in Californian material (Wiggins and Stockwell, 1937). Representatives of three disjunct taxa of the genus *Adenocaulon* have all been counted for the first time (Table 1) and all share a somatic complement of forty-six chromosomes. Further studies of relationships within this genus are in progress.

I wish to thank Mr. Donald Kyhos for the preparation showing meiosis in pollen mother cells of *Franseria*. Dr. Kenton L. Chambers, Oregon State University, Corvallis, and Mr. I. Fukuda, Tokyo Women's Christian College, Japan, very kindly collected the seed of *Adenocaulon*. My collecting trip to Chile was financed from National Science Foundation Grant No. G-13518 made to Dr. Harlan Lewis.

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CHROMOSOME COUNTS IN SECTION ERYTHRANTHE OF THE GENUS MIMULUS (SCROPHULARIACEAE). II[1]

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and Delbert Wiens

This investigation formed part of our long range biosystematic study of section *Erythranthe* (Vickery, 1956; Vickery, Mukherjee, and Wiens, 1958). It had two purposes. The first was to determine the chromosome numbers of two rare species, *Mimulus eastwoodiae* Rydberg and *M. nelsonii* Grant. The second was to analyze the genome homologies of the more common species of the section.

For the cytological portion of the investigation, buds expected to contain the desired stages of meiosis were placed for 24 hours in a freshly prepared fixative consisting of 3 parts absolute ethanol to 1 part glacial acetic acid saturated with ferric acetate. The anthers were then dissected from the buds, squashed, and lightly stained in aceto-carmine. For each determination, the chromosomes of ten or more cells were carefully studied and counted under a phase contrast microscope. Many of the configurations were recorded with the aid of a camera lucida.

Both *M. eastwoodiae* and *M. nelsonii* were found to have n=8 chromosomes (fig. 1 and table 1) as do the three more common species of the section, *M. cardinalis* Douglas, *M. lewisii* Pursh, and *M. verbenaceous*

[1] This work was supported by grants from the National Science Foundation and the University of Utah Research Fund.

Greene (Brozek, 1932; Vickery, Mukherjee, and Wiens, 1958). *Mimulus eastwoodiae* (fig. 2) is known from only six or seven localities in southern Utah and northern Arizona. The populations occur in shaded seeps in the desert at elevations below 4,500 feet. Generally, suitable seeps are on perpendicular or overhanging sandstone walls. In contrast, *M. nelsonii* (fig. 2) grows by small mountain streams in the cloud forest, 8,000 feet or above, in the central portion of the Sierra Madre Occidentale of Mex-

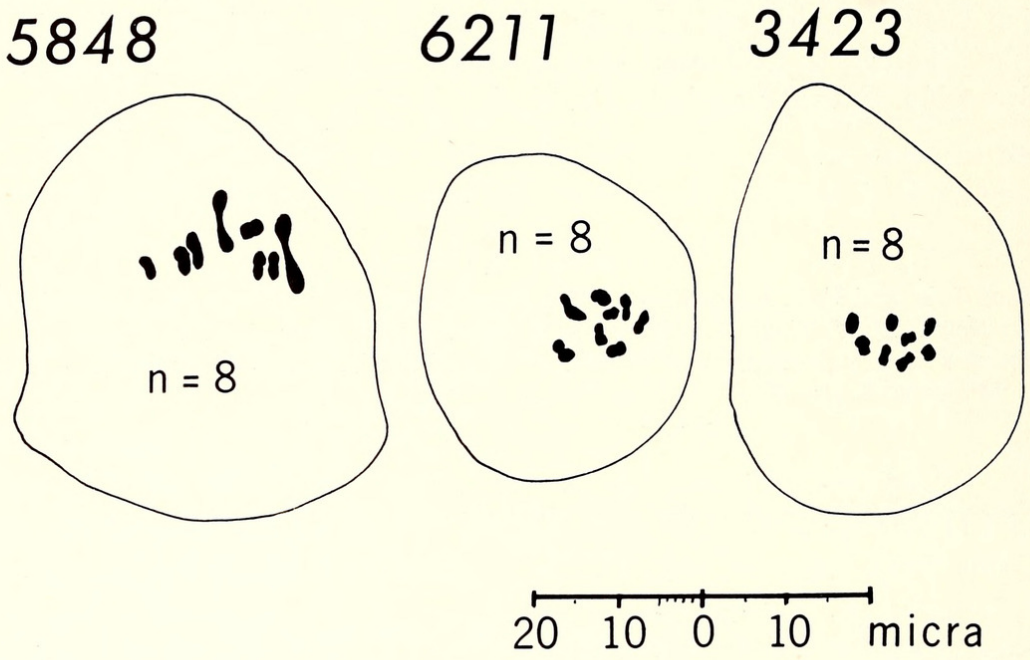

FIG. 1. Camera lucida drawings of meiotic chromosomes of *M. eastwoodiae* (5848), *M. nelsonii* (6211), and the F_1 hybrid (3423) of *M. cardinalis* (5311) × *M. verbenaceous* (5924). All pollen mother cells are at or near metaphase I.

TABLE 1. CHROMOSOME COUNTS IN MIMULUS, SECTION ERYTHRANTHE.

A. CULTURES OF NATIVE SPECIES.

n=8 *M. eastwoodiae*
Arches National Monument, Grand County, Utah, altitude 4,200 feet, *Vickery 339* (5848).

n=8 *M. nelsonii*
Crest of Sierra Madre on Durango-Mazatlán Road, Durango, Mexico, altitude 9,000 feet, *Wiens 2642* (6211).

B. INTERSPECIFIC AND INTERPOPULATION HYBRIDS.[2]

n=8 F_1 (3424) of *M. verbenaceous* (5924) × *M. cardinalis* (5316).

n=8 F_1 (6031) of *M. lewisii* (5875), Wasatch Mountains form) × M. lewisii (5032), Sierra Nevada form).

n=8 F_1 (3423) of *M. cardinalis* (5311) × *M. verbenaceous* (5924).

n=8 F_1 (3425) of *M. cardinalis* (5031) × *M. lewisii* (5875, Wasatch Mountains form).

n=8 F_2 (3502) of *M. cardinalis* (5077) × *M. lewisii* (5051, Sierra Nevada form).

[2] The chromosomes showed regular pairing and/or regular segregations in all cases.

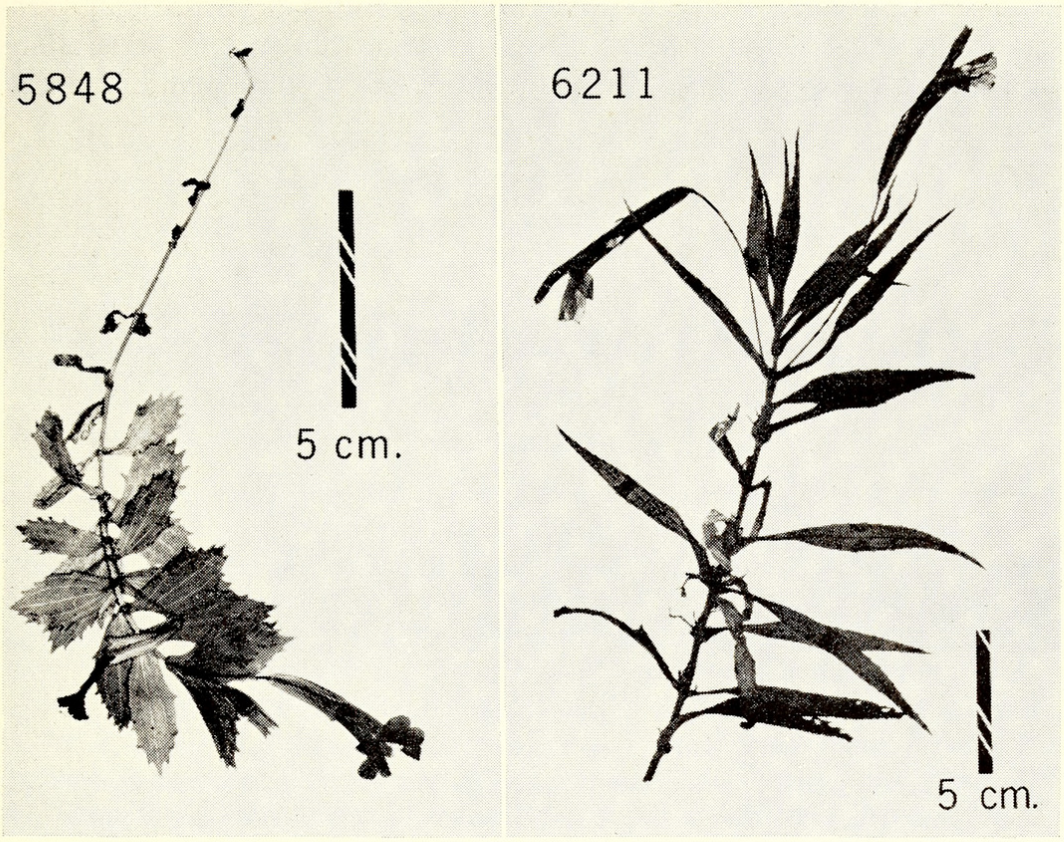

FIG. 2. Photographs of the two rare species of *Mimulus* studied in this investigation, *M. eastwoodiae* Rydberg (5848, UT 28,932) and *M. nelsonii* Grant (6211, UT 54,858).

ico. The full range of this unusual and strikingly beautiful species is not known. We collected it near the crest of the Durango-Mazatlán road, which is only the second locality reported (Grant, 1924).

For the cytogenetic part of the investigation, each interspecific combination was made reciprocally and was repeated using different cultures of the parental species. From one to ten flowers were carefully hand-pollinated for each combination. The putative hybrid seeds were sown and the resulting seedlings carefully checked to verify their hybrid nature. The hybrids that were investigated cytologically included combinations involving the three major species *M. cardinalis, M. verbenaceous,* and *M. lewisii* (table 1). They included the two distinctive forms of the latter species. In all cases the hybrids showed regular bivalent chromosome associations at metaphase I and normal segregations of the chromosomes in the later stages of meiosis.

The results of the present investigation taken in conjunction with the previous study (Vickery, Mukherjee, and Wiens, 1958) suggest that the common chromosome number of section *Erythranthe* is n=8. The regular bivalent association and normal segregation of the chromosomes of the hybrids involving four of the main taxa suggest the presence of essentially homologous genomes in these forms and possibly throughout the

section. Apparently, evolution in section *Erythranthe* is proceeding principally by the accumulation of diverse genes in the various populations and species rather than by the accumulation of chromosomal differences.

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AN ANALYSIS OF VARIATION IN VIOLA NEPHROPHYLLA

Norman H. Russell and Frank S. Crosswhite[1]

The genus *Viola* is well known to be one of the more taxonomically "difficult" of the temperate angiosperms. Though in North America the "species" were sorted out in what appeared at the time to be a satisfactory manner (Brainerd, 1920), subsequent studies have shown that their limits are anything but clear. In particular regions it is possible to distinguish separate forms easily; in others there is so much morphological and ecological variability that distinct forms or even morphological types are very difficult to describe. Polyploidy, introgression, genetic drift in isolated populations, and other hypotheses have been used to explain this situation.

More important than the explanation of this morphological and physiological variation is the accurate and objective description of it. A method for the more objective comparison of units (individuals and aggregations of individuals) has been suggested by the senior author elsewhere (Russell, 1961, 1962) and is used in the present analysis and description. It consists of the preparation and correlation of multiple pair comparisons,

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