

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 Ferdinand H. Steinmetz final oral examination for the degree of Master of Science . We recommend that the degree of Master of Science be conferred upon the candidate.

Minneapolis, Minnesota

May 31, 1921

Alamy

Chairman

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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 Ferdinand H. Steinmetz 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.

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A CLASSIFICATION OF FIELD BEANS, PHASEOLUS

A Thesis

Presented to the Faculty of the Graduate
School of the University of Minnesota in
Partial Fulfillment of the Requirements

For the Degree of
Master of Science

by

Ferdinand H. Steinmetz

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TABLE OF CONTENTS

	Page
Introduction	1
Review of Literature.....	2
Methods of Procedure.....	7
Effect of Environment upon Size of Seed.....	9
Effect of locality	
Effect of rate and date of planting	
Effect of seasonal variation	
Characters Useful in Classification and Description.....	15
Seedling Characters	
Mature plant characters	
Key to Species of Phaseolus and Varieties of vulgaris.....	48
Descriptions of Varieties.....	50
Summary.....	67
Conclusions.....	68
Explanation of Plates.....	69
Bibliography.....	72

INTRODUCTION

Several classifications of beans are available including European and American varieties, but up to the present none deal specifically with species of *Phaseolus* and varieties of *P. vulgaris* grown for their dry edible seeds. The field bean growing sections are somewhat localized in the New England, North Central and Pacific Coast states ranging from Oregon to southern California and Arizona. Since the range in climate between any two extremes of the above mentioned sections is wide, it follows that varieties grown in one extreme are not adapted in another. The choice of a variety which is adapted to local conditions directly affects the yield and profitableness of the crop; hence the choice of a variety for a given locality should receive careful consideration. However, in order to be able to make this choice the identity of types and varieties must be established with certainty. There is need, therefore, of a usable classification of field varieties by which a grower may identify the variety with which he is concerned. It is the purpose of this study (1) to determine a practical basis of classification of field varieties of common beans (2) to construct a key from the material at hand based upon characters which may be usable elsewhere (3) to describe the varieties as found when grown in the environment of University Farm.

REVIEW OF LITERATURE

Georg von Martens (8)¹ published his second revised classification of garden beans in 1869. He did not distinguish garden beans from field beans. In his classification the common beans, (*Phaseolus vulgaris*), are separated into seven species according to the shape of the seed. A secondary division is based upon the color of seed.

In 1865, Fearing Burr, Jr. (1) described fifty-six varieties of *Phaseolus vulgaris*. Eight of these appear to be field varieties recognized at present.

Irish (6) described all obtainable varieties from cultures grown at the Missouri Botanical Garden in 1901. His key to varieties is based primarily on the form and color of seed. For secondary divisions he uses plant and immature pod character. In part the system used by Irish is as follows:

*Seed subglobose or very slightly flattened or elongated, smooth:

 pods terete.

 ⊕ Seed white.

Usually less than 5/16 in. largest diameter.

 Plant a climber.

 Rice

 Plant dwarf or bushy with few runners.

 Dwarf Rice

Slightly elongated, ovate, usually 5/16 - 3/8 in. long.

 Pods less than 4 in. long.

 Plant a climber.

 Prédome

 Plant dwarf.

 Dwarf Prédome

 Pods more than 4 in. long.

 Plant a climber

 Princess

 Plant dwarf.

 Dwarf Princess

1. Reference is made by number to "Literature cited" in bibliography.

Decidedly subglobose, usually more than $3/8$ in. largest diameter.

Plant a climber.

Sugar.

Plant dwarf.

Dwarf Sugar.

☞ Seed black.

Plant a climber.

**Seed distinctly elongated ovate, breadth usually $2/3$ the length or more, not usually reniform rounded or tapering or sometimes truncated. Pods subterete, rarely flattened.

☞ Seed one color.

Small, $3/8$ in. long or less, white, smooth.

Navy.

Larger than the preceding, some varieties more or less wrinkled or dented.

Seed black, pods yellow.

Plant a climber.

Indian Chief.

Plant dwarf.

Black Wax.

Seed white.

Pods yellow.

Plant a climber.

The use of dry seeds and green pods becomes impractical in that the immature pods cannot be stored conveniently for future use in identification. Further such terms as globose and subglobose may be good descriptive terms, but it is doubtful whether they have sufficient meaning in use to distinguish groups of varieties in a key. The reliability of absolute measurements may at least be questioned. However, the combined use of seed, pod, and type of plant is a step toward what undoubtedly will become a comprehensive basis for the identification of varieties. Irish states that the variety, Navy, is largely grown as a field crop.

In 1907, Tracy (11) described American varieties of garden beans, *Phaseolus*, within the three species, - *vulgaris*, *lunatus*, and *multiflorus*. His major divisions are based upon plant habit and character of green pod. A secondary division

is based upon form, size, and color of dry seed. He includes varieties of field beans. In his key the varieties of field beans are set apart according to texture of green pod. In part his system is as follows:

Plant bush - continued.

Pods more or less green in color at snap stage - continued.

Fully developed snap pod brittle, etc. - continued.

Fully developed snap pods more or less tough or not readily breaking when bent, but sufficiently free from fiber to be in general use as snaps rather than as green or dry shell beans.

Fully developed snap pods decidedly tough and so full of fiber as to be in more general use as green and dry shell beans than as snaps.

Plants very spreading or with semirunners.

Plants thick stemmed; green shell pods oval-flat and purple in color. Black Turtle Soup.

Plants thick stemmed; green shell pods very flat and green in color (except, Lightning, which is sometimes tinged with brownish purple). Emperor William, Earliest Market, etc.

Plants thick stemmed; green shell pods changing to oval or nearly so and green in color. White Marrow, etc.

Plants slender stemmed; green shell pods changing to oval or nearly so and green in color. Snowflake, Navy, etc.

Plants erect or at least devoid of semirunners, except Boston Favorite.

Seeds of solid white color. White Kidney, Vineless Marrow, etc.

Seeds of solid brownish or violet shades. Red Kidney, etc.

Seeds splashed with violet, red, or similar colors with generally a pale buff as the predominating color. Boston Favorite, etc.

Tracy has made a fairly clear distinction between field and garden varieties of common beans based upon texture of green pod. However, when this com-

parison is extended to the dry mature pod the distinction becomes more apparent. Dry pods of field beans are fibrous and dehisce at the sutures while the dry pods of garden beans are brittle, contain relatively little fiber, and break in cross section rather than dehisce at the sutures during threshing.

The terms thick stemmed and thin stemmed are too indefinite to be of value in placing plants with stems intermediate in thickness. Tracy refers specifically to twelve varieties as field beans in his descriptions.

Jarvis (7) described American varieties of beans which he separated into three species of the genus *Phaseolus* and four other genera, -*Vicia*, *Vigna*, *Dolichos*, and *Glycine*. He utilizes color and form of seed, but bases his major classification upon size of seed and proportion of length to width. In his descriptions he groups varieties of *Phaseolus* according to type of plant and pod. In part the system used by Jarvis leading to species and varieties of *Phaseolus* is as follows:-

- A. With conspicuous lines radiating from the hilum to the dorsal margin.
Phaseolus lunatus
- AA. With no conspicuous lines radiating from the hilum to the dorsal margin.
 - B. At least 1.2 cm. in width and either pure white or light purple, the latter densely marked with black. *Phaseolus multiflorus*.
 - BB. Less than 1.2 cm. in width; if wider, some other color than white or light purple and black. *Phaseolus vulgaris*.
 - C. Of more than one color.
 - D. Part of seed white.
 - E. Predominating markings of yellow, ochraceous brown, or buff.
 - F. The yellow or buff region spotted with dark reddish brown. Concord.
 - FF. The colored region of uniform color.
 - G. Hilum with a greenish ring surrounding a brownish ring.

- H. Large clearly defined yellow blotch on ventral area; seed oval in outline. Yellow Eye.
- HH. Irregular markings on ventral area; at least 1.4 cm. in length, oblong or reniform.
 - I. Markings ochraceous yellow or brown. Vienna Forcing.
 - II. Markings, light buff. Grenell Stringless.
- GG. Hilum with only the brown ring present.
 - H. More than twice as long as broad.-Vienna Forcing.
 - HH. Not more than twice as long as broad.
 - I. At least 1.5 cm. in length. Grenell Stringless.
 - II. Less than 1.5 cm. in length.
 - J. Usually truncate at both ends; not more than 1.3 cm. in length. Old Fashioned Yellow Eye.

In the exclusive use of seed characters for the classification of varieties Jarvis makes many distinctions so minute as to greatly lessen the practical usefulness of his key. The combined use of seed, dry pod, and plant habit in a key would appear to greatly facilitate the identification of varieties. In his key he makes no separation of garden varieties and field varieties. However, in his descriptions he points out whether suited for green pod or dry shell purposes. He refers specifically to twenty-one varieties as field types.

In 1912, Freeman (4) described six native field varieties of *Phaseolus vulgaris*, namely, Pink, Bayou, Hansen, Garaypata, Red Indian, and Mottled Red Indian. In addition he first describes *Phaseolus acutifolius* var. *latifolius* as a new field species. There is incorporated a detail discussion of the origin of this new species. He concludes that it is a native of that section of the United States or Mexico. He adopts the name "tepary" which the natives use to distinguish it from the common "frijole" or kidney bean. Three varieties of "teparies" are described but he mentions that as many as forty-nine distinct forms are recognized.

In 1912, Hendry (5) described sixteen varieties of field beans adapted in California representing four genera - Vigna, Vicia, Cicer, and Phaseolus. He gives history and adaptation of the varieties described.

In 1919, Chittenden (2) grew two hundred and fifty-three stocks of beans of which two hundred and twenty-four are described as dwarf or non-climbing types. The remaining twenty-nine climbers or semi-climbers are not described. In part his system of grouping varieties is as follows:

A. Wax-pod Beans.

a. Seeds white; flowers white.

1. Young pods flattish. King of the Wax, Roi des Beurres, etc.

2. Young pods round. Early Gem.

b. Seeds black; flowers lilac.

1. Pods, at least at first, flattish oval. Prolific Wax, Saddleback Wax, etc.

2. Pods rounder when young. Pencil Pod Black Wax.

c. Seeds white with golden blotch round eye; flowers white. Golden Eyed Wax.

d. Seeds white with black markings round eye; flowers white. Brittle Wax.

e. Seeds white with slight markings round eye. New Kidney Wax.

* * * * *

B. Edible Green-podded Beans.

* * * * *

C. Tough Green-podded Beans.

a. Seeds brown; flowers lilac. Dutch Brown Type, Ne Plus Ultra, etc.

This sort of an arrangement is undoubtedly valuable as a convenience to growers, but is limited in usefulness because flowers and green pods are available only during a part of the growing season.

METHODS OF PROCEDURE

Several years ago, Mr. A. C. Army of the Minnesota Agricultural Experiment Station began making a collection of varieties of field beans. Seed from

the various bean growing sections of the United States and Canada were obtained through seedhouses, growers, and experiment stations. An effort was made to obtain seed of the main varieties grown in each of the bean growing sections of the United States, namely, the New England, North Central, Pacific Coast, and Southwestern sections. In addition a few samples were obtained from Sweden and from France. The growing of these varieties began in 1917 and was continued up until the present. Intensive work toward isolating types began with the harvesting of the 1918 crop.

From the beginning the beans have been planted in rows eighteen feet long and two feet apart with one seed dropped every three inches. In order to fix what appeared to be the true type for a given variety, commercial seed was planted in rows as described above. At harvest time typical and non-typical plants were selected and the seed planted in progeny rows for observation and increase. The rows having plants which were the most representative of a certain variety were chosen as the type. Other rows representing other types in the original sample were continued if sufficiently distinct. From the typical rows the one showing the best performance record was increased, classified, and described.

It is recognized that a certain amount of natural crossing occurs in beans. The only effort made to control this was to rogue out plants which varied from the selected type.

During the past two years where possible one hundred pods were selected from the various types at harvest time and stored in small pasteboard boxes. During the winter these pods were measured giving length and width of pod, and length of spur. From the same material the number of seeds per pod was determined and the three dimensions of one hundred seeds were taken. The weight per thousand seeds was determined from the bulk of the seed which was harvested separately for each row or plot. The seeds were counted into two lots of five hundred each for weighing.

EFFECT OF ENVIRONMENT UPON SIZE OF SEED

Among the factors affecting size of seed are locality, rate, and date of planting, and seasonal variation.

Freeman (4), Jarvis (7), and Hendry (5) use size of seed in their description of varieties. The measurements are reported in centimeters for their three dimensions. Zavitz (12) and Freeman (4) give seed weight as a descriptive characteristic. A summarized statement for a few varieties reported previously and in this study is found in Table I. It will be seen by comparing measurements in the above mentioned table that a wide variation exists. For example, the length of seeds in different years for the variety Red Kidney vary from 1.8 cm. in New York to 1.4 cm. in California. The weight per thousand seeds for different years as reported by Zavitz and in this report for the variety Red Kidney shows a wide variation in size. By examination of this table it is apparent that a classification based mainly upon size of seed may well be questioned except possibly for a particular locality.

In cooperation with the substations and cooperative experiment plots in this state Mr. Army arranged to have some of the bean varieties grown at Crookston, Grand Rapids, Duluth, Coon Creek, and Raddison Farms. From field reports at these points and determinations made from the seed samples sent to University Farm, it was possible to make a study of the effect of environment upon the size of seed produced. From Table II it is evident that for two varieties grown in 1920 there is a wide variation in size of seed. Robust beans are approximately forty percent smaller by weight grown on peat at Raddison Farm than at Grand Rapids on sandy loam. The difference is not so marked between any other two localities, but is great enough to make it questionable whether a classification of Robust beans for different localities can be based upon size of seed. The variation in size of seed produced for the variety Improved Goddard is approximately thirty percent by weight between seed grown at Grand Rapids and Crookston.

TABLE I

Measurements of Length, Width, and Thickness of Seeds and Weight per Thousand
Seeds Reported from Various Sources

Variety	: Weight per 1000 seeds in gms. :				: Length, width, and thickness of seeds in cm. :			
	: Ontario :	: Arizona :	: Minnesota :	: New York :	: Arizona :	: California :	: Minnesota :	
	: 1915 :	: 1912 :	: 1920 :	: 1908 :	: 1912 :	: 1918 :	: 1920 :	
Pearce's Imp. Tree	: 436.6 :	: ----- :	: 331.0 :	: ----- :	: ----- :	: ----- :	: 1.159 x .746 x .478 :	
Red Kidney	: 513.1 :	: ----- :	: 390.9 :	: 1.8x1x.65 cm. :	: ----- :	: 1.41x.82x.60 :	: 1.539 x .701 x .542 :	
Imp. Yellow Eye	: 462.1 :	: ----- :	: 338.1 :	: 1.25x.8x.7 cm. :	: ----- :	: ----- :	: 1.106 x .685 x .604 :	
Hansen	: ----- :	: 230.0 :	: 237.3 :	: ----- :	: 1.15x.68x.48 :	: ----- :	: 1.116 x .709 x .469 :	
Garaypata	: ----- :	: 230.0 :	: 266.8 :	: ----- :	: 1.11x.68x.40 :	: ----- :	: 1.191 x .703 x .480 :	
Red Indian	: ----- :	: 210.0 :	: 301.2 :	: ----- :	: 1.13x.68x.48 :	: 1.08x.72x.49 :	: 1.157 x .744 x .500 :	
Black Turtle Soup	: ----- :	: ----- :	: 199.4 :	: 1.15x.7x.45cm. :	: ----- :	: ----- :	: 1.044 x .599 x .402 :	

TABLE II

Variation in Size of Seed of Beans of Various Varieties Grown in Different Localities in 1920

Variety	Locality	Length of Seed cm.	Width of Seed cm.	Thickness of seed cm.	Ratio			Thickness Width Factor	Wt. per 1000 seeds in gms
					Length	Width	Thickness		
Robust (36-'18)	University Farm	.840	.584	.480	1:	.695:	.571	.822	176.8
" "	Duluth	.849	.625	.508	1:	.736:	.598	.813	185.8
" "	Crookston	.893	.651	.539	1:	.739:	.603	.828	205.2
" "	Grand Rapids	.872	.682	.564	1:	.782:	.647	.827	236.2
" "	Coon Creek Sand	.840	.577	.452	1:	.687:	.539	.783	157.4
" "	Raddison Peat	.785	.569	.446	1:	.725:	.568	.787	133.0
Improved Goddard									
(1098a-'19)	Duluth	1.603	.798	.593	1:	.498:	.369	.743	529.0
" "	Crookston	1.522	.727	.565	1:	.477:	.371	.777	380.8
" "	Grand Rapids	1.615	.818	.604	1:	.507:	.374	.738	550.0
" "	University Farm	1.529	.765	.534	1:	.500	.349	.698	435.7

The above evidence points out that the size of seed produced from different varieties is affected when grown in different localities.

At University Farm some work was done upon rate and date of planting. The seeds produced in 1920 from Robust beans (Table III) planted late are smaller in size than those planted at the regular time and those spaced far apart in rows are larger than those planted close. For example, Robust beans planted May 12th weigh 233 grams per thousand and those planted May 22nd weigh 211 grams per thousand while the late planting, June 22nd, weigh 204 grams per thousand. It appears, therefore, that date of planting has an effect upon the size of seed produced. The other factor, rate of planting, gave similar results. Robust beans planted four inches apart in rows produced seed weighing 218 grams per thousand while seeds planted eight inches apart in rows produced a crop which weighs 244 grams per thousand seeds. The evidence thus affirms the statement that date and rate of planting effect the size of seed produced.

The growing season of 1919 was favorable throughout at University Farm while the season of 1920 was less favorable. Until about July 10th there was heavy precipitation but during the remainder of the growing season there was little rainfall. The crop of beans produced was effected differently during its development in the two seasons mentioned as seen in Table IV. Robust beans produced in 1919 weigh 227 grams per thousand while seeds of the same variety produced in 1920 weigh 177 grams per thousand. The variety, Improved Goddard, does not show similar variation. Seeds produced from the variety, Improved Goddard, in 1919 weigh 434 grams per thousand while seeds of the same variety produced in 1920 weigh 436 grams per thousand. The variety, Improved Goddard, is an early type while the variety, Robust, matures approximately two weeks later. It is probable that the variety, Improved Goddard, matured before the drouth had progressed far enough to hinder normal development while the variety, Robust, was hampered by drouth. The Robust beans grown on a very sandy soil at Coon Creek

TABLE III

Variation in Size of Seed of Beans Grown at University Farm 1920.
Planted at Different Rates and Dates

Variety	Rate		Length	Width	Thick-	Ratio			Thickness	Wt. per 1000 seed in gms.
			of seed :cm.	of seed :cm.	ness of :seed :cm.	Length	Width	Thick-	Width	
			:	:	:	:	:	:	:	:
Robust (36-'18)	1 seed each 4"	May 5, 1920	.935	.662	.551	1:	.708:	.589	.832	217.7
" "	1 seed each 8"	May 5, 1920	.949	.673	.559	1:	.709:	.589	.831	243.8
" "	1 seed each 3"	May 12, 1920	.945	.677	.562	1:	.716:	.594	.830	233.0
" "	1 seed each 3"	May 22, 1920	.924	.645	.527	1:	.698:	.570	.817	211.6
" "	1 seed each 3"	June 22, 1920	.901	.651	.597	1:	.723:	.597	.826	204.4

TABLE IV

Variation in Size of Beans Grown at University Farm in 1919 and 1920

Variety	Year	Length of seed cm.	Width of seed cm.	Thickness of seed cm.	Ratio			Thickness: Width factor	Wt. per 1000 seeds in gms.
					Length	Width	Thickness		
Improved Goddard	1919	1.580	.797	.539	1:	.504:	.341	.710	433.8
	1920	1.529	.765	.534	1:	.500:	.349	.698	435.6
Robust	1919	.912	.669	.567	1:	.733	.622	.847	227.1
	1920	.840	.584	.480	1:	.695	.571	.822	176.8

in 1920 weigh 157 grams per thousand. Undoubtedly these were checked in development due to drouth. From the evidence given it appears that seasonal variation may be great enough to make it impossible to base a classification of beans upon size of seed except for use at one location for one year.

By summarizing the data from other writers and that obtained in this study, it appears impractical to base a classification of beans upon size of seed which could be used for all localities and under various seasonal and cultural conditions.

CHARACTERS USEFUL IN CLASSIFICATION AND DESCRIPTION.

The observations here reported are based upon two years' work as found under the environment of University Farm.

Seedling Characters

The term, seedling leaves, as here used, refers to the first pair of leaves above the cotyledons. Size of seedling is closely correlated with size of seed. In use, it is of limited value as an aid to identification of varieties.

Color of seedling leaves and stem is closely correlated with color of seed coat. In the brown-seeded varieties the stem is tinted brown especially close to the surface of the soil. The same color distribution is true for red-seeded varieties. In the solid black or black mottled varieties under observation a purple tint extends into the veins of the seedling leaves. In all except the solid black or black mottled varieties the color soon disappears. However, in the latter group the purple color remains, especially in the stems, until maturity. There are varying shades of green but this occurs in both white and colored seeded varieties. The Tepary and Lima beans have distinctly dark green seedling leaves. The usefulness of this character is merely supplementary in description.

Length of petiole. Freeman (4) has pointed out that the length of seedling leaf petiole is an easy method of distinguishing tepary beans from common beans. The petiole is very short in the former and considerably longer in the latter.

Smoothness of seedling leaf surface is useful in identifying a few varieties of common field beans. The seedling leaf surface in a majority of varieties is smooth. However, there are all gradations of smoothness, ranging from smooth in Navy Pea to very wrinkled in Vineless Marrow. The latter variety is readily distinguished by this character from White Marrow, a long trailing variety having seeds similar in size and appearance.

Pubescence of seedling leaf surface is useful largely in distinguishing species of the genus *Phaseolus*. Members of the species *acutifolius* and *lunatus* have glabrous leaf surfaces while *vulgaris* and *multiflorus* have pubescent leaf surfaces.

Mature Plant Characters.

In habit of growth bean plants may be classified as bush (Fig. 1) and trailing (Fig. 2). The latter range from short to long trailing while the former have less range in height due to their habit of growth.

Bush beans are characterized by having a determinate growth habit. The plants are erect and have from five to eight nodes and terminate in an inflorescence, which is in accord with the findings of Emerson (3). He gives the characteristics of bush beans rather clearly in the following: "The main axis is terminated by an inflorescence when from about four to eight internodes have developed and cannot be forced to make further growth though provided with most favorable conditions of moisture and temperature, and even though the flowers be removed to prevent the drain of seed production." He believes that the common bush bean is a mutation from the pole bean.



Fig. I. Bush habit of Improved Goddard.

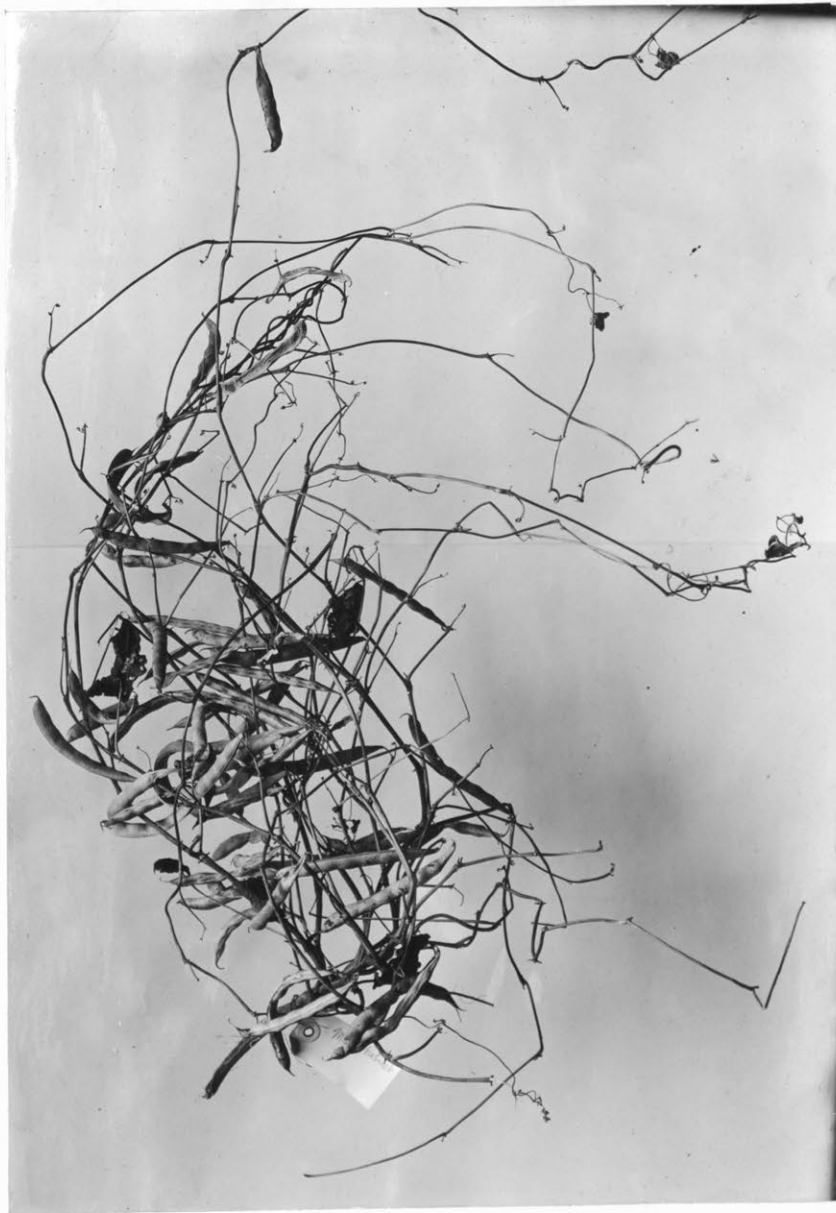


Fig. 2. Trailing habit of the Navy Pea,
variety Robust.



Fig. 3. Erect trailing habit of Black Turtle Soup.

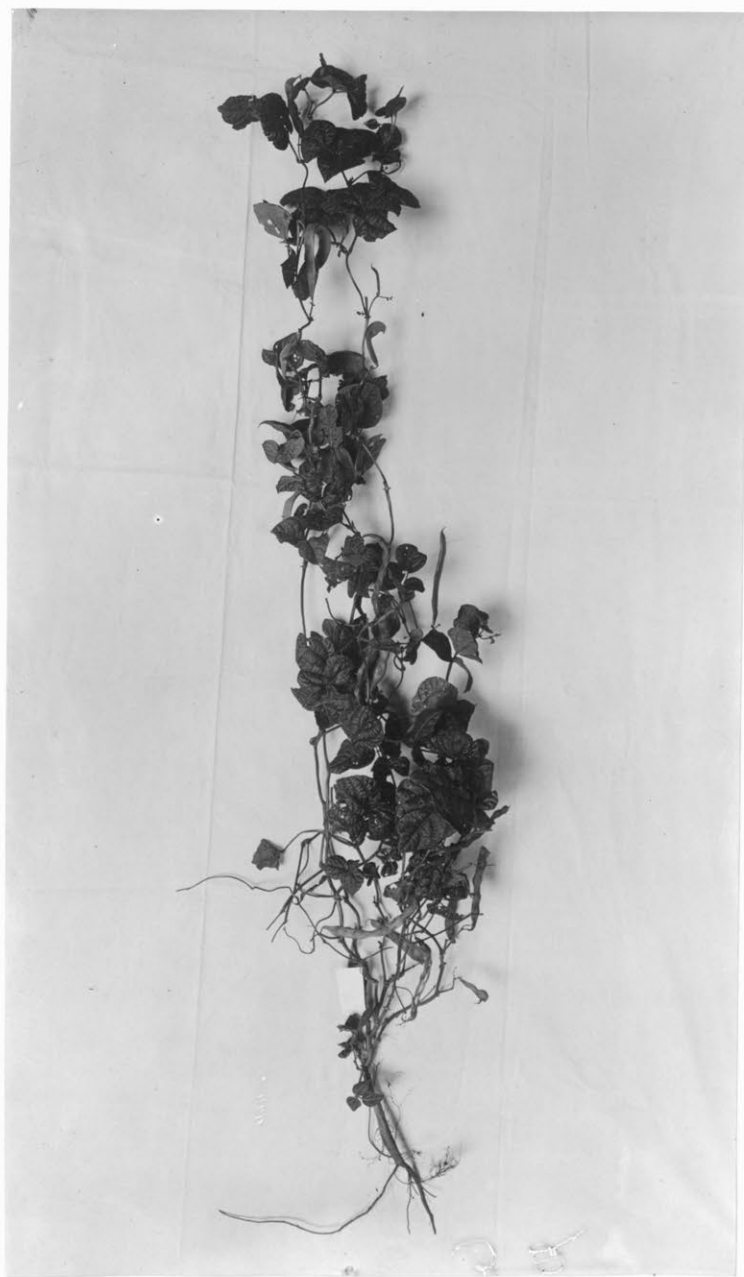


Fig. 4. Decumbent habit of Great Northern.

The plants of trailing beans are characterized by having an indeterminate growth habit. The plants range from erect (Fig. 3) to decumbent (Fig. 4) in habit. They may also be grouped as short and long trailing. The short trailing forms have from eleven to sixteen nodes while the long trailing forms range up to twenty-eight or thirty in number. The first flower clusters appear rather low down and the others progressively higher as new nodes are added. Emerson (3) states that if favorable conditions for growth are provided and if heavy seed production is prevented, pole beans can be kept growing for a long time, if not indefinitely.

Height obviously is determined by number of nodes and internode lengths. Some trailing varieties have long internodes while others have short internodes. For example, White Marrow, in 1920, shows an average of seventeen nodes with an internode length 7.8 centimeters, while Red Indian had the same average number of nodes with an internode length of 4 centimeters. There appears to be a similar variation in bush varieties. For example, in 1920, Red Kidney has an average of seven nodes with an internode length of 6.4 centimeters while Nippissing Pea has an average of six nodes with an internode length of 5.7 centimeters. Emerson (3) states there exist distinct types of bush beans with respect to both number of internodes and internode length. The same, he states, is true of pole beans. Data reported in this study were taken when the plants had reached their approximately maximum height. The measurements were taken of representative plants and recorded in centimeters. The number of nodes was determined by averaging the actual count of ten representative plants. Both of these determinations were made for the years 1919 and 1920.

The color of fully developed leaves and stem in the majority of varieties is green throughout. However, in some dark-seeded varieties, such as Black Turtle Soup, Zebra, and Small Garaypata, the stems are tinted purple. These same varieties have dark green leaves. On the other hand, Lady Washington, a

white-seeded variety has dark green leaves. Consequently there appears to be no correlation between color of leaf and color of seed.

Size of mature leaf varies closely with size of seed. On a single plant, leaves vary from small near the growing tip to large where fully developed. Previous writers have used size of leaf in description of varieties. Irish (6) states the size in actual measurements while Tracy (11) and Jarvis (7) use such general terms as large, medium, and small. Freeman (4) gives averages of one hundred mature leaves taken at random for length and breadth to show that tepary leaves are smaller than common bean leaves. Hendry (5) tabulates length and breadth dimensions for median leaflet of the varieties grown in California. The use of absolute measurements in the description of varieties within a species appears to be impractical because of the wide variation in size of leaf on a single plant. In these descriptions size refers to fully developed leaves of the variety concerned. The leaf shown in Fig. 7 is described as large and the one shown in Fig. 6 as medium, while the leaf shown in Fig. 5 is described as small.

Mature leaves vary in shape. The leaf shown in Fig. 5 is described as small and short pointed and the one shown in Fig. 6 is described as medium in size and long pointed, while the leaf shown in Fig. 8 is described as broad and short pointed. Mature leaf surfaces are referred to as crumpled as is shown in Fig. 9, and as smooth as shown in Fig. 8.

Color of blossom was determined by careful comparison of fresh, newly opened flowers with the colors of a standard chart (10). Since there is a variation of color in the different parts of the corolla, the color was determined for the standard and the keel. Previous writers have recognized color of blossom, but usually use a general term such as pink or violet to describe color. Tracy (11) refers to the use of a color chart published by Henri Dauthenay, but does not give specific citation to color plates.

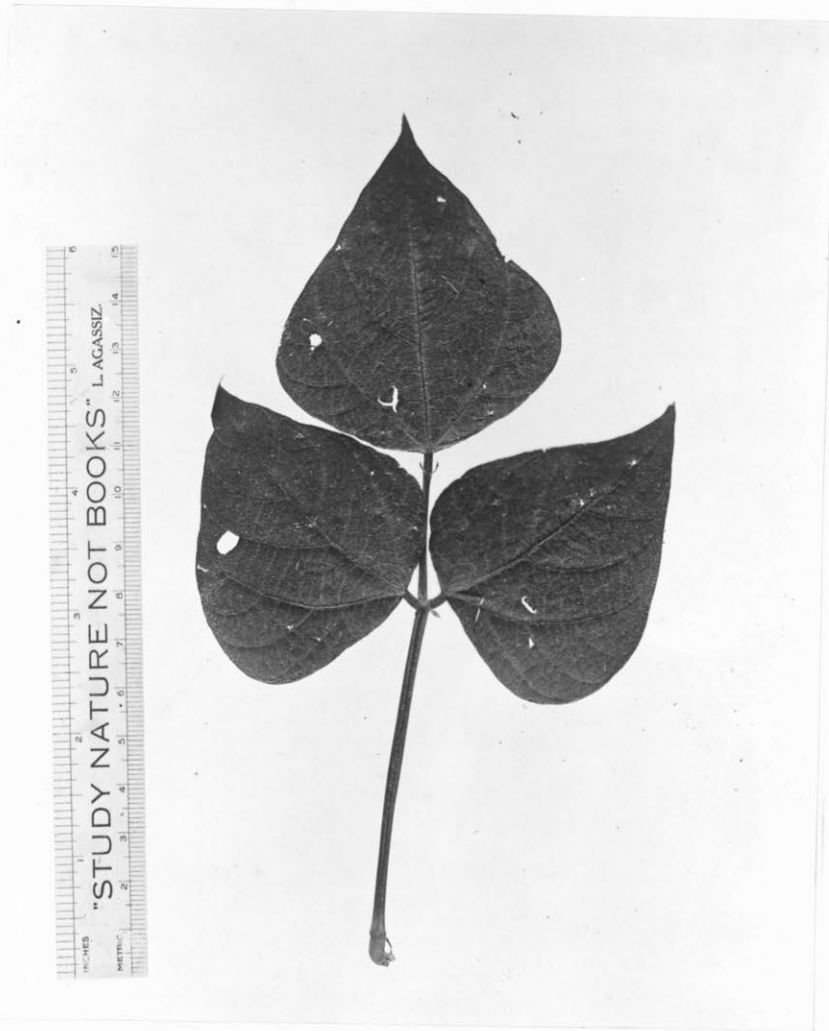


Fig. 5. Fully developed leaf of the
Navy pea, variety Robust.

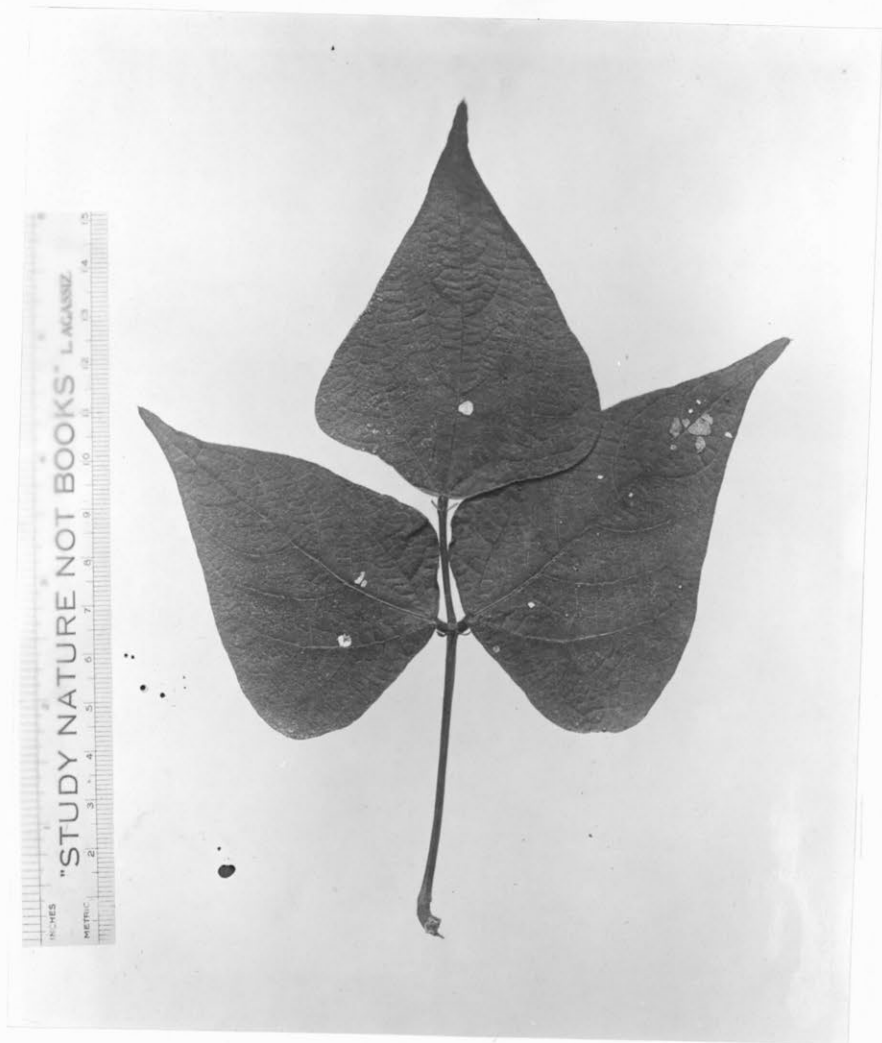


Fig. 6. Fully developed leaf of the variety,
Ruby Horticultural Bush.



Fig. 7. Fully developed leaf of the variety,
White Marrow.



Fig. 8. Fully developed leaf of the variety,
Yellow Indian.



Fig. 9. Fully developed leaf of the variety,
Eureka.

Many varieties develop characteristic pod color just as they approach maturity. For example, selection (1099-1919) shows very marked purple splashed areas (Fig. 10) which are permanent while Red Kidney (Fig. 11-2) which often shows red tinged areas on the immature pods usually shows no color in the dry, mature state. Great Northern, a white-seeded variety, often develops purple splashed areas which are permanent. Color in pods is described as found at the period approaching maturity. Observations in these cultures indicated no con-

sistent correlation between pod color and other coloration in the plant which is in accord with the findings of Shaw and Norton (9).



Fig. 10. Colored mature pod of Selection 1099-1919 and colorless mature pod of Yellow Indian.



Fig. 11. Colorless mature pod of Red Kidney at left.

Shape of pods has been used in descriptions by Irish (6) and Tracy (11). The former introduces into his classification shape of pods as seen in lateral view while the latter introduces the shape of pod as seen in cross section. Both of these workers considered the pod as found in green or snap pod condition. Since pod characters are rather fixed, both lateral and ventral view are used in the classification and description of mature pods.



Fig. 12. Showing (1) long straight pod of Red Kidney, (2) long curved pod Selection (1-1919), (3) short straight pod Selection (86-1919), (4) short curved pod of Brown Swedish (133-1919), (5) pod curved at free end and opposite curve at stem end Selection (10-1919).

In lateral view pods are described as long and straight (Fig. 12-1), short and straight (Fig. 12-3), long and curved (Fig. 12-2), short and curved (Fig. 12-4), and as curved at free end and opposite curve at stem end (Fig. 12-5). In ventral view pods are referred to as flat (Fig. 13-2) and as rounded (Fig. 13-1). Pods which are broad in ventral view are described as rounded.

Mature pods vary from coarse, thick, and fibrous to thin, papery and fibrous in texture. The coarse type is represented by Vineless Marrow (Fig. 14-1) and the papery type by Great Northern (Fig. 14-2).



Fig. 13. Showing flat pod of Pearce's Improved Tree at right and rounded pod of Vineless Marrow at left.



Fig. 14. Showing coarse pod of Vineless Marrow at left and thin papery pod of Great Northern at right.

Length and width of pod has been used in descriptions by previous writers. The general terms long and short are used. Tracy (11) gives approximate length of snap pods in inches. Hendry (5) tabulates pod dimensions in length, breadth, and thickness. In these descriptions actual measurements of dry mature pods are given for length and width. Length was measured from tip of spur to junction of pod and petiole.

Width was measured at the widest axis which was found to be at approximately the second seed from the spur. All pod measurements were made with a caliper and measured to tenths of a centimeter.

Pod apex as used in these descriptions is that portion of the pod between the base of the spur and the point where the pod begins to taper toward the free end. Apparently previous writers have not distinguished between pod apex and spur. For example, in describing the pod of White Kidney, Tracy (11) uses the expression "point of pod medium in length and straight" while Jarvis (7) uses the expression, "moderately stout straight point". From these quotations it seems that it can be safely inferred that they had reference to the pod spur. Differences in pod apex may readily be seen by examining the apex of Nippissing Pea (Fig. 11-2) which tapers off gradually toward the spur while in Selection (86-1919) the apex tapers off rather abruptly toward the spur (Fig. 12-3). The former type of apex is described as elongated and the latter as abrupt.

The term spur as used in these descriptions refers to the narrow projection at the free end of the pod beginning where the pod ceases to be hollow. This point was determined on in order to have a definite point from which to measure to secure the length of spur. When the spur extends in line with the ventral suture, it is described as marginal. When it extends from a point not in line with the ventral suture, it is described as not marginal. Spurs are curved (Fig. 12-3) or straight (Fig. 11-2). Straight spurs are those which extend approximately in a straight line with the longitudinal axis of the free end of the pod. Curved spurs are those which bend away from a straight line with the longitudinal axis of the free end of the pod toward the dorsal suture.

Dry seeds are used exclusively in the key by Jarvis (7) in classifying American varieties of beans. All writers have given seeds a prominent place in description which is in accord with classification and descriptions reported in this study.

Size of dry seed as reported in this discussion is expressed in their three dimensions and weight per thousand. Each measurement was taken at the broadest axis with a micrometer and read to one one-hundredth of a millimeter. The weighings represent actual weight of one thousand seeds in the majority of cases. All weighings were made on a No. 17 Troemner balance.

Previous workers, Jarvis, Irish, and Tracy, have made use of seed and pod measurements in classification and description. However, no mention is made regarding the number measured. In order to determine how large a number is required to give a fair representation, measurements of length were made of fifteen, fifty, and one hundred seeds of four varieties representing different sizes and shapes of seed. Each set of measurements was arranged into frequency tables. Following this the mean, standard deviation, and coefficient of variation were determined with probable error for each (Table V). The frequency distributions are shown in charts 1, 2, 3, and 4. It will be seen that the smoothness of the curve increases with the number in each case. From these charts it is obvious that fifteen measurements do not give a normal distribution curve and that one hundred measurements give a more nearly normal curve than fifty. The probable error of the coefficient of variation increases in magnitude with the decrease in number of seeds measured. The measurements reported in this study are largely based upon one hundred determinations. In only a very few cases are numbers less than fifty used.

Shape of dry seeds has been recognized by the majority of writers. Von Martens (8) based his major groups upon shape, while Jarvis (7) recognized work done by Gilmore at Cornell in grouping field beans into four market groups, namely, kidney, marrow, medium, and pea. In this classification seeds of varieties are grouped as reniform (Fig. 15-1,2) and not reniform (Fig. 15-3 to 6 inc.). In cross section the seeds are described as flat (Fig. 16-1,2), intermediate (Fig. 16-3,4), and rounded (Fig. 16-5,6). From the measurements taken a single

TABLE V

Range in length of 15, 50, and 100 seeds of beans from four varieties with their mean, standard deviations, and coefficients of variation.

Variety	Number Meas.	Highest	Lowest	Range	Mean	Standard Deviation	Coefficient of variation
Robust	100	.972	.681	.291	.825 ± .0556	.043 ± .0021	5.21 ± .0025
Snowflake	100	.989	.682	.307	.810 ± .0544	.063 ± .0030	7.77 ± .0037
Improved Goddard	100	1.793	1.318	.475	1.537 ± .1037	.0901 ± .0043	5.87 ± .0028
Imp. Yellow Eye	100	1.275	.933	.342	1.090 ± .0735	.0587 ± .0028	5.39 ± .0026
Robust	50	.972	.693	.279	.833 ± .0795	.046 ± .0031	5.52 ± .0037
Snowflake	50	.989	.682	.307	.818 ± .0780	.070 ± .0047	8.55 ± .0058
Improved Goddard	50	1.778	1.358	.420	1.448 ± .1381	.1153 ± .0078	7.96 ± .0054
Imp. Yellow Eye	50	1.275	.950	.325	1.090 ± .1039	.0601 ± .0041	5.51 ± .0037
Robust	15	.946	.830	.116	.851 ± .1482	.0371 ± .0046	4.36 ± .0054
Snowflake	15	.989	.682	.307	.846 ± .1473	.0902 ± .0111	10.66 ± .0131
Improved Goddard	15	1.778	1.366	.412	1.556 ± .2710	.1017 ± .0125	6.54 ± .0081
Imp. Yellow Eye	15	1.183	1.012	.171	1.103 ± .1921	.0486 ± .0060	4.41 ± .0054

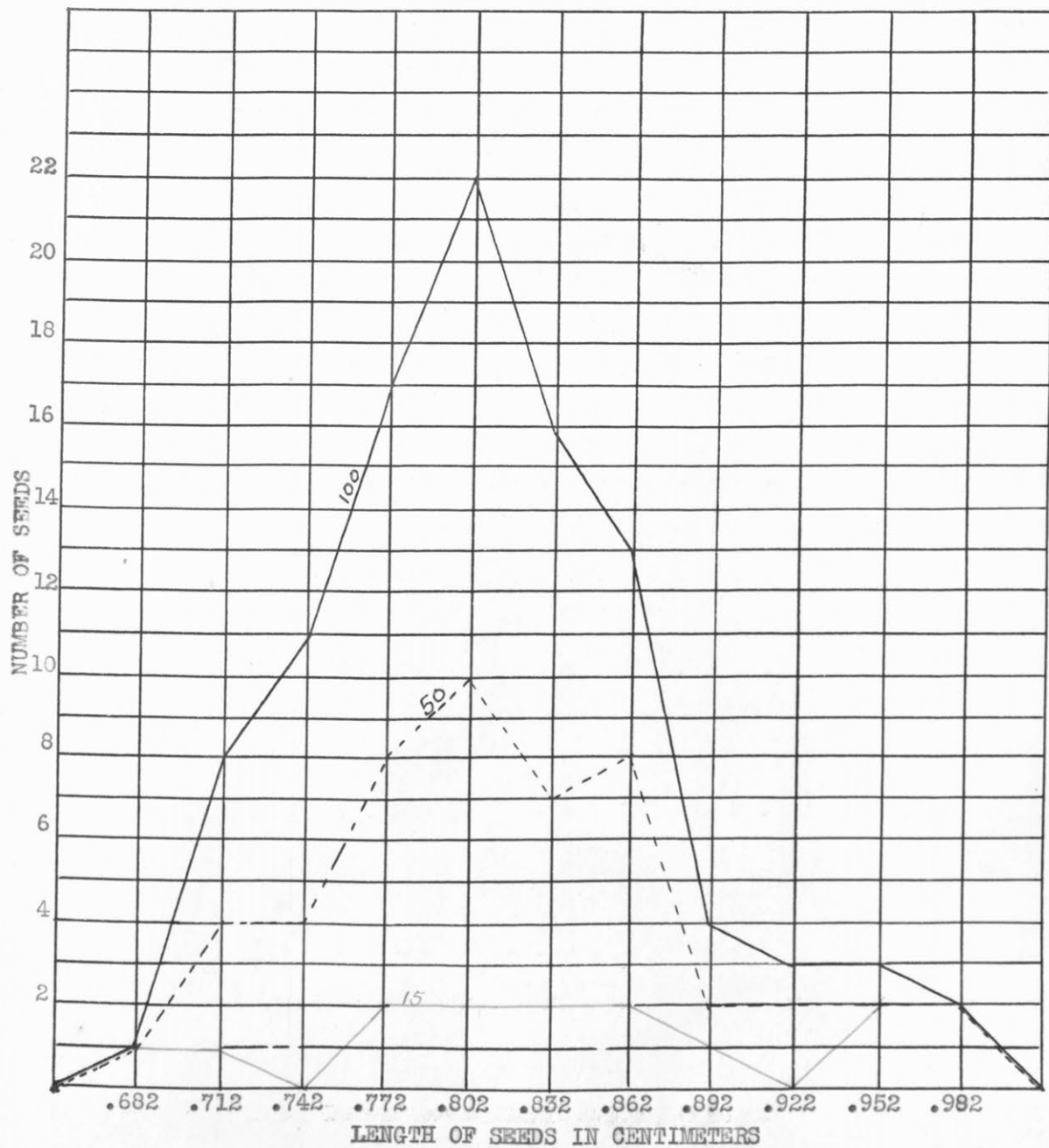


Chart I. Graph showing the frequency distribution of beans measured for length in centimeters. Variety, Snowflake.

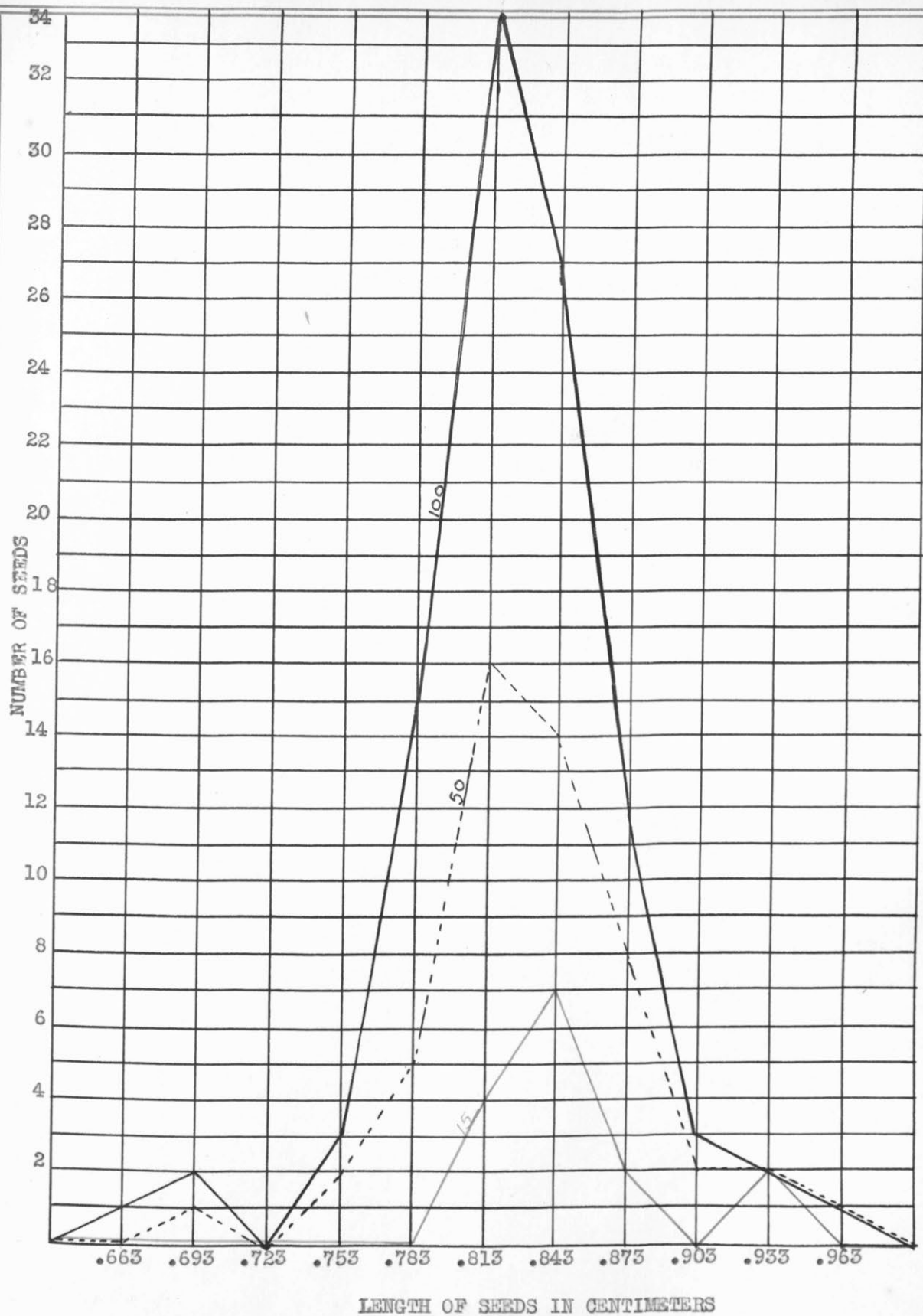


Chart II. Graph showing the frequency distribution of beans measured for length in centimeters. Variety, Robust.

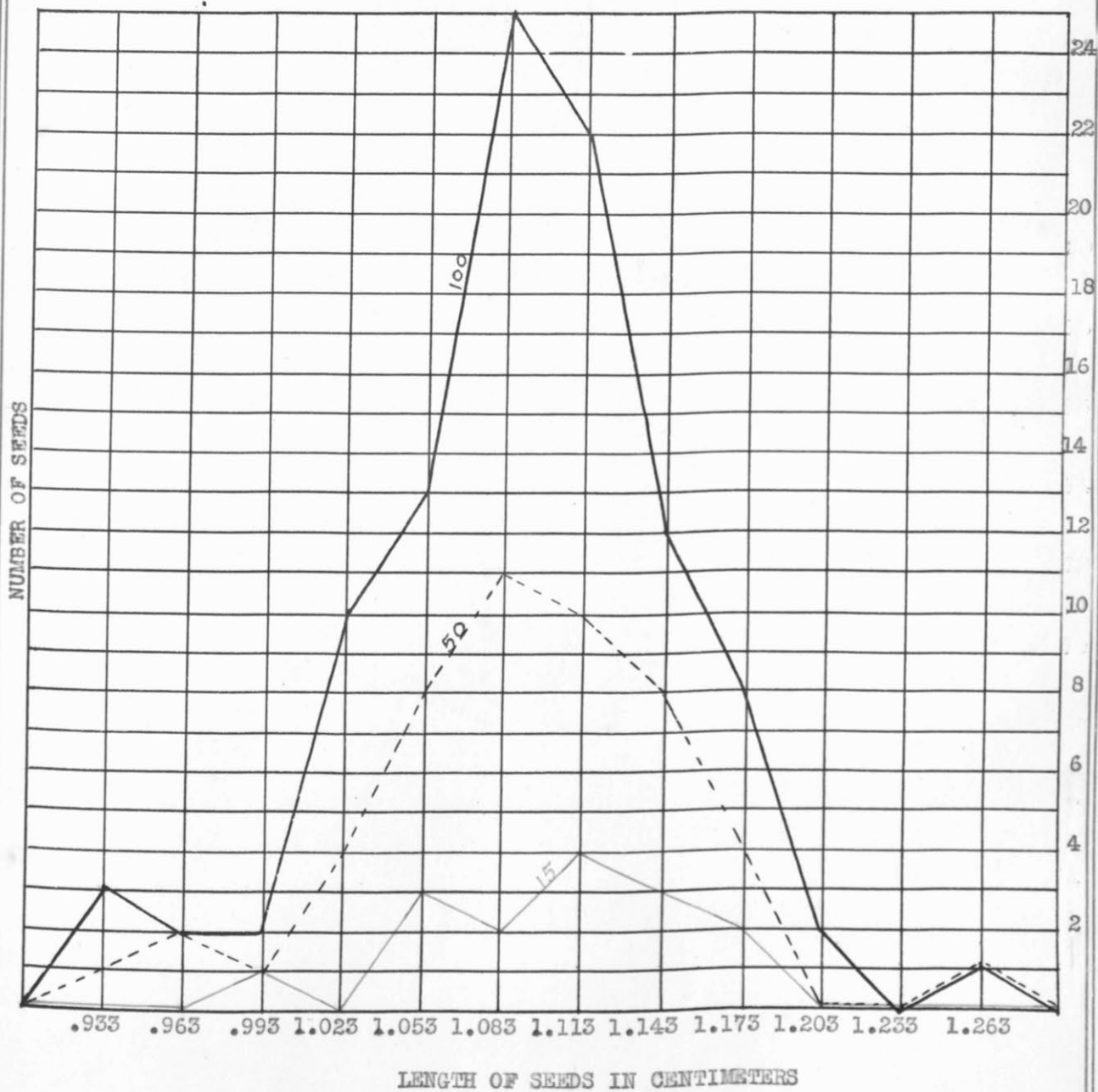


Chart III. Graph showing the frequency distribution of beans measured for length in centimeters. Variety, Improved Yellow Eye.

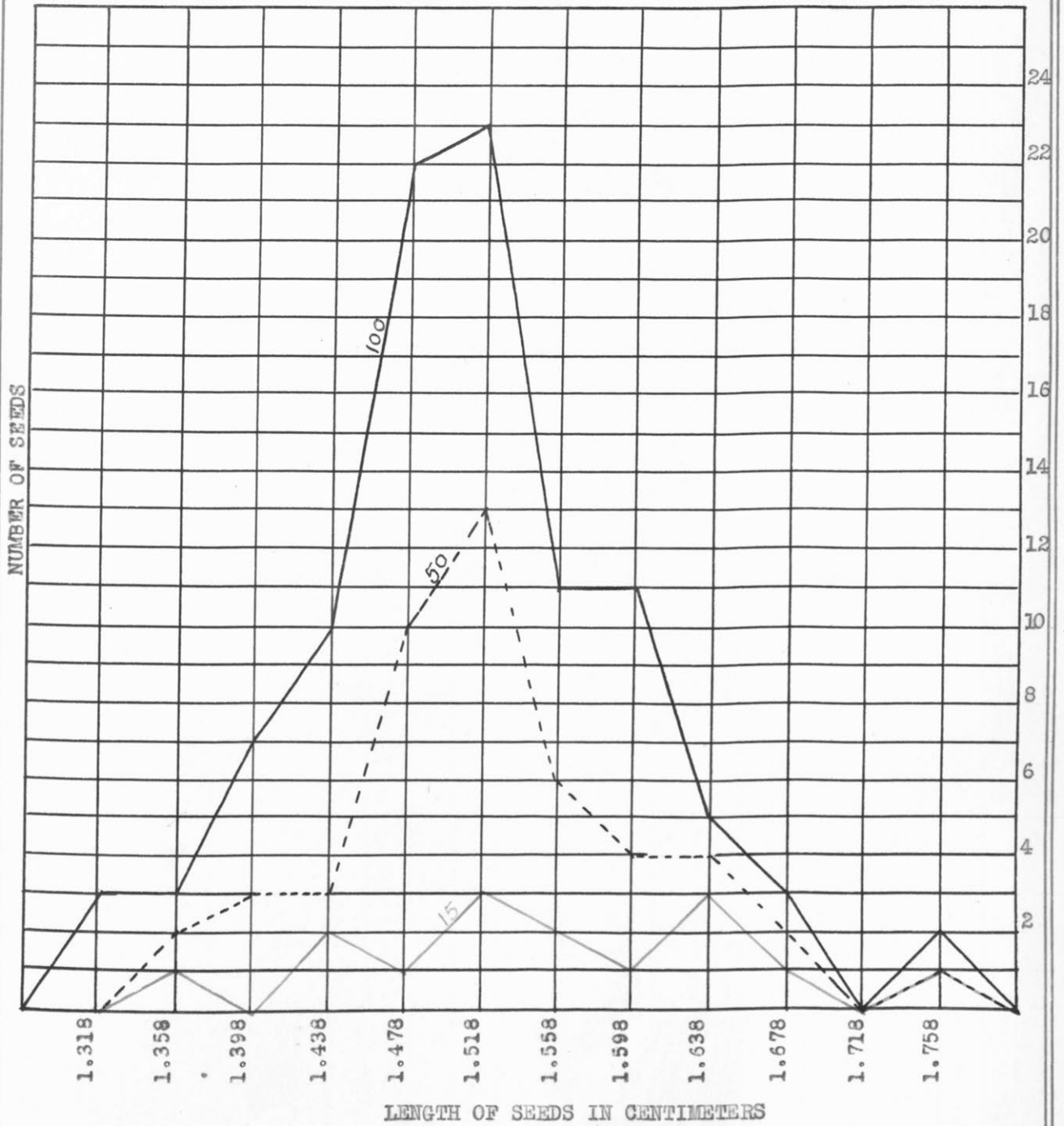


Chart IV. Graph showing the frequency distribution of beans measured for length in centimeters. Variety, Improved Goddard.

factor was derived by dividing the thickness by the width to designate whether seeds are flat, intermediate, or rounded. Those with a thickness factor less than seven tenths are classified as flat, those falling between seven and eight tenths are grouped as intermediate, and those with a factor of eight tenths or over are designated as rounded. In the descriptions seeds are described as oval (Fig. 15-3) and as spherical (Fig. 15-4). The ends of seeds are described as rounded (Fig. 15-2,4) and as truncated (Fig. 15-5,6).

Color of dry seeds was used by von Martens and fills an important place in the descriptions of all writers. Chittenden (2) places seed color second to pod texture in classifying Dwarf French beans at Wisley. All writers have recognized colors in a general way, but Freeman (4) is the first to give specific citations to a standard color chart. In these descriptions beans are arranged into two main groups with respect to color, namely, those with solid colored (Fig. 17) seed coats and those with patterned seed coats (Fig. 18). All color types of beans may have eye markings. The "eye" as referred to in these descriptions is that small colored area surrounding the hilum and above the caruncle as shown in Fig. 19-4. Eyed varieties frequently have a narrow ring immediately surrounding the hilum. This is referred to as "hilum ring". "Eyes" may be patterned as in Old Fashioned Yellow Eye in which the "eye" is defined by an outer snuff brown ring. At each end of the hilum there is a Roman ochre colored area and at each side of the hilum there is a white area which frequently connects up with the white body color of the seed coat. Color patterns are distributed throughout the entire seed coat or localized in an area of varying size surrounding the "eye". Beans with fully patterned seed coats are of three types, namely, those showing longitudinal stripes (Fig. 18-1), those showing less definitely defined color areas (Fig. 18-4), and those with definitely defined color areas (Fig. 18-5). Beans with color patterns surrounding the "eye" are of two types: those showing one color (Fig. 19-1,2) and those showing two colors

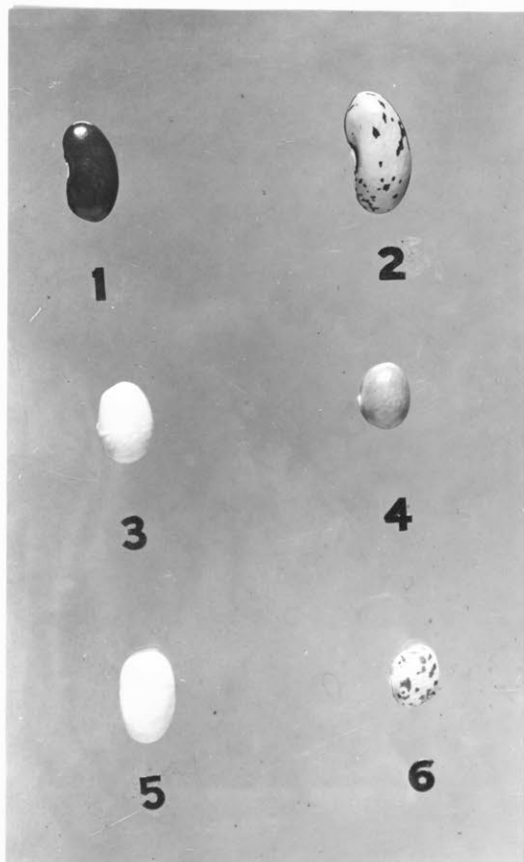


Fig. 15. (1) Black Turtle Soup,
 (2) Improved Goddard,
 (3) Vineless Marrow
 (4) Eureka
 (5) Pearce's Improved Tree,
 (6) Small Garaypata.

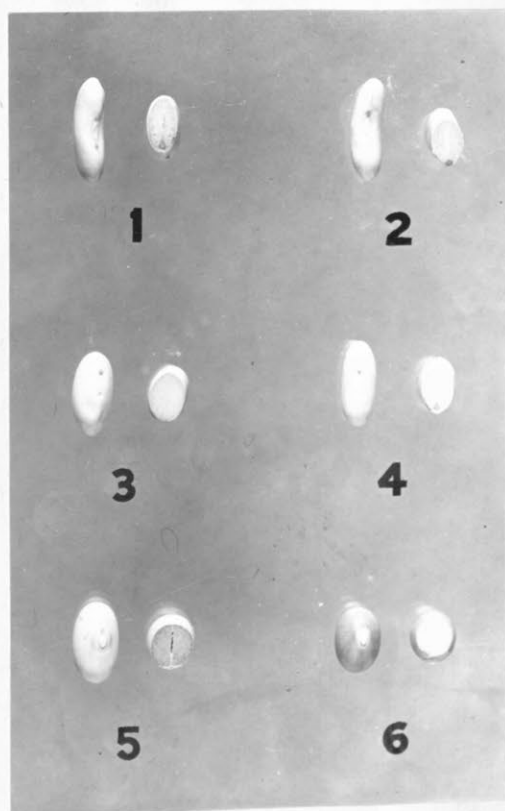


Fig. 16. Showing cross section of
 seeds.
 (1) Selection 1-19,
 (2) Great Northern,
 (3) Burlingame Medium,
 (4) Selection 66-19,
 (5) Vineless Marrow,
 (6) Eureka.

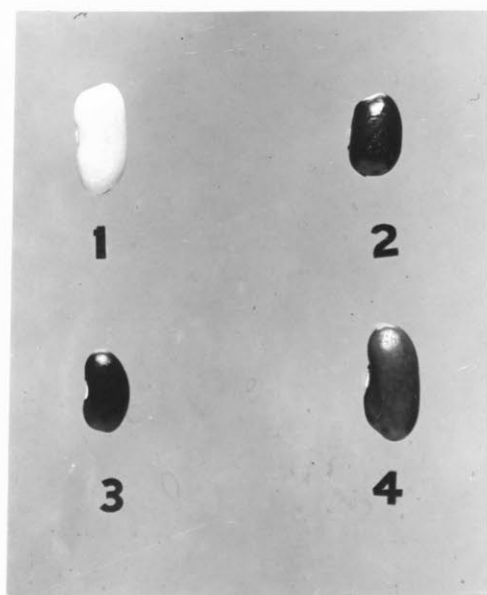


Fig. 17. Showing solid colored seed coats.

- (1) White Kidney,
- (2) Brown Swedish,
- (3) Black Turtle Soup,
- (4) Red Kidney.

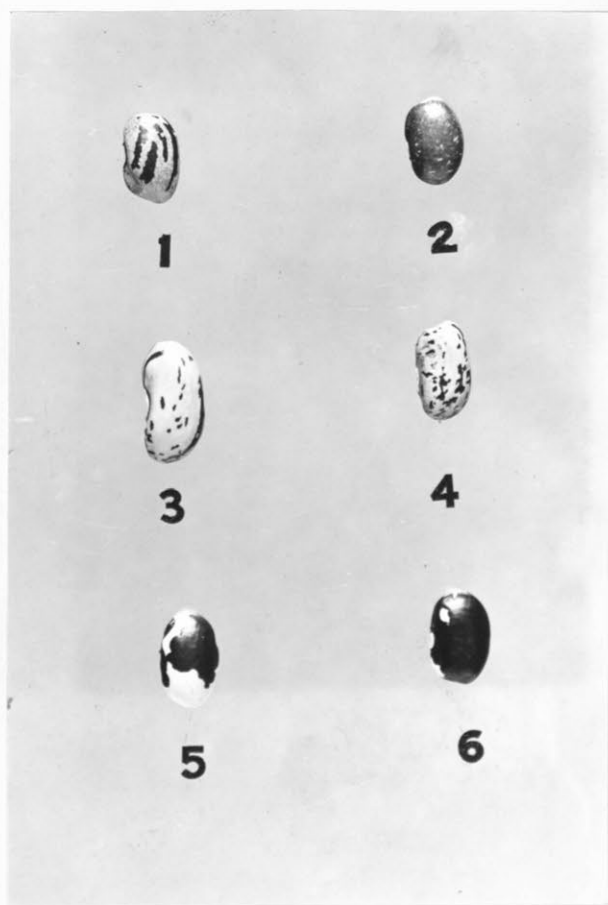


Fig. 18. Showing patterned seed coats.

- (1) Zebra,
- (2) Hansen,
- (3) Improved Goddard,
- (4) Selection 1099,
- (5) (6) Mottled Red Indian.

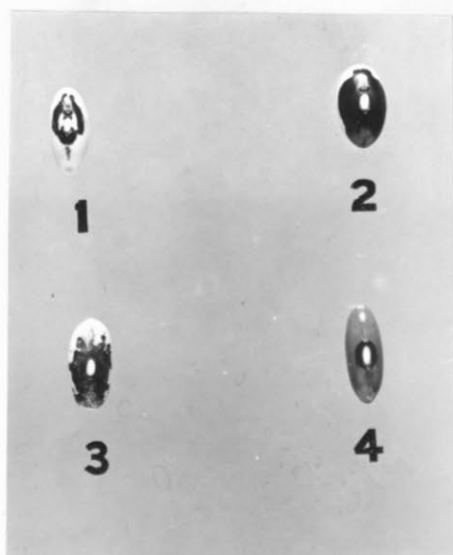


Fig. 19. Showing (1) patterned eye of Old Fashioned Yellow Eye, (2) eye pattern of Improved Yellow Eye, (3) mottled eye pattern of China Red Eye, (4) "eye" of Long Yellow.

(Fig. 19-3). Patterns surrounding the "eye" vary in area and in definiteness of their margins. All color determinations as herein reported were made by comparing fresh, fully mature, dry seed with the colors of a standard chart (10). In a study of garden beans Shaw and Norton (9) point out that there is no consistent correlation between color of seed coat and color of flowers which is in accord with the findings of this study of field beans.

Time of maturity is of considerable economic importance in that

length of growing season limits the growing of some late maturing types. As a character useful in classification and description it is of decided importance in identifying varieties otherwise similar in seed and plant character. For example, Snowflake and Robust have seed and plant characters which are similar, but the former matures early while the latter matures approximately two weeks later. Time of maturity as referred to in this study applies to conditions as they are at University Farm.

Productiveness is largely a character of economic importance. As a character useful in description, it undoubtedly merits consideration. Jarvis (7) and Tracy (11) use comparative terms to express yields of green snap pods. Hendry (5) and Freeman (4) give yields in tabular form showing the relative yielding power of the varieties described in their localities. Data on yielding power is of necessity restricted to a given locality. In this discussion four degrees of



Fig. 20. Showing anthracnose on pods. Beginning at left, pods of Red Indian, pods of Vineless Marrow, pods of Ruby Horticultural Bush, pods of Robust, pods of Black Turtle Soup.

comparison are used, namely, low, medium, productive, and very productive. In the majority of cases these comparisons are based upon plot tests (8 x 16 ft.) replicated four times over a period of two and three years.

Disease resistance data are reported as found for the crop years 1919 and 1920. Anthracnose (Fig. 20) was the most serious disease prevalent. The data were based upon injury to green pods. It is apparent from the figure shown that there is a wide variation in the susceptibility of varieties to anthracnose. Blight (Fig. 21) was less prevalent. In this case notes were taken only as developed on green pods. Leaf rust developed on several of the late maturing varieties in 1919 (Fig. 22). Under the rather humid condition which prevailed throughout the growing season of 1919 anthracnose did considerable damage. On the other hand the rather dry growing season of 1920 apparently checked the development of anthracnose.



Fig. 21. Pods of Red Kidney showing blight injury.

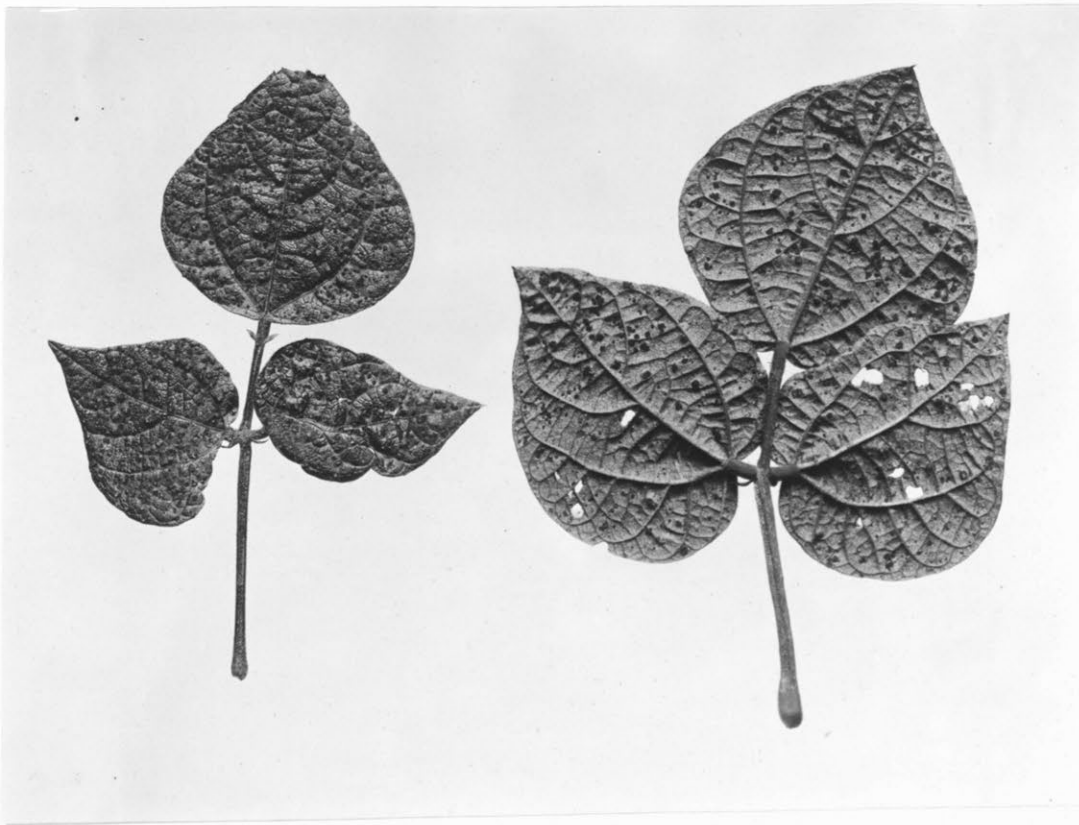


Fig. 22. Showing leaf rust pustules on upper and lower leaf surfaces.

KEY TO SPECIES OF PHASEOLUS AND VARIETIES
OF P. VULGARIS

- A. Leaves glabrous.
 - B. Seeds with conspicuous lines radiating from the hilum.
Phaseolus lunatus
 - BB. Seeds with no conspicuous lines radiating from the hilum.
Phaseolus acutifolius var. latifolius
- AA. Leaves pubescent.
 - B. Roots tuberous.
Phaseolus multiflorus
 - BB. Roots not tuberous.
Phaseolus vulgaris
 - C. Seeds white.
 - D. Plants bush.
 - E. Seeds reniform to subreniform.
 - F. Seeds flat. Thickness less than .7 of the width.
French Dwarf Kidney (18-1920).
 - FF. Seeds rounded. Thickness at least .8 of width.
White Kidney (1077-1919).
 - EE. Seeds not reniform or subreniform.
 - F. Seeds rounded. Thickness at least .8 of width.
Small, conspicuously veined.
Nipissing Pea (80-1919).
- DD. Plants not bush - trailing.
 - E. Seeds reniform to subreniform.
 - F. Seeds flat. Thickness less than .7 of the width.
 - G. Pods large. 1.1 cm. respectively. Slightly curved.
 - H. Uniformly curved. Selection (1-1919).
 - HH. Curved at free end with opposite curve at stem end. Selection (10-1919).
 - GG. Pods intermediate.
 - H. Pods distinctly curved. Great Northern (23-1919).
Selections (16-1919, 19-1920).
 - HH. Pods only slightly curved. Selections (27-1919, 6-1919, 14-1919).
 - F. Seeds intermediate. Thickness .7 to .8 of width.
 - G. Pods flat to intermediate - curved. Lady Washington (1081-1919). Selections (66-1919, 78-1919).
 - GG. Pods rounded - curved.
 - H. Seeds not truncated, medium in size. Selections (24-1919, 36-1919).
 - HH. Seeds truncated - small. Yankee Winter (50-1919).
 - FF. Seeds rounded. Thickness at least .8 of width. Selection (43-1919).
 - EE. Seeds not reniform or subreniform.
 - F. Seeds flat. Thickness less than .7 of the width.
 - G. Pods broad. Pearce's Improved Tree (31-1919).
 - FF. Seeds intermediate. Thickness .7 to .8 of width.
 - G. Pods straight - broad. Burlingame Medium (25c-1918).
Selections (35-1919, 86-1919, 20-1920).
White Wonder (26c-1918) and Selection (27-1918).
 - GG. Pods curved - broad.
 - H. Pods decidedly curved, very broad.
French White (22-1920).

(Continued)

HH. Pods slightly curved.

White Marrow (91-1919).

Selection (28-1920).

FFF. Seeds rounded. Thickness at least .8 of width.

G. Seeds medium in size.

Vineless Marrow (1093-1919).

GG. Seeds small.

H. Pods curved - Navy Pea Group.

I. Early Maturing. Snowflake (57-1919).

Selections (1084-1919, 555a-1919).

II. Medium maturing. Robust (36-1918).

Selection (37-1920).

III. Late maturing. Selections (69-1919, 70-1919).

HH. Pods straight, long, frequently tinted purple.

Blue Pod (39-1920).

CC. Seeds colored.

D. Plants bush

E. Seeds reniform to subreniform

F. Seeds flat. Thickness less than .7 of width.

FF. Seeds intermediate in thickness .7 to .8 of width.

G. Seeds garnet brown Red Kidney (1102-1919).

GG. Seeds chamois Long Yellow (142-1919).

GGG. Seeds flesh color, mottled garnet brown.

Improved Goddard (1098a-1919).

FFF. Seeds rounded. Thickness at least .8 of width.

G. Seeds Roman ochre. Brown Swedish Group.

H. Mature pods curved, long.

I. Seeds eyed, not stippled. Selection (138-1919).

II. Seeds eyed, stippled. Brown Norwegian.
(1169-1919).

III. Seeds not eyed. Selection (7-1920).

HH. Mature pods distinctly curved, short. Selection
(141-1919).

HHH. Mature pods straight. Selection (12-1920).

GG. Seeds Naples yellow Madawaska (145a-1919).

EE. Seeds not reniform or subreniform.

F. Seeds rounded. Thickness at least .8 of width.

G. Seeds one color.

H. Seeds Naples yellow - Eureka (144-1919).

HH. Seeds Roman ochre - Brown Swedish Group.

I. Seeds eyed, not stippled. Selection (133-
1919).

II. Seeds eyed, stippled. Selection (1086-
1920).

III. Seeds not eyed. Selection (132-1919).

GG. Seeds patterned.

H. Seeds with irregular ox blood red pattern at hilum.
China Red Eye (13-1920).

HH. Seeds with small irregular yellow ochre pattern
at eye.

Old Fashioned Yellow Eye (1097-1919)

- DD. Plants not bush - trailing.
- E. Seeds reniform to subreniform.
- F. Seeds flat. Thickness less than .7 of width.
- G. Seeds one color.
- H. Seeds raw sienna. Yellow Indian (1100-1919)
- HH. Seeds black Black Turtle Soup (104c-1918)
- GG. Seeds with more than one color.
- H. Seeds dull purple lake stippled.
Selection (114-1919).
- HH. Seeds with longitudinal bands.
- I. Seeds smoke gray, bands black.
Zebra (125-1919).
- II. Seeds stone colored, bands vinous mauve.
Hansen (107-1919).
- HHH. Seeds patterned.
- I. Seeds pale yellowish flesh patterned
black. Selection (1099-1919)
- II. Seeds salmon flesh, patterned snuff brown.
Large Garaypata (119-1919).
- III. Seeds white with large irregular pattern
of plum violet. Mottled Red Mexican (5-
1920).
- FF. Seeds intermediate in thickness. .7 to .8 of width.
- G. Seeds raw sienna, small. Bayou Chico (1103-1919).
- GG. Seeds pale pink, large. Bayou Grande (4-1920).
- GGG. Seeds flesh color mottled sepia.
Small Garaypata (121-1919).
- EE. Seeds not reniform or subreniform.
- F. Seeds flat. Thickness less than .7 of width.
- G. Seeds one color.
- H. Seeds plum violet. Red Indian (15-1920)
- HH. Seeds snuff brown. Selection (134-1919)
- GG. Seeds more than one color.
- H. Seeds patterned.
- I. Seeds with very large sharply defined
yellow ochre eye pattern.
Improved Yellow Eye (1096-
1919).
- II. Seeds flesh color, mottled garnet brown.
Ruby Horticultural Bush (3b-1918).

DESCRIPTIONS OF VARIETIES

- - - - -

Seed from the various sources was first grown under the name attached. The names were retained with these types which were obviously true to known variety description. Others were given correct names as they were identified or, if they have not been identified, they are reported here by selection number only. Many types selected from various seed stocks, some of which are probably due to hybridization and therefore not true to any known variety description, are also described under selection number. The unidentified types will be continued in culture. If their performance record warrants it, they will be given names later. Numbers are carried with named varieties for reference only.

Bush Varieties - White seeded

French Dwarf Kidney (18-1920)

Plant strictly bush, height 35 cm., nodes 5 to 6. Leaves and stem green throughout. Leaves large. Flowers white. Mature pods not colored, slightly curved, medium texture, length 10.0 to 12.0 cm., width 1.2 to 1.3 cm., flat, 5 to 6 seeded. Apex abrupt. Spur, not marginal, .9 to 1.0 cm., long, curved. Dry seeds (1.25 x .75 x .47 cm.), reniform, thickness .654 of width, flat. Weight 284 gms. per 1000. Color milk white (11-1,2)(10)*. Late, low productivity, resistant to anthracnose. Plate I, fig. 7; IV. fig. 4.

White Kidney (1077-1919)

Plant strictly bush, height 45 to 50 cm., nodes 5 to 6. Leaves and stem green throughout. Leaves large, broad, long pointed. Flowers white. Mature pods not colored, straight, rounded, length 12.3 to 13.2, width .86 to .96, 4 to 5 seeded. Apex abrupt. Spur, straight, 1.38 to .50 cm., long, not marginal. Dry seeds (1.56 to 1.58 x .70 to .74 x .58 to .56 cm.), reniform, rounded, thickness .758 to .819 of width. Weight 452 to 468 gms. per 1000. Color milk white.

*Numbers in parenthesis after color names refer to numbers of colors in the color chart.

(11-1,2). Late, low productivity, resistant to anthracnose, susceptible to blight. Plate I, fig. 8; IV, fig. 5.

Nippissing Pea (80-1919)

Plant strictly bush, height 28 to 34 cm., nodes 5 to 6. Leaves and stem green throughout. Leaves medium size, long pointed. Flowers white. Mature pods not colored, distinctly curved, rounded, length 8.8 to 9.1 cm., width .89 to .97, 4 to 5 seeded. Apex elongated. Spur straight, marginal, length 1.2 to 1.3 cm. Dry seeds (.82 to .83 x .62 to .63 x .55 to .56) spherical, thickness .887 to .889 of width, conspicuously veined. Weight 200 to 250 gms. per 1000. Color, fleshy white (9). Very early, medium productivity, resistant to anthracnose. Plate I, fig. 9; IV, fig. 6.

Trailing Varieties - White Seeded

Selection (1-1919)

Plant long trailing, height 75 to 140 cm., nodes 14 to 18. Leaves and stem green throughout. Leaves large, broad, short pointed, seedling leaves rough wrinkled. Flowers white. Mature pods not colored, curved, flat, length 12.2 cm., width 1.19 cm., medium texture 4 to 5 seeded. Apex elongated. Spur 1.26 cm., long, curved, marginal. Dry seeds (1.40 x .80 x .47 cm.) reniform, flat, thickness .594 of width. Color, milk white (11-1,2). Weight 412 to 459 gms. per 1000. Very late, medium productivity, resistant to anthracnose. Plate I, fig. 10; IV, fig. 7.

Selection (10-1919)

Plant long trailing, height 105 to 250 cm., nodes 17 to 22. Leaves and stem green throughout. Leaves large, medium pointed, broad, seedling leaves wrinkled. Flowers white. Mature pods not colored, curved at free end and opposite curve at stem end, length 13.1 cm., width 1.33 cm., medium texture, 5 to 6 seeded. Apex elongated. Spur 1.03 cm. long, curved, marginal. Dry seeds (1.39 x .79 x .50 cm.), reniform, flat, thickness .633 of width. Weight 369 to

405 gms. per 1000. Color milk white (11-3,4). Very late, low productivity, resistant to anthracnose. Plate I, fig. 11; IV, fig. 8.

Great Northern (23-1919)

Plant short trailing, height 70 to 75 cm., nodes 16 to 20. Leaves and stem green throughout. Leaves medium size, short pointed. Flowers white. Mature pods often splashed purple, distinctly curved, flat, length 9.41 cm., width .99, papery in texture, 4 to 5 seeded. Apex slightly elongated. Spur .91 cm. long, curved, marginal. Dry seeds (1.28 x .69 x .45 cm.), reniform, flat, thickness .660 of width. Weight 275 to 318 gms. per 1000. Color creamy white (10-1,2), veined. Medium late, medium productivity, susceptible to anthracnose. Plate I, fig. 12; V, fig. 1.

Selection (19-1920)

Similar to Great Northern. Pods more curved, length 10.69 cm., width 1.10 cm. Plate I, fig. 13; V, fig. 2.

Selections (27-1919, 6-1919, 14-1919)

Similar to Great Northern. Pods somewhat shorter, less papery texture, only slightly curved, seeds less reniform. Plate I, figs. 15, 16, 17; V, fig. 3.

Lady Washington (1081-1919)

Plant short trailing, height 65 to 70 cm., nodes 17 to 20. Leaves and stem green throughout. Leaves dark green, medium size, short pointed. Flowers white. Mature pods not colored, slightly curved, flat, length 9.46 to 9.68 cm., width .83 cm., medium texture, 5 to 6 seeded. Apex elongated. Spur curved, .84 to .94 cm. long, marginal. Dry seeds (.89 x .58 x .43 cm.), subreniform, thickness .744 of width, ends rounded. Weight 181 to 203 gms. per 1000. Color, milk white (11-1,2). Late, medium productivity, resistant to anthracnose. Plate I, fig. 18; V, fig. 4.

Selection (78-1919)

Plant similar to Lady Washington. Mature pods, 8.8 to 10.0 cm. long,

width 1.02 to 1.04 cm., 5 to 6 seeded. Apex abrupt. Spur .92 to .99 cm. long, not marginal. Dry seeds (.96 to .98 x .64 to .67 x .49 to .52 cm.). Weight 259 gms. per 1000. Plate I, fig. 20.

Selection (66-1919)

Plant similar to Lady Washington, Mature pods 10.83 to 10.87 cm. long, width 1.01 to 1.08 cm., 5 to 6 seeded. Apex abrupt. Spur curved, .79 to .81 cm. long, marginal. Dry seeds (1.13 x .66 x .49 cm.). Weight 281 to 291 gms. per 1000. Susceptible to anthracnose. Plate I, fig. 19; V, fig. 5.

Selection (24-1919)

Plant short trailing, height 60 to 65 cm., nodes 16 to 18. Leaves and stem green throughout. Leaves medium size, short pointed. Flowers white. Mature pods not colored, curved, rounded, length 10.01, width .98 cm., rather coarse texture, 5 to 6 seeded. Apex abrupt. Spur curved, .81 cm. long, marginal. Dry seeds (.98 x .63 x .50 cm.), reniform, thickness .784 of width, ends rounded. Weight 242 gms. per 1000. Color, milk white (11-1,2). Late, medium to low productivity, resistant to anthracnose. Plate I, fig. 21; V, fig. 6.

Selection (36-1919)

Similar to Selection 24. Leaves dark green. Mature pods curved, 9.50 to 9.52 cm. long, width .94 to .97 cm. Apex abrupt. Spur curved, not marginal .86 to .95 long. Dry seeds (1.02 x .66 x .52 cm.). Weight 229 to 242 gms. per 1000. Resistant to anthracnose. Plate I, fig. 22.

Yankee Winter (50-1919)

Plant short trailing, height 65 to 75 cm., nodes 18 to 22. Leaves and stem green throughout. Leaves small, short pointed. Flowers white. Mature pods not colored, slightly curved, rounded, length 8.6 cm., width .71 cm., medium texture, ventral suture depressed. Apex slightly elongated, Spur curved, 6 cm. long, marginal. Dry seeds (.86 x .59 x .43), reniform, thickness .769 of width, ends truncated. Weight 147 to 177 gms. per 1000. Color milk white (11-1,2).

Very late, low productivity, susceptible to anthracnose. Plate I, fig. 23; V, fig. 7.

Selection (43-1919)

Plant short trailing, height 90 to 120 cm., nodes 18 to 24. Leaves and stem green throughout. Leaves small, short pointed. Flowers white. Mature pods not colored, curved, length 9.78 to 9.10 cm. long, width .84 to .91 cm. long, medium texture. Apex slightly elongated. Spur curved, .6 to .8 cm. long, marginal. Dry seeds (.90 to .98 x .59 to .67 x .48 to .56 cm.), subreniform, rounded, thickness .811 to .820 of width, ends rounded. Weight 200 to 238 gms. per 1000. Color milk white (11-3,4). Late, medium productive, susceptible to anthracnose. Plate I, fig. 24; V, fig. 8.

Pearce's Improved Tree (31-1919)

Plant short trailing, height 80 to 110 cm., nodes 16 to 22. Leaves and stem green throughout. Leaves medium size, short pointed. Flowers white. Mature pods not colored, curved, very flat, length 9.9 cm., width 1.2 cm., thin, 4 to 5 seeded. Apex abrupt. Spur curved, 1.07 cm., long, marginal. Dry seeds (1.06 x .72 x .54 cm.), not reniform, flat, thickness .638 of width, ends truncated. Weight 331 to 417 gms. per 1000. Color milk white (11-1, 2). Very late, medium productivity, susceptible to anthracnose. Plate I, fig. 25; V, fig. 9.

Burlingame Medium (25c-1918)

Plant short trailing, height 80 to 90 cm., nodes 15 to 18. Leaves and stem green throughout. Leaves medium size, short pointed. Flowers white. Mature pods not colored, straight, flat, length 9.77 cm., width 1.11 cm., medium texture, 4 to 5 seeded. Apex abrupt. Spur curved, 1.02 cm. long, marginal. Dry seeds (1.06 x .72 x .54 cm.), not reniform, thickness .748 of width, ends truncated. Weight 300 to 334 gms. per 1000. Color milk white (11-1,2). Medium late, very productive, susceptible to anthracnose. Plate I, fig. 26; V, fig. 10.

Selection (86-1919)

Similar to 25c. Mature pods often splashed purple, 9.45 cm. long, 1.13 cm. wide. Apex abrupt. Spur curved, .93 cm. long, marginal. Seed thickness .71 of width. Plate I, fig. 27; VI, fig. 1.

Selection (20-1920)

Similar to 25c. Mature pods, width 9.37 cm., length 1.02 cm., less flattened, slightly curved. Apex abrupt. Spur marginal. Seed, thickness .821 of width. Plate I, fig. 28; VI, fig. 2.

Selection (35-1919)

Similar to 25c, varying slightly in size of pod, size of seed, and curvature of pod. Plate I, fig. 29; VI, fig. 3.

Selection (27-1918)

Similar to 25c, varying in size of pod, length 8.95 cm., width .90 cm., size of seed (.90 x .66 x .44 cm.). Plate I, fig. 31; VI, fig. 4.

Selection (26c-1918)

Similar to 25c, varying most in flatness of seed, thickness .712 of width. Plate I, fig. 30; VI, fig. 5.

French White (22-1920)

Plant short trailing, height 95 cm., nodes 16 to 18. Leaves and stem green throughout. Leaves medium size, short pointed. Flowers white. Mature pods not colored, decidedly curved, very flat, length 11.6 cm., width 1.28 cm., thin, 5 to 6 seeded. Apex abrupt. Spur curved, 1.01 cm. long, not marginal. Dry seeds (1.12 x .76 x .59 cm.), not reniform, thickness .781 of width, ends rounded. Weight 361 gms. per 1000. Color milk white (11-1,2). Plate I, fig. 32; VI, fig. 6.

White Marrow (91-1919)

Plant long trailing, height 135 to 145 cm., nodes 18 to 24. Leaves and stem green throughout. Leaves large, long pointed. Flowers white. Mature

Pods not colored, slightly curved, medium texture, flat, length 10.0 to 11.5 cm., width 1.03 to 1.13 cm., 5 to 7 seeded. Apex abrupt. Spur, curved, .8 to .9 cm. long, not marginal. Dry seeds (1.01 to 1.03 x .68 to .71 x .54 to .58 cm.), not reniform, thickness .79 to .82 of width, ends rounded. Weight 291 to 292 gms. per 1000. Color milk white (11-1,2). Very late, medium productivity, susceptible to anthracnose. Plate I, fig. 33; VI, fig. 7.

Selection (28-1920)

Similar to 91. Plant height 90 cm., nodes 13 to 15. Color, milk white (11-1,2). Plate I, fig. 34; VI, fig. 8.

Vineless Marrow (1093-1919)

Plant short trailing, height 80 cm., nodes 12 to 16. Leaves and stem green throughout. Seedling leaves wrinkled, leaves large, broad, long pointed. Flowers white. Mature pods not colored, curved, rounded, coarse, length 9.85 cm., width 1.01 cm., 4 to 5 seeded. Apex elongated. Spur straight to slightly curved, 1.3 cm. long, not marginal. Dry seeds (1.10 x .73 x .65 cm.), not reniform, rounded, thickness .886 of width, ends rounded, seed coat often wrinkled. Weight 408 to 460 gms. per 1000. Color, milk white (11-3,4). Late, medium productivity, very susceptible to anthracnose. Plate I, fig. 35; VI, fig. 9.

Navy Pea (558-1920)

Plant short trailing, much branched, erect, height 75 to 80 cm., nodes 16 to 20. Leaves and stem green throughout. Leaves small, short pointed. Flowers white. Mature pods not colored, slightly curved, medium texture, length 8.6 to 9.0 cm., width .85 to .86 cm., 4 to 6 seeded. Apex abrupt. Spur curved, .76 cm. long, not marginal. Dry seeds (.80 x .59 x .51 cm.), not reniform, rounded, thickness .864 of width, slightly truncated. Weight 191 gms. per 1000. Color, milk white (11-1,2). Medium early maturing, very productive, resistant to anthracnose and blight. Plate II, fig. 36; VII, fig. 1.

Snowflake (57-1919)

Similar to navy pea. Pods 5 to 6 seeded. Seeds not truncated. Color, milk white (11-1,2). Early maturing. Plate II, fig. 37; VII, fig. 2.

Selection (1084-1919)

Similar to Snowflake. Pods more rounded. Seeds truncated, seed coat veined. Color, fleshy white (9). Early maturing. Plate II, fig. 38; VII, fig. 3.

Selection (555a-1920)

Similar to Snowflake. Seeds more rounded. Thickness .923 of width. Color, milk white (11-1,2). Early maturing. Plate II, fig. 39; VII, fig. 4.

Robust (36-1918)

Similar to Navy Pea. Seeds are more truncated, rather conspicuously veined. Color, fleshy white (9). Medium early maturing, more productive than Navy Pea. Plate II, fig. 40; VII, fig. 5.

Selection (37-1920)

Similar to Navy Pea. Seeds smaller. Weight 168 gms. per 1000. Color, fleshy white (9), thickness .877 of width. Medium early maturing. Plate II, fig. 41; VII, fig. 6.

Selection (69-1919)

Differs from Navy Pea in time of maturity, very late. Color, fleshy white (9). Plate II, fig. 42; VII, fig. 7.

Selection (70-1919)

Similar to 69 in character differing from it and all other Navy pea types in length of spur. Spur .420 cm. long. Plate II, fig. 43; VII, fig. 8.

Blue Pod (39-1920)

Plant short trailing, much branched, erect, height 110 cm., nodes 17 to 20. Leaves and stem green throughout. Leaves small, short pointed. Flowers white. Mature pods tinged purple, straight to reflex curved, medium texture, rounded, length 9.43 cm., width .77 cm., 6 to 7 seeded. Apex abrupt. Spur,

curved, .76 cm. long, not marginal. Dry seeds (.81 x .55 x .45 cm.), oval, veined, thickness .816 of width, ends rounded. Smallest seed type, weight 149 gms. per 1000. Color, fleshy white (9). Very late, resistant to anthracnose, productive. Plate II, fig. 44; VII, fig. 5, 9, and 10.

Bush Varieties - Colored Seeded

Red Kidney (1102-1919)

Plant strictly bush, height (46-50 cm.), nodes 6 to 7. Leaves and stem green throughout. Leaves large, long pointed. Flowers, standard lilac (176-1,2). Mature pods often splashed red, straight, coarse, length 12.0 to 13.0 cm., width 1 cm., 4 to 5 seeded. Apex slightly elongated. Spur 1.2 cm. long, straight, not marginal. Dry seeds (1.54 x .70 x .54 cm.), intermediate in cross section, thickness .773 of width, ends rounded. Weight 390-425 gms. per 1000. Color, garnet brown (164). Late, medium productivity, anthracnose resistant, blight susceptible. Plate II, fig. 45; VIII, fig. 1.

Long Yellow (142-1919)

Plant strictly bush, height (44-46 cm.), nodes 5-6. Leaves and stem green throughout. Leaves large, long pointed. Flowers, standard lilac (176-3,4), keel lilac (176-1,2). Mature pods not colored, slightly curved, coarse, length 11.9 to 12.2 cm., width .83 to .93 cm., 5 to 6 seeded. Apex slightly elongated. Spur 1.2 - 1.5 cm. long, straight, not marginal. Dry seeds (1.50 x .65 x .50 cm.), subreniform, thickness .769 of width. Weight 340-358 gms. per 1000. Color, chamois (325-1,2), eye color raw umber (301, hilum ring Roman ochre (327)). Very early, medium productivity, resistant to anthracnose. Plate II, fig. 46; VIII, fig. 2.

Improved Goddard (1098a-1919)

Plant strictly bush, height 42-44 cm., nodes 6 to 7. Leaves and stem green throughout. Leaves large, long pointed. Flowers, standard lilac (176-3,4), keel lilac (176-1,2). Mature pods splashed red, slightly curved, coarse, length

12.5 to 13.5 cm., width 1.0 cm., 4 to 5 seeded. Apex elongated. Spur 1.5 to 1.6 cm. long straight, marginal. Dry seeds (1.53 x .77 x .53 cm.) reniform, flat in cross section, thickness .698 of width, ends rounded. Weight 434 to 436 gms. per 1000. Color, flesh (139-1), mottled garnet brown (164-4), eye Roman ochre (329), no distinct hilum ring. Very early, medium productivity, anthracnose resistant, blight susceptible. Plate II, fig. 47; VIII, fig. 3.

Brown Swedish - Kidney Type (138-1919)

Plant strictly bush, height 40 to 42 cm., nodes 5 to 6. Leaves and stem green throughout. Leaves large, long pointed. Flowers, standard lilac (176-3,4), keel lilac (176-1,2). Mature pods not colored, curved, coarse, dehisce readily, length 11.1 cm., width .85 cm., rounded, 4 to 5 seeded. Apex elongated. Spur 1.4 cm. long, straight, marginal. Dry seeds (1.38 x .68 x .53 cm.), reniform, thickness .833 of width, ends rounded. Weight 337 to 380 gms. per 1000. Color, Roman ochre (327-3,4) eye snuff brown (303), hilum ring Roman ochre (327). Early, medium productivity, susceptible to anthracnose and blight. Plate II, fig. 48; VIII, fig. 4.

Brown Norwegian (1169-1919)

Similar to 138. Seeds smaller. Weight 273 gms. per 1000. Seed coat stippled dark brown, 5 to 6 seeds per pod. Plate II, fig. 49; VIII, fig. 5.

Selection (7-1920)

Similar to 138 except that pods are distinctly sickle shaped, 5 to 6 seeded. Seeds without eye markings. Plate II, fig. 50; VIII, fig. 6.

Selection (141-1919)

Similar to 138 except that pods are shorter (10.0 cm. long), distinctly sickle shaped, 5 to 6 seeded. Seeds (1.18 x .65 x .52 cm.), weight 313 to 321 gms. per 1000. Plate II, fig. 51; VIII, fig. 7.

Selection (12-1920)

Similar to 138 except that pods are straight, 5 to 6 seeded. Spur,

not marginal. Seeds less reniform. Eye marking less distinct. Plate II, fig. 52; VIII, fig. 8.

Madawaska (145a-1919)

Plant strictly bush, height 35 to 38 cm. Nodes 6 to 7. Leaves and stem green throughout. Leaves large, dark green. Flowers white. Mature pods not colored, curved, coarse, length 9.1 cm., width 1.0 cm., flattened, 4 to 5 seeded. Apex slightly elongated. Spur curved, 1.2 cm. long, not marginal. Dry seeds (1.0 x .62 x .55 cm.), reniform, thickness .878 of width, ends rounded. Weight 245 to 277 gms. per 1000. Color, Naples yellow (29-1). Early, low productivity. Plate II, fig. 53; VIII, fig. 9.

Eureka (144-1919)

Plant strictly bush, height 42-44 cm., nodes 6 to 7. Leaves and stem green throughout. Leaves large crumpled, oval, blunt pointed. Flowers, standard lilac (176-3,4), keels lilac (176-1,2). Mature pods not colored, straight, rounded, coarse, length 8.5 to 9.0 cm., width 1.1 to 1.0 cm., 4 to 5 seeded. Apex abrupt. Spur .74 to .78 cm. long, straight, not marginal. Dry seeds (.90 x .72 x .62 cm.) spherical, thickness .890 of width. Weight 267-290 gms. per 1000. Color, Naples yellow (29-1). Medium late, medium productivity, anthracnose and blight resistant. Plate II, fig. 54; IX, fig. 1.

Brown Swedish (133-1919)

Plant strictly bush, height 40 to 42 cm., nodes 6 to 7. Leaves and stem green throughout. Leaves large, long pointed. Flowers, standard lilac (176-3,4), keel lilac (176-1,2). Mature pods not colored, distinctly curved, coarse, dehisce readily, length 8.82 cm., width .79 cm., rounded, 5 to 6 seeded. Apex slightly elongated. Spur 1.17 cm. long, straight, not marginal. Dry seeds (1.08 x .69 x .57 cm.), oval, thickness .862 of width, ends rounded. Weight 304 to 396 gms. per 1000. Color, Roman ochre (327-3,4), snuff brown eye (303), hilum ring Roman ochre (327). Early, medium productivity, susceptible to anthracnose and blight. Plate II, fig. 55; IX, fig. 2.

Selection (1086-1919)

Obtained from Sweden, differs from 133 only in having straight pods, length 10.54 cm., width .79 cm. Spur 1.58 cm. long. Dry seeds stippled dark brown. Plate II, fig. 56; IX, fig. 3.3

Selection (132-1919)

Similar to 133 except that pods are less curved. Seeds, weight 262 to 326 gms. per 1000. Eye marking less prominent, Plate II, fig. 57; IX, fig. 4.

China Red Rye (13-1920)

Plant strictly bush, height 28 to 30 cm., nodes 5 to 6. Leaves and stem green throughout. Flowers white. Mature pods not colored, straight, coarse, length 10.0 to 11.0 cm., width .9 to 1.0 cm., 4 to 5 seeded. Apex slightly elongated. Spur 1.1 to 1.2 long, curved, not marginal. Dry seeds (1.20 x .73 x .60 cm.), oval, thickness .828 of width. Weight 353 to 390 gms. per 1000. Color, white with ox blood red (94), mottled, irregular pattern around eye covering approximately one-fourth of entire area, no eye markings. Very early, low productivity, susceptible to anthracnose and blight. Plate II, fig. 58; IX, fig. 5.

Old Fashioned Yellow Eye (1097-1919)

Plant bush, height 50-52 cm., nodes 6 to 7. Leaves and stem green throughout. Flowers white. Mature pods not colored, slightly curved, coarse, length 9.8 to 10.8 cm., width 1.0 to 1.2 cm., 4 to 5 seeded. Apex slightly elongated. Spur 1.2 cm. long, curved, not marginal. Dry seeds (1.20 x .80 x .70 cm.) oval, thickness .846 of width. Weight 413 to 439 gms. per 1000. Color, white with irregular yellow ochre (326-4), pattern around hilum covering approximately one-fourth of entire area, eye snuff brown (303) with white spot on each side of hilum. Medium early, medium productivity, resistant to anthracnose and blight. Plate II, fig. 59; IX, fig. 6.

Trailing Varieties - Seeds Colored

Yellow Indian(1100-1919)

Plant short trailing, decumbent, not highly branched, height 75 to 80

cm., nodes 15 to 16. Leaves and stem green throughout. Leaves medium size, broad, short pointed. Flowers white. Mature pods not colored, curved, papery, length 9.5 to 10.0 cm., width .9 to 1.0 cm., 5 to 6 seeded. Apex abrupt. Spur .82 cm. long, marginal, curved. Dry seeds (1.30 x .71 x .50 cm.), decidedly reniform, thickness .608 of width, very flat. Weight 282-300 gms. per 1000. Color, raw sienna (328-1,2) no eye marking. Medium early, productive, resistant to anthracnose and blight. This variety most resembles Bayou Chico, but differs from it in size and flatness of seed. Plate II, fig. 60; IX, fig. 7.

Black Turtle Soup (104c-1918)

Plant short trailing, erect, height 58-60 cm., nodes 13 to 14. Leaves medium size, dark green. Stems purple. Flowers, standard magenta (182-2), keel violet rose (154-2). Mature pods often purple tinged, distinctly curved near free end, medium coarse, length 8.7 cm., width .80 cm., 5 to 6 seeded. Apex abrupt. Spur .63 cm. long, straight, marginal. Dry seeds (1.04 x .60 x .40), thickness .671 of width, reniform, flat. Weight 193-200 gms. per 1000. Color, violet black (374-4). Late, very productive, very resistant to anthracnose, susceptible to blight. Plate II, fig. 61; IX, fig. 8.

Selection (114-1919)

Plant short trailing, height 70 to 75 cm., nodes 14 to 15. Leaves and stem green throughout. Leaves medium size, broad with short point. Flowers white. Mature pods slightly splashed red, curved, flat, papery, length 9.5 to 10.0 cm., width .9 to 1.0 cm., 5 to 6 seeded. Apex abrupt. Spur .82 to .85 cm. long, curved, marginal. Dry seeds (1.33 x .72 x .50 cm.) reniform, flat. Weight 312 to 328 gms. per 1000. Color, dull purple lake (170-3,4), stippled white, no eye marking. Late, medium productivity, resistant to anthracnose. This selection most nearly resembles Hansen (107-1919). Plate II, fig. 62; IX, fig. 9.

Zebra (125-1919)

Plant short trailing, height 60 to 65 cm., nodes 16 to 17. Leaves dark

green, medium size, short pointed. Stems, purple. Flowers, standard (182-2), keel violet rose (154-2). Mature pods purple splashed, curved, flat, medium texture, length 8.8 cm., width .9 cm., 4 to 5 seeded. Apex abrupt. Spur .8 cm. long, curved, marginal. Dry seeds (1.15 x .71 x .50 cm.), reniform, thickness .690 of width, often truncated, flat in cross section. Weight 265 to 283 gms. per 1000. Color, smoke gray (365) longitudinal black stripes, eye black, no hilum ring marking. Late, medium productivity, slightly susceptible to anthracnose. Plate II, fig. 63; IX, fig. 10.

Hansen (107-1919)

Plant short trailing, height 70 to 80 cm., nodes 17 to 18. Leaves and stem green throughout. Leaves medium size, short pointed. Flowers, color pale reddish lilac (131-1), keel and standard alike, but standard has deeper tint at endge. Mature pods not colored, curved, medium texture, flat, length 9.0 to 9.5 cm., width .95 to .97 cm., 5 to 6 seeded. Apex abrupt. Spur .7 to .8 cm. long, curved, marginal. Dry seeds (1.11 x .72 x .48 cm.), thickness .663 of width, flat. Weight 240 to 280 gms. per 1000. Color, striped with circular longitudinal violet (vinous mauve, (184)) bands on a stone colored (312) background which is tinged with lilac mauve (196). Very late, medium productivity, very susceptible to anthracnose. Plate II, fig. 64; X, fig. 1.

Selection (1099-1919)

Plant short trailing, height 70-75 cm., nodes 17 to 18, decumbent habit, not highly branched. Leaves dark green, stems purple. Flowers, standard magenta (182-2), keel violet rose (154-2). Mature pods, splashed purple, curved, medium texture, length 9.4 to 9.6 cm., width .9 to 1.0 cm., 5 to 6 seeded. Apex abrupt. Spur, curved .9 to 1.0 cm. long, marginal. Dry seeds (1.25 x .73 x .50 cm.), sub-reniform, thickness .688 of width, truncated. Weight 275 to 300 gms. per 1000. Color, pale yellowish flesh (66-2), mottled black, no eye markings. Late, medium productivity, susceptible to anthracnose. Plate II, fig. 65; X, fig. 2.

Large Garaypata (119-1919)

Plant short trailing, height 60 to 65 cm., nodes 16 to 17, decumbent habit, not highly branched. Leaves and stem green throughout. Flowers white. Mature pods splashed with red, curved, medium texture, length 8.7 to 9.6 cm., width .90 to .95 cm., 4 to 5 seeded. Apex abrupt. Spur .9 to 1.0 cm. long, curved, not marginal. Dry seeds (1.22 x .72 x .50 cm.), subreniform, thickness .690 of width. Weight 247 to 266 gms. per 1000. Color, salmon flesh (138-2), eye color raw sienna (329-1,2), mottled snuff brown (303), eye raw sienna (329). Late, medium productivity, susceptible to anthracnose. Plate II, fig. 66; X, fig. 3.

Mottled Red Indian (5-1920)

Plant short trailing, height 50 to 66 cm., nodes 24 to 26. Leaves and stem green throughout. Leaves dark green, large, broad, very pubescent, short pointed. Flowers white. Mature pods not colored, markedly curved, papery, flat, length 9 to 10 cm., width .8 to 1.0 cm., 5 to 6 seeded. Spur .9 to 1.0 cm. long, curved, marginal. Dry seeds (1.6 x .77 x .53 cm.), subreniform, thickness .768 of width, flat, weight 225 to 230 gms. per 1000. Color, white with irregular plum violet (172-4) pattern throughout covering approximately three-fourths of seed coat, no eye markings. Very late, low productivity, very susceptible to anthracnose, not adapted to this section of United States. Plate II, fig. 67.

Bayou Chico (1103-1919)

Plant short trailing, height 70 to 72 cm., nodes 19 to 20, Leaves and stem green throughout. Leaves small, short pointed. Flowers white. Mature pods not colored, curved, papery, length 9.0 cm., width .8 to .9 cm., 5 to 6 seeded. Apex abrupt. Spur .9 to 1.0 cm. long, curved, marginal. Dry seeds (1.07 x .67 x .47 cm.), reniform, thickness .701 of width. Weight 205 to 215 gms. per 1000. Color raw sienna (329-1,2) no eye marking. Medium early, medium productivity, very susceptible to anthracnose. Plate II, fig. 68; X, fig. 4.

Bayou Grande (4-1920)

Plant short trailing, height 45 to 50 cm., nodes 10 to 11. Leaves and stem green throughout. Leaves large, markedly pubescent, blunt pointed. Flowers standard lilac (176-3,4), keel lilac (176-1,2). Mature pods often splashed red, curved, wrinkled surface, somewhat brittle, length 10 to 12 cm., width .9 to 1.0 cm., 4 to 5 seeded. Apex abrupt. Spur .8 cm. long, straight marginal. Dry seeds (1.4 x .81 x .63 cm.), reniform, thickness .794 of width, rounded in cross section. Weight 430 to 450 gms. per 1000. Color, pale pink (135-2), with Roman ochre (327) eye, hilum ring snuff brown (303) changing to yellow and brown with exposure and age. Very late, low productivity, very susceptible to anthracnose, not adapted in this section of United States. Plate II, fig. 69; X, fig. 5.

Small Garaypata (121-1919)

Plant short trailing, height 60 to 65 cm., nodes 16 to 17. Leaves dark green, medium size, blunt pointed. Stems purple. Flowers, standard magenta (182-2), keel reddish violet (180-1). Mature pods splashed purple, straight, medium texture, length 7.5 to 8.0 cm., width .9 to 1.0 cm., rounded, 5 to 6 seeded. Apex abrupt. Spur .74 to .78 cm. long, curved, marginal. Dry seeds (.88 x .66 x .50 cm.), not reniform, thickness .750 of width, truncated, rounded in cross section. Weight 201 to 224 gms. per 1000. Color, flesh (67-1), mottled sepia (300), not distinctly eyed. Late, very productive, quite resistant to anthracnose and blight. Plate II, fig. 70; X, fig. 6.

Red Indian, Mexican Type (15-1920)

Plant short trailing, similar to Mottled Red Indian, height 75 to 90 cm., nodes 23 to 26. Leaves and stem green throughout. Leaves large, short pointed, very pubescent. Flowers white. Mature pods not colored, curved, papery, flat, length 10.1 to 11.2 cm., width .9 to 1.0 cm., 5 to 7 seeded. Apex abrupt. Spur .8 to .9 cm. long, marginal, curved. Dry seeds (1.2 x .70 x .50 cm.), not reniform, thickness .672 of width, flat, truncated. Weight 301.2 gms. per 1000. Color, plum violet (172-4), no eye marking. Very late, low product-

ivity, very susceptible to anthracnose, not adapted in this section of United States. Plate III, fig. 71; X, fig. 7.

Red Indian (152-1919)

Similar to 15-1920, Red Mexican type. Height 70 to 75 cm., nodes 17 to 20. Dry seeds (1.00 x .65 x .49 cm.). Weight 216 to 266 gms. per 1000, thickness .746 of width. Color Indian chestnut red (333-1). Not adapted in this section of the United States. Very susceptible to anthracnose. Plate III, fig. 73.

Red Indian (1101-1919)

Very similar to 15-1920, Red Mexican type. Height 70 to 75 cm., nodes 17 to 20. Mature pods, length 8.68 cm., width .91 cm., 4 to 5 seeded. Seeds, weight 265 to 283 gms. per 1000, thickness .680 of width. Medium late, medium productivity, adapted in this section of the United States. Very susceptible to anthracnose. Plate III, fig. 72.

Selection (134-1919)

Plant short trailing, height 75 to 120 cm., nodes 13 to 17. Leaves and stem green throughout. Leaves medium, short pointed. Flowers white. Mature pods often splashed red, curved, flat, thin, length 9.9 cm., width 1.1 cm., 4 to 5 seeded. Apex abrupt. Spur 1.0 cm. long, curved, marginal. Dry seeds (1.16 x .79 x .49 cm.), not reniform. flat, thickness .629 of width. Weight 320 to 348 gms. per 1000. Color snuff brown (303), no eye marking. Medium early, productive, resistant to anthracnose. Plate III, fig. 74; X, fig. 8.

Improved Yellow Eye (1096-1919)

Plant short trailing otherwise same as Old Fashioned Yellow Eye. Height 75 to 80 cm., nodes 11 to 12. Mature pods curved, 5 to 6 seeded. Apex abrupt. Spur .9 to 1.0 cm. long, curved, not marginal. Dry seeds (1.17 x .77 x .68 cm.), oval, thickness .882 of width. Weight 338 to 394 gms. per 1000. Color, white with irregular yellow ochre (326-4) pattern around hilum, covering approximately one-third of entire area, eye snuff brown (303) with yellow ochre (326-4) hilum ring. Plate III, fig. 75; X, fig. 9.

Ruby Horticultural Bush (3b-1918)

Plant short trailing, similar to Vineless Marrow. Height 75 to 80 cm., nodes 11 to 12. Leaves and stems green throughout. Leaves medium size, long pointed. Flowers, standard lilac (176-3,4), keel lilac (176-1,2). Mature pods splashed red, slightly curved, coarse, length 9.3 cm., width 1.0 cm., 3 to 5 seeded. Apex elongated. Spur 1.2 cm. long, curved, marginal. Dry seeds (1.20 x .75 x .61 cm.), oval, thickness, 812 of width. Weight 395 to 425 gms. per 1000. Color, flesh (139-1), mottled and striped garnet brown (164-4), eye Roman ochre, no distinct hilum ring. Medium early, productive, very susceptible to anthracnose, resistant to blight. Plate III, fig. 76; X, fig. 10.

Selection (98-1919)

Similar to 3b differing in size of seed, (1.3 to 1.4 x .87 to .75 x .58 to .66 cm.). Matures approximately one week earlier. Plate III, fig. 77.

Summary

1. Varieties of field beans obtained from the various bean growing sections of the United States and Canada including a few varieties from Europe have been grown at University Farm, and at several substations and outlying trial fields, during the past few years.
2. Intensive work toward the identification of varieties began with the harvest of the 1918 crop by selecting individual plants. The seed of these individual plants was grown in progeny rows. The row with plants and seeds most typical was selected as the type for a given variety. The promising non-typical forms are described by selection numbers without names.
3. Data useful in classification and description was obtained from observations of field cultures during the crop years 1917 to 1920 inclusive, and from an examination of pods and seeds in the laboratory for the crop produced in 1919 and 1920.

4. From an examination of the data obtained it was apparent that morphological characters, such as plant habit, pod shape, seed shape, and color, were more stable than size of seed and pod.

5. A classification of the species of *Phaseolus* and field varieties of *P. vulgaris* has been made.

6. Five promising new varieties of field beans are here named and described. They are Nippissing Pea, Yellow Indian, Zebra, Small Garaypata, and Great Northern.

Conclusions

Available classifications of beans do not meet the need for a classification of field bean varieties.

It has conclusively been shown that the size of seed in field beans is affected in size by locality in which the crop is grown, by date and rate of planting, and by seasonal variation. It, therefore, appears that absolute weights and measurements are not a satisfactory basis for classification of field beans.

EXPLANATION OF PLATES.

Plate I. - Side and ventral views of ripe seeds, natural size. 1, Dwarf Lima; 2, White Tepary; 3, Yellow Tepary; 4, Mottled Tepary; 5, Black Tepary; 6, Scarlet Runner; 7, French Dwarf Kidney; 8, White Kidney; 9, Nippissing Pea; 10, Selection (1-1919); 11, Selection (10-1919); 12, Great Northern; 13, Selection (19-1920); 14, Selection (16-1919); 15, Selection (27-1919); 16, Selection (6-1919); 17, Selection (14-1919); 18, Lady Washington; 19, Selection (66-1919); 20, Selection (78-1919); 21, Selection (24-1919); 22, Selection (36-1919); 23, Yankee Winter; 24, Selection (43-1919); 25, Pearce's Improved Tree; 26, Burlingame Medium; 27, Selection (86-1919); 28, Selection (20-1920); 29, Selection (35-1919); 30, Selection (26c-1918); 31, Selection (27-1918); 32, French White; 33, White Marrow, 34, Selection (28-1920); 35, Vineless Marrow.

Plate II. - Side and ventral views of ripe seeds, natural size. 36, Navy Pea; 37, Snowflake; 38, Selection (1084-1919); 39, Selection (555a-1920); 40, Robust; 41, Selection (37-1920); 42, Selection (69-1919); 43, Selection (70-1919); 44, Blue Pod; 45, Red Kidney; 46, Long Yellow; 47, Improved Goddard; 48, Brown Swedish-Kidney Type (138-1919); 49, Brown Norwegian; 50, Selection (7-1920); 51, Selection (141-1919); 52, Selection (12-1920); 53, Madawaska; 54, Eureka; 55, Brown Swedish; 56, Selection (1086-1920); 57, Selection (132-1919); 58, China Red Eye; 59, Old Fashioned Yellow Eye; 60, Yellow Indian; 61, Black Turtle Soup; 62, Selection (114-1919); 63, Zebra; 64, Hansen; 65, Selection (1099-1919); 66, Large Garaypata; 67, Mottled Red Indian; 68, Bayou Chico; 69, Bayou Grande; 70, Small Garaynata.

Plate III. - Side and ventral views of ripe seeds, natural size. 71, Red Indian Mexican Type; 72, Red Indian; 73, Red Indian; 74, Selection (134-1919); 75, Improved Yellow Eye; 76, Ruby Horticultural Bush; 77, Selection (98-1919); 78, Pink; 79, Small White.

Plate IV. - Side view of mature pods, natural size. 1, Dwarf Lima; 2, White Tepary; 3, Yellow Tepary; 4, French Dwarf Kidney; 5, White Kidney; 6, Nippissing Pea; 7, Selection (1-1919); 8, Selection (10-1919).

Plate V. - Side view of mature pods, natural size. 1, Great Northern; 2, Selection (19-1920); 3, Selection (6-1919); 4, Lady Washington; 5, Selection (66-1919); 6, Selection (24-1919); 7, Yankee Winter; 8, Selection (43-1919); 9, Pearce's Improved Tree; 10, Burlingame Medium.

Plate VI. - Side view of mature pods, natural size. 1, Selection (86-1919); 2, Selection (20-1920); 3, Selection (35-1919); 4, Selection (27-1918); 5, Selection (26c-1918); 6, French White; 7, White Marrow; 8, Selection (28-1920); 9, Vineless Marrow.

Plate VII. - Side view of mature pods, natural size. 1, Navy Pea; 2, Snowflake; 3, Selection (1084-1919); 4, Selection (555a-1920); 5, Robust; 6, Selection (37-1920); 7, Selection (69-1919); 8, Selection (70-1919); 9 and 10, Bluepod.

Plate VIII. - Side view of mature pods, natural size. 1, Red Kidney; 2, Long Yellow; 3, Improved Goddard; 4, Brown Swedish; 5, Brown Norwegian; 6, Selection (7-1920); 7, Selection (141-1919); 8, Selection (12-1920); 9, Madawaska.

Plate IX. - Side View of mature pods, natural size. 1, Eureka; 2, Brown Swedish (133-1919); 3, Selection (1086-1920); 4, Selection (132-1919); 5, China Red Eye; 6, Old Fashioned Yellow Eye; 7, Yellow Indian; 8, Black Turtle Soup, 9, Selection (114-1919); 10, Zebra.

Plate X. - Side view of mature pods, natural size. 1, Hansen; 2, Selection (1099-1919); 3, Large Garaypata; 4, Bayou Chico; 5, Bayou Grande; 6, Small Garaypata; 7, Red Indian Mexican Type (15-1920); 8, Selection (134-1919); 9, Improved Yellow Eye; 10, Ruby Horticultural Bush.

BIBLIOGRAPHY.

- (1) Burr, Fearing, Jr.
1865. American Garden Beans. In The Field and Garden Vegetables of America. 667 p. Boston.
- (2) Chittenden, F.J.
1920. Dwarf French Beans at Wisley, 1919.
In the Journal of the Royal Horticultural Society, V.45, pts. 2 and 3, p.316-353.
- (3) Emerson, R.A.
1916. A Genetic Study of Plant Height in *Phaseolus vulgaris*. Nebr. Agr. Exp. Sta. Research Bul.7, p. 1-73, illus.
- (4) Freeman, G.F., Jaffa, Albro, and De Ong.
1912. Southwestern Beans and Teparies. Ariz. Agr. Exp. Sta. Bul. 68, p.573-619, illus.
- (5) Hendry, G.W.
1918. Bean Culture in California. Cal. Agr. Exp. Sta. Bul. 294, p.287-347, illus.
- (6) Irish, H.C.
1901. Garden Beans Cultivated as Esculents. In the Twelfth Report of the Missouri Botanical Garden, p. 81-165, illus.
- (7) Jarvis, C.D.
1908. American Varieties of Beans. New York Cornell Agr. Exp. Sta. Bul. 260, p.149-255, illus.
- (8) von Martens, Georg.
1869. Die Gartenbohnen. Zweite vermehrte ausgabe Ravensburg. Druck und Verlag von Eugen Ulmer, illus.
- (9) Shaw, J.K., and Norton, John B.
1918. The Inheritance of Seed Coat Color in Garden Beans. Mass. Agr. Exp. Sta. Bul. 185, p.59-104.

(10) Société Francaise Des Chrysanthémistes et Oberthür.

1905. René, - Dauthenay, Henri.
Repertoire de Couleurs des Fleurs,
des Feuillages et des Fruits.

(11) Tracy, W.W., Jr.

1907. American Varieties of Garden Beans.
U.S.D.A., B.P.I. Bul. 109, illus.

(12) Zavitz, C.A.

1915. Field Beans. Ontario Agricultural College
Bul. 232, illus.

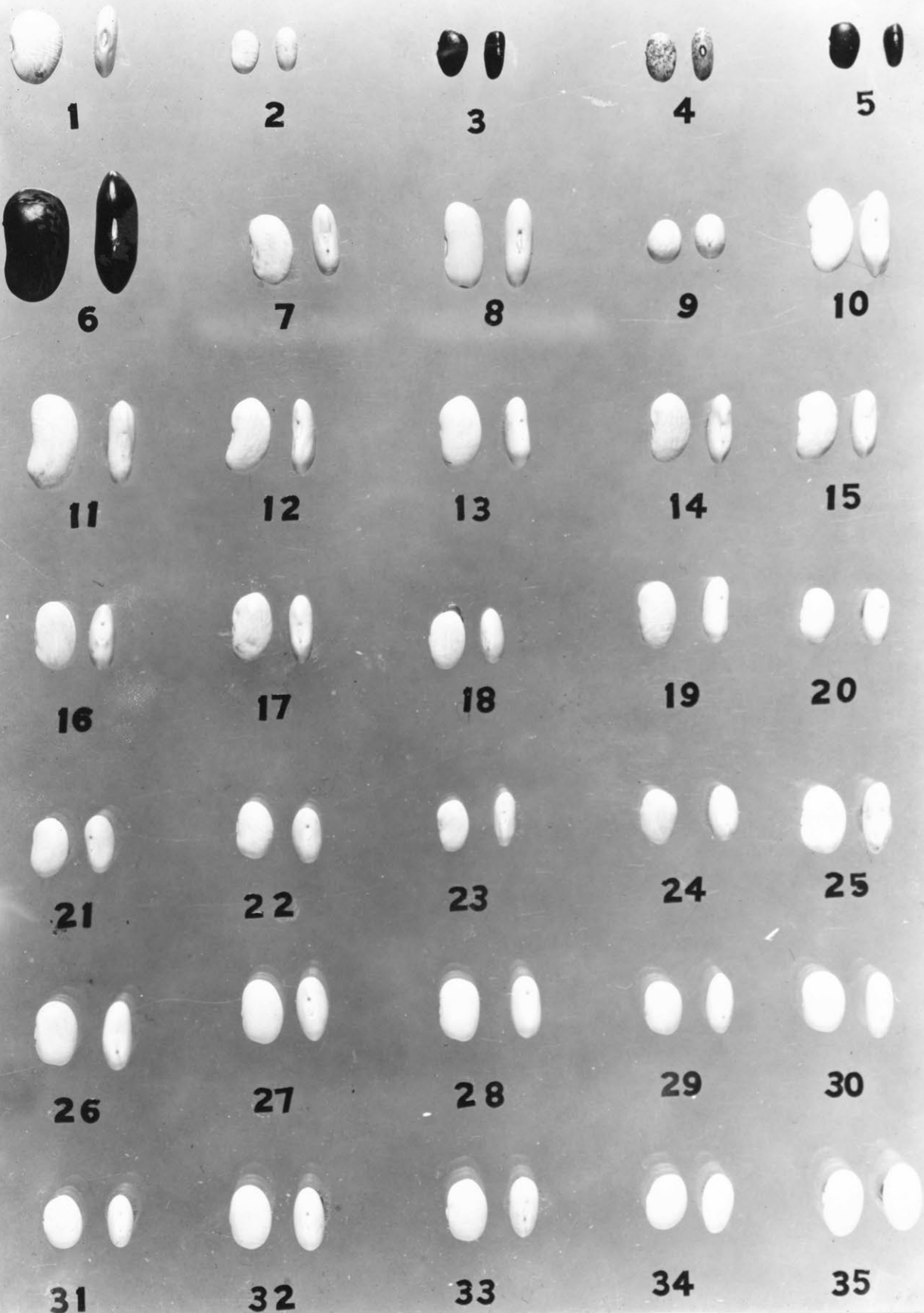


Plate I. Showing seeds in lateral and ventral views.



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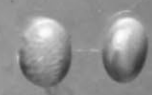
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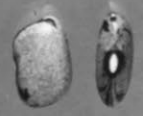
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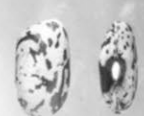
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Plate II. Showing seeds in lateral and ventral views.



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Plate III. Showing seeds in lateral and ventral views.



Plate IV. Showing pods in lateral view.

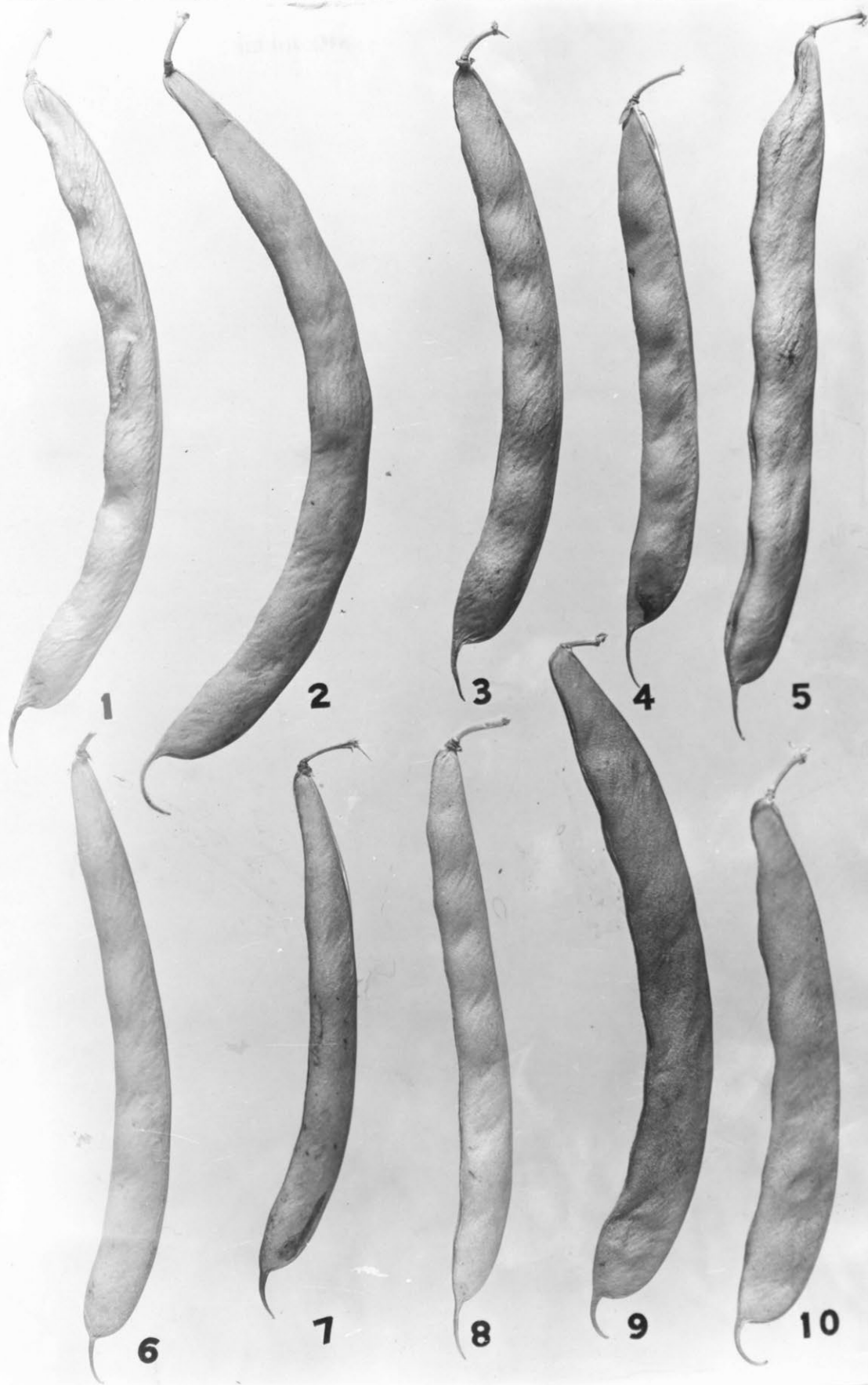


Plate V. Showing pods in lateral view.

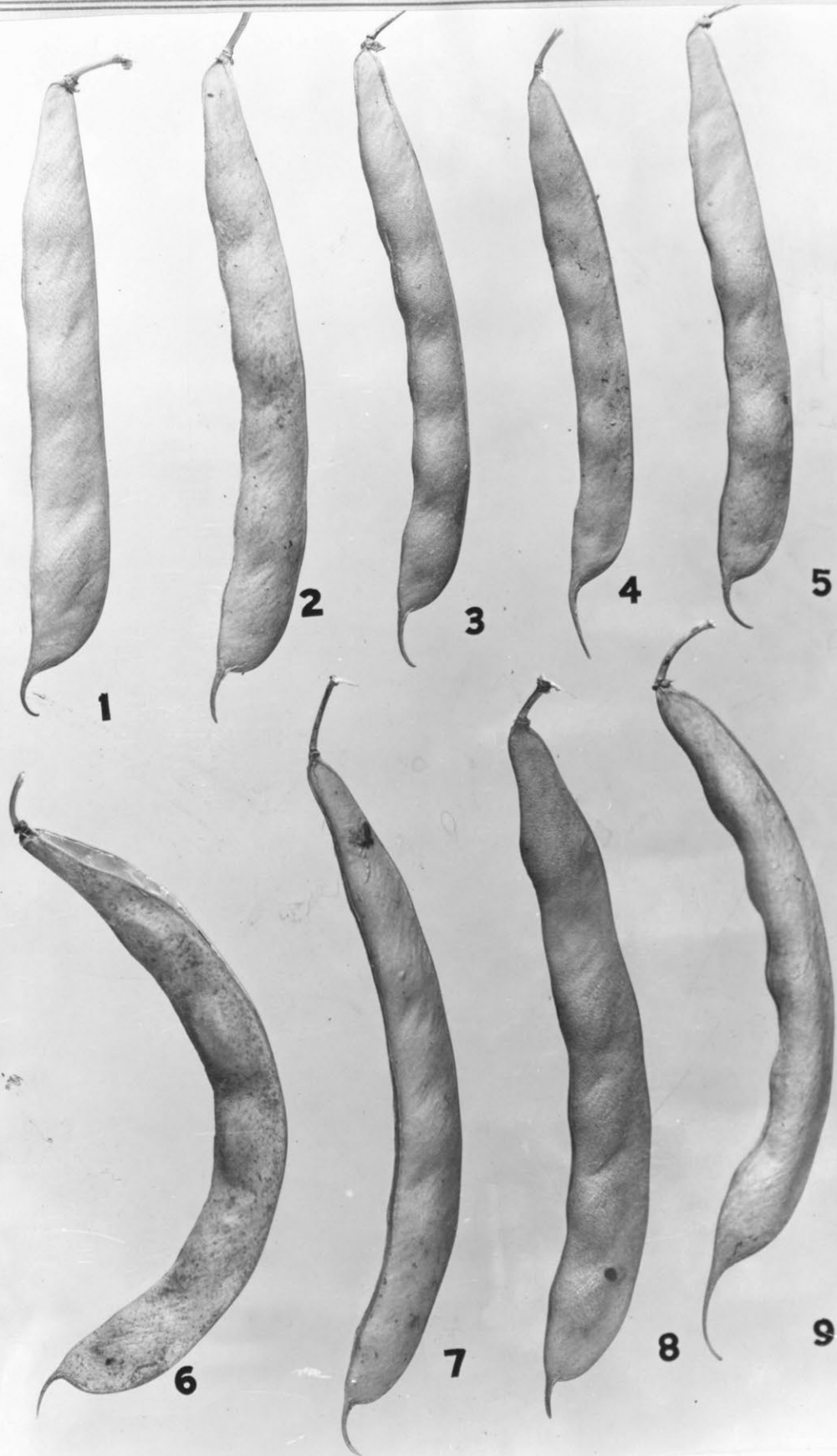


Plate VI. Showing pods in lateral view.

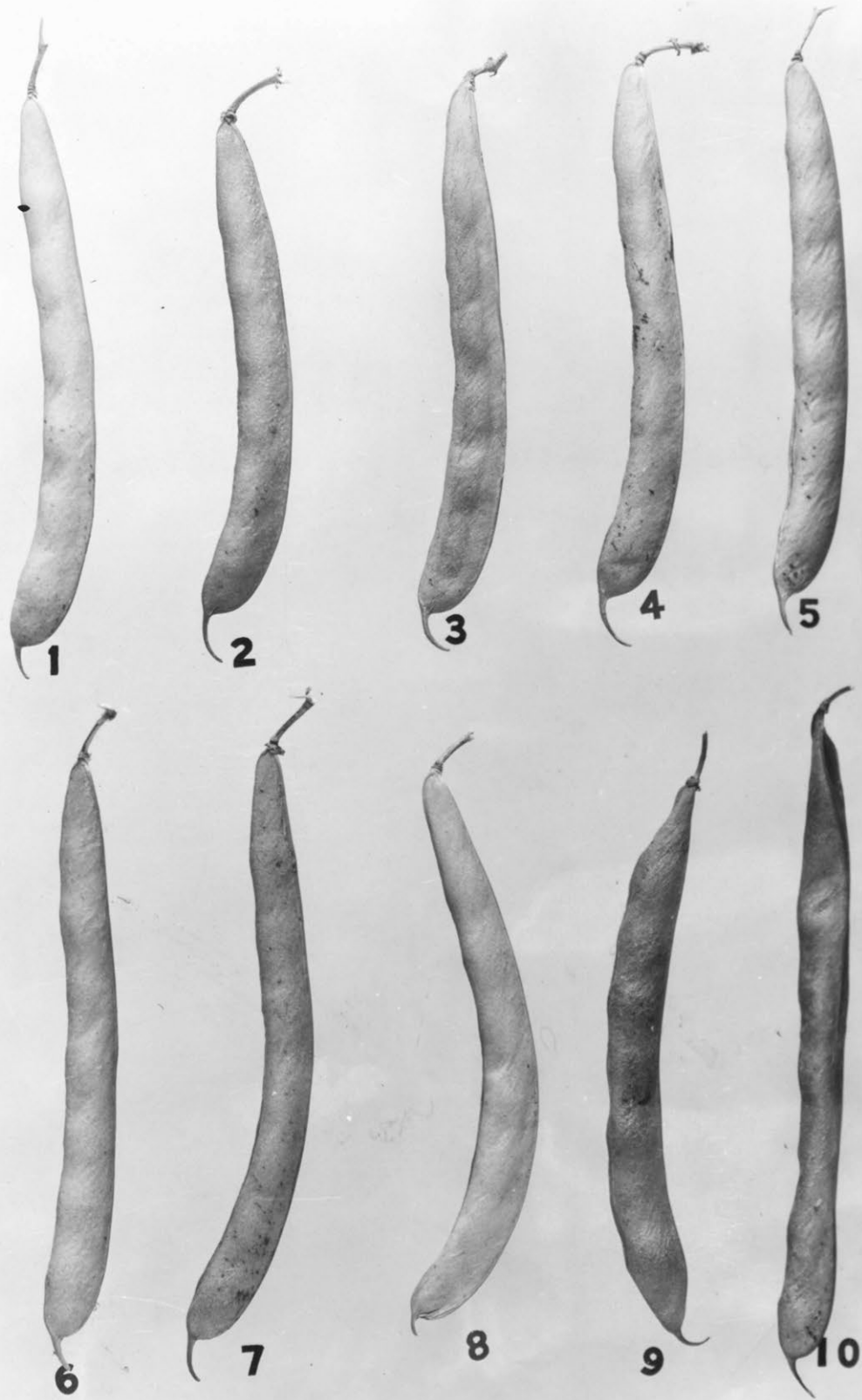


Plate VII. Showing pods in lateral view.

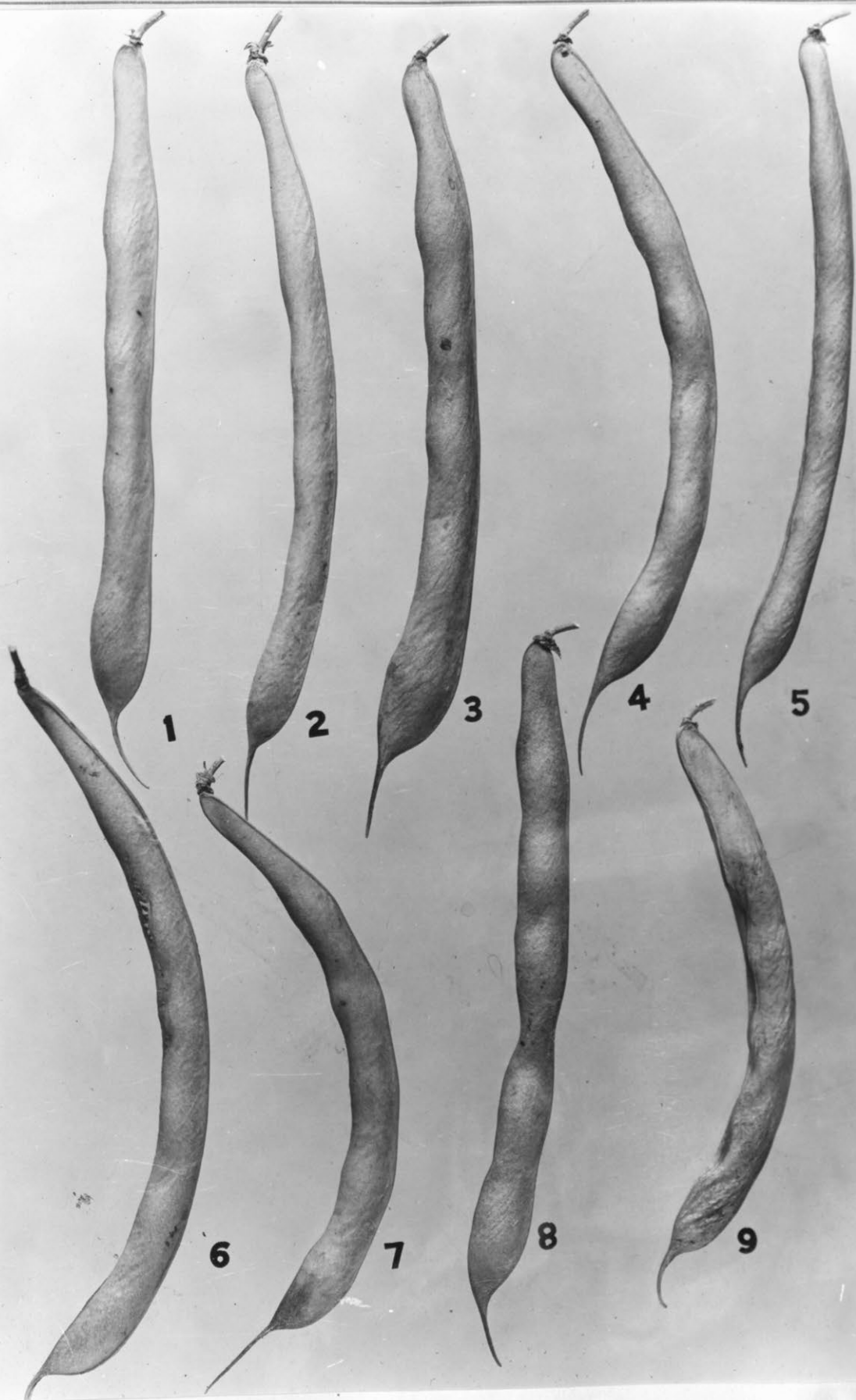


Plate VIII. Showing pods in lateral view.

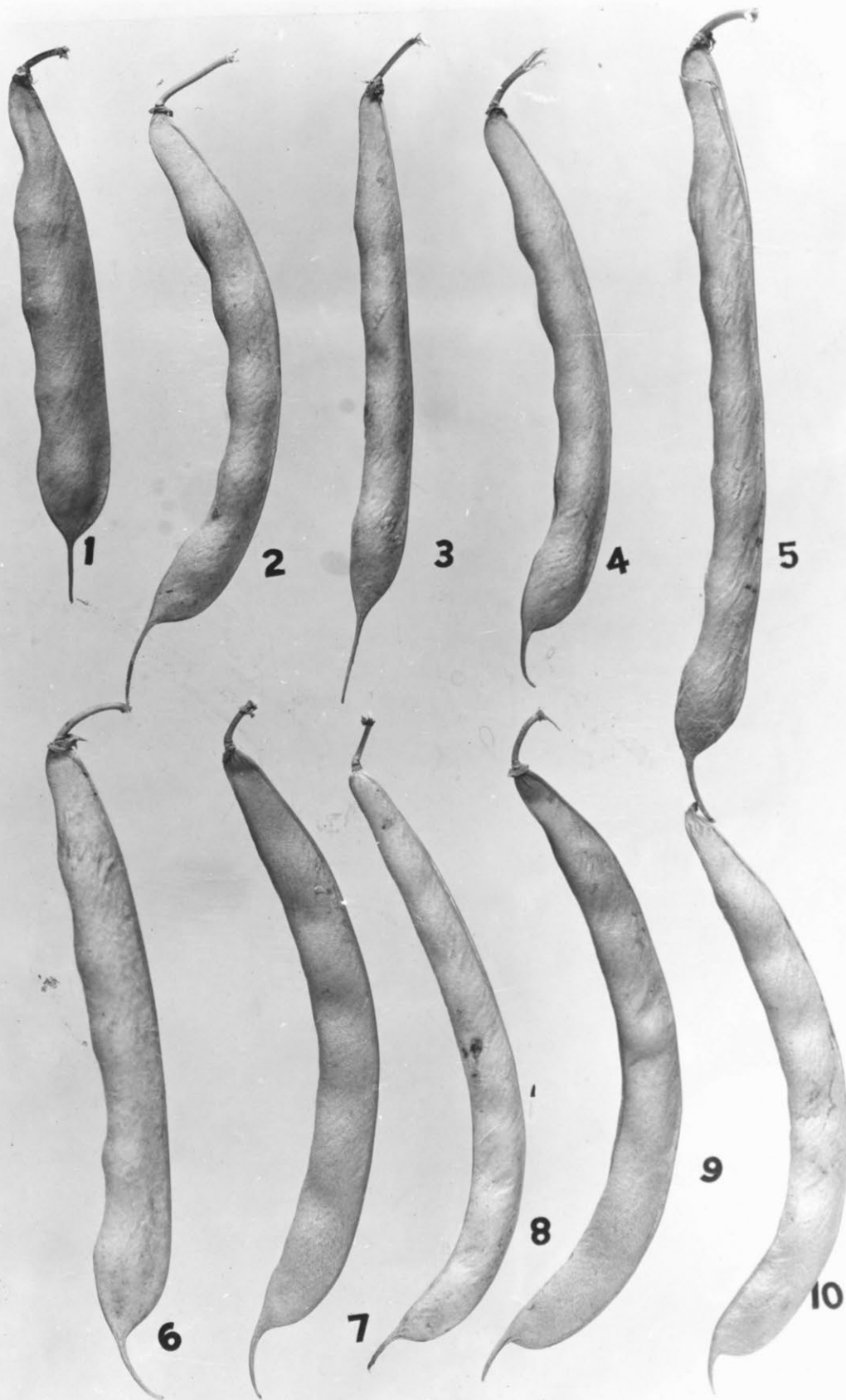


Plate IX. Showing pods in lateral view.

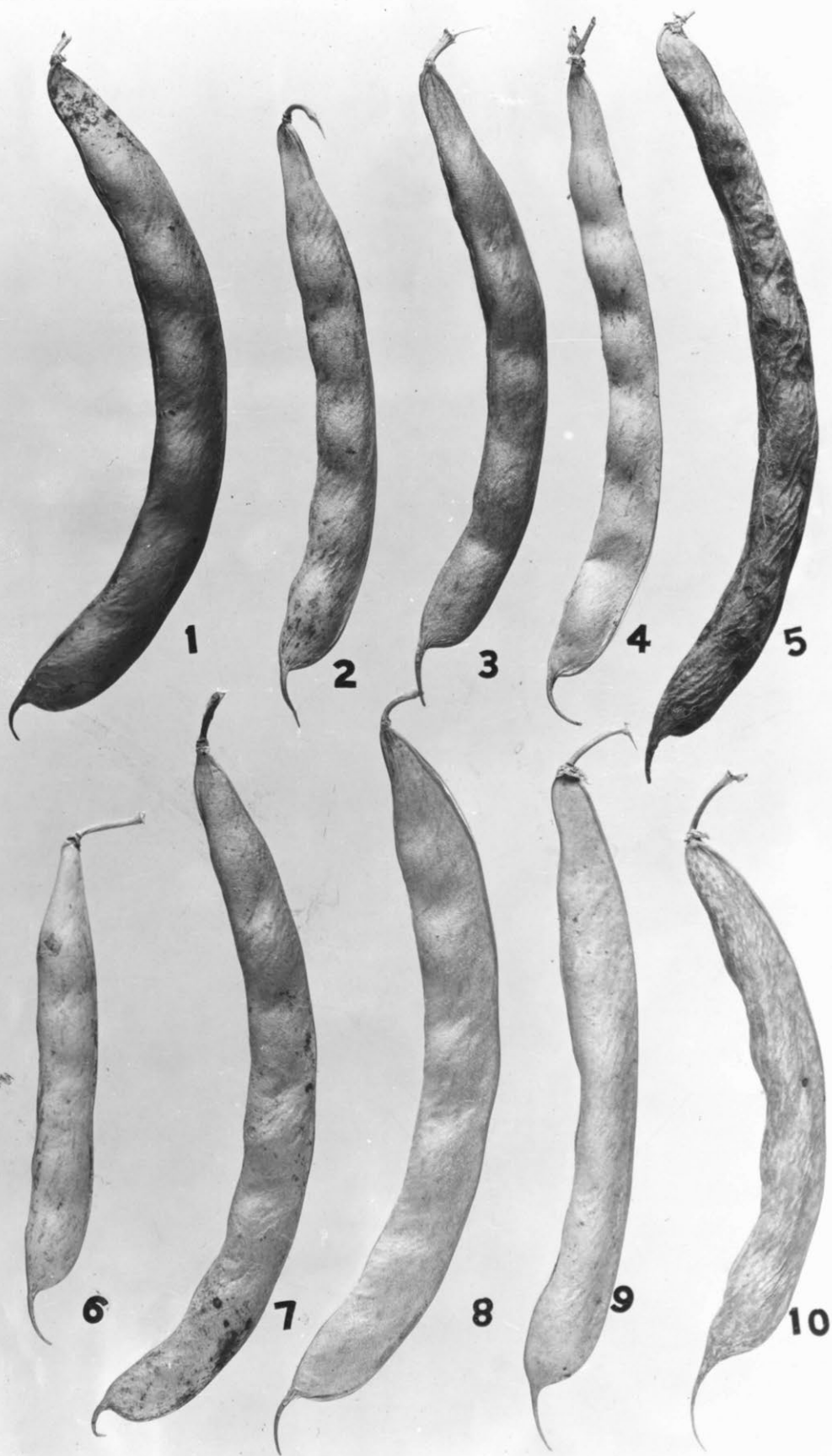


Plate X. Showing pods in lateral view.