Proceedings of the Iowa Academy of Science

Volume 66 | Annual Issue Article 25

1959

# Flowering Dates of Viola sororia Willd. and V. pensylvanica Michx. at Different Latitudes

Theodore A. McConnell
*Grinnell College*

Norman H. Russell
*Grinnell College*

# Flowering Dates of *Viola sororia* Willd. and *V. pensylvanica* Michx. at Different Latitudes

By THEODORE A. MCCONNELL and NORMAN H. RUSSELL

*Abstract.* The response to daylength has been shown to be significant in the initiation of flowering in many species of vascular plants. Herbarium specimens of *Viola sororia* Willd. and *V. pensylvanica* Michx. from a wide range of latitudes were examined to ascertain correlation between dates of flowering and length of day. Two observations were made: the higher the latitude, the later flowering occurred in the spring; and the higher the latitude the greater the daylength at the time of open flowering. It is suggested that these north-south clines represent a genetic response arrived at through natural selection. Further studies are proposed to test this hypothesis.

Early in the present century H. A. Allard and W. W. Garner (1920) of the United States Department of Agriculture observed that the initiation of flowering in the Maryland Mammoth variety of *Nicotiana tabacum* L. was apparently dependent upon the relationship between the length of darkness and the length of the light period to which the plants were exposed each day. They established that there was a definite correlation of this environmental factor with the flower formation processes both in this plant and in others. They designated three classes of response: long-day, short-day, and day-neutral. Within these, it was supposed, all angiosperm species could be classified with respect to flowering responses.

According to the classification of Garner and Allard, short-day plants produce flowers only when the total period of illumination per twenty-four hour day is less than a given critical length which varies with the species. This period of illumination is generally any point below twelve to thirteen hours of light per day. Long-day plants, by comparison, flower only when the total period of illumination during each photoperiodic cycle exceeds a given critical minimum, generally fifteen to sixteen hours. As the name implies, day-neutral species show no apparent reaction to photoperiod with respect to flowering, responding to other factors.

The concept of photoperiodic classification cannot be clearly defined, and this in fact is stated by Garner and Allard (1940), who defined the concept as ". . . decreasing progressively from continuous illumination, a long-day plant is one that ceases to flower or shows delayed or less profuse flowering, whereas a short-day plant is one that begins to flower or shows hastened or more profuse flowering when the length of day is sufficiently shortened."

Several investigators have noted the great sensitivity of violets in responding to the photoperiodic phenomenon. These include Huxley (1943), Garner and Allard (1940), and Madge (1929). Garner and Allard (1940) reported that under day-length environments of ten to twelve hours, formation of the normal blue, petaliferous spring flowers occurred in *Viola fimbriatula* J. E. Smith and *V. papilionacea* Pursh, while cleistogamous (self-fertilized) flowers were produced under long-day environments. Madge (1929) reported on studies on *Viola odorata* L. var. *praecox* Gregory. Her studies, carried out over a period of two years, demonstrated an annual rhythm, closely correlated with length of day, in the alternate production of open and closed flowers. The present junior author has obtained similar results on about twelve midwestern violets, but the results of these studies are not yet ready for publication.

An apparently novel approach has been used by the present authors in attempting to ascertain what sort of geographic variation exists in flowering time in the violets. The present report concerns the spring production of open (chasmogamous) flowers. Data ob-

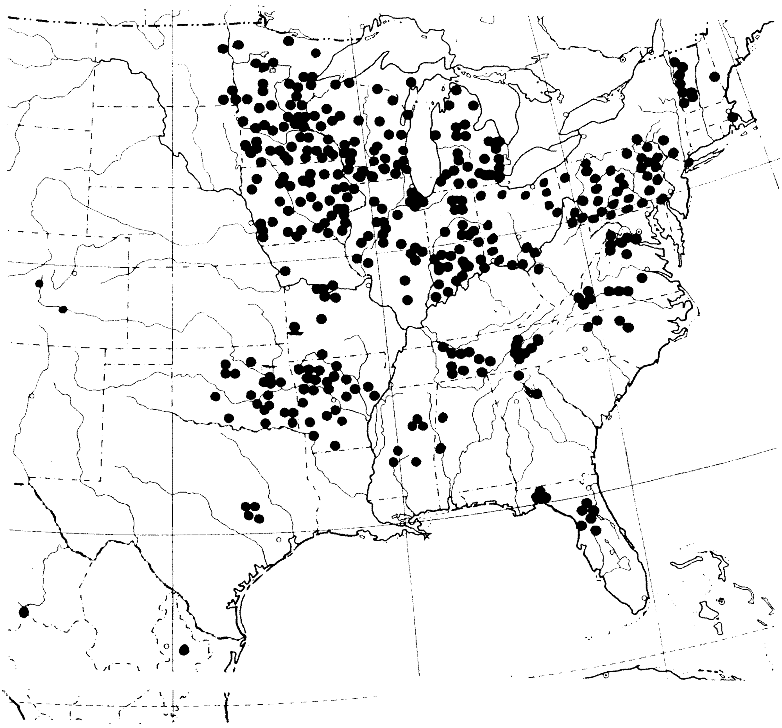


Figure 1. Distribution of *Viola sororia* Willd.

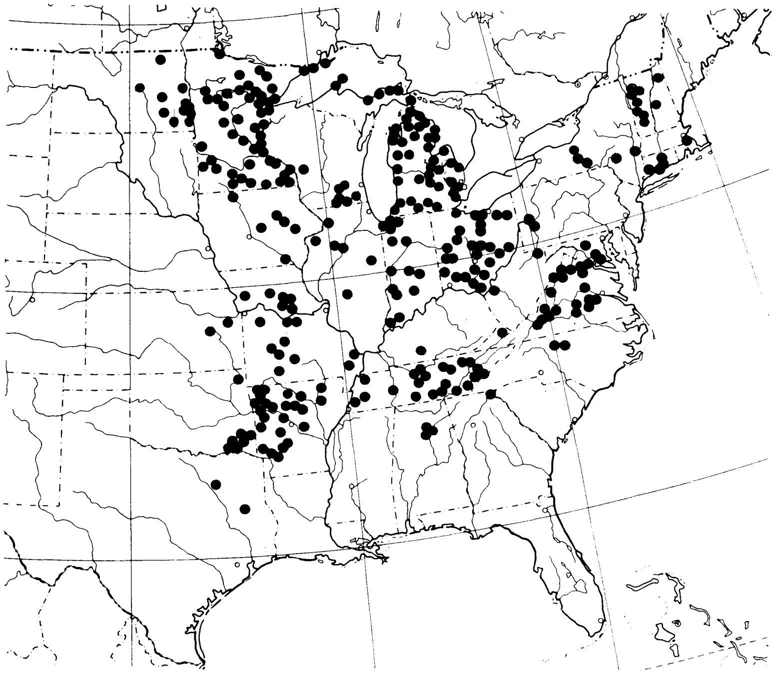


Figure 2. Distribution of *Viola pensylvanica* Michx.

tained for two species, *Viola pensylvanica* Michx. and *V. sororia* Willd., have been analyzed.

The two species chosen for this analysis were selected because of their relatively extensive latitudinal occurrence in eastern North America. Both occur from southern Canada southward to the southern coastal plain (Figures 1 and 2). *Viola sororia* has been found also in Florida and Mexico. Over their ranges both species are abundant. *Viola sororia* is the "common blue violet." It is a small, pubescent, blue-flowered species with cordate or reniform leaves arising from a fleshy underground rootstock. *Viola pensylvanica* is the most common of the leafy-stemmed, yellow-flowered violets of the eastern and central United States. Both species grow in woodland habitats and are often found together.

Data used in this study were obtained exclusively from herbarium specimens. Appreciation is expressed to the curators of the following herbaria for the loan of their material: State University of Iowa, University of Michigan, University of Minnesota, University of Illinois, University of Indiana, University of Pennsylvania, and the University of Oklahoma. The study was supported in part by a grant (G4994) to the junior author from the National Science Foundation.

## Methods

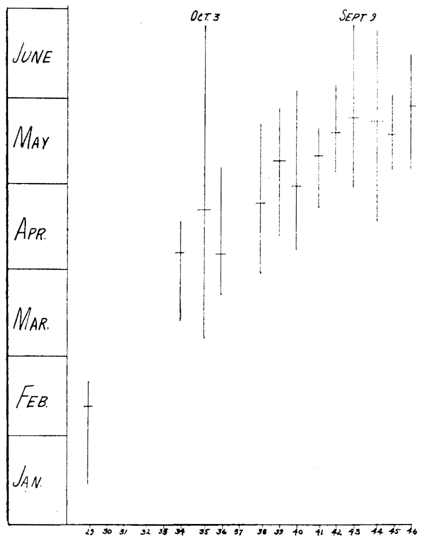
Using a Goode base map, the United States was divided into latitudinal bands of one degree, beginning with 29° 1′ and continuing through 48° 59′ north latitude. Herbarium specimens of each species were examined from the various latitude zones to ascertain their condition with respect to flowering. The collection date and exact location were noted in the case of all flowering specimens. Due to the relatively short period of flowering for individual plants of these two species the actual dates of collection were adopted as the basis for determination of the average date at which flowering occurred among all examined specimens for each latitudinal zone. Greenhouse and field studies by the junior author indicate that the maximum period of flowering for any single plant of these two species is approximately ten days. Using these dates a determination was made of the average daylength under which flowering occurred in each latitude zone. The standard latitudinal daylength chart of Garner and Allard (by McKnight and McKnight) was used for this determination. Analysis of any latitudinal zone was omitted if fewer than ten flowering specimens were available for it.

The following determinations have been made:

1. Range of dates of flowering of each species over a period of many years (primarily the last 50 years) (Figure 3).
2. Average flowering dates for each species (Figure 3).
3. Average daylength at which flowering occurred in each zone (Figure 4).

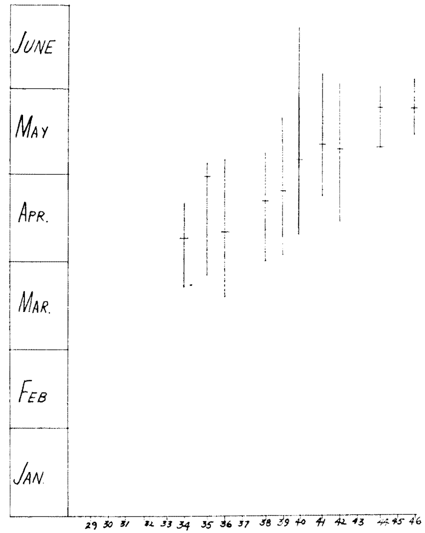
It will be seen from the charts that in most zones *V. sororia* has a somewhat greater range of flowering time in the spring than *V. pensylvanica*. The average dates of flowering of both species were observed, with minor deviations, to be progressively later in the growing season with increases in latitude. In the case of *V. sororia* the average date of flowering was observed to increase from February 10 at 29° north latitude to April 6 at 34° and to May 26 at 46°. By comparison, the average date of flowering for *V. pensylvanica* was observed to increase from April 8 at 34° north latitude to May 23 at 46°. The average daylength during which flowering occurred was noted to increase progressively with the increase in latitude zones north for both species. In *V. sororia* the average daylength for flowering increased from 13½ hours at 34° north latitude to 16½ hours at 46°. In the case of *V. pensylvanica,* the average daylength for flowering increased from 13¾ hours at 34° north latitude to 16¼ hours at 46°.

RANGE OF DATES OF FLOWERING OF SPECIMENS OF VIOLA SORORIA WILLD IN NORTHERN LATITUDE ZONES




ZONES IN DEGREES NORTH LATITUDE
(ZONES FROM 1' TO 59')

RANGE OF DATES OF FLOWERING OF SPECIMENS OF VIOLA PENNSYLVANICA MICHX IN NORTHERN LATITUDE ZONES




ZONES IN DEGREES NORTH LATITUDE
(ZONES FROM 1' TO 59')

**Figure 3**

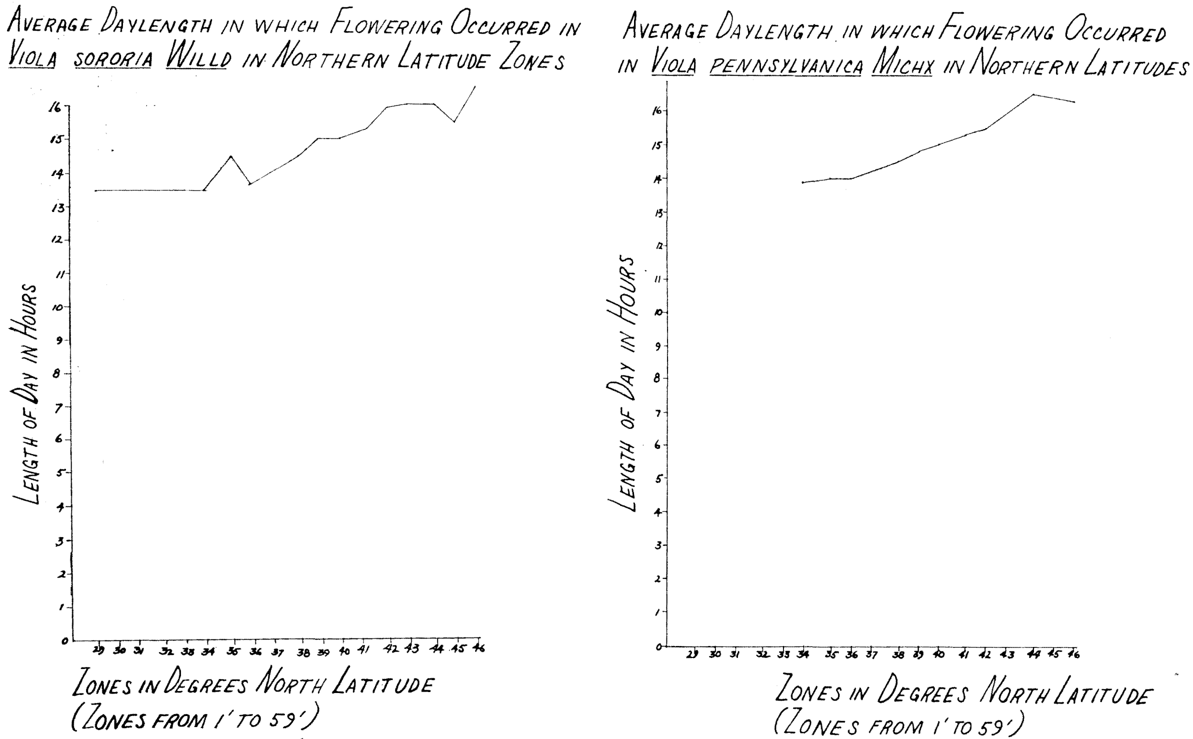

AVERAGE DAYLENGTH IN WHICH FLOWERING OCCURRED IN VIOLA SORORIA WILLD IN NORTHERN LATITUDE ZONES
LENGTH OF DAY IN HOURS
ZONES IN DEGREES NORTH LATITUDE (ZONES FROM 1' TO 59')
AVERAGE DAYLENGTH IN WHICH FLOWERING OCCURRED IN VIOLA PENNSYLVANICA MICHX IN NORTHERN LATITUDES
LENGTH OF DAY IN HOURS
ZONES IN DEGREES NORTH LATITUDE (ZONES FROM 1' TO 59')

**Figure 4**

## Discussion

The progression in average dates of flowering corresponds closely with the normal annual progression which occurs in initiation of the growing season from lower to higher latitude regions. Two hypotheses may be considered to account for these physiological clines. Because the violets do not flower at a constant daylength at different latitudes it may be that daylength is not the principal factor initiating the production of flower primordia. From the work of other investigators it has been established that temperature is of considerable importance both independently and acting with daylength in stimulating flower production in certain plants. Lang and Melchers (1943) and Melchers (1927), experimenting with *Hyoscyamus niger*, a long-day plant, found that at 30° C. twelve hours of illumination were required for flowering, while at 15° C. flowering occurred after only nine hours of light per day. Similar results in a variety of other plants have been obtained by other investigators.

On the other hand the clines may represent truly genetic responses to photoperiods of different length, arrived at through natural selection. Similar clines have been found by the junior author in morphological characters in many species. Unpublished greenhouse studies indicate that temperature variations normally present in nature may be of relatively little importance in affecting the time of flowering in species of *Viola*.

The investigations reported here are being continued by the authors to determine not only the flowering responses of other species of *Viola*, but, in addition, to test the above two hypotheses by greenhouse experimentation under conditions of controlled day length and growing temperature.

### Literature Cited

Garner, W. W. and H. A. Allard. 1920. Effect of the relative length of day and night and other factors of the environment on growth and reproduction in plants. Jour. Agric. Res. 18: 553-606.

——— and ———. 1940. Further observations on the response of various species of plants to length of day. U. S. Dept. Agric. Tech. Bull. No. 727.

Huxley, Julian. 1943. Evolution, The Modern Synthesis. New York City. Harper and Brothers.

Madge, M. A. P. 1929. Spermatogenesis and fertilization in the cleistogamous flowers of *Viola odorata*, var. *praecox* Gregory. Ann. Bot. 43: 545-577.

Lang, A. and G. Melchers. 1943. Die photoperiodische reaktion von *Hyoscyamus niger*. Planta Arch. Wiss. Bot. 33: 653-702.

Melchers, G. 1927. Die wirkung von genen, tiefen temperaturen und bluhenden pfropfpartnern auf die blubreife von *Hyoscyamus niger* L. Biol. Zent. 57: 568-614.

Department of Biology
Grinnell College
Grinnell, Iowa