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THE CHROMOSOME RELATIONS OF SOLIDAGO RIGIDA AND A GIANT MUTATION

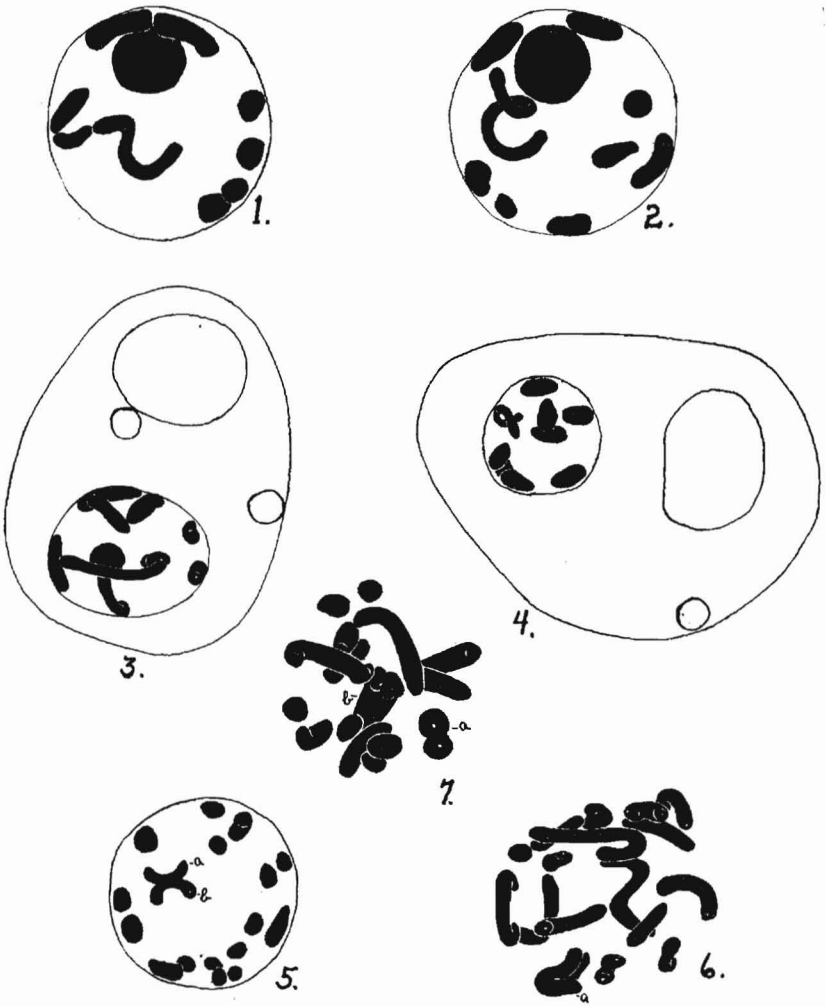
By NOE L. HIGINBOTHAM

During the summer of 1930 an unusual variant race of *Solidago rigida L.* was collected in Newton county, Indiana. This variant was transplanted to the Botanical Garden of Butler University where it has grown since, showing no tendency toward return to the characteristic form of the normal *S. rigida* plants growing in the same plot beside it. The most notable distinctions of this variant are: the larger size, being about twice as high, with larger leaves and flowers; the upper cauline leaves being ovate, obtuse and sessile, with an unequally cordate base; and the later time of blooming, which seems to be due not so much to later initiation as to slower development and maturation of flowers.

The problem as to taxonomic status of the variant naturally arises. The conclusion that it might be a hybrid does not appear likely, because all of its characters appear to be derived from *S. rigida* parents. That the differences are more than mere physiological responses to some environmental factor is evidenced by the fact that they have been maintained when the two kinds of plant are grown under the same condition. To date, nothing has been done to see what its offspring would be. The obviously close relationship of the form to the species makes it unwise to consider it as a new species. Since the differences are chiefly modifications in size, it was thought that the variant might be a gigas-mutation with a tetraploid chromosome complement.

Flower buds of normal *Solidago rigida* and of the variant were collected during the summer of 1934, on August 8 and 17, at the following times: 6:30 a. m., 12:30 p. m., 6:30 p. m. and 12:00 midnight. The buds were left entire and killed and fixed immediately in Nawaschin's fluid. After embedding in paraffin, both longitudinal and transverse sections were made 10 microns in thickness and stained in iron hæmatoxylon differentiated in picric acid, following Tuan's method (4). Observations were made with a Spencer research microscope having a 1.9 apochromatic objective, aplanatic condenser and 20X compensating ocular, giving an initial magnification of 1900 diameters.

Study of the sections revealed comparatively few countable figures, most of the cells being resting pollen mother, dyad or tetrad cells indi-



EXPLANATION: Figures 1, 2, *Solidago rigida,* meiotic prophase. Figues 3, 4, prophase of equational division. Figure 5, *Solidago rigida,* giant variation, somatic prophase. Figure 6, meiotic anaphase. Figure 7, early meiotic anaphase.

cating nearly simultaneous meiotic divisions with a short interphase. This was substantiated by the fact that the size of tbe chromosomes after the second division appeared to be about half the size of those in the first division. Cells in the same anther were in the same phase in nearly every case, dyads and tetrad both had the same number of chromosomes, and no signs of meiotic irregularity were observed.

Solidago rigida L. (normal). (x = 9). Figures 1-4. Both Figures 1 and 2 show 9 bivalent chromosomes in the prophase stage of a pollen mother cell. Both show one chromosome much longer than the rest, four rather short, and four of an intermediate length. This was borne out by focusing for depth, though no exact measurements were made in any case. Figure 3 shows 9 univalents and the nucleolus while in Figure 4 there are 9 univalents but the nucleolus is missing. Both the latter are dyad nuclei. The chromosomes of Figures 1 and 2 are larger than those in 3 and 4. In every case the nuclear membrane was visible.

Solidago rigida L. (giant variation). (x = 9). Figures 5-7. Figure 5 shows a somatic nucleus in prophase with 18 (2X) chromosomes. Though chromosome "a" appeared to be partially fused with "b," their relation was interpreted to be only one of proximity. Apparently "a" and "b" are the long chromosomes of the diploid complement. The nuclear membrane was still present. Figure 6 shows 18 univalent chromosomes in the early anaphase of reduction division. The bivalent "a" had not completed disjunction. The nuclear membrane had disappeared. Figure 7 represents an early anaphase, showing 14 univalent and 2 bivalent chromosomes, "a" and "b," which had not completed disjunction. Observations indicated that the long chromosomes were among the first to go to the poles.

Figures 3 and 4 show extra-nuclear bodies which showed staining reaction similar to the chromatin material. They were present in nearly every dyad cell observed but there was nothing to indicate their origin. In many instances the bodies were of irregular sizes and shapes. It is suggested as an hypothesis that the unknown bodies (Figures 3 and 4) may be excluded chromatin material similar to that found in Ginkgo hy Shimamura (3). No study was made of this phenomenon.

The chromosome counts agree with those published heretofore for Solidago (x = 9, 18, 27) (1, 2), indicating a basic number of 9 for the genus. The observations revealed no visible morphological or numerical differences in the chromosome complements of the two forms studied. The variation in stature and other characters noted above apparently is

due to gene mutations rather than duplication of genes. At least, there is no duplication resulting from increased chromosome number. It is possible that a more exact technique would disclose morphological differences in the two chromosome sets but there is no evidence of such differences in the sections studied. It is more logical to conclude the variations to be due to gene mutations (point mutations).

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