NEW MUTANT CHARACTERS OF THE JAPANESE MORNING GLORY

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DURING some fifteen years' investigation of the Japanese morning glory, *Pharbitis nil*, I have noticed a number of new mutant characters, some of which were described in my earlier papers.[2, 3, 5, 6] Meanwhile, two other mutant characters were reported by Hagiwara[1] and Miyazawa[7]. According to personal information, Mr. C. U of Kônosu Experiment Station has been studying several mutant forms which appeared under his observation. In this paper, I intend to present a description of five new mutant characters, reserving the others for future publication.

Though mutations, in general, make their rare and sporadic appearance, one class of mutations occurs frequently in a definite proportion. In the latter case, the variations are induced by certain mutable genes, which alter at intervals in one and the same direction. In the Japanese morning glory, the mutants produced by mutable genes are generally normal in type, reverting to their prototype (Figure 14). Willow, however, reverts to maple and not to normal, but maple is one of the common variations in this plant. Therefore, mutable genes give no new characters. Quite contrary to this, sporadic mutations frequently give new traits. The five mutations, of which I am going to describe, brought about new characters by their occurrence.

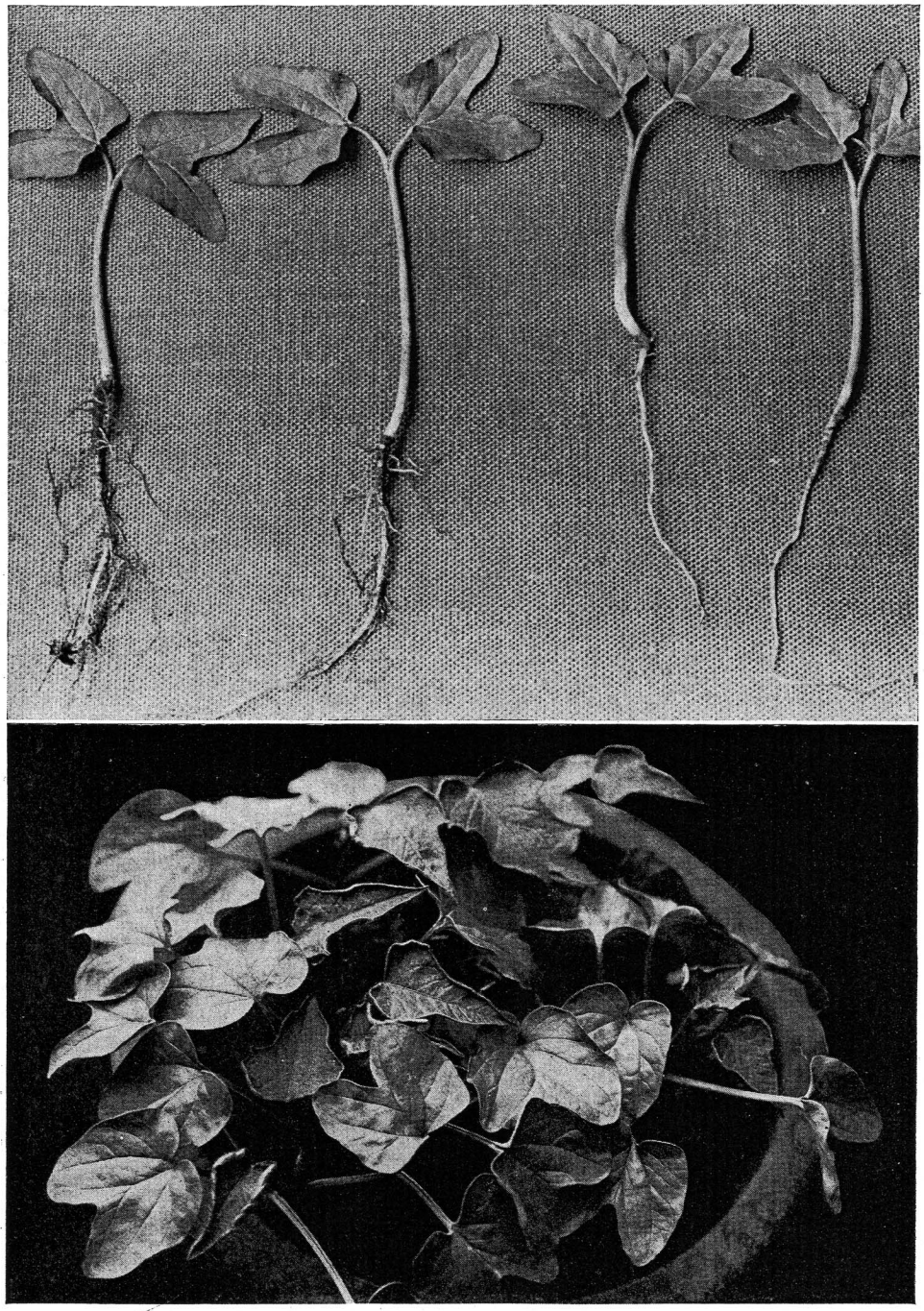
Rootletless

One of the five pedigrees of No. T7, bred in 1927, contained some seedlings with a peculiar root system. The seedlings had no rootlets in their early stage after germination (Figure 15), so that the new character is called rootletless. Twenty-nine rootletless seedlings appeared among a total of 202, the sister seedlings being normals with numerous slender rootlets (Figure 15). Previously I had observed only normal seedlings in this strain (No. T7), and therefore the rootletless character is considered to have appeared by mutation. The succeeding generation was raised in 1929. Three rootletless plants bred true for the abnormality, giving 64 rootletless seedlings in all. Of the nineteen sister normals, ten plants bred true to normal, and nine segregated rootletless seedlings as recessives. The segregations occurred in the ratio of 885 normal and 177 rootletless seedlings in total, giving 16.7 percent of recessive rootletless. The deficiency of rootletless segregates was also observed in 1927 when this mutant character made its appearance; namely, 14.4 percent. The low ratio of the rootletless segregates cannot be passed over and this is the subject of another experiment now in progress. Aside from this, the rootletless character is a simple recessive to normal.

Rootletless seedlings generally have cotyledons with shallow lobing (Figure 15). Later in the seedling stage, however, numerous thick and crooked rootlets appear (Figure 16), and the plants grow up vigorously, but they never become as luxuriant as normals. Hairs growing over the plant body, such as the stem, petiole, leaf, peduncle, calyx, etc., are remarkably short, appearing to have been clipped off (Figures 15 and 16).

Folded

A new mutant character folded appeared in the mutant rootletless

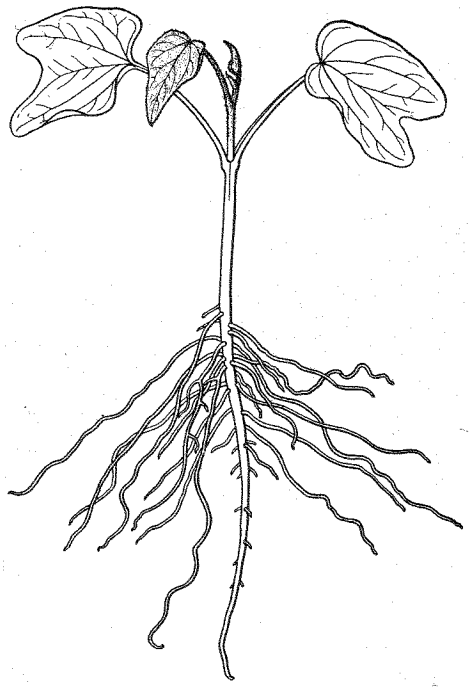


NORMAL AND ROOTLETLESS SEEDLINGS

Figure 15

Rootless seedlings (two at right, above) are compared with normal seedlings (left). Rootless appeared by mutation as recessive segregates in a normal family. In the photo, the slender rootlets of the normal seedlings are withered and somewhat crooked in form.

Below is shown a pot of rootless seedlings; the cotyledons generally have shallow lobes. The leaf hairs are remarkably short, and appear as though they had been clipped off.



AN OLD ROOTLETLESS SEEDLING WITH ROOTLETS

Figure 16

Rootless seedlings bear thick and crooked rootlets in their later growth. Note the extremely short hair on the foliage. These seedlings produce plants that do not become as large as normal plants.

strain. In 1930 three folded mutants made their appearance among fifteen rootletless plants. The new character is named by the flowers remaining closed all through their existence (Figure 17). The flower-buds grow to normal size, but they never open, but fall from the plant when the folded flowers turn yellow. The pistils are apparently normal, but quite sterile, even when hand-pollinated by normal pollen. Stamens are apparently also normal containing some pollen-grains, but without shedding them. The new mutant character was segregated as a recessive from normal mother plants, which were evidently heterozygous for folded.

Pigmy

In 1929, I bred 124 pedigrees of strain SK6 to examine the mutability of the flecked character. One of them gave nine peculiarly dwarf seedlings called pigmy in a total of 59, the sister seedlings were quite normal. The cotyledons of the mutant pigmy seedlings are small in size and hard in texture, curved backwards and of a deep green color. Between two cotyledons, which are attached to the hypocotyl with very short stalks, there appear a few crumpled leaves with very short petioles (Figure 18). The seedlings do not grow beyond this stage, even when they are carefully tended. In the succeeding generation of the sister normal plants, ten segregating pedigrees contained a total of 160 normal and 45 pigmy seedlings, showing a simple assortment with a deficiency of the pigmy seedlings, which have low viability.

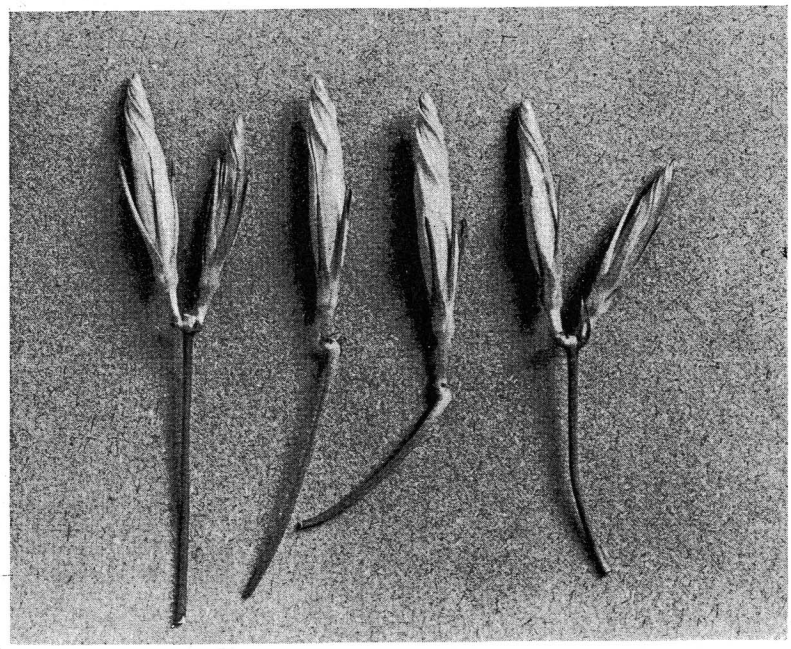
Cocoa

In 1929, cocoa seeds were collected on three plants of an albescent strain, the twelve sister plants producing normal black seeds. The cocoa seeds occurred quite suddenly as recessive mutants. The color of the cocoa seeds is "dark brown," being intermediate between chocolate and brown in the seed-color variations of this plant.

Shrubby

In 1929, one of the four F_2 families obtained by cross 471×450 gave fourteen shrubby, the 53 sister plants being normal (Figure 19). The shrubby character was segregated as a simple recessive to normal and bred true to the character in 1930.

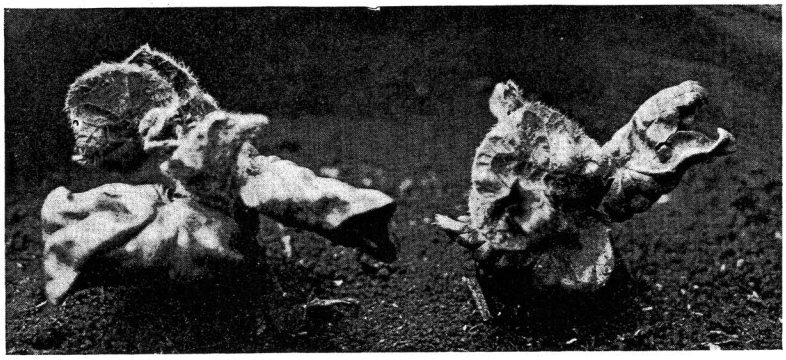
The manifold manifestations of the gene shrubby are as follows: Somewhat small seedlings; branches appearing from the lower part of the main stem; lobes of the leaf sharp-pointed and somewhat hard in texture (Figure 20); the flower normal in type. All these characters are transmitted *en masse,* and represent collectively the shubby character. By



FOLDED FLOWERS AND FLOWER-BUDS

Figure 17

Folded flowers made their appearance as recessive mutants in a rootletless family. The flowers turn yellow in color later in their existence, and then fall off, without opening. The photo shows six flowers and flower-buds, of which the second (from the left) and the sixth are flower-buds, the fifth corresponds to a flower just blooming and the others are old folded flowers. Note the vestiges from which withered flowers have dropped.



PIGMY SEEDLINGS

Figure 18

Pigmy is a very dwarf form which occurred by one-gene mutation under observation. Cotyledons are small, curved backwards and of a deep green color. A few small and crumpled leaves appear between the cotyledons. Cotyledons and leaves have very short stalks, therefore the foliage is crowded on a short hypocotyl. It does not grow beyond this state.

NORMAL AND SHRUBBY PLANTS IN BLOOM

Figure 19

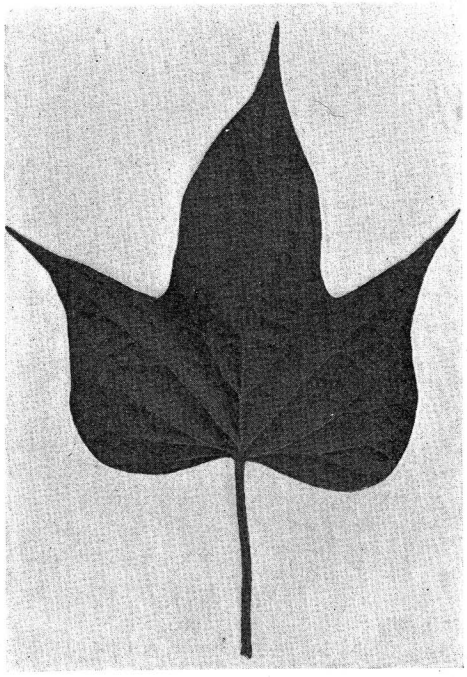
The central two plants on the foreground are shrubby. The shrubby character occurred by a sporadic mutation in an F_2 family. The others on the foreground are normal.

the linked segregation with interaxil-green, Rayed, etc., the mutant shrubby was determined to be located in the contracted chromosome.[4]

Origin of Mutations

The five new mutations above described made their appearance as recessives, according to the simple Mendelian segregation, though, in some cases, a considerable deficit of the mutant segregates was observed. The mode of their appearance shows that their mother plants, which were normal (for the mutant characters) in appearance, were heterozygous for the mutant genes. As to the origin of the mutant genes, there are the following two possibilities:

1. Mutation occurred in gametogenesis of the grand-mother plant, giving a gamete carrying



A SHRUBBY LEAF

Figure 20

The shrubby leaf has three sharp-pointed lobes with a hard texture.

a mutant gene. This mutant gamete when united with a normal gamete produced the heterozygous mother plant.

2. At fertilization or in the early stage of the embryonic development of the mother plant, a single gene mutation occurred, and the mother plant developed to be heterozygous.

The former seems more probable than the latter, though we have no definite proof to determine which represents the actual origin of the mutations.

Summary

1. Five new mutant characters, rootletless, folded, pigmy, cocoa and shrubby, are described. The mutants appeared as recessives, in accordance with a simple Mendelian ratio.

2. Rootletless has no rootlets in the early seedling stage. However, thick and crooked rootlets appear in later seedling stages. Cotyledons have shallow lobing in general. Hair covering the plant body is remarkably short.

3. The flowers of folded do not open, remaining closed all through their existence. All flowers drop off when they turn yellow, producing no fruits.

4. Pigmy is a very dwarf form. Cotyledons are small in size, curved backwards and of a deep green color. Stalks of cotyledons are very short in length. A few crumpled leaves with very short petioles appear between two cotyledons. The pigmy seedling does not grow beyond this stage.

5. Cocoa seed has approximately an intermediate color of chocolate and brown in the seed-color variations of this plant.

6. Shrubby is a mutant having a bush habit. The leaf has sharp-pointed lobes, with a hard texture.

Literature Cited

1. HAGIWARA, T. 1926. Genetic studies of leaf-character in morning glories. V. *Bot. Magazine, Tokyo,* 40:226-235. (Japanese.)

2. IMAI, Y. 1927. The vegetative and seminal variations observed in the Japanese morning glory, with special reference to its evolution under cultivation. *Journ. Col. Agric. Imp. Univ. Tokyo,* 9:223-274.

3. IMAI, Y. 1929. The segregation of albescent seedlings and the mutation to defective seeds in a pedigree of the Japanese morning glory. *Amer. Nat.,* 63:151-159.

4. IMAI, Y. 1930. Linkage studies in *Pharbitis Nil.* I. *Genetics,* 16:26-41.

5. IMAI, Y. In press. The property of the genes affecting the flower colour of *Pharbitis Nil. Journ. Genetics.*

6. IMAI, Y., and TABUCHI, K. 1929. Dominant mutations of the Japanese morning glory. *Amer. Nat.,* 63:362-366.

7. MIYAZAWA, B. 1929. On the inheritance of the "Matsushima"—variegation in the Japanese convolvulus. *Jap Journ. Genetics.* 4:167-184. (Japanese.)

Cooperation in Evolution

With the development of the nervous system, closer cooperation becomes possible and larger numbers of the advances in evolution have come about through the selection of cooperating groups rather than through the selection of individuals. This implies that the two great natural principles of struggle for existence and of cooperation are not wholly in opposition, but that each may have reacted upon the other in determining the trend of animal evolution.—ALLEE, W. C., *Animal Aggregations,* Page 361.