A MORPHOLOGICAL STUDY OF BLIND AND FLOWERING ROSE SHOOTS, WITH SPECIAL REFERENCE TO FLOWER-BUD DIFFERENTIATION[1]

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INTRODUCTION

The formation of nonflowering shoots on forced rose plants represents a great economic loss to rose growers, for in certain varieties this flowerless growth may bring about a 50-percent reduction of each year's potential rose crop.[3]

It is well known that under greenhouse conditions the flowering rose shoot reaches maturity in approximately 45 days, whereas the blind shoot ceases growth after about 30 days and produces a new shoot from the last axillary bud. In the majority of cases this new shoot continues with blind growth for 30 days, at the end of which time it produces a new shoot in the same manner as its parent. The process of flower differentiation in the rose has not yet been established, nor has the author been able to find any report of an anatomical or morphological study of blind and normal rose wood. This paper reports the results of studies made on blind and flowering rose shoots of the variety Briarcliff.

REVIEW OF LITERATURE

The first important work concerning the causes of blindness in roses was done by Corbett.[4] He attributed the production of blind wood to inheritance. The relation of blind-wood production to length of day is being studied by Grove.[5] In a recent report by the present writer,[3] the following results were presented:

A correlation between the physiological behavior and chemical differences of blind and flowering rose shoots indicates that blindness in the rose is a physiological rather than a genetic or pathological condition.

A combination of pruning and budding experiments indicates that blindness is a result of the stock and is not due to impotency of the buds. This point is emphasized by the differences in the chemical composition of blind and flowering wood.

Growth and differentiation were definitely affected by the monthly hours of illumination and the available nitrate supply. A decrease in illumination decreased both flower and blind-shoot production, while the normal increase in illumination in the spring months increased flower production more rapidly than blind-shoot production.

With an increase in soil nitrates blind-shoot formation decreased and flower production increased; with a decrease in soil nitrates blind-shoot formation increased and flower production decreased.

The chemical analyses indicate that blindness is associated with high percentages of noncolloidal nitrogen and insoluble carbohydrates, whereas the flowering shoots contain high percentages of reducing sugars.

[1] Received for publication Aug. 9, 1933; issued February 1934.

[2] The author expresses his appreciation to Prof. J. R. Cooper and Dr. L. M. Turner for suggestions and criticisms throughout the progress of this work.

[3] Hubbell, D. S. Unpublished thesis, Iowa State College. 1932.

[4] Corbett, L. C. improvement of roses by bud selection, or blind vs. flowering wood for rose cuttings. Mem. Hort. Soc. N.Y. 1: [93]–101, illus. 1902.

[5] Grove, L. D. Unpublished material, Iowa State College.

Since this work indicated that flower-bud formation is influenced by various cultural practices, a successful interpretation of these influences would depend upon a definite understanding of the time and extent of flower-bud differentiation. In order to obtain such an understanding it would be necessary to make a complete anatomical analysis of the two types of shoots. The purpose of the study here reported was to establish through morphological methods whether blindness in roses is a genetic or a physiological condition. When this point has been established the foundation for the control of blindness in roses will have been laid.

MATERIALS AND METHODS

Beginning December 1, 1932, 10 buds from flowering rose shoots and 10 buds from blind rose shoots were tagged each day until January 4, 1933. Each day the mature stems of blind and flowering stems were selected. The stems were cut back to the buds occupying the fourth axillary position and these buds were collected and studied after they had attained the desired age. The collection consisted of 350 buds and shoots from apparently blind wood and 350 normal buds and shoots. The buds and shoots collected ranged in age from 1 to 35 days.

Immediately after collection the buds and shoots were killed in formalin acetic alcohol. The material was then fixed, cleared, embedded, and sectioned according to the standard method as outlined by Chamberlain.[6] The slides were stained with safranine and light green.

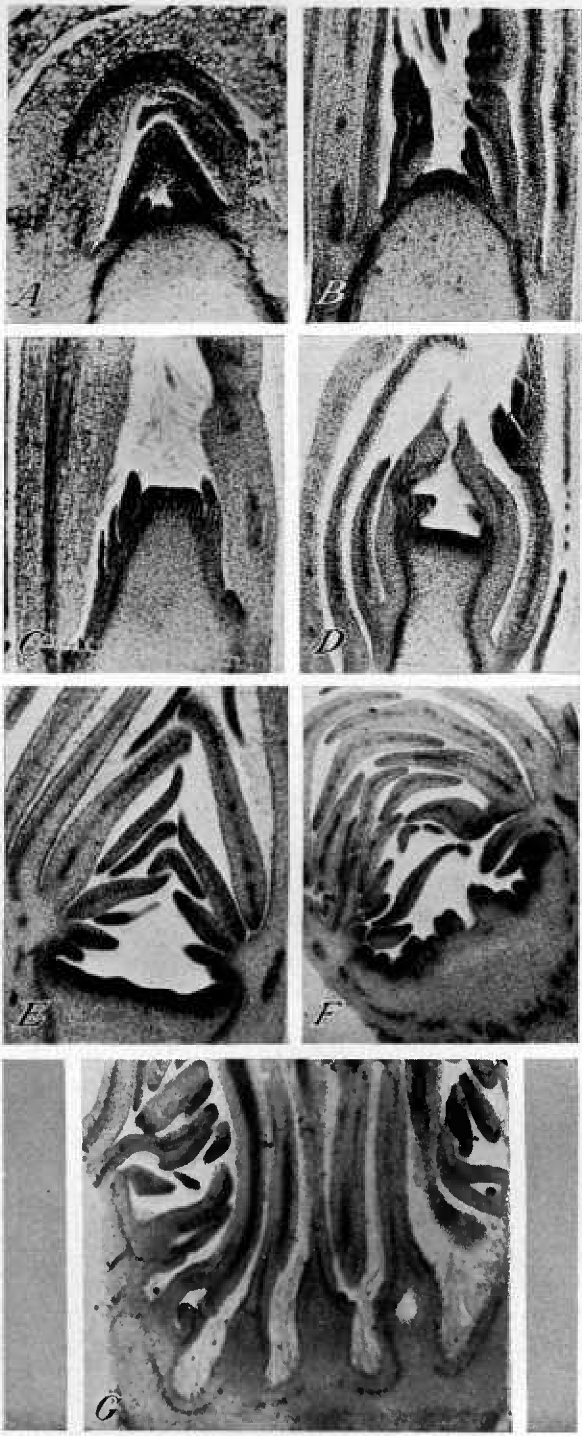
RESULTS

DIFFERENTIATION AND DEVELOPMENT OF FLOWERING SHOOTS

Some differences were noted in the rate of shoot development among buds and shoots of the same age. In general, however, the majority of the buds developed at the same rate for the entire 35 days. Of the shoots and buds gathered, 3.8 percent developed blind wood, 2.8 percent failed to develop it, and 93.4 percent developed normally.

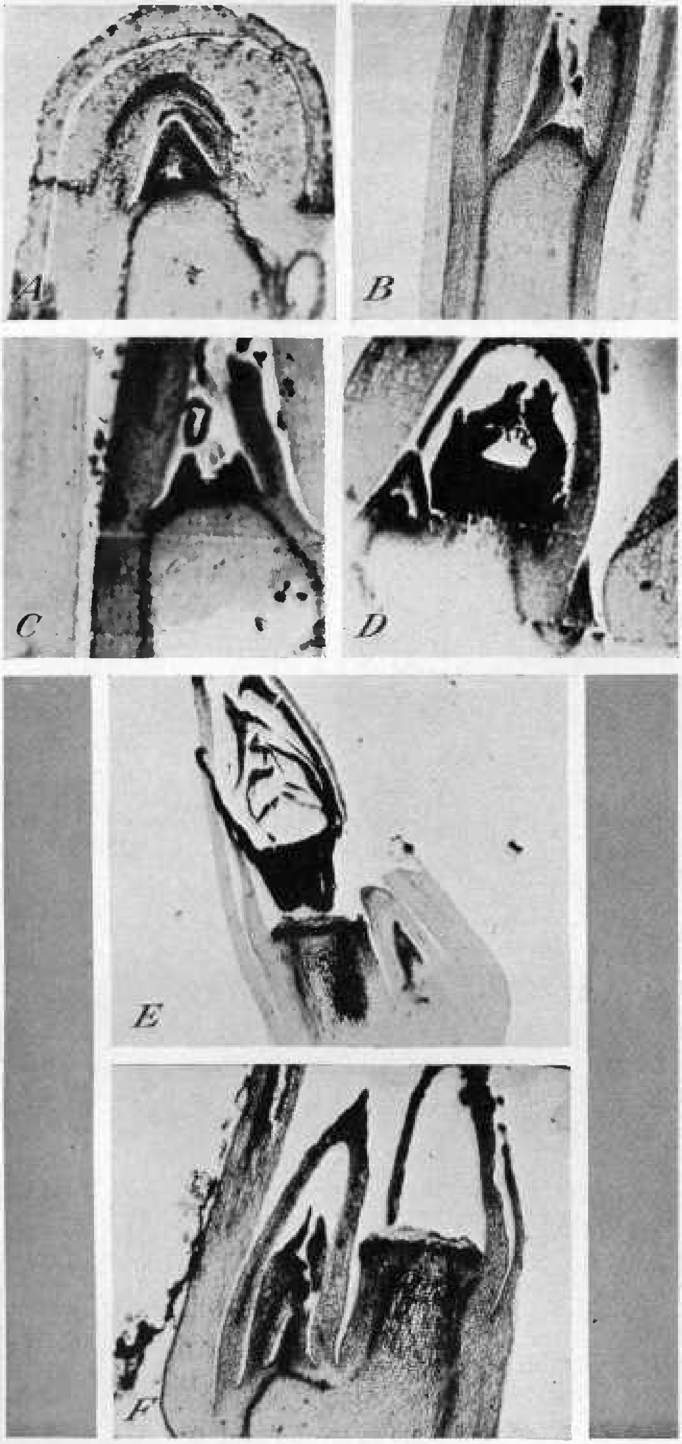
Figure 1 and plate 1 show the development of a normal flowering rose shoot from the purely vegetative bud to the complete formation of the floral parts. The first evidence of differentiation was found 8 days after the axillary bud had been made to assume the terminal position by the removal of the terminal bud (fig. 1, *D*). At this time a broadening and thickening of the floral axis was noted. The ninth day gave evidence of sepal protuberances pushing up from the sides of the bud (fig. 1, *E*). The first stages of petal primordia were observed after the lapse of 12 days (fig. 1, *G*). On December 30, when the bud was 20 days of age pistil primordia appeared as small protuberances on the bottom of the recepticale cup (fig. 1, *J*). At this stage the stamen primordia were also visible, although they were not clearly differentiated into anthers and filaments until the twenty-second day (fig. 1, *K*). By December 25 the stamens and pistils were so well differentiated that their component parts could be readily identified, and the petals had so far developed as to enclose the stamens and pistils (fig. 1, *L*).

[6] CHAMBERLAIN, C. J. METHODS IN PLANT HISTOLOGY. 3d rev. ed., 314 pp., illus. Chicago. 1915.



PHOTOMICROGRAPHS OF LONGITUDINAL SECTIONS THROUGH FLOWERING ROSEBUDS AT VARIOUS STAGES OF DEVELOPMENT.

A, Immature bud 1 day old. *B*, 8-day shoot showing the first stage of differentiation. *C*, 10-day shoot showing the formation of sepal primordia. *D*, 12-day shoot with evidence of petal primordia. *E*, 21-day shoot showing pistil protuberances and stamen formation. *F*, 23-day shoot showing advanced stages of pistil primordia. *G*, 25-day shoot showing complete development of all floral organs. × 80.



PHOTOMICROGRAPHS OF LONGITUDINAL SECTIONS THROUGH BLIND ROSEBUDS AT VARIOUS STAGES OF DEVELOPMENT.

A, Immature bud at the end of the first day. *B*, Signs of differentiation at the end of 10 days. *C*, Sluggish differentiation at 20 days. *D*, Evidence of abortion at 28 days, with petal primordia just beginning to develop. *E*, Evidence of abortion after complete petal formation. *F*, Axillary bud starting active growth after abortion of the terminal bud. × 80.

DEVELOPMENT OF BLIND SHOOTS

The development of the buds taken from blind stems was very irregular, as is shown in plate 2. Of the shoots and buds gathered, 5 percent formed flowers, 10 percent failed to develop beyond the axillary stage, and 85 percent formed blind shoots. The growth rate of the actively growing blind shoots was so lacking in uniformity that

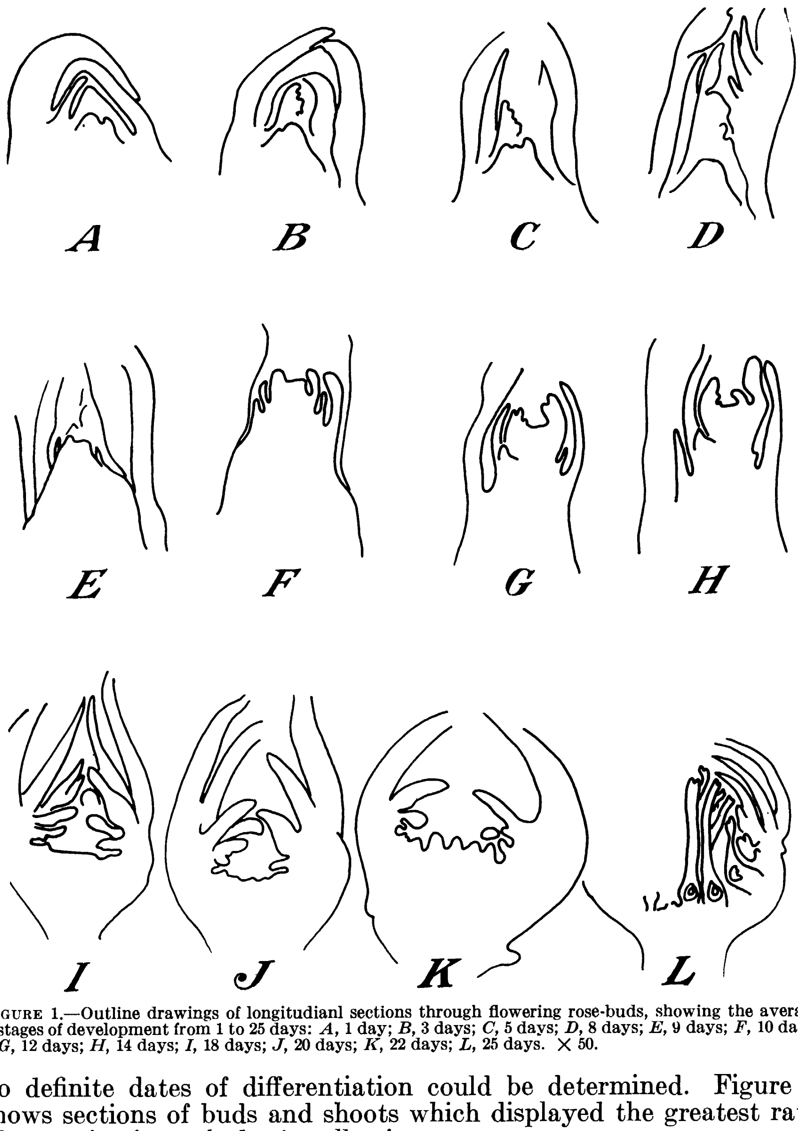


FIGURE 1.—Outline drawings of longitudianl sections through flowering rose-buds, showing the average stages of development from 1 to 25 days: *A*, 1 day; *B*, 3 days; *C*, 5 days; *D*, 8 days; *E*, 9 days; *F*, 10 days; *G*, 12 days; *H*, 14 days; *I*, 18 days; *J*, 20 days; *K*, 22 days; *L*, 25 days. × 50.

no definite dates of differentiation could be determined. Figure 2 shows sections of buds and shoots which displayed the greatest rate of maturity in each day's collection.

Figure 2, *C*, shows the characteristic flattening of the main axis which was the first indication of flower differentiation noted in the flowering shoots. This initial development took place 2 days later in the blind shoots than in the flowering shoots. At the end of the twentyfourth day (fig. 2, *E*) the sepal primordia were very prominent, and definite petal primordia appeared from 2 to 6 days later, as is shown in figure 2, *F* and *G*. The formation of petals and sepals, together with a broadening of the receptacle cup, continued until the shoot was 34 days of age. At that time, without any evidence of pistil or stamen

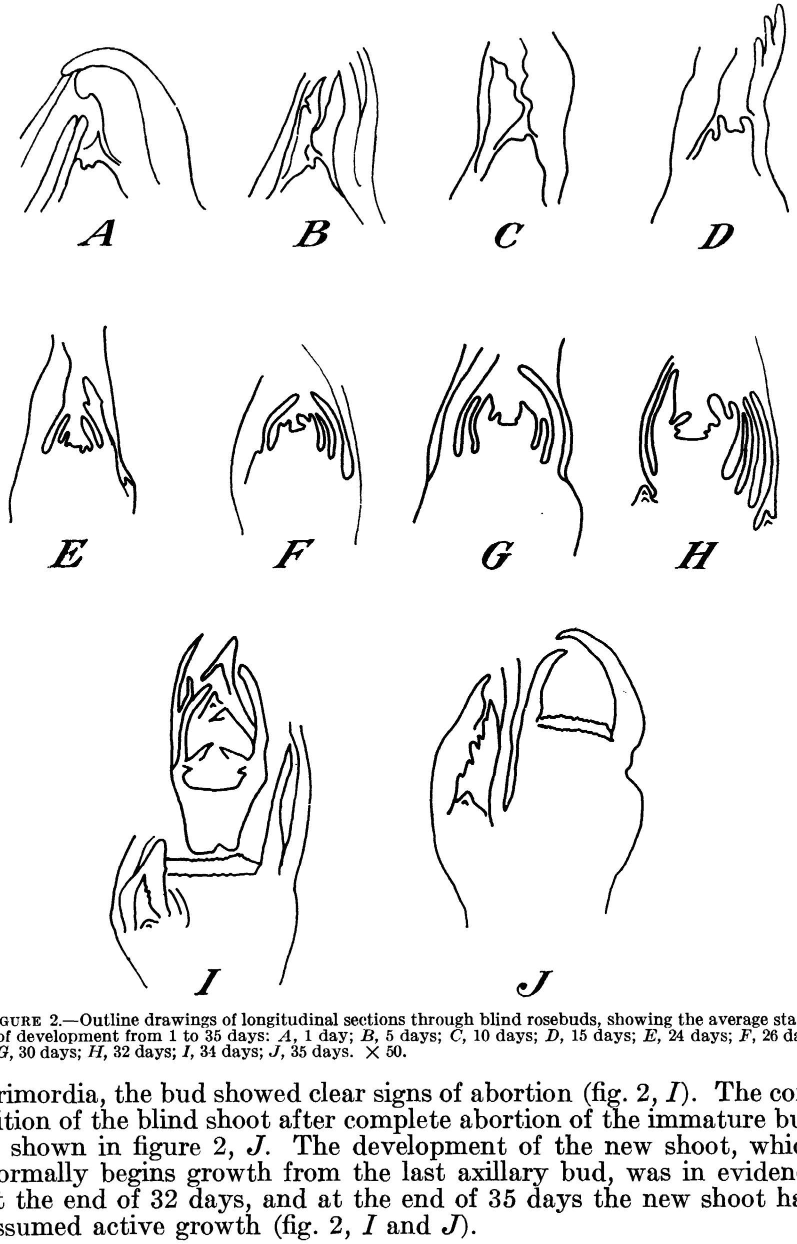


FIGURE 2.—Outline drawings of longitudinal sections through blind rosebuds, showing the average stages of development from 1 to 35 days: *A*, 1 day; *B*, 5 days; *C*, 10 days; *D*, 15 days; *E*, 24 days; *F*, 26 days *G*, 30 days; *H*, 32 days; *I*, 34 days; *J*, 35 days. × 50.

primordia, the bud showed clear signs of abortion (fig. 2, *I*). The condition of the blind shoot after complete abortion of the immature bud is shown in figure 2, *J*. The development of the new shoot, which normally begins growth from the last axillary bud, was in evidence at the end of 32 days, and at the end of 35 days the new shoot had assumed active growth (fig. 2, *I* and *J*).

SUMMARY AND CONCLUSIONS

A study was made of the growth and development of blind and flowering rose shoots with special reference to the date of flower-bud differentiation and the morphological differences between blind and flowering shoots. It was found that the approximate date of flower bud differentiation on flowering shoots was from 8 to 10 days after active growth had started. The complete formation of the flower with all parts completely differentiated was first noted at the end of the twenty-fifth day. Blind shoots were formed when the floral axis failed to develop a complete set of floral organs. Flower-bud differentiation started about 2 days later in the blind shoots than in the flowering shoots. The sepals and petals formed in the blind shoots, but no stamen or pistil primordia appeared. At the end of 30 days the undeveloped flower showed signs of abortion and 5 days later it had completely aborted. Signs of abortion were noted in a few cases at the end of 28 days.

Since the writer [7] has shown that blindness may be controlled by altering nutritional factors, and since abortion is associated with nutrition, it is evident that blindness is purelya physiological condition, in which an abortive bud is formed as a result of an improper balance of nutritional factors.

[7] HUBBELL, D. S. See footnote 3.

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