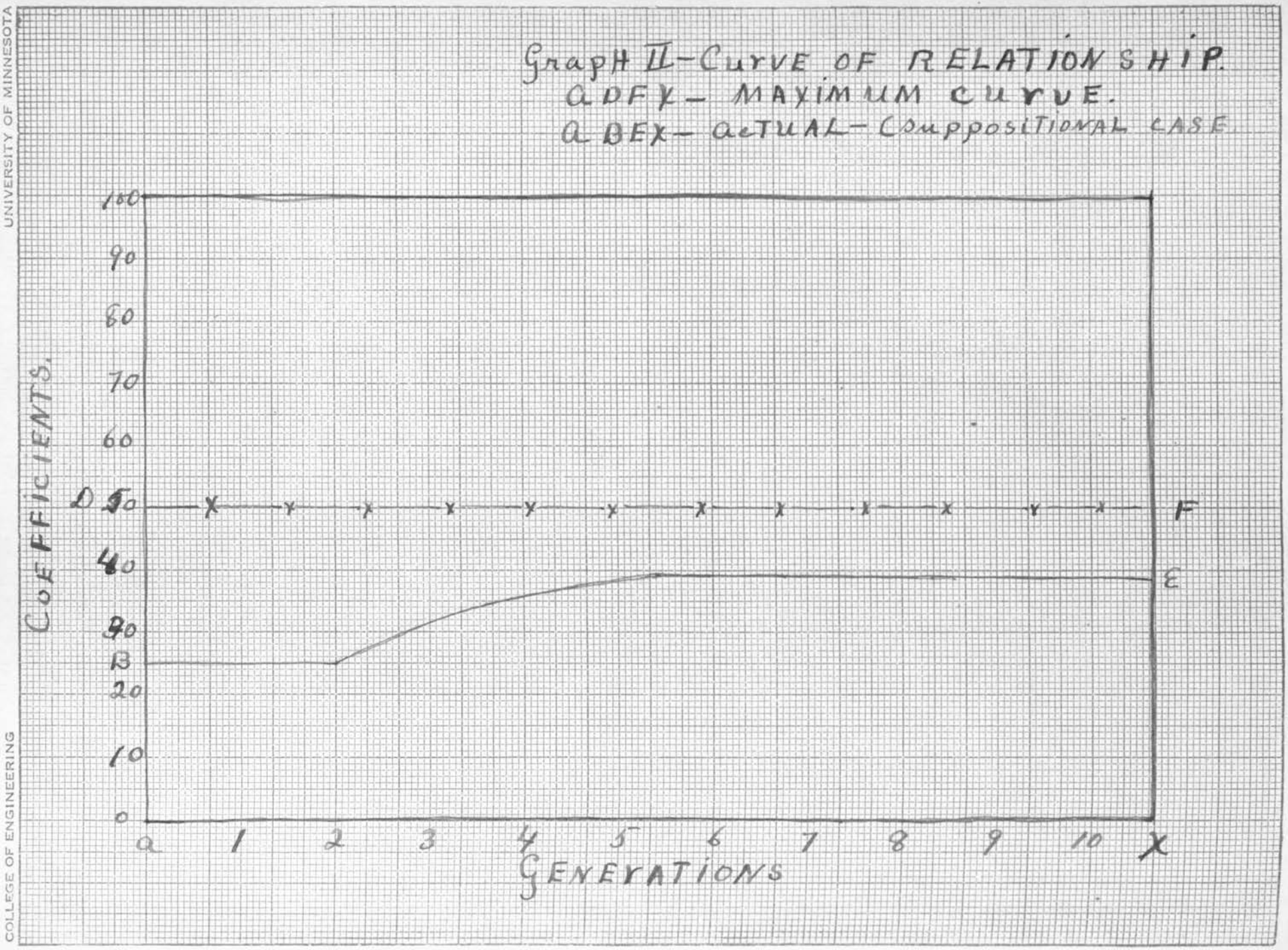
The Areas to be compared are the areas included by the relationship curve and the area included by the maximum relationship curve.(16) Graph II.

The maximum value of the coefficient of relationship will in every generation be 50 percent; as no more than 50 percent of the individuals in a generation of a pedigree can appear in both halves of the pedigree.(17)

Graph II – Curve of Relationship.

ADFX – Maximum curve.

ABEX – Actual – Coupositional case.



Since the maximum values of the coefficient of relationship are 50 in every generation beginning at k_1 , then the area in question is for that reason simply 50 times the number of generations involved. (18)

The formula of the total relationship coefficient for n generations is then the following: (19)

$$K\,Tn = \frac{100 \; E \frac{Kn}{Kl}}{50n} = \frac{2 \; E \frac{Kn}{Kl}}{n}$$

(d) Relationship Inbreeding Index

To indicate the proportion of the inbreeding that is due to relationship between the sire and dam of the individual whose pedigree is being examined, a single numerical expression is used, namely, the total relationship inbreeding index. This index indicates the proportion of the area included by the relationship curve to the area included by the inbreeding curve.(20)

The formula being as follows:

$$K\,Z\,Tn = \frac{100 \; E \frac{Kn}{Kl}}{E \frac{Zn}{Zl}}$$

(e) The Application of Inbreeding

To make clear the foregoing statements and to show their use in the analysis of inbreeding, the pedigree of Letty's Fancy Lady 241551 is given for four ancestral generations.(21)

(Ida's Rioter of
(St. Lambert 13656
(King of (
(St. Lambert 15175 (Allie of St. Lambert
((24991
(Rioter of (
(St. Lambert 16501 ((Stake Page's 3rd 2238
(((
((May Day Stoke Pogis(28353 (May Day of St. Lambert
([redacted] 5109
Rioter's (x
St. Lambert ((#Ida's Rioter of
King 58644 (•o (St. Lambert 13656
((King of St.Lambert (x
(15175 (#Allie of St. Lambert
((24991
(Phyllis of (
(St. Lambert 78867 ((Canada's John Bull
((8388
(Allie of St. (•o
(Lambert 2nd (#Allie of St. Lambert
24991

LETTY'S FANCY LADY 241551

(Bachelor of St. Lambert
(4558
(Exile of St.Lambert(•
(13657 (#Allie of St.Lambert
(24991
(Rioters Exile of (
(St. Lambert 48288 ((Dianna's Rioter 10481
((((
((Letty Rioter (
(73475 (Letty Coles 2nd
Letty's Fancy (
160320 (•
((Canada's John Bull 8388
((
((St. Lambert Boy (
(17408 (Oakland's Nora 14880
(Lady Letty Rioter (
142135 (•o
((St. Lambert Boy 17408
(Lady Letty (
(Lambert 124201 (•o
(Letty Coles 2nd 48128

In the pedigree of Letty's Fancy Lady 241551, the symbols have the following significance: A solid circle indicates a primary reappearance of an ancestor, having reference to the pedigree of Letty's Fancy Lady as a whole; for example King of St. Lambert 15175 makes a primary reappearance as sire of Phyllis of St. Lambert 78867. A cross indicates an entailed reappearance consequent upon the primary reappearance denoted by the solid circle, for example, Ida's Rioter of St. Lambert 13656 and Allie of St. Lambert 24991, are consequent upon the reappearance primarily of King of St. Lambert 15175. An open circle indicates a primary reappearance in the pedigree of the sire of Letty's Fancy Lady, considered by itself and without reference to her dam's pedigree; For example, King of St. Lambert 15175 as sire of Phyllis of St. Lambert 78867. Similarly with Letty's Fancy 160320, the dam of Letty's Fancy Lady 241551. (22)

(1)

Pedigree elimination table for the total inbreeding of Letty's Fancy Lady. (23)

Name of Animal primarily reappearing:	Ancestral generation in which primary reappearances occur.			
	1	2	3	4
King of St. Lambert	0	0	1	2
Allie of St. Lambert	0	0	0	2
Canada's John Bull	0	0	0	1
St. Lambert Boy	0	0	0	1
Letty Coles 2nd	0	0	0	1
Totals	0	0	1	7

Accordingly $Zn = \frac{100(Pn + 1 - Qn + 1)}{Pn + 1}$

$Zo = 0\ \%$

$Z1 = 0\ \%$

$Z2 = \frac{100(8 - 7\frac{1}{2})}{8} = 12.50\ \%$

$Z3 = \frac{100(16 - 9)}{16} = 43.75\ \%$

(II)

Pedigree elimination table for Rioter's St. Lambert King.(24)

Name of animal primarily reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
King of St. Lambert	0	0	1	2
Allie of St. Lambert	0	0	0	1
Totals	0	0	1	3

(III)

Pedigree elimination table for Lettys Fancy.

Name of animal primarily reappearing	Ancestral generation in which Primary reappearance occurs			
	1	2	3	4
St. Lamberts Boy	0	0	0	1
Letty Coles 2nd	0	0	0	1
Totals	0	0	0	2
Combined totals =	0	0	1	5
Difference between combined totals of II and III and of Table I =	0	0	0	2

Accordingly -

$$K1 = 0\ \%$$

$$K2 = 0\ \%$$

$$K3 = \frac{100 \times 2}{16} = 12.5\ \%$$

Total inbreeding (25) Letty's Fancy Lady =

$$Z\ Tn = \frac{100\ E\ \frac{Zn}{Z1}}{F\ Tn} = \frac{100 \times 56.25}{212.5} = 26.4 \text{ percent.}$$

The total Relationship Coefficient: (26)

$$K\ Tn = \frac{2\ E\ \frac{Kn}{K1}}{n} = \frac{2 \times 12.5}{3} = 8.3 \text{ percent.}$$

Total Relationship Inbreeding Index.(27)

$$K\ Z\ Tn = \frac{100\ E\ \frac{Kn}{K1}}{E\ \frac{Zn}{Z1}} = \frac{100 \times 12.5}{56.25} = 22.2 \text{ percent.}$$

Expressed verbally. In four generations Letty's Fancy Lady is 26.4 percent inbred. Her sire and dam are 8.3 percent related and the part of inbreeding due to relationship between her sire and dam is 22.2 percent of the actual total inbreeding.

PLAN OF TABULATION OF PEDIGREES

The pedigrees which have been used in this study are those of the Shorthorn and of the Hereford, first and second prize winners in the following classes at the International Live Stock Exposition, Chicago, for the years 1910 to 1921 inclusive, excepting 1914 and 1915 during which years the Exposition was not held.

Classes

Bulls - Aged

Bulls - Two years old and under three years

Bulls - Senior Yearling

Bulls - Junior Yearling

Cows - Aged

Heifers - Two years old and under three years

Heifers - Senior Yearling

Heifers - Junior Yearling

Compared with these three hundred and twenty pedigrees of high merit animals, are three hundred pedigrees (one hundred and fifty each of Shorthorn and of Hereford breeding) taken from a large number of association sale catalogues which would therefore be representative of the general average of their respective breeds.

Based on the method which has been presented, the pedigree of each animal is tabulated according to the values found for the:

Coefficient of Total Inbreeding

Coefficient of Total Relationship

Total Relationship Inbreeding Index

One pedigree is given in full for each of the several values found in the pedigrees of the Shorthorn prize winning animals to illustrate the method of inbreeding used and to show concretely the relationship existing. Then follows a list of animals whose pedigrees show the same values as that of the pedigree given in full.

Since the values found in the pedigrees of the Hereford prize winning animals follow very closely those found in the pedigrees of the Shorthorn prize winners, no pedigrees are given in full but they are listed under their respective classifications. The names of the animals taken from the sale catalogues are not listed but the values found for their pedigrees are summarized under Tables 4 and 5.

TABULATION AND DISCUSSION OF PEDIGREES

Shorthorn Aged Cow
Second Prize
1919

Avondale 254144

(White Hall Sultan
(163573

(Avalanche 2nd

(Bapton Sultan
(163570

(Bapton Pearl

(Mescoglee 222700

(Avalanche

(Bapton Victor

(Moon Daisy

(Count Lavender
(132875

(Primrose 2nd

(Captain Lavender
(222673

(Meadow Pipit 7th

(Sittyton Scarlet

(Averne 10th

Maxwalton Queen 127524
Calved January 2, 1912.

Highland Queen
46493

(Highland Champion
(222688

(Queen of Scots 5th
42-640

(Loreat Champion
(157617

(Interlude 13th
(46-453 E

(Baron Gloster
(101657

(Queen of Scots 2nd
(40-536

(Royal Star 151795

(Victoria

(Vice Chancellor
(56681

(Interlude 9th

(Commander 79556

(Duchess of Gloster

(Lord Lancaster 5th
(81968

(Queen of Scots

The pedigree of Maxwalton Queen 127524 has no animal reappearing on either half of the pedigree in the first four ancestral generations, therefore:

The Coefficient of Inbreeding = 0 percent

The Coefficient of Relationship = 0 percent

The total Relationship Inbreeding Index = 0 percent.

The pedigrees of the following animals show the same values as that of Maxwalton Queen:

White Star 338500 (Tarell Uxov 338494 / (Snowball)
1910 - Aged Shorthorn bull - 1st prize

Ringmaster 307894 (Snow Flake 263207 / (Lady Dorothea 2nd)
1910 - Shorthorn bull, 2 yrs. and under 3 yrs. - 1st prize

Roan Sultan (Glenbrook Sultan 243185 / (Ingleside Belle)
1910 - Senior Yearling Shorthorn Bull - 1st prize

Princess Marshall 41341 (Sharon Marshall 121136 / (Mezzo Linto)
1910 - Aged Shorthorn Cow - 1st prize

Susan Cumberland 40319 (Cumberland's Last 229522 / (Imp. Susand 2nd)
1910 - Shorthorn Heifer, 2 yrs. old - 1st prize

Mandolin 2nd 59045 (Glenbrook Sultan 243185 / (Josephine)
1910 - Senior Yearling Shorthorn Heifer - 1st prize

King Cumberland 288383 (Cumberlands Last 229822 / (Miss Walpole)
1910 - Aged Shorthorn Bull - 2nd prize

Selection 306209 (Avondale 245144
(
(Cherry Missie

1910 - 2 yr. old Shorthorn Bull - 2nd prize

Prime Knight 317036 (Gloster Knight 263198
(
(Foxhall Queen 31267

1910 - Senior Yearling Shorthorn Bull - 2nd prize

Herdsman's Favorite 336714 (Gladstone 239313
(
(Margaret 68-910

1910 - Junior Yearling Shorthorn Bull - 2nd prize

Mina Princess 12641 (White Hall Count 209775
(
(Mina Princess 3rd

1910 - Aged Shorthorn Cow - 2nd prize

Imp. Fair Start 2nd 68802 (Golden Hope 323637
(
(Fair Start

1910 - Shorthorn Heifer, 2 yrs. old - 2nd prize

Sweet Bracelet 67986 (Scotch Goods 259864
(
(Lad's Bracelet

1910 - Senior Yearling Shorthorn Heifer - 2nd prize

Minnie 4th (See. A. Cumberland 267738
(
(Minnie 2nd 28033

1910 - Junior Yearling Shorthorn Heifer - 2nd prize

Ringmaster 307894 (Snow Flake 263207
(
(Lady Dorothea 2nd

1911 - Aged Shorthorn Bull - 1st prize

Roan Sultan 316627 (Glenbrook Sultan 243186
(
(Ingleside Belle

1911 - Shorthorn Bull, 2 yrs. old - 1st prize

Gainford Marquis 370987 (Gainford Knight 370986
(
(Dalmeny Marchioness

1911 - Senior Yearling Shorthorn Bull - 1st prize

The Marshall 337666 (Anoka Marshall 270019, (Village Maid)

1911 - Junior Yearling Shorthorn Bull - 1st prize

Princess Marshall 41341 (Sharon Marshall 121136, (Mezzo Linto)

1911 - Aged Shorthorn Cow - 1st prize

Roan Queen (Gloster Choice 284895, (Maid of Straun)

1911 - Senior Yearling Shorthorn Heifer - 1st prize

Maxwalton Gloster 3rd (Avondale 245144, (Duchess of Gloster 39th)

1911 - Junior Yearling Shorthorn Heifer - 1st prize

Sultan Mine 320243 (White Hall Sultan 163573, (Lady Zenda 4th)

1911 - Aged Shorthorn Bull - 2nd prize

White Hall Rosedale 320004 (Avondale 245144, (Rosewood Pride)

1911 - Shorthorn Bull, 2 yrs. old - 2nd prize

Royal Cumberland 334808 (Cumberland's Last 229822, (Royal Princess)

1911 - Senior Yearling Shorthorn Bull - 2nd prize

Cumberland's Best 334805 (Cumberland's Last 229822, (Pro Narassus 2nd)

1911 - Junior Yearling Shorthorn Bull - 2nd prize

Dales Gift 41150 (Avondale 245144, (Wedding Gift 16th)

1911 - Aged Shorthorn Cow - 2nd prize

New Years Delight 59502 (Barmpton Knight 148795, (Forest Daisy 2nd)

1911 - Shorthorn Heifer, 2 yrs. old - 2nd prize

(Ruberta's Goods 283807
Sittyton Goods (
85327 (Sittyton Duchess
1911 - Junior Yearling Shorthorn Heifer - 2nd prize

(Good Choice 227853
Diamond Goods (
333014 (Sweetheart 13925
1912 - Aged Shorthorn Bull - 1st prize

(Avondale 245144
Count Avon 334946 (
(Lady Marjorie
1912 - Shorthorn Bull, 2 yrs. old - 1st prize

(Avondale 245144
Dale's Gift 2nd (
(Wedding Gift 16th
1912 - Aged Shorthorn Cow - 1st prize

(Glosters Choice 284895
Roan Queen (
(Maid of Straun 59526
1912 - Shorthorn Heifer, 2 yrs. old - 1st prize

(White Hall Sultan 163573
Sultan Mine 320243 (
(Lady Zenda 4th
1912 - Shorthorn Bull, 3 yrs. or over - 2nd prize

(White Hall Sultan 163573
Sultan Stamp (
(Imp. Rachel's Daughter
1912 - Shorthorn Bull, 2 yrs. and under 3 yrs. - 2nd prize

(Villager 295884
Village Baronet (
354063 (Highland Arabella
1912 - Senior Yearling Shorthorn Bull - 2nd prize

(Golden Hope 323627
Imp. Fair Start 2nd (
68802 (Fair Start
1912 - Aged Shorthorn Cow - 2nd prize

(Glenbrook Sultan 243185
Mary Ann of Oakland (
86840 (Ingleside Belle
1912 - Shorthorn Heifer, 2 yrs. and under 3 yrs. - 2nd prize

Ringmaster 307894 (Snow Flake 263207 / (Lady Dorothea 2nd

1913 - Aged Shorthorn Bull - 1st prize

Maxwalton Renown 367543 (Avondale 245144 / (Lavender Bloom

1913 - Senior Yearling Shorthorn Bull - 1st prize

Roan Queen 108792 (Glosters Choice 284895 / (Maid of Straun 59526

1913 - Aged Shorthorn Cow - 1st prize

Monarchs Victoria 127903 (Orange Monarch / (Victoria of Glenwood 23rd

1913 - Junior Yearling Shorthorn Heifer - 1st prize

Orange Goods (Standard Goods 333018 / (Carnation 118284

1913 - Senior Yearling Shorthorn Bull - 2nd prize

Kings Secret 369111 (King Cumberland 288383 / (Secret Rose 48937

1913 - Junior Yearling Shorthorn Bull - 2nd prize

Maxwalton Gloster 3rd 107403 (Avondale 245144 / (39th Duchess of Gloster

1913 - Aged Shorthorn Cow - 2nd prize

Pleasant Mildred 106369 (Gladstone 239313 / (Orange Blossom 28044

1913 - Shorthorn Heifer, 2 yrs. and under 3 yrs. - 2nd prize

Bun Brae Sultan 80325 (Superb Sultan 312047 / (Winnifried 3rd

1916 - Aged Shorthorn Bull - 1st prize

Queen Elizabeth 114472 (Bondsmann Commander 482919 / (Cecelia Lady 514414

1916 - Senior Yearling Shorthorn Heifer - 1st prize

Lady Dorothy 62 E (Hoar Frost 112077 / (Countess 6th

1916 - Junior Yearling Shorthorn Heifer - 1st prize

Royal Pride 446973 (Village Pride 352176 / (Lady Barmpton 161133

1916 - Junior Yearling Shorthorn Bull - 2nd prize

Countess 16th 108254 (Lyn Hero 514405 / (Countess 11th 514415

1916 - Shorthorn Heifer, 2yrs. and under 3 yrs.- 2nd prize

Viola 214958 (Maxwalton Pride 367542 / (Juliet

1916 - Junior Yearling Shorthorn Heifer - 2nd prize

Imperial Mistletoe 423031 (Imperial Gloster 340225 / (Sweet Mistletoe

1917 - Shorthorn Bull, 2 yrs. old - 1st prize

Villager's Coronet 476473 (Villager 295884 / (Golden Venus 11th

1917 - Senior Yearling Shorthorn Bull - 1st prize

Maxwalton Queen (Avondale 245144 / (Highland Queen 46493

1917 - Aged Shorthorn Cow - 1st prize

Viola 214958 (Maxwalton Pride 367542 / (Juliette

1917 - Shorthorn Heifer, 2 yrs. old and under 3 yrs.-1st prize

Lavina Cumberland 3rd (Cumberlands Best 334805 / (Lavina 2nd

1917 - Aged Shorthorn Cow - 2nd prize

Field Marshall 487370 (Bandsman's Commander 482419 / (Belmar Wimpal 28460

1917 - Shorthorn Bull, 2 yrs. and under 3 yrs. - 2nd prize

Maxwalton Dower 496403 (Revolution 388359 / Miss Dorothy 59736)
1917 - Junior Yearling Shorthorn Bull - 2nd prize

Violet Maid 8th (Archer Sultan 317159 / Violet Maid 2nd 28889)
1917 - Senior Yearling Shorthorn Heifer - 2nd prize

Lord Rhybon (Lord Maderville 716298 / Gentle Rosemary 716303)
1918 - Shorthorn Bull, 2 yrs. and under 3 yrs., - 1st prize

Rodney 144993 (Sanquhar Dreadnaught 113244 / Rosetta 7th)
1918 - Junior Yearling Shorthorn Bull - 1st prize

Brable 713264 (Mew.B.Augustus Champion 713262 / Not Law Beauty 10th)
1918 - Aged Shorthorn Cow - 1st prize

Clover Leaf Gloster 583943 (Maxwalton Pride 367542 / Gloster of B. 205652)
1918 - Junior Yearling Shorthorn Heifer - 1st prize

Knight Avon 438984 (Count Avon 334946 / Laura Knight 2nd)
1918 - Aged Shorthorn Bull - 2nd prize

Lavender Sultan 474341 (Sultan Stamp 334974 / Golden Lavender)
1918 - Shorthorn Bull, 2 yrs. and under 3 yrs., - 2nd prize

Dale Augustus 515616 (Pride of Avon 352673 / Augusta 84th 152917)
1918 - Senior Yearling Shorthorn Bull - 2nd prize

Master Prince 576033 (Master Ruby 446601 / Village Princess 5th 150636)
1918 - Senior Yearling Shorthorn Bull - 2nd prize

Village Rose 168981 (Villager 295884 / (Scatia 4th)

1918 - Aged Shorthorn Cow - 2nd prize

Pleasant Princess 581625 (Fair Acres Sultan 354154 / (Princess Josephine 3rd 86165)

1918 - Shorthorn Heifer, 2 yrs. and under 3 yrs. - 2nd prize

Pride of Oakland 496710 (Pride of Albion 352820 / (Sultans Rosewood 109564)

1919 - Aged Shorthorn Bull - 1st prize

Lespedeza Collynie 576037 (Lespedeza Sultan 406929 / (Sweet Mistletoe)

1919 - Shorthorn Bull, 2 yrs. old and under 3 yrs. - 1st prize

Hercules Diamond 714760 (Gainford Perfection 442173 / (Strawberry 6th 153674)

1919 - Senior Yearling Shorthorn Bull - 1st prize

Little Sweetheart 578263 (Golden Goods Jr. 374838 / (Sweetheart 181947)

1919 - Senior Yearling Shorthorn Heifer - 1st prize

Lavender 47th 627839 (Pride of Albion 352820 / (Lavender Lass 206442)

1919 - Senior Yearling Shorthorn Heifer - 1st prize

Strawberry Blossom 2nd 840637 (Sea Jem's Pride 796293 / (Strawberry Blossom 840636)

1919 - Junior Yearling Shorthorn Heifer - 1st prize

Maxwalton Queen 127524 (Avondale 245144 / (Highland Queen 46493)

1919 - Aged Shorthorn Cow - 2nd prize

Clover Leaf Gloster 583943 (Maxwalton Pride 367542 / (Gloster Blair Gowrie 205652)

1919 - Shorthorn Heifer, 2 yrs. and under 3 yrs. - 2nd prize

Gloryford Augustus 716421 (Butterfly Boy 3rd 716416 / (Beauty 716420

1919 - Shorthorn Bull, 2 yrs. and under 3 yrs. - 2nd prize

Pride of Albion 730697 (Pride of Oakdale 496710 / (Bell Flower 229070

1919 - Junior Yearling Shorthorn Bull - 2nd prize

Clover Leaf Royal 916625 (Village Royal 355016 / (Clara Belle 4th 207066

1920 - Junior Yearling Shorthorn Bull - 1st prize

Matilde of M. L. 820723 (Lexicon 713185 / (Matilda 2nd 727170

1920 - Junior Yearling Shorthorn Heifer - 1st prize

Maple Rose Pride 830028 (Maxwalton Pride 367542 / (Baroness Wimple 7th 522705

1920 - Senior Yearling Shorthorn Bull - 2nd prize

Rothes King 4th (Collynie Bright Star 750097 / (Queen of Mill Hills 950346

1920 - Junior Yearling Shorthorn Bull - 2nd prize

Lady Dorothy 526415 (Hoar Frost 526409 / (Countess 6th 526414

1920 - Aged Shorthorn Cow - 2nd prize

Non Pareil Lady 762507 (Maxwalton Adorne 426666 / (Non Pareil Girl 558461

1920 - Shorthorn Heifer - 2 yrs. and under 3 yrs. - 2nd prize

Cumberland Royal 916625 (Village Royal 355016 / (Clara Bell 4th 207066

1921 - Shorthorn Bull, 2 yrs. and under 3 yrs. - 1st prize

Bapton Prince 926202 (Master Bapton 556804 / (Village Princess 5th 150636

1921 - Senior Yearling Shorthorn Bull - 1st prize

Richland Augustus 992210 (Sterling Supreme 596719 / (Augusta Lily 476598

1921 - Junior Yearling Shorthorn Bull - 1st prize

Lady Clara 9th (Cornerstone 363116 / (Lady Clara 4th 220460

1921 - Aged Shorthorn Cow - 1st prize

Clara 51st (Master Bapton 556804 / (Maxwalton Clara 113463

1921 - Shorthorn Heifer 2 yrs and under 3 yrs. - 1st prize

Ravendale Devergail 919906 (Glozford Augustus 716421 / (Devergail Diana 753170

1921 - Junior Yearling Shorthorn Heifer - 2nd prize

Princely Stamp 576045 (Regal Stamp 396730 / (Premier Queen 99222

1921 - Aged Shorthorn Bull - 2nd prize

Sultan Clarion (Lavender Sultan 474341 / (Superb Claret 176569

1921 - Junior Yearling Shorthorn Bull - 2nd prize

Best Sort 876368 (Huron Sort 530975 / (White Beauty 632712

1921 - Senior Yearling Bull - 2nd prize

Dale's Gift 41150 (Avondale 245144 / (Wedding Gift 16th

1911 - Shorthorn Heifer 2 yrs and under 3 yrs. - 1st prize

King's Secret 369111 (King Cumberland 288383 / (Secret Rose

1913 - Junior Yearling Shorthorn Bull - 1st prize

Maxwalton Roan Lady 127525 (Avondale 245144 / (Imp. Roan Lady 36th 70925

1913 - Senior Yearling Shorthorn Heifer - 1st prize

(Avondale 245144
Maxwalton Roan Lady (
127525 (Imp. Roan Lady 36th 70925

1916 - Aged Shorthorn Cow - 1st prize

(Glenbrook Sultan 243185
Mary Ann of Oakland(
86840 (Ingleside Belle

1911 - Senior Yearling Shorthorn Heifer - 2nd prize

Junior Yearling Shorthorn Bull
First Prize
1912

Villager 295884

(Village Beau
(295883
(
(
(
(
(Rosy Cloud

(Merry Morning
(247833
(
(
(Village Maid 17th

(Misty Morning
(71021
(
(
(Rose Blossom

(Pride of Morning
(120557
(
(Missie 135th

(Master of the
(Ceremonies 56162
(
(Village Maid 15th

(Pride of Morning
(120551
(
(Missie 137th

(Clan Alpine
(
(
(Roselinty

Augustine 354344

(King of Fashion
(151756
(
(
(
(
(Augusta 80th

(Prince of Fashion
(136634
(
(
(Maud 6th

(Waverly 68072
(
(
(
(
(Augusta 30th

(Scottish Archer
(117301
(
(Primrose 3rd

(Royal James 54972
(
(
(Maud 5th

(Bendigo 56935
(
(
(Witch of Erin

(Clear the Way
(47604
(
(Augusta 7th

Table I. Pedigree Elimination Table for the Total Inbreeding of Augustine 354344.

Name of animal primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Pride of the Morning 120551	0	0	0	1
Totals	0	0	0	1

$Z\,0 = 0\,\%$

$Z\,1 = 0\,\%$

$Z\,2 = 0\,\%$

$Z\,3 = 100\,\frac{(16 - 15)}{16} = 6.25\,\%$

Table II. Pedigree Elimination Table for Villager 295884 (sire)

Name of animal primarily reappearing	Ancestral generation in which Primary reappearances occur			
	1	2	3	4
Pride of Morning 120551	0	0	0	1
Totals	0	0	0	1

Table III. Pedigree Elimination Table for Imp. Augusta 83rd (dam)

Name of animal primarily reappearing	Ancestral generation in which Primary reappearances occur			
	1	2	3	4
Animal [illegible]	0	0	0	0
Totals	0	0	0	0

	1	2	3	4
Combined totals of Tables II and III	0	0	0	1
Difference between combined totals of Tables II and III and of Table I	0	0	0	0

Then

$K\,0 = 0\ \%$

$K\,1 = 0\ \%$

$K\,2 = 0\ \%$

$K\,3 = 0\ \%$

Total Inbreeding of Augustine 354344

$$Z\,Tn = \frac{100\ E^{Zn}_{Z1}}{F\,Tn} = \frac{100 \times 6.25}{212.5} = 2.9\%$$

Total Relationship coefficient

$$K\,Tn = \frac{2\ E^{Kn}_{K1}}{n} = \frac{2 \times 0}{3} = 0\ \%$$

Total Relationship Inbreeding Index

$$K\,Z\,Tn = \frac{100\ E^{Kn}_{K1}}{E^{Zn}_{Z1}} = \frac{100 \times 0}{6.25} = 0\ \%$$

Thus in four ancestral generations, Augustine 354344, is 2.9 percent inbred, no relationship exists between his sire and dam, consequently none of the inbreeding is due to relationship.

The pedigrees of the following animals show the same values as that of Augustine 354344.

Her Excellence (Straight Marshall 247519
(Village Belle 3rd

1912 - Junior Yearling Shorthorn Heifer - 2nd prize

Augustine 354344 (Villager 295884
(Imp. Augusta 83rd

1912 - Junior Yearling Shorthorn Bull - 1st prize

Village Denmark 334459 (Villager 295884
(Lady Margaret

1913 - Aged Shorthorn Bull - 2nd prize

Pride of Albion (Shenstone Albino 317105
(Imp. Rosewood Pride

1916 - Aged Shorthorn Bull - 2nd prize

O. K. (Augustine 354344
(Lady Fragrant 5th

1916 - Senior Yearling Shorthorn Bull - 2nd prize

Fair Gift 182698 (Good Count 328610
(Gift Albion 107199

1916 - Shorthorn Heifer, 2 yrs. old and under 3 yrs. -1st prize

Duchess of Gloster 80th (Gainford Marquis 370987
(Duchess of Gloster 78th 112340

1917 - Senior Yearling Shorthorn Heifer - 2nd prize

Lady Clara 9th 471771 (Cornerstone 363116
(Lady Clara 4th 220460

1917 - Senior Yearling Shorthorn Heifer - 1st prize

Victoria 74th (Dale Clarion 385195
(Fair View Victoria 215184

1918 - Junior Yearling Shorthorn Heifer - 2nd prize

Goldie's Ruby 543365 (Dale Clarion 385195
(Susan Lady 2nd 51923

1918 - Shorthorn Heifer, 2 yrs. and under 3 yrs. - 1st prize

Rosebud 5th 655005 (Dale Clarion 385195 / (Rosebud 100308)

1918 - Senior Yearling Shorthorn Heifer - 2nd prize

Violet's Dale 424602 (White Hill Rosedale 320004 / (Violet Goods 85328)

1919 - Aged Shorthorn Bull - 2nd prize

Marshall Joffre 807343 (Cumberland Gift 575019 / (Villager Rosalie 203805)

1920 - Senior Yearling Shorthorn Bull - 1st prize

Swinton Rosicrucian 2nd (Swinton Blood Royal 893731 / (Gainford Rosebud 950334)

1920 - Shorthorn Bull, 2 yrs. and under 3 yrs. - 2nd prize

Countess Vesta (Harvieston Grandee 732379 / (Countess D. 692763)

1921 - Junior Yearling Shorthorn Heifer - 1st prize

Marshall Joffre 807343 (Cumberland Gift 575019 / (Villagie Rosalie 203805)

1921 - Shorthorn Bull, 2 yrs. and under 3 yrs. - 2nd prize

Lady Susan 543365 (Dale Clarion 385195 / (Susan Lady 4th 51923)

1918 - Senior Yearling Shorthorn Heifer - 1st prize

New Year Delight (Barmpton's Knight 148795 / (Forest Daisy 2nd)

1910 - Junior Yearling Shorthorn Heifer - 1st prize

Junior Yearling Shorthorn Bull
First Prize
1919

(Bapton Sultan
(163570
(White Hall Sultan (
(163573 (Imp. Bapton Pearl
(
(Avondale 245144 (
((Nescombe 222700
(((
((Avalanche 2nd (
((Avalanche
(
Revolution 388359((Scottish Wanderer
((
((Damon 377068 (
(((Dashing Girl
((
(Roan Rosebud 12th (
((Centaus 70118
(War Queen (
(
(Roan Rosebud 3rd

Maxsalton Monarch 699471

(White Hall Sultan
(163573
(Gold Sultan 312039 (
((Gold Duchess
(
(Gay Monarch 398379 (
((Lemidor 151010
((Sally 8th (
((
((Sally 4th
Sittyton Princess (
201022 (
((Sir Arthur's
((Strawberry Chief (Farewell 229283
((391298 (
(Dora 200990 ((Strawberry 10th
(
(
(Mollie 201007 (Tecumseh 426441
(
(
(Golden Belle
200994

Table I. Pedigree Elimination Table for Maxwalton Monarch 699471

Name of Animal Primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
White Hall Sultan	0	0	0	1
Total	0	0	0	1

Then $Z_0 = 0\ \%$

$Z_1 = 0\ \%$

$Z_2 = 0\ \%$

$Z_3 = 100\ \frac{(16 - 15)}{16} = 6.25\ \%$

Table II. Pedigree Elimination Table for Revolution 388359 (sire)

Name of Animal Primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Animal	0	0	0	0
Total	0	0	0	0

Table III. Pedigree Elimination Table for Sittyton Princess 201022 (dam)

Name of Animal Primarily reappearing	Ancestral generation in which Primary reappearances occur			
	1	2	3	4
Animal	0	0	0	0
Total	0	0	0	0

	1	2	3	4
Combined totals of Tables II and III	0	0	0	0
Difference between total of Tables II and III and of Table I =	0	0	0	1

Then K 0 = 0 %

K 1 = 0 %

K 2 = 0 %

$$K\,3 = \frac{100 \times 1}{16} = 6.25\ \%$$

Total inbreeding coefficient =

$$Z\,Tn = \frac{100\ E^{Zn}_{Z1}}{F\,Tn} = \frac{100 \times 6.25}{212.5} = 2.9\ \%$$

Total relationship coefficient =

$$K\,Tn = \frac{2\ E^{Kn}_{K1}}{n} = \frac{2 \times 6.25}{3} = 4.16\ \%$$

Total Relationship Inbreeding Index

$$K\,Z\,Tn = \frac{100\ E^{Kn}_{K1}}{E^{Zn}_{Z1}} = \frac{100 \times 6.25}{6.25} = 100\ \%$$

In four ancestral generations, Maxwalton Monarch 699471 is 2.9 percent inbred; One animal appears in both halves of the pedigree, establishing a relationship of 4.16 percent; As all the inbreeding is due to the reappearance of this animal, the amount of inbreeding due to relationship is 100 percent.

The pedigrees of the following animals show the same values as that of Maxwalton Monarch 699471.

Maxwalton Pride (Maxwalton Renown 367543
(
(Imp. Rosewood Pride

1916 - Shorthorn Bull, 2 yrs. and under 3 yrs. - 1st prize

Leapadeza Sultan 406929 (Sultan's Stamp 324974
(
(Victoria 3rd 129770

1917 - Aged Shorthorn Bull - 2nd prize

Leapadeza Sultan 406929 (Sultan's Stamp 324974
(
(Victoria 3rd 129770

1918 - Aged Shorthorn Bull - 1st prize

Maxwalton Monarch 699471 (Revolution 388359
(
(Sittyton Princess 201022

1919 - Junior Yearling Shorthorn Bull - 1st prize

Maxwalton Monarch 699471 (Revolution 388359
(
(Sittyton Princess 201022

1920 - Shorthorn Bull, 2 yrs. and under 3 yrs. - 1st prize

Maxwalton Monarch 699471 (Revolution 388359
(
(Sittyton Princess 201022

1921 - Aged Shorthorn Bull - 1st prize

Maxwalton Missie 2nd 107208 (Avondale 245144
(
(Imp. Missie 145

1913 - Shorthorn Heifer, 2 yrs. old and under 3 yrs.-1st prize

Senior Yearling Shorthorn Heifer
Second Prize
1918

Radium 385197

(Double Dale 337156
(Red Lassie 99345

(Avondale 245144
(Good Lassie

(Maxwalton Rosewood 12640
(Snow Flake 263237

(White Hall Sultan
(Avalanche 2nd

(Avondale 245144
(Aldie Duchess of Gloster

(Non Pareil Stamp 186487
(Pitlivie Caroline

(Choice Goods 186802
(Golden Lassie

Lovely of Parkdale 4th 121149

(Best of Goods 262678
(Hamptons Lovely 60-609

(Choice Goods 186802
(The Runaway Girl 53-590

(Hamptons Best 170818
(Lovely of Greendale 3rd 44-804

(Remus 151790
(Geraldine 5th

(Collynie 135022
(Rosedale Violet 9th

(Merry Hampton 132572
(Secret of Hill Farm 2nd

(Barmptons Royal 122721
(Lovely 27th

Lovely of Parmdale 15th 555630
Calved Sept. 8, 1916

Table I. Pedigree Elimination Table of Lovely of Parkdale 15th 555630

Name of Animal primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Avondale	0	0	0	1
Choice Goods	0	0	0	1
Totals	0	0	0	2

Then $Z\,0 = 0\,\%$

$Z\,1 = 0\,\%$

$Z\,2 = 0\,\%$

$Z\,3 = 100\,\frac{(16-14)}{16} = 12.5\,\%$

Table II. Pedigree elimination table of Radium 385197 (sire)

Name of Animal primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Avondale	0	0	0	1
Total	0	0	0	1

Table III. Pedigree elimination table of Lovely of Parkdale 4th 121149 (dam)

Name of Animal Primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Animal	0	0	0	0
Total	0	0	0	0

	1	2	3	4
Combined total of Tables II and III	0	0	0	1
Difference between total of Tables II and III and of Table I	0	0	0	1

Then K 0 = 0 %

K 1 = 0 %

K 2 = 0 %

$$K\,3 = \frac{100 \times 1}{16} = 6.25\ \%$$

Total Inbreeding Coefficient =

$$Z\,Tn = \frac{100\ E\ \frac{Zn}{Z1}}{K\,Tn} = \frac{100 \times 12.5}{212.5} = 5.8\ \%$$

Total Relationship Coefficient =

$$K\,Tn = \frac{2\ E\ \frac{Kn}{K1}}{n} = \frac{2 \times 6.25}{3} = 4.16\ \%$$

The Relationship Inbreeding Index

$$K\,Z\,Tn = \frac{100\ E\ \frac{Kn}{K1}}{E\ \frac{Zn}{Z1}} = \frac{100 \times 6.25}{12.5} = 50\ \%$$

In four ancestral generations, Lovely of Parkdale 15th 555630, is 5.8 percent inbred. One of the two animals primarily reappearing, appears in both halves of the pedigree, giving a relationship coefficient of 4.16 percent. Since only one of the two animals primarily reappearing occurs in both halves of the pedigree, then the amount of the total inbreeding due to relationship is 50 percent.

The pedigrees of the following animals show the same values as that of Lovely of Parkdale 15th, 555630.

Village Supreme 423856 (Sultan Supreme 367161 / (Village Clara 108337)

1916 - Senior Yearling Shorthorn Bull - 1st prize

Parkdale Victoria (Radium 385147 / (Parkdale Victoria 2nd)

1917 - Junior Yearling Shorthorn Heifer - 1st prize

Lovely of Parkdale 15th (Radium 385197 / (Lovely of Parkdale 4th)

1918 - Senior Yearling Shorthorn Heifer - 2nd prize

Gainford Matchless (Gainford Marquis 370987 / (Matchless 38th 75387)

1918 - Senior Yearling Shorthorn Bull - 1st prize

Lady Supreme 694468 (Sultan Supreme 367161 / (Emma S. 182616)

1920 - Shorthorn Heifer, 2 yrs. old - 1st prize

Divide Iris (Second Thought 394904 / (Anemone 181341)

1921 - Senior Yearling Shorthorn Heifer - 2nd prize

Moss Rose 6th 108330 (Anoka Sultan 264212 / (Moss Rose 4th)

1912 - Senior Yearling Shorthorn Heifer - 1st prize

Pellipar Iris 950332 (Edgcote Regalia 950314 / (Pellipar Pansy 850345)

1920 - Aged Shorthorn Cow - 2nd prize

True Cumberland 317602 (Cumberland's Last 229822 / (Wimple's Royal)

1910 - Junior Yearling Shorthorn Bull - 1st prize

Junior Yearling Shorthorn Bull
Second Prize
1912

White Hall Marshall 209776

(White Hall Sultan 163573
(Imp. Missie 167th 48 - 370
(Bapton Sultan 163570
(Lord of Fame 157722
(Imp. Bapton Pearl
(Missie 147th 44-529E
(Bapton Victor
(Moon Daisy
(Count Lavender 132575
(Primrose 2nd
(Lord Douglas 132003
(Lily Fame
(William of Orange 50694
(Missie 88th

Lavender Marshall 353516
Calved March 11, 1911.

(Lord Missie 252006
(Lady Lavender 9th 66-530
(Godwin 115676
(Imp. Collynie Missie 47 - 240
(Godwin 115676
(Lady Lavender 42-1166
(Spartan Hero 77932
(Golden Thistle
(Nonpareil Victor 132573
(Dalmeny Missie 4th
(Spartan Hero 77932 x
(Golden Thistle
(Golden Shield 92576
(Linwood Lavender 4th

Lady Lavender 14th 51314

Table I. Pedigree elimination table for Lavender Marshall 353516

Name of Animal Primarily Reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Godwin	0	0	1	2
Total	0	0	1	2

Then $Z_0 = 0\ \%$

$Z_1 = 0\ \%$

$Z_2 = 100\ \frac{(8 - 7)}{8} = 12.5\ \%$

$Z_3 = 100\ \frac{(16 - 14)}{16} = 12.5\ \%$

Table II. Pedigree elimination table for White Hall Marshall 209776 (sire)

Name of Animal Primarily Reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Animal	0	0	0	0
Total	0	0	0	0

Table III. Pedigree elimination table for Lady Lavender 4th 51014 (dam)

Name of Animal Primarily Reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
Godwin	0	0	1	2
Total	0	0	1	2

	1	2	3	4
Combined total of Table II and III	0	0	1	2
Difference between totals of Table II and III and of Table I	0	0	0	0

Then $K\,0 = 0\,\%$

$K\,1 = 0\,\%$

$K\,2 = 0\,\%$

$K\,3 = 0\,\%$

Total Inbreeding Coefficient =

$$Z\,Tn = \frac{100\ E^{Zn}_{Z1}}{K\,Tn} = \frac{100 \times 25}{212.5} = 11.7\,\%$$

Total Relationship Coefficient =

$$K\,Tn = \frac{2\ E^{Kn}_{K1}}{n} = \frac{2 \times 0}{3} = 0\,\%$$

Total Relationship Inbreeding Index =

$$K\,Z\,Tn = \frac{100\ E^{Kn}_{K1}}{E^{Zn}_{Z1}} = \frac{100 \times 0}{25} = 0\,\%$$

In this pedigree Godwin 115676 makes a primary reappearance as sire of Lady Lavender 9th, in the third ancestral generation, giving an inbreeding coefficient of 11.7 percent.

The primary reappearance of Godwin 115676 affects only the dam's side of the pedigree, therefore, there is no relationship in the first four ancestral generations between the sire and dam of Godwin 115676, consequently none of the inbreeding is due to relationship.

The pedigrees of the following animals show the same values as that of Lavender Marshall 353516.

Maxwalton Commander 406947 (Avondale 245144 / Roan Lady 36th 70925)
1917 - Aged Shorthorn Bull - 1st prize

Sultan's Bean (Lespedeza Sultan 406929 / Sweet Bracelet 67986)
1917 - Junior Yearling Shorthorn Bull - 1st prize

Simplicity 9th (Cumberland's Archer 432399 / Simplicity 8th 225139)
1919 - Senior Yearling Shorthorn Heifer - 2nd prize

Cumberland Marshall 807342 (Cumberland Marshall 412384 / Golden Girl 156180)
1919 - Senior Yearling Shorthorn Bull - 2nd prize

Simplicity 10th (Cumberland's Archer 432399 / Simplicity 8th 225139)
1921 - Shorthorn Heifer, 2 yrs. and under 3 yrs.- 2nd prize

Junior Yearling Shorthorn Bull
First Prize
1916

Cumberlands Type 388132

(Cumberlands Best 334805
(Gladsome

(Cumberlands Last 229822
(Pro Narcissus 2nd
(Champion 118343
(Gladiolus

(Cumberland 118578
(Lady Douglas
(Steadfast 141552
(Pro Narcissus
(Favorite of Maple-leaf 107851
(Imp. Athene
(Brunswick 96512
(Imp. Gardenia

Types Model 429408

Roan Sinnissippi 150932

(Burwood Royal 317596
(Sinnissippi Blossom 10145

(Royal Sultan 223948
(Lady Dorothea 11th
(Cumberlands Last 229882
(Archers Blossom

(White Hall Sultan 163573
(Jessie 2nd
(Baron Gold Dust 3rd 127367
(Lady Dorothea 8th
x
(Cumberland 118578
(x
(Lady Douglas
(Cermonius Archer 171479
(Browndale Blossom 2nd

The pedigree of Types Model 429408 shows the same amount of inbreeding as that of Lavender Marshall 353516, but Cumberlands Last 228822 makes a primary reappearance on the dam's side of the pedigree, thus establishing a relationship coefficient of 16.6 percent. All of the inbreeding is due to the primary reappearance of Cumberlands Last, therefore, the amount of inbreeding due to relationship is 100 percent.

The pedigrees of the following animals show the same values as that of Types Model 429408.

Types Model 429408 (Cumberlands Type 388132
(Roan Sinnissippi 150932
1916 - Junior Yearling Shorthorn Bull - 1st prize

For Sultan 494475 (Fair Acres Sultan 354154
(Lady Douglas 4th 28968
1917 - Senior Yearling Shorthorn Bull - 2nd prize

Miss Cumberland 2nd 796142 (Choice Cumberland 410399
(Lady Cumberland 2nd 467710
1920 - Senior Yearling Shorthorn Heifer - 1st prize

Sultans Graceful 594745 (Princely Sultan 350513
(Maxwalton Graceful 2nd 153015
1921 - Aged Shorthorn Cow - 2nd prize

Aged Shorthorn Bull, 3 yrs. old and over
Second Prize
1920

Cumberland Repeater 454657

(King Cumberland 352076
(Walpole Lady 150147

(Cumberlands last 229822
(Miss Walpole 68-807
(Red Archer 278105
(Miss Walpole

(Cumberland 118578
(Lady Douglas
(Ury Prince 177870
(Bonnie Bell Lancaster 2nd
(Cermonius Archer 171479
(P.G. Mildred 3rd
x
(Ury Prince 177870
x
(Bonnie Bell Lancaster 2nd

Cumberland Gift 575019
Calved March 1, 1917

Kings Gift 203804

(Cumberland Marshall 412384
(Gift of Albion 107199

(King Cumberland 288383
(Marshalls Queen 87585
(Shemstone Albino 317105
(Dales Gift 41150

(Cumberlands Last 229822
(Miss Walpole
(White Hall Marshall 209776
(Sinnissippi Queen 1346
(Speculator 317112
(Amy 3rd
(Avondale 245144
(Wedding Gift 16th

The primary reappearances in the pedigree of Cumberland Gift 575019 are much the same in occurence as those of the pedigree of Silver Mist 2nd 765344. There are besides a primary reappearance in the third ancestral generation, two primary reappearances in the fourth ancestral generation, giving a total inbreeding coefficient of 17.6 percent. The primary reappearance in the third ancestral generation of Miss Walpole affects only the pedigree of the sire of Cumberland Gift, therefore the amount of inbreeding due to relationship is only 33.3 %.

Senior Yearling Shorthorn Heifer
Second Prize
1920

Glosters Gift
438555

(Fair Acres Gloster
(385760
(
(
(
(Wedding Gift 32d
(150351

(Fair Acres Sultan
(354154
(
(
(Ontaria Duchess
(47864
(
(
(Scotch Sultan
(296331
(
(
(Wedding Gift 28th
(48055

(Whitehall Sultan
(163573
(
(Snowbird 11648

(Uppermill Omega
(295763
(
(Ontaria D. of
(Gloster 4th 47865

•

(White Hall Sultan
(162573
(
(Red Lady

(Ben Lomond 253006
(
(
(Wedding Gift 7th

Silver Mist 2nd 765344
Calved Sept. 14, 1918

Silver Mist
516868

(Champion Goods
(410385
(
(
(
(
(
(
(
(
(
(Silver Nell
(180804

(Ruberts Goods
(283807
(
(
(
(Lady Marengo 2nd
(68-943

•

(Fair Acres Sultan
(354154
(
(
(Golden Nell 40117

(Golden Goods 253393
(
(
(Ruberta

(King Champion
(181878
(
(Lady Marengo

x

(White Hall Sultan
(
(x
(Snowbird 11648

(Golden Favorite
(240626
(
(Diamond's Nellie

Table I. Pedigree elimination table for Silver Mist 2nd 765344

Name of animal primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Fair Acres Sultan 354154	0	0	1	2
White Hall Sultan 163573	0	0	0	1
Total	0	0	1	3

Then $Z\,0 = 0\,\%$

$Z\,1 = 0\,\%$

$Z\,2 = 100\,\frac{(8 - 7)}{8} = 12.5\,\%$

$Z\,3 = 100\,\frac{(16 - 13)}{16} = 18.7\,\%$

Table II. Pedigree elimination table for Gloster's Gift 438555 (sire)

Name of animal primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
White Hall Sultan	0	0	0	1
Total	0	0	0	1

Table III. Pedigree elimination table for Silver Mist 516868 (dam)

Name of animal Primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Animal	0	0	0	0
Total	0	0	0	0

	1	2	3	4
Combined totals of Table II and III =	0	0	0	1
Difference between total of II and III and Table I =	0	0	1	2

$K\,0 = 0\,\%$

$K\,1 = 0\,\%$

$K\,2 = \frac{100 \times 1}{8} = 12.5\,\%$

$K\,3 = \frac{100 \times 2}{16} = 12.5\,\%$

Total Inbreeding Coefficient =

$$Z\,Tn = \frac{100 \times E^{\frac{Zn}{Z1}}}{K\,Tn} = \frac{100 \times 31.2}{212.5} = 14.6\%$$

Total Relationship Coefficient =

$$K\,Tn = \frac{2 \, E^{\frac{Kn}{K1}}}{n} = \frac{2 \times 25}{3} = 8.33\,\%$$

The Relationship Inbreeding Index =

$$K\,Z\,Tn = \frac{100 \times E^{\frac{Kn}{K1}}}{E^{\frac{Zn}{Z1}}} = \frac{100 \times 25}{31.2} = 80.1\,\%$$

In the pedigree of Silver Mist 2nd 765344, primary reappearances of animals occur in both the third and fourth ancestral generations, giving an inbreeding coefficient of 14.6 percent. Owing to the primary appearance in the third ancestral generation of an animal on both sides of the pedigree, the relationship inbreeding index is 80.1 percent, or 80.1 percent of the inbreeding is due to relationship between the sire and dam of Silver Mist 2nd.

The pedigrees of the following animals show the same values as that of Silver Mist 2nd 765344.

Maxmill Susan 949929 (Princely Stamp 576045
(Overbrook Susan 2nd

1921 - Senior Yearling Shorthorn Heifer - 1st prize

Senior Yearling Shorthorn Heifer
Second Prize
1916

Saramac 355331

(The Dutchman
(282689
(
(
((
(
(
(
(
(Sunday 45466

(Choice Bud 212003
(
(
(
(
(Ontario Duchess of
(Gloster 48-222

(Choice Goods 186802
(
(
(Plum Bud

(Duke of Lavender
(69290
(
(Canadian Duchess of
(of Gloster 15th

(Golden Champion
(250443
(
(Queen Mab

(Scottish Prince
(250444
(
(
(
(Sunset 55-849

(St. Valentine 121014
(
(
(Sunrise

Lucile 199705
Calved Nov. 18, 1914.

(Scottish Choice
(306343
(
(
(
(
(
(
(Dutch Lowerley
114634

•
$Scottish Prince
(250444
(
(
(
(Lucy's Choice
(58-979

•
(The Dutchman
(
(
(
(
(
(
(
(Lowerley's Lady
67-948

(Golden Champion
(250443
(x
(Queen Mab

(Choice Goods
(
(
(Lucy Lee

x
(Choice Bud 212003
(
(x
(Ontario Duchess of
Gloster

(General White 162501
(
(
(Lowerley's Matchless

12-21-6m

Table I. Pedigree elimination table for Lucile 199705

Name of Animal primarily reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
Scottish Prince	0	0	1	2
The Dutchman	0	0	1	2
Total	0	0	2	4

Table II. Pedigree elimination table of Saranac 355331 (sire)

Name of Animal primarily reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
Animal	0	0	0	0

Table III. Pedigree elimination table of Scottish Lowerley 168123 (dam)

Name of Animal primarily reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
Animal	0	0	0	0
Combined totals of Tables II and III =	0	0	0	0
Difference between combined totals of Tables II and III and of Table I =	0	0	2	4

Then $Z\,0 = 0\,\%$ $\qquad K\,0 = 0\,\%$

$Z\,1 = 0\,\%$ $\qquad K\,1 = 0\,\%$

$Z\,2 = 100\,\frac{(8 - 6)}{8} = 25\%$ $\qquad K\,2 = \frac{100 \times 2}{8} = 25\,\%$

$Z\,3 = 100\,\frac{(16 - 12)}{16} = 25\%$ $\qquad K\,3 = \frac{100 \times 4}{16} = 25\,\%$

Total Inbreeding Coefficient =

$$Z\,Tn = \frac{100\,E\,^{Zn}_{Z1}}{K\,Tn} = \frac{100 \times 50}{212.5} = 23.5\,\%$$

Total Relationship Coefficient =

$$K\,Tn = \frac{2\,E\,^{Kn}_{K1}}{n} = \frac{2 \times 50}{3} = 33.3\,\%$$

The Relationship Inbreeding Index =

$$K\,Z\,Tn = \frac{100 \times E\,^{Kn}_{K1}}{E\,^{Zn}_{Z1}} = \frac{100 \times 50}{50} = 100\,\%$$

In the pedigree of Lucile 199705 we have the first occurence of two primary reappearances in the third ancestral generation, giving an inbreeding coefficient of 23.5 percent.

Scottish Prince 250444 and The Dutchman 282689 which occur in the pedigree of the sire, primarily reappear in the pedigree of the dam, therefore the inbreeding in the pedigree of Lucile 199705 is all due to relationship. Only one other pedigree occurs with the same value as that of Lucile 199705.

Carries Last 218404 (Abbotsburn 243458
(Carrie Abbotsburn

1918 - Aged Shorthorn Cow - 1st prize

Senior Yearling Shorthorn Bull
First Prize
1912

Leader of Fashion 300790

(White Hall Marshall 209776
(Bapton Sultan 168570
(White Hall Sultan 163573
(Imp. Bapton Pearl
(Lord of Faine
(Imp. Missie 167th
(Missie 147th
(Fortune 164137
(Bulwark 228401
(Butterfly 27th
(Imp. Shenstone Princess
(Idol 201627
(Imp. Twin Princess 9th
(Twin Princess 7th

Gloster Fashion 350512

(White Hall Marshall
x (Bapton Sultan 168570
• (White Hall Sultan 163573
x (Imp. Bapton Pearl
x (Lord of Faine 157722
x (Imp. Missie 167th
x (Missie 147th

Anoka Gloster 2nd

(Anoka Gloster
(Best of Archers 141832
(Scottish Archer 117301
(Bredna
(Owen of Scots 5th
(Baron Gloster 101657
(Queen of Scots

Table I. Pedigree elimination table of Gloster Fashion 350512

Name of animal primarily reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
White Hall Marshall	0	1	2	4
Total	0	1	2	4

Table II. Pedigree elimination table of Leader of Fashion 300790 (sire)

Name of animal primarily reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
Animal	0	0	0	0

Table III. Pedigree elimination table of Anoka Gloster 2nd (dam)

Name of animal primarily reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
Animal	0	0	0	0
Combined totals of Tables II and III =	0	0	0	0
Difference between totals of Tables II and III and of Table I =	0	1	2	4

Then $Z\,0 = 0\,\%$ $\qquad K\,0 = 0\,\%$

$Z\,1 = 100\,\frac{(4-3)}{4} = 25\,\%$ $\qquad K\,1 = \frac{100 \times 1}{4} = 25\,\%$

$Z\,2 = 100\,\frac{(8-6)}{8} = 25\,\%$ $\qquad K\,2 = \frac{100 \times 2}{8} = 25\,\%$

$Z\,3 = 100\,\frac{(16-12)}{16} = 25\%$ $\qquad K\,3 = \frac{100 \times 4}{16} = 25\,\%$

Total Inbreeding Coefficient =

$$Z\,Tn = \frac{100 \times \overset{Zn}{E\ Z1}}{K\,Tn} = \frac{100 \times 75}{212.5} = 35.2\ \%$$

Total Relationship Coefficient =

$$K\,Tn = \frac{2 \times \overset{K2}{E\ K1}}{n} = \frac{2 \times 75}{3} = 50\ \%$$

Relationship Inbreeding Index =

$$K\,Z\,Tn = \frac{100\ \overset{Kn}{E\ K1}}{\underset{Z\ 1}{E\ Z\ n}} = \frac{100 \times 75}{75} = 100\ \%$$

In the pedigree of Gloster Fashion 350512 occurs the first primary reappearance of an animal in the second ancestral generation. White Hall Marshall 209776 is the sire of Leader of Fashion 300790 and Anoka Gloster 2nd, sire and dam respectively of Gloster Fashion. The inbreeding coefficient is therefore 35.2 per cent. The inbreeding in the pedigree is all due to relationship between sire and dam of Gloster Fashion 350512. The two pedigrees listed below have the same value as the pedigree under discussion.

Gloster Fashion 350512 (Leader of Fashion 300790
(Anoka Gloster 2nd

1913 - Shorthorn Bull - 2 yrs. and under 3 yrs. - 1st prize

Goldies Ruby 576035 (Master Ruby 446601
(Goldie's Rose 183035

1920 - Aged Shorthorn Cow - 1st prize

Shorthorn Cow, 3 yrs. or over
Second Prize
1916

Avondale 245144
- (White Hall Sultan (163573
  - (Bapton Sultan (163570
    - (Bapton Victor
    - (Moon Daisey
  - (Imp. Bapton Pearl
    - (Count Lavender (122875
    - (Primrose 2nd
- (Imp. Avalance 2nd
  - (Mescombe 222700
    - (Captain Lavender (222673
    - (Meadow Pip 7th
  - (Avalanche
    - (Sittyton Scarlet
    - (Averne 10th

Maxwalton Mina 8th 176765
Calved Oct. 20, 1912

Maxwalton Mina 2nd 86601
- (Avondale 245144
  - x (White Hall Sultan
    - (Bapton Sultan (163570
    - (x (Imp. Bapton Pearl
  - x (Mescombe 222700
    - (x (Imp. Avalanche 2nd
    - (x (Avalanche
- (Mina Princess 4th (12641
  - (White Hall Count (209775
    - • (White Hall Sultan (163573
    - (Cresent (Imp)
  - (Mina Princess 3rd 58 - 630
    - (Royal Canada 136788
    - (Mina Princess 2nd

Table I. Pedigree elimination table of Maxwalton Mina 8th.

Name of Animal primarily reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
Avondale	0	1	2	4
White Hall Sultan	0	0	0	1
Total	0	1	2	5

Table II. Pedigree elimination table of Avondale 245144 (sire)

Name of Animal primarily reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
Animal	0	0	0	0

Table III. Pedigree elimination table of Maxwalton Mina 2nd 86601

Name of Animal primarily reappearing	Ancestral generation in which primary reappearance occurs			
	1	2	3	4
White Hall Sultan	0	0	0	1
Total	0	0	0	1
Combined totals of Tables II and III =	0	0	0	1
Difference between total of Tables II and III and of Table I =	0	1	2	4

Then $Z\,0 = 0\,\%$ $\qquad K\,0 = 0\,\%$

$Z\,1 = 100\,\frac{(4-3)}{4} = 25\%$ $\qquad K\,1 = \frac{100 \times 1}{4} = 25\,\%$

$Z\,2 = 100\,\frac{(8-6)}{8} = 25\%$ $\qquad K\,2 = \frac{100 \times 2}{8} = 25\,\%$

$Z\,3 = 100\,\frac{(16-11)}{16} = 31.25\%$ $\qquad K\,3 = \frac{100 \times 4}{16} = 25\,\%$

Total Inbreeding Coefficient =

$$Z\,Tn = \frac{100\,\frac{E\,Zn}{N1}}{F\,Tn} = \frac{100 \times 81.25}{212.5} = 38.2\,\%$$

Total Relationship Coefficient =

$$K\,Tn = \frac{2\,E\,\frac{Kn}{K1}}{n} = \frac{2 \times 75}{3} = 50\,\%$$

Relationship Inbreeding Index =

$$K\,Z\,Tn = \frac{100 \times E\,\frac{Kn}{K1}}{E\,\frac{Zn}{Z1}} = \frac{100 \times 75}{81.25} = 92.3\,\%$$

The pedigree of Maxwalton Mina 8th 176765, shows that she is produced to a mating of Avondale 245144, sire of the individual under discussion, to his daughter, Maxwalton Mina 2nd. This is the only occurence found in the one hundred and sixty Shorthorns of this in the first ancestral generation.

The breeding due to relationship is 90.3%, the remainder being due to the primary reappearance of White Hall Sultan in the pedigree of the dam.

Junior Yearling Shorthorn Heifer
Second Prize
1920

Revolution 388859

(Avondale 245144
(Roan Rosebud 12th 59553

(White Hall Sultan 163573
(Avalanche 2nd
(Damon 317068
(War Queen 52-873E

(Bapton Sultan
(Bapton Pearl
(Mescombe 222700
(Avalanche
(Scottish Wanderer 317104
(Dashing Girl
(Centaur (70118)
(Roan Rosebud 3rd

Maxwalton Mina 20th 811188
Calved Jan. 20, 1919

Maxwalton Mina 8th 176765

(Avondale 245144
(Maxwalton Mina 2nd 86601

x (White Hall Sultan 163573
x (Avalanche 2nd
• (Avondale 245144
(Mina Princess 4th 12641

x (Bapton Sultan
x (Bapton Pearl
x (Mescombe 222700
x (Avalanche
x (White Hall Sultan 163573
x (Avalanche 2nd
(White Hall Count 209775
(Mina Princess 3rd

Table I. Pedigree elimination table of Maxwalton Mina 20th

Name of Animal primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Avondale	0	1	2	4
Avondale	0	0	1	2
Total	0	1	3	6

Table II. Pedigree elimination table of Revolution 388359 (sire)

Name of Animal primarily reappearing	Ancestral generation in which Primary reappearances occur			
	1	2	3	4
None	0	0	0	0

Table III. Pedigree elimination table of Maxwalton Mina 8th (dam)

Name of Animal primarily reappearing	Ancestral generation in which primary reappearances occur			
	1	2	3	4
Avondale	0	0	1	2
Total	0	0	1	2
Combined totals of Tables II and III =	0	0	1	2
Difference between combined totals of Tables II and III and of Table I =	0	1	2	4

Then $Z\,0 = 0\,\%$ $\quad K\,0 = 0\%$

$$Z\,1 = \frac{100\,(4-3)}{4} = 25\,\% \quad K\,1 = \frac{100 \times 1}{4} = 25\,\%$$

$$Z\,2 = \frac{100\,(8-5)}{8} = 37.5\% \quad K\,2 = \frac{100 \times 2}{8} = 25\,\%$$

$$Z\,3 = \frac{100\,(16-10)}{16} = 37.5\% \quad K\,3 = \frac{100 \times 4}{16} = 25\,\%$$

Total Inbreeding Coefficient =

$$Z\,Tn = \frac{100 \times E^{Zn}\,Z1}{212.5} = \frac{100 \times 100}{212.5} = 47.05\,\%$$

Total Relationship Coefficient =

$$K\,Tn = \frac{2\,E^{Kn}\,K1}{n} = \frac{2 \times 75}{3} = 50\,\%$$

The Relationship Inbreeding Index

$$K\,Z\,Tn = \frac{100 \times E^{Kn}\,K1}{E^{Zn}\,Z1} = \frac{100 \times 75}{100} = 75\,\%$$

In the pedigree of Maxwalton Mina 20th 811188, we have an occurence of mating Brother and Sister and of mating Sire and Daughter in the first and second ancestral generations respectively, giving a high coefficient of total inbreeding.

This pedigree is the only occurence except one of an inbreeding coefficient of 47% in the pedigrees of one hundred and sixty animals. A knowledge of the performance of her progeny would be of value.

The pedigree of Lancaster Duchess 7th 125860, second prize Junior Yearling Heifer, 1913, shows the same value as that of Maxwalton Mina 20th.

HEREFORD

The pedigrees of the Hereford animals approximate very closely the values of those of the Shorthorns, therefore representative pedigrees are not given.

The pedigrees of the animals listed below show the following values.

Coefficient of Inbreeding = 0 %

Coefficient of Relationship = 0 %

Relationship Inbreeding Index = 0 %

Condo Fairfax 807316 (Perfection Fairfax 179767 / Beau's Real Maid 353436)
1921 - Hereford Bull, 2 yrs. old - Second prize

Hazel Farmer 811744 (Farmer 426279 / Pauline 268161)
1921 - Hereford Heifer, 2 yrs. old - 1st prize

Miss Princess 782957 (Bright Lad 547628 / Vernet Princess 33rd 504480)
1921 - Hereford Heifer, 2 yrs. old - 2nd prize

Lady Ileen 5th (Bocaldo 6th 464826 / Rose Mischief 616077)
1921 - Senior Yearling Hereford Heifer - 1st prize

Tippicanoe Lula 606675 (Tippicanoe 7th 390013 / Lula 245741)
1918 - Senior Yearling Hereford Heifer - 2nd prize

Brummel Fairfax 512465 (Perfection Fairfax 179767 / Lena 139839)
1919 - Aged Hereford Bull - 2nd prize

Tippicanoe Diamond 614845 (Tippicanoe Promise 501422 / (Diamond Lucile 217674)

1919 - Hereford Bull, 2 yrs. old - 2nd prize

Miss Princess 782957 (Bright Lad 547628 / (Vernet Princess 33rd 504480)

1920 - Senior Yearling Hereford Heifer - 2nd prize

Gay Missie 834885 (Gay Lad 9th 386873 / (Sophia 470692)

1920 - Aged Hereford Cow - 1st prize

Wyoming 8th (Wyoming 505146 / (Reach 2nd 485173)

1920 - Senior Yearling Hereford Bull - 2nd prize

Bonnie Donald 612677 (Beau Donald 77th 564984 / (Bonnie Lass 2nd 217669)

1918 - Senior Yearling Hereford Heifer - 1st prize

Dolly Fairfax 547455 (Perfection Fairfax 179767 / (Dolly 450252)

1918 - Hereford Heifer, 2 yrs. old - 2nd prize

Grand Champion Wyoming 505146 (Beau Carlos 2nd 352001 / (Cora 27th 355119)

1918 - Aged Hereford Bull - 1st prize

Tippicanoe Diamond 614845 (Tippicanoe Promise 501422 / (Diamond Lucile 217674)

1918 - Junior Yearling Hereford Bull - 2nd prize

Dolly Rupert 499214 (Prince Rupert 52nd 395528 / (Beau's Dolly 379742)

1918 - Aged Hereford Cow - 2nd prize

Repeater 129th 618940 (Repeater 7th 386905 / (Bonita 399158)

1918 - Junior Yearling Hereford Bull - 1st prize

Tippicanoe Ideal 543427
(Perfection Fairfax 6th 266757
(Graceful Maid 169004
1917 - Senior Yearling Hereford Bull - 1st prize

Repeater 41st 540859
(Repeater 289598
(Harris Princess 59th 287281
1917 - Senior Yearling Hereford Bull - 2nd prize

Princeps Astor 586268
(Beau Astor 412145
(Princips Lady 372891
1917 - Junior Yearling Hereford Bull - 2nd prize

Clive Iris 3rd 545495
(Coup D'Ore 545040
(Clive Iris 2nd 545048
1917 - Aged Hereford Cow - 1st prize

Shadeland Jewel 2nd 594418
(Gay Lad 16th 316946
(Shadeland Queen 1st 339324

Tippicanoe Lula 606675
(Tippicanoe 7th 390013
(Lula 245741
1918 - Senior Yearling Hereford Heifer - 2nd prize

Clive Iris 3rd 545495
(Coup D'Ore 545040
(Clive Iris 2nd 545048
1916 - Aged Hereford Cow - 2nd prize

Vernet Princess 23rd 461070
(Point Comfort 14th 337488
(Indirect 326085
1916 - Hereford Bull, 2 yrs. old - 2nd prize

Vernet Princess 27th 494966
(Point Comfort 14th 339488
(Ethel 343658

Prime Lass Britisher 492703
(British Jr. 295145
(Prime Lass 2nd 173023
1916 - Senior Yearling Hereford Bull - 2nd prize

Ardmore 566000 (Bonnie Lad 20th 355369
(Lady Ellen 250605

1917 - Aged Hereford Bull - 1st prize

Golden Lad 9th 485278 (Prime Lad 38th 261816
(Aneline 6th 289137

1917 - Hereford Bull, 2 yrs. old - 2nd prize

Vigina Fairfax 36355 7 (Perfection Fairfax 179767
(Lady Real 30th 116212

1913 - Hereford Heifer, 2 yrs. old - 1st prize

Defender's Lassie 2nd 385300 (Defender 140037
(Forget Me Not 296524

1913 - Hereford Heifer, 2 yrs. old - 2nd prize

Gertrude Fairfax 388822 (Perfection Fairfax 179767
(Lovely Lady 251322

1913 - Junior Yearling Hereford Heifer - 2nd prize

Tippicanoe 7th 390013 (Tippicanoe 294100
(Miss Carnation 160770

1916 - Aged Hereford Bull - 2nd prize

Brummel Fairfax 512465 (Perfection Fairfax 179767
(Lena 139839

1916 - Junior Yearling Hereford Bull - 2nd prize

Juliet Bonnie Lass 21st 568169 (Perfection Fairfax 179767
(Joan 156910

1916 - Aged Hereford Cow - 1st prize

Byron Fairfax 344282 (Perfection Fairfax 179767
(Miss Armour Donald 183591

1912 - Hereford Bull, 2 yrs. old - 2nd prize

Corrector Fairfax 332653 (Perfection Fairfax 179767
(Likely 107730

1912 - Hereford Bull, 2 yrs. old - 1st prize

(Disturber 139989
Disturber's Lassie (
5th 369627 (Pretty Lassie 160150
1912 - Senior Yearling Hereford Heifer - 2nd prize

(Perfection Fairfax 179767
Corrector Fairfax (
332653 (Likely 107730
(1913 - Aged Hereford Bull - 2nd prize

(Tippicanoe 294100
Tippicanoe 7th (
390013 (Miss Carnation 160770
1913 - Senior Yearling Hereford Bull - 2nd prize

(Perfection 92891
Perfection Lass (
342053 (Orphan Girl 142680
1911 - Senior Yearling Hereford Heifer - 1st prize

(Perfection 92891
Perfection Lass (
342053 (Orphan Girl 142680
1913 - Aged Hereford Cow - 1st prize

(Bonnie Brae 3rd 203317
Miss Brae 29th (
342899 (Petunia 195326
1913 - Aged Hereford Cow - 2d prize

(Disturber 139989
Distributors Lassie (
4th 349146 (Pretty Lassie 160150
1912 - Hereford Heifer, 2 yrs. old - 2nd prize

(Perfection 92891
Perfection Lass (
342053 (Orphan Girl 142680
1912 - Hereford Heifer, 2 yrs. old - 1st prize

(Perfection 92891
Perfection Jr. (
373642 (Belle Donald 140th 310043
1912 - Junior Yearling Hereford Bull - 2nd prize

(Perfection Fairfax 179767
Fairfax 16th 316931 (
(Cherry Donald 189271
1912 - Aged Hereford Bull - 1st prize

Graceful Lad 3rd 367358 — (Folly's Lad 177956 / (Graceful Maid 169004

1912 - Senior Yearling Hereford Bull - 1st prize

Beau Columbus — (Beau Roland 102767 / (British Columbia 215952

1911 - Aged Hereford Bull - 1st prize

Gay Lad 6th 316936 — (Prime Lad 16th 213969 / (Sister Perfection 139658

1911 - Hereford Bull, 2 yrs. old - 1st prize

Fairfax 16th 316931 — (Perfection Fairfax 179767 / (Cherry Donald 189271

1911 - Hereford Bull, 2 yrs. old - 2nd prize

Corrector Fairfax 332653 — (Perfection Fairfax 179767 / (Likely 107730

1911 - Senior Yearling Hereford Bull - 1st prize

Young Gleed 356409 — (Gleed 259477 / (Gentle Zephr 164294

1911 - Junior Yearling Hereford Bull - 2nd prize

Princess 16th 288350 — (Princeps 4th 143394 / (Arminta 4th 159982

1911 - Aged Hereford Cow - 2nd prize

Lady Fairfax 4th 265180 — (Perfection Fairfax 179767 / (Miss Armour Donald 183541

1910 - Aged Hereford Cow - 1st prize

Miss Filler 2nd 230514 — (Fullfiller 107722 / (Belle Donald 20th 205176

1910 - Aged Hereford Cow - 2nd prize

Princess 16th 288350 — (Princeps 4th 143394 / (Arminta 4th 159982

1910 - Hereford Heifer, 2 yrs. old - 1st prize

(Perfection Fairfax 179767
Lady Fairfax 9th (
294557 (Miss Armour Donald 183541
1910 - Hereford Heifer, 2 yrs. old - 2nd prize

(Disturber 139989
Disturbers Lassie (
3rd 325350 (Pretty Lassie 160150
1910 - Junior Yearling Hereford Heifer - 1st prize

(Princeps 2nd 136735
Principal 6th 273293(
(Christine 146530
1910 - Aged Hereford Bull - 2nd prize

(Distributor 176433
Repeater 289598 (
(Mina 184985
1910 - Hereford Bull, 2 yrs. old - 1st prize

(Prime Lad 16th 213969
Gay Lad 6th 316936 (
(Sister Perfection 139658
1910 - Senior Yearling Hereford Bull - 1st prize

(Disturber 139989
Discounter 325348 (
(Nora 65389
1910 - Junior Yearling Hereford Bull - 1st prize

(Beau Perfect 231328
Beau Perfection (
(Vera 72399
1910 - Junior Yearling Hereford Bull - 2nd prize

The pedigrees of the animals listed below show the following values:

Coefficient of Inbreeding = 2.9 %

Coefficient of Relationship = 0 %

Relationship Inbreeding Index = 0 %

Lilly Stanway 699128 (Bright Stanway 366600 / Star 479844)

1920 - Aged Hereford Cow - 2nd prize

Harland 105500 (Prince Domino 499611 / Princess Rose 372893)

1921 - Hereford Bull, 2 yrs. old - 1st prize

Brummel Fairfax 4th (Newman Fairfax 727916 / Queen 647126)

1921 - Senior Yearling Hereford Bull - 2nd prize

Donna Woodford 5th (Woodford 1st 500001 / Jean A. Donald 497004)

1921 - Aged Hereford Cow - 1st prize

Lilly Stanway 699128 (Bright Stanway 366600 / Star 479844)

1921 - Aged Hereford Cow - 2nd prize

Belle Woodford 63d 877638 (Woodford 9th 559720 / Principess 570565)

1921 - Senior Yearling Hereford Heifer - 2nd prize

Bocaldo Beauty 720837 (Bocaldo 6th 464826 / Beauty 403192)

1919 - Junior Yearling Hereford Heifer - 2nd prize

Woodford 71st 811574 (Woodford 9th 559720 / Miss Shyness 546985)

1920 - Junior Yearling Hereford Bull - 2nd prize

Princeps Domino 793463 (Prince Domino 499611 / Princess Rose 372893)
1920 - Junior Yearling Hereford Bull - 1st prize

Hazford Bocaldo 3rd 786771 (Bocaldo 6th 464826 / Bonnie Lassie 595353)
1920 - Senior Yearling Hereford Bull - 1st prize

Belle Woodford 28th 720716 (Woodford 500000 / Lorna Lady 296538)
1920 - Hereford Heifer, 2 yrs. old - 2nd prize

Donna Woodford 5th 694193 (Woodford 1st 500001 / Jean A. Woodford 497004)
1920 - Hereford Heifer, 2 yrs. old - 1st prize

Bonnie Doris (Bonnie Lad 20th 355369 / Doris Erling 360744)
1918 - Hereford Heifer, 2 yrs. old - 1st prize

Romeo Fairfax 608237 (Perfection Fairfax 179767 / Belle Donald 33rd)
1919 - Hereford Bull, 2 yrs. old - 1st prize

Beau Woodford 714155 (Woodford 9th 559720 / Mercy 470679)
1919 - Junior Yearling Hereford Bull - 1st prize

Lena Fairfax 179767 (Perfection Fairfax 179767 / Lena 139839)
1919 - Aged Hereford Cow - 2nd prize

Lily Stanway 699128 (Bright Stanway 366600 / Star 479844)
1919 - Hereford Heifer, 2 yrs. old - 2nd prize

Belle Blanchard 63rd 685477 (Beau Blanchard 302904 / Esther 261965)
1919 - Senior Yearling Hereford Heifer - 1st prize

(Beau McDonald 75th 187361
Matron McDonald (
449302 (Majestic Matron 314203
1916 - Hereford Heifer, 2 yrs. old - 1st prize

(Prime Lad 9th 213963
Prince Brummel (
615846 (Bright Lucy 109750
1917 - Aged Hereford Bull - 2nd prize

(Bonnie Lad 20th 355369
Bonnie Doris 548959 (
(Doris Erling 360774
1917 - Junior Yearling Hereford Heifer - 1st prize

(Panama 451986
Miss Joy 560154 (
(Joy 430777
1917 - Junior Yearling Hereford Heifer - 2nd prize

(Gay Lad 9th 386873
Madam Donald 2nd (
630108 (Madam Donald 362135
1918 - Junior Yearling Hereford Heifer - 1st prize

(Perfection Fairfax 179767
Romeo Fairfax 608237(
(Belle Donald 33rd
1918 - Senior Yearling Hereford Bull - 2nd prize

(Young Beau Brummel 207148
Scottish Lassie (
305352 (The Last Rose 204731
1912 - Aged Hereford Cow - 1st prize

(Perfection Fairfax 179767
Beau Fairfax 368360 (
(Belle Donald 33rd 109873
1912 - Junior Yearling Hereford Bull - 1st prize

(Druid of Point Comfort 219625
Point Comfort 14th (
331488 (Lady Christina 204806
1913 - Aged Hereford Bull - 1st prize

(Perfection Fairfax 179767
Beau Fairfax 368360 (
(Belle Donald 33rd 109873
1913 - Hereford Bull, 2 yrs. old, - 1st prize

(Eaton Pearl 426016
Farmer 426279 (
(Fidget 426022
1913 - Hereford Bull, 2 yrs. old - 2nd prize

Fairview Prince 388031 (Prince Lad 11th 324669 / (Princess 2nd 264207

1913 - Junior Yearling Hereford Bull - 2nd prize

Crown Prince 281466 (Young Beau Brummel 207148 / (Miss Cheesevat of Sunset Farm 193128

1910 - Hereford Bull, 2 yrs. old - 2nd prize

Scottish Lassie 305352 (Young Beau Brummel 207148 / (The Last Rose 204731

1910 - Senior Yearling Hereford Heifer - 1st prize

Harris Princess 320357 (Beau Donald 5th 86142 / (Grace 141384

1910 - Junior Yearling Hereford Heifer - 2nd prize

Scottish Lassie 305352 (Young Beau Brummel 207148 / (The Last Rose 204731

1911 - Hereford Heifer, 2 yrs. old - 1st prize

Francis Brummel 343659 (Young Beau Brummel 207148 / (Mary Francis 131897

1911 - Junior Yearling Hereford Heifer - 2nd prize

The pedigrees of the animals listed below show the following values:

Coefficient of Inbreeding = 2.9 %

Coefficient of Relationship = 4.16 %

Relationship Inbreeding Index = 100 %

Banza 316601 (Beau Beauty 193235
(Manzanita 91711
1911 - Hereford Heifer, 2 yrs. old - 2nd prize

Sally 374215 (Simpson 199217
(Winsome 292858
1912 - Senior Yearling Hereford Heifer - 1st prize

Prince Real 396530 (Beau Real 15th 317645
(Princess R. 15th 325578
1913 - Junior Yearling Hereford Bull - 1st prize

Bonnie Dee 349143 (Disturber 139989
(Bonnie Brummel 126496
1917 - Aged Hereford Cow - 2nd prize

Repeater Junior 696352 (Repeater 289598
(Harris Princess 230th
1918 - Hereford Bull, 2 yrs. old - 1st prize

Repeater Jr. 696352 (Repeater 289598
(Harris Princess 230th 387367
1920 - Aged Hereford Bull - 1st prize

The pedigrees of the animals listed below show the following values:

Coefficient of Inbreeding = 5.8 %

Coefficient of Relationship = 4.16 %

Relationship Inbreeding Index = 50 %

Lady Secret 3rd (Diamond Lad 108905 / Lady Secret 149105)

1911 - Aged Hereford Cow - 1st prize

Colandine 2nd 371605 (Paragon 12th 299116 / Clematis 253235)

1912 - Junior Yearling Hereford Heifer - 1st prize

Avonmore 700001 (Duke Real 388816 / Lady Ellen 250605)

1918 - Hereford Bull, 2 yrs. old - 2nd prize

Woodford Lady 5th 503376 (Gay Lad 9th 386873 / Bonnie Lass 21st 367122)

1917 - Hereford Heifer, 2 yrs. old - 1st prize

Woodford 28th (Woodford 500000 / Miss Landholme 388949)

1919 - Senior Yearling Hereford Bull - 2nd prize

Belle Woodford 46th 811548 (Woodford 500000 / Miss Katy 497170)

1920 - Junior Yearling Hereford Heifer - 2nd prize

Carman Velie 786833 (Peerless Prince 533333 / Gipsy Mischief 552949)

1920 - Junior Yearling Hereford Heifer - 1st prize

Blayney's Domino 706077
(Prince Domino 499611
(Miss Gaiety 2nd 562830

1920 - Hereford Bull, 2 yrs. old - 2nd prize

Blayney's Domino 991345
(Prince Domino 499611
(Miss Gaiety 2nd 562830

1921 - Aged Hereford Bull - 2nd prize

Hazford Anxiety 885725
(Publican 429762
(Omeate 2nd 566709

1921 - Senior Yearling Hereford Bull - 1st prize

The pedigree of the animals listed below show the following values:

Coefficient of Inbreeding = 8.8 %

Coefficient of Relationship = 4.16 %

Relationship Inbreeding Index = 33.4 %

Donald Lad 7th 348415 (Donald Rex 270986 / Lady Lucy 212289)

1911 - Junior Yearling Hereford Bull - 1st prize

Lady Rex 394708 (Donald Rex 270986 / Prime Lady 2nd 324661)

1913 - Junior Yearling Hereford Heifer - 1st prize

Publican 4th 429762 (Publican 189221 / Blos 2nd 328056)

1916 - Aged Hereford Bull - 1st prize

Beau Franklin 566830 (Russell Fairfax 363934 / Queen Militant 386931)

1916 - Hereford Bull, 2 yrs. old - 2nd prize

Belle Blanchard 511791 (Beau Blanchard 362904 / Petrolia 12th 374321)

1919 - Aged Hereford Cows - 1st prize

Lady Donald 1st 635041 (Good Donald 625400 / Victoria 476154)

1919 - Hereford Heifer, 2 yrs. old - 1st prize

The pedigrees of the animals listed below show the following values:

Coefficient of Inbreeding = 8.8 %

Coefficient of Relationship = 8.3 %

Relationship Inbreeding Index = 66.8 %

Perfect Donald 2nd 484382
(Beau Perfection 23rd 394172
(Belle Donald 175th 372543
1916 - Senior Yearling Hereford Bull - 1st prize

Beau Perfection 48th 513979
(Beau Perfection 23rd 394172
(Belle Donald 175th 372543
1916 - Senior Yearling Hereford Bull - 2nd prize

Woodford 1st 500001
(Woodford 500000
(Belle Donald 267190
1917 - Hereford Bull, 2 yrs. old - 2nd prize

Belle Blanchard 511791
(Beau Blanchard 362904
(Petrolia 12th 374321
1918 - Aged Hereford Cow - 1st prize

Belle Woodford 794914
(Woodford 500000
(Vernial Donald 483945
1919 - Junior Yearling Hereford Heifer - 1st prize

Mischievous Jr. 791452
(The Heir 188995
(Mischievous 3rd 343220
1920 - Aged Hereford Bull - 2nd prize

Coefficient of Inbreeding = 11.7 %
Coefficient of Relationship = 0 %
Relationship Inbreeding Index = 0 %

Bonnie Lass 7th (Bonnie Brae 8th 239653 / Buttercup 233032)
1911 - Senior Yearling Hereford Heifer - 2nd prize

Bonnie Lass 10th 355376 (Bonnie Brae 8th 239653 / Meta 269916)
1911 - Junior Yearling Hereford Heifer - 1st prize

Bonnie Lass 15th 367116 (Bonnie Brae 8th 239653 / Doris 108906)
1912 - Senior Yearling Hereford Heifer - 2nd prize

Maple Lass 22nd (Bonnie Brae 8th 239653 / Lady Wilton Incomparable 130145)
1913 - Senior Yearling Hereford Heifer - 2nd prize

Lady Albany 29th 387237 (Albany 31st 341330 / Belle Donald 2nd of Herefordale 197001)
1913-Senior Yearling Hereford Heifer, 1st prize

Miss Brae 70th 491137 (Bonnie Brae 3rd 203317 / Dulcinea 6th 142312)
1916 - Junior Yearling Hereford Heifer - 2nd prize

Cavalier 645219 (Don Perfect 400000 / Coral Perfect 499082)
1918 - Senior Yearling Hereford Bull - 1st prize

Bonnie J. 595351 (Bonnie Brae 69th 417835 / Iola 430196)
1919 - Aged Hereford Bull - 1st prize

Maude Stanway 768275 (Bright Stanway 366600 / Miss Maude 373345)
1920 - Senior Yearling Hereford Heifer - 1st prize

Coefficient of Inbreeding = 14.6 %
Coefficient of Relationship = 0 %
Relationship Inbreeding Index = 0 %

Prime Lady 2nd 324661 (Honora's Beau 275089 / Prime Lass 146741)

1910 - Senior Yearling Hereford Heifer - 2nd prize

Prime Lady 2nd 324661 (Honora's Beau 275089 / Prime Lass 146741)

1912 - Aged Hereford Cow - 2nd prize

Harlequin 102500 (Bonnie Brae 60th 413606 / Rosewood 37th 511266)

1921 - Aged Hereford Bull - 1st prize

Lady Woodford (Woodford 6th 505407 / Lady Gaston 5th 550522)

1921 - Junior Yearling Hereford Heifer - 1st prize

Coefficient of Inbreeding = 14.6 %
Coefficient of Relationship = 20.3 %
Relationship Inbreeding Index = 100 %

Bocaldo 17th 685018 (Bocaldo 6th 464826 / Bloss 11th 493284)

1919 Junior Yearling Hereford Bull - 2nd prize

Domino Prince 4th (Domino Prince 603255 / Princess R. 10th 292948)

1921 - Junior Yearling Hereford Bull - 1st prize

Lady Ileen 8th 885762 (Bocaldo 6th 464826 / Princess Camulus 343685)

1921 - Junior Yearling Hereford Heifer - 2nd prize

Coefficient of Inbreeding = 14.6 %
Coefficient of Relationship = 16.6 %
Relationship Inbreeding Index = 80.3 %

Toyah 493296 (Caldo 2nd 260444 / Beldona 3rd 372141)

1916 - Junior Yearling Hereford Bull - 1st prize

Coefficient of Inbreeding = 17.6 %
Coefficient of Relationship = 16.6 %
Relationship Inbreeding Index = 66.6 %

Woodford 9th (Woodford 500000
(Belle Donald 108th 259511

1917 - Junior Yearling Hereford Bull - 1st prize

Yerba Santa 544948 (Beau Blanc 415826
(Herwina 392253

1917 - Junior Yearling Hereford Heifer - 1st prize

Coefficient of Inbreeding = 17.6 %
Coefficient of Relationship = 20.8 %
Relationship Inbreeding Index = 83.2 %

Bocaldo 6th 464826 (Bocaldo 362186
(Blueen 372147

1916 - Hereford Bull, 2 yrs. old - 1st prize

Coefficient of Inbreeding = 23.5 %
Coefficient of Relationship = 0 %
Relationship Inbreeding Index = 0 %

Paragon 21st 324449 (Beau Paragon 211322
(Amethyst 188671

1910 - Senior Yearling Hereford Bull - 2nd prize

Paragon 12th 299116 (Beau Paragon 211322
(Amethyst 188671

1911 - Aged Hereford Bull - 2nd prize

Bonnie Lad 26th 367112 (Bonnie Brae 8th 239653
(Maxine 209899

1912 - Senior Yearling Hereford Bull - 2nd prize

Standard 325950 (Bonnie Brae 8th 239653
(Tulip 333037

1912 - Aged Hereford Bull - 2nd prize

Coefficient of Inbreeding = 23.5 %
Coefficient of Relationship = 33.3 %
Relationship Inbreeding Index = 100 %

Peerfect Fairfax 332660
(Perfection Fairfax 179767
(Sister Perfection 139658
1911 - Senior Yearling Hereford Bull - 2nd prize

Beau Blanc Visage 1st
(Beau Blanc Visage 700000
(Donna Anna 39th
1919 - Senior Yearling Hereford Bull - 1st prize

Beau's Best 890000
(Beau Blanc Visage 700000
(Donna Anna 39th 492287
1920 - Hereford Bull, 2 yrs. old - 1st prize

Coefficient of Inbreeding = 26.4 %
Coefficient of Relationship = 16.6 %
Relationship Inbreeding Index = 44.4 %

Braemore 666666
(Bonnie Brae 8th 239653
(Gondola 12th 397717
1918 - Aged Hereford Bull - 2nd prize

Coefficient of Inbreeding = 35.2 %
Coefficient of Relationship = 50 %
Relationship Inbreeding Index = 100 %

Lady Perfection 3rd 504647
(Belle's Perfection 386946
(Lady Masque 26th 431646
1917 - Hereford Heifer, 2 yrs. old - 1st prize

Repeater 66th 914126
(Repeater 63rd 486426
(Miss Repeater 12th 395944
1921 - Junior Yearling Hereford Bull - 2nd prize

Coefficient of Inbreeding = 38.2 %
Coefficient of Relationship = 50 %
Relationship Inbreeding Index = 92.3 %

Elope Mischief (Bean Mischief 218371
(Penelope 4th 331621

1918 - Junior Yearling Hereford Heifer - 2nd prize

Coefficient of Inbreeding = 38.2 %
Coefficient of Relationship = 54.1 %
Relationship Inbreeding Index = 100 %

Woodford 6th 505407 (Woodford 500000
(Belle of Perfection 19th 372547

1916 -

Coefficient of Inbreeding = 49.9 %
Coefficient of Relationship = 93.7 %
Relationship Inbreeding Index = 88.2 %

Mischief Maker 6th 681567 (Bean Mischief 268371
(Gwendoline 34th 292846

1919

Prince Rupert 50th 385648 (Prince Rupert 37th 346865
(Princess R. 2nd 271101

1913 - Senior Yearling Hereford Bull - 1st prize

SUMMARY OF INBREEDING VALUES FOUND IN THE PEDIGREES

The results found by tabulation of the pedigrees for the various values of,

The Total Inbreeding Coefficient;

The Total Relationship Coefficient, and

The Relationship Inbreeding Index, are summarized as follows:

Table 2. Shorthorns (Prize Winners)

Number of Animals	Coefficient of Inbreeding percent	Coefficient of Relationship percent	Relationship Inbreeding Index percent
101	0	0	0
19	2.9	0	0
8	2.9	4.16	100
10	5.8	8.33	100
6	11.7	0	0
5	11.7	16.6	100
2	14.6	8.33	80.1
1	17.6	33.3	0
2	23.5	33.3	100
3	35.2	50	100
1	38.2	50	92.3
2	47.05	50	75
Total 160			

63.12 percent of the Shorthorn pedigrees show no inbreeding.

80 percent of the pedigrees show 2.9 percent or less of inbreeding.

96.25 percent of the pedigrees show less than 25 percent of inbreeding.

Table 3. Herefords (Prize Winners)

Number of Animals	Coefficient of Inbreeding percent	Relationship percent	Relationship Inbreeding Index percent
63	0	0	0
34	2.9	0	0
6	2.9	4.16	100
10	5.8	4.16	50
6	8.8	4.16	33.4
6	8.8	8.3	66.8
9	11.7	0	0
4	14.6	0	0
4	14.6	20.3	100
3	17.6	16.6	66.6
5	23.5	0	0
1	26.4	16.6	44.4
3	23.5	33.3	100
2	35.2	50	100
2	38.2	50	92.3
2	50	93.7	88.2
Total 160			

39.37 percent of the Hereford pedigrees show no inbreeding.

64.37 percent of the pedigrees show 2.9 or less percent of inbreeding.

93.75 percent of the pedigrees show less than 25 percent of inbreeding.

The results found from an analysis of the pedigrees of the Shorthorns and of the Hereford animals taken from the sale association catalogs are as follows:

Table 4. Herefords (Sale Catalogue Representatives)

Number of Animals	Coefficient of Inbreeding percent	Relationship percent	Relationship Inbreeding Index percent
82	0	0	0
30	2.9	0	0
10	5.8	0	0
2	5.8	4.16	50
2	8.8	4.16	33.4
8	11.7	0	0
2	11.7	8.3	50
1	11.7	4.16	25
1	11.7	16.6	100
2	14.6	0	0
3	14.6	16.6	80
1	14.6	20.8	100
1	17.6	8.33	33
3	35.2	50	100
1	37.2	0	0
1	47	50	75

In the first four ancestral generations 54.66 percent of these pedigrees show no inbreeding; 74.66 percent show 2.9 percent or less, and 96.66 percent show less than 25 percent.

Table 5. Shorthorns (Sale Catalogue Representatives)

Number of Animals	Coefficient of Inbreeding PERCENT	Relationship PERCENT	Relationship Inbreeding Index PERCENT
118	0	0	0
7	2.9	0	0
2	5.8	0	0
2	5.8	4.16	50
1	5.8	8.3	100
7	11.7	0	0
4	11.7	16.6	100
1	11.7	4.16	50
1	18.6	20.8	83.2
1	23.5	16.6	50
4	35.2	50	100
2	47.04	66.6	100

In the first four ancestral generations 78.66 percent of these pedigrees show no inbreeding, 83.33 percent show 29 percent or less, and 96 percent show less than 25 percent of inbreeding.

Table 6.
Comparison of the results found for the pedigrees
of the Shorthorn and of the Hereford prize winning animals.

Amount of Inbreeding	Shorthorns percent	Herefords percent
No Inbreeding	63.12	39.37
2.9 or less percent	80.00	64.37
12 or less percent	93.12	83.75
25 or less percent	96.25	93.75

Table 7.
Comparison of Shorthorns

High merit animals vs. Sale catalog representatives

No Inbreeding	63.12	78.66
2.9 or less percent	80.00	83.33
12 or less percent	93.12	94.66
25 or less percent	96.25	96.00

Table 8.
Comparison of Herefords

High merit animals vs. Sale catalog representatives

No Inbreeding	39.37	54.66
2.9 or less percent	64.37	74.66
12 or less percent	83.75	92.00
25 or less percent	93.75	96.66

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DISCUSSION OF DATA

Table 6 indicates that more inbreeding has been practiced to produce the prize winning Hereford animals than there has to produce the prize winning Shorthorns.

From Table 7 we conclude that more inbreeding, of a low degree such as 2.9 percent, has been used to produce the prize winning animals than to produce animals represented by sale catalogue individuals. Of particular significance is the fact that the number are practically identical in both classes which have been produced by more than 25 percent of inbreeding; Apparently a high percentage of inbreeding in the pedigree of an animal is not a guaranty of excellence. Objections may be raised to the last statement to the effect that those animals belonging to the sale catalogue class and with a high percentage of inbreeding had no chance of showing their potential excellence due to being in herds where showing was not practiced; To conclusively answer this objection would require an analysis of the pedigrees of all of the animals which were shown but did not receive recognition and also all of the animals produced in the herds from which the prize winners were taken but which did not possess excellence sufficient to be fitted for show.

Consideration of Table 8 leads to the same conclusion as that drawn from Table 7, which is that the prize winning Hereford animals were more inbred than the sale catalogue representatives.

An inbreeding coefficient of 2.9 percent means that one animal appeared twice in the fourth ancestral generation, and therefore a coefficient

of that value may be considered of little or no significance and would indicate that the breeders were avoiding inbreeding and resorting to outbreeding to produce their animals. On this basis the data given in Table 6, 80 percent of the prize winning Shorthorns and 64.37 percent of the prize winning Herefords with 2.9 percent or less of inbreeding, - indicate that outcrossing is the most favored principle of breeding.

Comparing the figures in Tables 7 and 8 for the various values of inbreeding, shows that while 23.75 percent more of the Shorthorn than of the Hereford had no inbreeding and 15.63 percent more had 2.9 percent or less of inbreeding, that a difference of only 2.50 percent is noted in those having more than 25 percent of inbreeding. Notwithstanding the fact that more inbreeding has been used with the Hereford cattle, the proportion with a relatively high degree of inbreeding are small, indicating that intensive inbreeding has not been successful with either breed of cattle.

What significance attaches to the fact that 80 percent of the Shorthorn and 64.37 percent of the Hereford pedigrees showed 2.9 percent or less of inbreeding? Have breeders found that animals produced by inbreeding do not possess the excellence required of show yard animals or are they suspicious of evil results from inbreeding, thus have not followed that practice? The solution to these questions may be indicated by a consideration of the methods used by early breeders and of literature dealing with the subject of inbreeding.

REVIEW OF LITERATURE

(a) Methods of Foundational Breeders and Findings of Geneticists and Scientists.

Mr. Wriedt (28) representative of the Norwegian Department of Agriculture, states "That apart from a few professional geneticists and a few great breeders, those concerned with live stock in the United States still display a good deal of suspicion and misunderstanding of the use of inbreeding."

The German Genetic Association (29), with which pedigree study is the keynote of their activity, have found that in every breed the valuable strains or families are found to contain the names of a very few ancestors, repeated a great many times. In short, that the valuable part of any breed is due to a small number of animals, usually sires, these sires which we would call prepotent have been used as much as possible through inbreeding and line breeding.

"The secret of the great successes in live stock breeding then appears to be merely that the valuable blood lines were picked out and conserved through inbreeding."

That inbreeding does not lead to disaster is exemplified by the breed of Kladrub horses in Bohemia. The breed is a very small one, rarely consisting of more than one hundred individuals. New blood is very seldom introduced into this breed and because of the small number of animals existing, inbreeding has been quite close for several centuries. The Kladrub horses probably represent in their history more inbreeding than any living breed. There has been no diminution in fertility nor any

increase in the number of weak or defective animals. Although slow in maturing they remain vigorous to a very advanced age. (30)

Marshall (31) a noted authority on British livestock, writes at the close of the 18th century on the question of inbreeding: "The means of improvement in the established practice of the kingdom at large are those of selecting females from the native stock of the country and crossing with males of an alien breed, under an opinion which has been universally received, that continuing to breed from the same line of parentage tends to weaken the breed."

"Rooted, however, as the opinion has been and universally as that practice has prevailed, there is little doubt of the fact that the superior breeds of livestock of this district have been raised by a practice directly contrary, that of inbreeding not from the same line only, but from the same family." "The sire and the daughter, the son and the mother, the brother and the sister are in the ordinary practice of superior breeders, now permitted to improve their own kind."

Culley (32) was a stronger advocate of inbreeding than Marshall. "Mr. Bakewell has not had a cross for upward of twenty years: His best stock have been bred by the nearest affinities, yet they have not decreased in size, neither are they less hardy or more liable to disorder, but on the contrary have kept in a progressive state of improvement."

By the example of the half wild cattle in Chillingham Park in Northumberlandshire, Culley seeks to demonstrate that even long continued inbreeding is harmless. This race, the purest breed in Europe, is hardy, sound and of good form and has not changed in color for more than five hundred years.

Kraemer (33) states that the numerous examples from Shorthorn herds show that consanguineous breeding of a very wide extent may be practiced without leading to the extinction of the herd. They do not show however, that continuous inbreeding is in itself uninjurious. Darwin shows that even Collins practiced crossing and while Bates practiced close inbreeding for thirteen years, yet during the next seventeen years he was obliged three times to introduce new blood into his herd.

With sheep, according to Darwin (33) inbreeding has been much practiced. Messrs. Brown are said never to have introduced new blood into their Leicesters during fifty years. Mr. Barford in the course of half a century had come to the conclusion that inbreeding did no harm, if practiced on animals quite sound in constitution.

Kraemer (34) states that Cornevin made limited experiments in inbreeding his own cattle, sheep and swine very closely. His Hollanders were inbred for twelve and his Jerseys for seven years without showing any evil results, and the prizes which the animals won each year at district shows certainly indicate that they did not present evidence of degeneracy.

Kraemer (35) expresses his personal opinion as follows: "Continued inbreeding always must result in weakened constitution through its own influence."

McCombie (36) one of the founders of the Aberdeen Angus breed of cattle says :- "Breeding in-and-in has some advantages and many advocates. My own experience led me to adopt a middle course: That experience has not been in favor of the system; By adhering to it I found that quality was maintained and even improved, but size was reduced and symptoms of delicacy of constitution were manifested. It may be pursued for a time

until the type is developed, but to continue for any length of time to breed in-and-in is not only against my experience but I believe against nature."

De Chapeaurouge (37) is specific in his belief that every argument against inbreeding must cease when the pedigrees of Bolingbroke and Comet are considered. He believes that prepotency only comes about through inbreeding or as a result of animal sports.

As evidence that prepotency does not come about necessarily through inbreeding are outstanding sires such as White Hall Sultan 163573, Avondale 245144, Villager 295884, and Perfection Fairfax 179767. These are considered the most prepotent sires of the last two decades, yet in four ancestral generations the pedigrees of White Hall Sultan 163573 and Perfection Fairfax 179767 show no inbreeding, and those of Avondale 295144 and Villager 295884 show only 2.9 percent.

The leading sires of prize winning animals from 1910 to 1921 at the International Live Stock Exposition are ranked as follows:

Avondale 245144

Villager 295884

Glenbrook Sultan 243185

Cumberland's Last 229822

Fouracres Sultan 354154

White Hall Sultan 163573

Revolution 388359

Sultan Stamp 334974

Radium 385197

Master Ruby 446601

Gladstone 239315

Maxwalton Pride 367542

Double Dale 337156

Lespedeza Sultan 406929

Dale Clarion 385195

From this list the following are those which show 2.9 percent or less of inbreeding:

Avondale

Villager

White Hall Sultan

Maxwalton Pride

Lespedeza Sultan

Sultan Stamp

Revolution

Fair Acres Sultan

Cumberland's Last

Double Dale 337156 appears thirteenth in the list of fifteen. His coefficient of inbreeding is 35.2 percent. From these facts the conclusion which must be drawn is that the great sires of recent times have not been produced by inbreeding.

(b) Experimental Evidence Relative to Inbreeding.

Ritzema Bos (38) was one of the first biologists to bring forward experimental evidence of value from animal breeding. His foundation stock consisted of seven young rats of one litter coming from the mating of an Albino female to an Agouti male. An unrelated Albino male was bred to two of the seven foundation animals and after this no new blood was introduced into the colony. The colony was continued for six years or thirty generations through the mating of animals of or from the original seven. The most common types of mating were between parents and offspring and between brothers and sisters.

The average size of litters - 1887 - 7½; 1888 - 7-1/7; 1889 - 7-12/17; 1890 - 6-7/12; 1891 - 4-7/12; and 1892 - 3-1/5 individuals. The certainty of pregnancy varied during the experiment as the table shows;

Percentage of Unsuccessful matings

1887	1888	1889	1890	1891	1892
0	2.63	5.55	17.39	50	41.18

Bos noted that the pairing of brothers and sisters afforded much worse results than the pairing of mother and son or father and daughter.

The mortality rate among the offspring is shown by the table below which shows the percentage of deaths among the young during the four weeks period of greatest loss during the respective years.

1887	1888	1889	1890	1891	1892	
3.9	4.4	5.	8.7	36.4	45.5	percent

Conclusions drawn from this experiment covering six years and embodying the study of several thousand rats.

(1) The number of sterile matings increased.

(2) The average number of young in a litter decreased.

(3) The ability of the young to survive as well as the power of the mother to successfully rear them largely decreased.

(4) It seems also to cause a decrease in body size after many generations.

(5) It is possible but not proven, that continued inbreeding of closest relatives causes a greater predisposition to disease and deformities.

Weisman (39) inbred mice for twenty-nine generations and this work was continued by Von Guaita.

Generation	No. of Young	No. of Litters	Avg. per litter
1 - 10	1345	219	6.1
11 - 20	252	62	5.6
21 - 29	124	29	4.2

Von Guaita started with the last generation of Weismann's stock viz. the twenty-ninth and reports the following results:

	Avg. No. of Young per litter
1st and 2nd generations	3.5
3rd and 4th "	3.6
5th and 6th "	2.9

There is a decrease in size of litters, 52.4 percent between Weisman's first ten generations and Von Guaita's third and fourth generations.

Castle (40) and assistants inbred Drosophila brother and sister matings for fifty-nine generations in a low producing strain, without obtaining a diminution in either the vigor or the fecundity of the race. Nevertheless, crossing of two inbred strains of Drosophila, both of which were doing well under inbreeding, produced offspring superior in

productiveness to either inbred strain. Even in this case, therefore, though inbreeding is tolerated cross breeding has advantages.

The Bureau of Animal Industry (41) has made experiments on the subject of inbreeding involving more than 26000 guinea pigs. A number of distinct families have been maintained wholly by matings of brother with sister. The fact that one of these has reached the twentieth generation without any conspicuous decline in vigor in any respect is further evidence that the evils of inbreeding are by no means as great as often pictured. Other families, however, suffered a rapid decline and some decline is shown by the average of all families.

The great difference between families confirm the suggestion that inbreeding is merely likely to lead to decline in vigor but does not necessarily do so. One family lost markedly in vitality but not in size or fertility. In another the reverse was the case. In fact, nearly all combinations of favorable or unfavorable characteristics were represented by one or more families after a number of generations of inbreeding.

The results of crosses between different inbred families made distinctly better gains and a larger percentage were raised of those born alive than in their inbred cousins raised at the same time under the same conditions. The cross bred females had much larger litters and have them more frequently. More of their young are born alive and the birth weights are greater than of young born of inbred dams.

Crampe (42) started with a litter of five rats, obtained by crossing an Albino female with a white and gray male. These animals were inbred in various degrees for seventeen generations. During the

experiment many rats showed great susceptibility to disease, divers kinds of abnormalities, diminished fertility and increased total sterility.

King (43) started with a litter of four slightly undersized but otherwise normal Albino Norway rats, two males and two females. From these females two lines, A and B, were carried on for twenty five generations by mating brother and sister. At first the inbred rats exhibited many of the defects reported by Crampe. Numerous females were either sterile or produced but one or two small litters. Other animals were characterized by low vitality, dwarfing and malformations. Stock rats exhibiting the same characteristics at this time, however, led to a change in food following which the "dire effects of inbreeding" practically disappeared. Whether this improvement in the colony was due entirely to the change of diet or may be attributed partly to selective elimination of the weaker rats cannot be determined. By selection vigorous, uniform strains were built up, strains somewhat larger, more fertile and longer lived than many strains of stock rats.

Inbreeding has but one demonstrable effect on organisms subjected to its action; the isolation of homozygous types. The diversity of the resulting types depends directly upon the number of heterozygous hereditary factors present in the individuals with which the process is begun; it is likely therefore, to vary directly with the amount of cross breeding experienced by their immediate ancestors. The rapidity of the isolation of homozygous types is a function of the tendency of inbreeding.(44)

SUMMARY

The correlation established by this study between showyard winnings and inbreeding and outbreeding demonstrates that excellence and uniformity are not dependent upon the concentration of blood lines through inbreeding.

The great sires, in the last two decades, of the Shorthorn and Hereford breeds, have not been produced by inbreeding. The descendant of these sires have supplied the larger proportion of prize winners at the Live Stock Exposition, Chicago from 1910 to 1921. The greater percentage of their pedigrees show none or no appreciable amount of inbreeding.

The relationship existing between the pedigrees of the prize winning animals and those selected from the sale catalogues indicates that a larger proportion of a relatively small percentage of inbreeding is found in the former representing a small amount of concentration of blood of the prepotent sires, but when a high degree of inbreeding (25% or more) is considered the number is practically identical in both classes. The important question with the breeder is not what amount of inbreeding has occured in an animal's pedigree, but whether or not the animal is vigorous and fertile, and of this, direct observation is the best and only safe criterion.

The experimental evidence indicates that decline in vigor and fecundity has no necessary relation to the amount of inbreeding which has occured in the ancestry. Vitality and fertility are requisites and both must be possessed in a high degree by any individual or family that is to figure much in descent; consequently the method of breeding, be it inbreeding or outbreeding, must be subservient to the principle of selection.

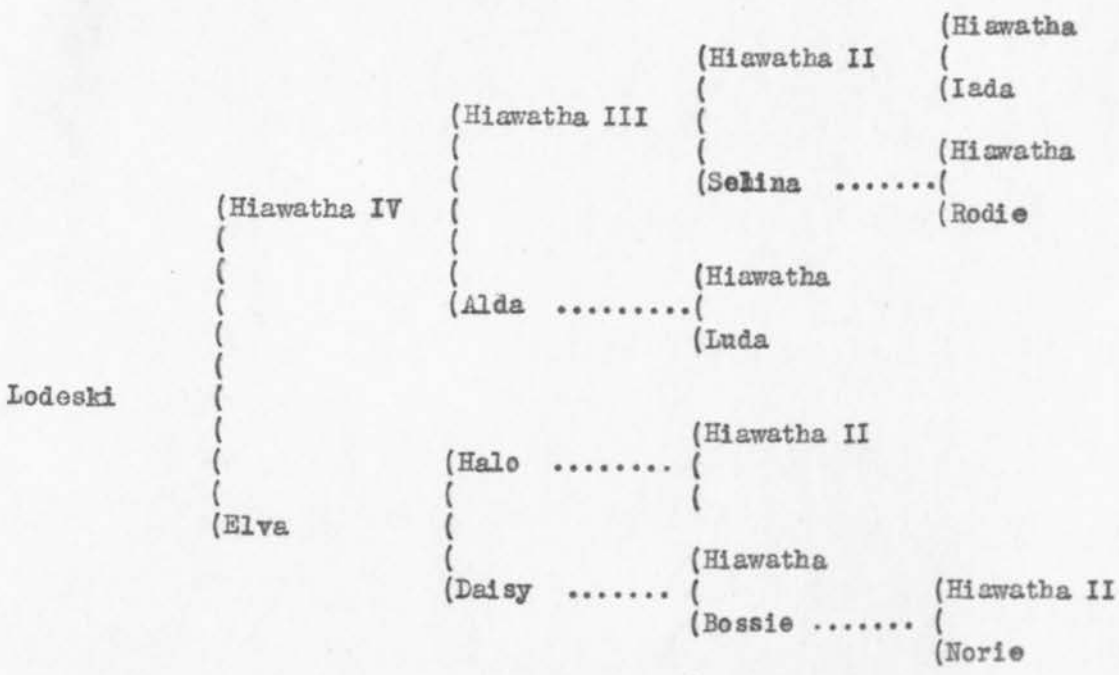
APPENDIX

Throughout this thesis the term "inbreeding" has been used, and from the genetic concept correctly so, to cover all occurences where one or more animals made primary reappearances in the first four ancestral generations, or expressed in another form, where fewer actual ancestors appeared in a given generation than the total possible number. This is the terminology used in most discussions of animal breeding from the genetic standpoint.

There is a form of inbreeding called linebreeding which is the most frequent method of inbreeding used by present day breeders. The term,"linebreeding", is however, very often improperly used therefore an example of linebreeding is given in order to define the terms inasmuch as many of the animals considered in the thesis were linebred animals.

The term "linebreeding" was used by the early breeders to cover only one plan of inbreeding. When one of the old time breeders found an animal, sire or dam, that possessed one or more characters that he especially desired to perpetuate, he bred that animal upon his own progeny or upon some animal closely related to him that resembled him in the desired points or characteristics. Such mating is the beginning of a system of linebreeding and the offspring of such mating can be said to be linebred for one generation. But to carry out a system of linebreeding so that the future progeny can be said to be linebred, the results of each mating must be bred to animals closely related to the original sire or dam. An animal may be closely inbred from generation to generation and still be carrying less of the blood of a certain ancestor. While by linebreeding the proportion of that blood may be constantly increased.

Pedigree showing example of linebreeding (45).



The animal Lodeski is linebred to Hiawatha. The only animals in the pedigree that do not carry Hiawatha blood are Jada, Rodie, Luda and Norie. The blood of Hiawatha has been perpetuated and intensified.

If Iada was mated to a son of Rodie and the offspring is mated with a descendant of Luda and the offspring is then mated with Lodeska, not one of these animals is related to Hiawatha although they are related to each other and to Lodeski. The use of such offspring upon Lodeski would be inbreeding but it would not be linebreeding with reference to Hiawatha. Thus while linebreeding is always inbreeding, there are many forms of inbreeding that are not linebreeding. Linebreeding is the type of inbreeding however, that has received most attention from the practical live stock breeder, and probably will be the form of inbreeding that will prove of greatest value to present day breeders in the immediate future.

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