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A CONTRIBUTION TO THE ECOLOGICAL LIFE CYCLE OF *LEAVENWORTHIA STYLOSA*

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ABSTRACT

During a period of abnormally low temperature in central Tennessee in July 1970, many seeds of the narrowly endemic winter annual. *Leavenworthia stylosa* Gray, germinated. Normally, germination of this species does not occur until September and October. Although most of the July-germinated seedlings died during August and September, a small percentage completed their life cycle. Flowering of the July-germinated plants began in December, about 2 months before flowering began in autumn-germinating plants. Flowers that opened before late February did not set seed, probably because insects did not effect cross pollination in this self-incompatible species; whereas, flowers that opened in late February and thereafter did set seeds. The life cycle of both July- and autumn-germinating plants terminated with seed maturity and dispersal at the same time in late May.

Leavenworthia stylosa Gray (Cruciferae) is endemic to the cedar glades of the Nashville basin of Tennessee (Rollins, 1963). Within the cedar glades it is particularly abundant in and around seasonal pools and ditches and in areas over which water drains or stands on the solid beds of limestone bedrock during the winter. Its life cycles is that of a winter annual (Zager, 1962; Rollins, 1963; Bangma, 1966; Baskin and Baskin, 1971). According to these investigators the ecological life cycle is as follows: Seed germination occurs in September and October, and an overwintering rosette is formed in the autumn. Flower buds are initiated during January or February; flowering begins in late February or early March and continues through April. Mature seeds are shed by late May or early June, and the seeds lie at or near the soil surface until September and October at which time germination occurs.

During the week of 17-23 July 1970 a period of abnormally low temperatures occurred in middle Tennesseee. Both the maximum and minimum daily temperatures for this period averaged 5°C (9°F) below normal (Table 1). The coolest part of this week was from 21-23 July when the daily maximum temperatures averaged 11°C (20°F) below normal, and the minimum temperatures averaged 4.4°C (7.9°F) below normal (Table 1). During the latter and coolest 4 days of the cool period (20-23 July), 47.6 mm (1.88 in.) of rainfall were recorded at the nearby Murfreesboro water plant (U.S.D.C., 1970). The combination of low temperature and adequate soil moisture stimulated hundreds of seeds of *L. stylosa* to germinate 5 to 8 weeks before they normally do so in September and October. Quadrat data show that of the total number of seeds of *L. stylosa* that germinated on a cedar glade near Murfreesboro in the summer and fall of 1970, 18% germinated in July (Baskin and Baskin, unpub. data). Numerous seedlings occurred on other glades in July, but no quantitative data were taken. Although the greatest majority of the July-germinating seedlings died during August and September (only 10.4% of the 117 July-germinating seedlings in three 2-dm-square quadrats at the Murfreesboro glade were still alive on 4 October), some plants did survive to flower and produce seeds.

TABLE 1. Average daily maximum and minimum temperatures recorded at the Murfreesboro, Tennessee water plant for the week of 17-23 July 1969 and 1970. Normal maximum and minimum average daily temperatures for July (10 yr. average, 1951-1960) also are given for comparison.

Avg. Daily Temps. (°C)	17-23 July 1969[a]	17-23 July 1970[b]	21-23 July 1969[a]	21-23 July 1970[b]	Normal for July [c]
Maximum	34.8	28.3	34.8	22.3	33.3
Minimum	20.5	15.0	21.5	15.7	20.1

[a](U.S.D.C., 1969), [b](U.S.D.C., 1970), [c](U.S.D.C., 1965)

Not only did germination of *L. stylosa* occur in a different season than previously has been reported for the species, but flower bud formation and flowering began much earlier than usual. On 29 December 1970 at the Murfreesboro glade (U.S. 70S, 1 mile northwest of Murfreesboro, Tennessee, Rutherford County), we observed plants of *L. stylosa* representing a range of sizes and stages (Fig. 1). Several plants of *L. stylosa* which germinated in July were in flower, and many other July-germinating plants had large flower buds. These plants were flowering approximately 6 to 8 weeks earlier than previously has been reported for the species. In the same population there were small rosettes without flower buds (Fig. 1c,d,e). Apparently these plants germinated much later than the others, probably in September and October.

On 29 December 1970, a number of plants of *L. stylosa* in flower were marked so that seed set in the December flowers could be determined. Visits to the glades in late winter and spring of 1971 revealed that the December flowers did not set seeds. On 27 February plants that had flowered in December had 3 to 5 open flowers and as many as 10 to 15 undeveloped pistils of flowers that already had shed their petals. The undeveloped pistils were from flowers that opened between late December and probably early February. They did not set seeds. In view of the fact that *L. Stylosa* is self incompatible (Rollins, 1963; Baskin and Baskin, unpub. data), it is not surprising that flowers that opened from late December to early February did not set seeds; pollinators are not active during this period. On the other hand, many of the flowers that were open on 27

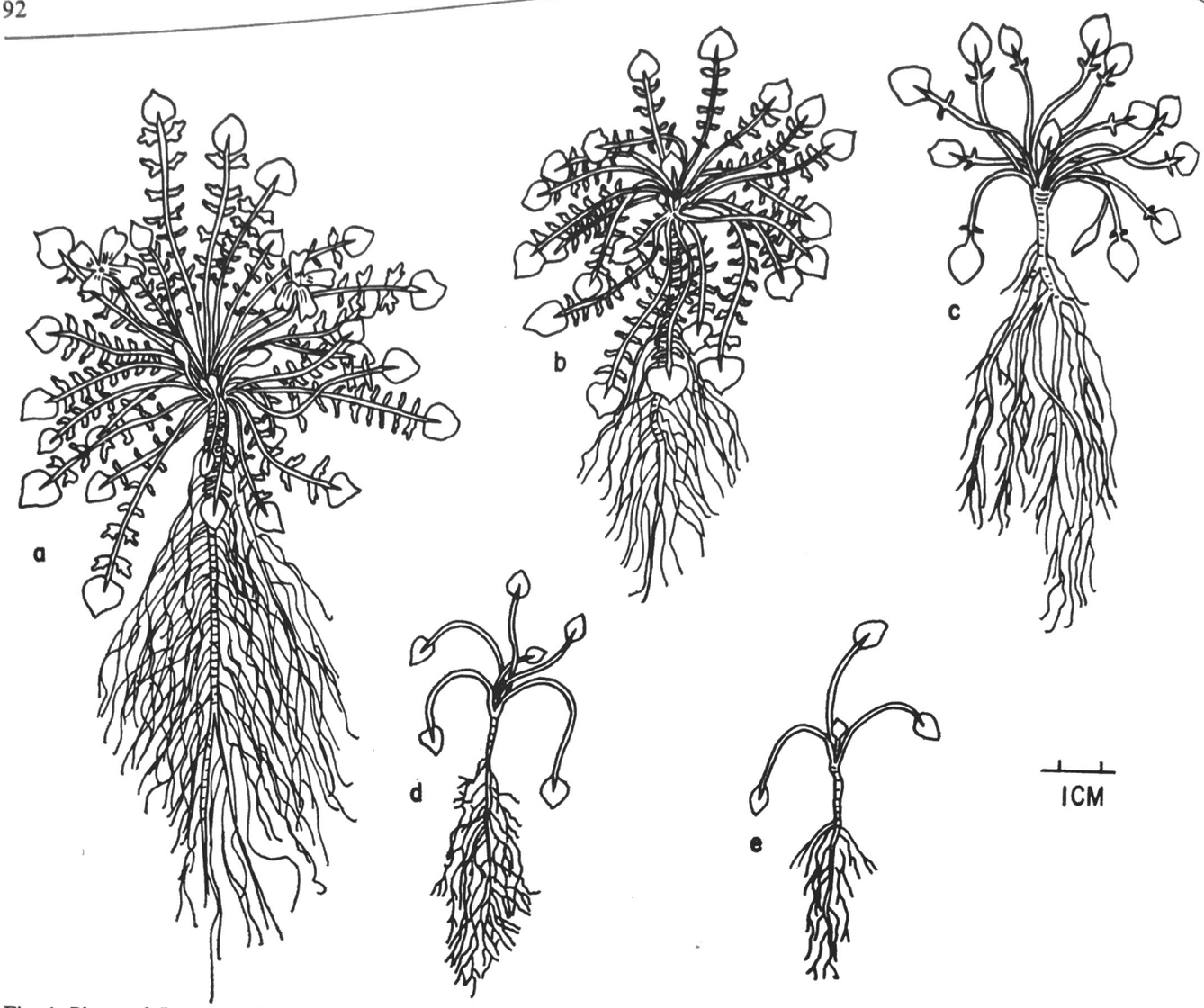

Fig. 1. Plants of *Leavenworthia stylosa* collected in the field on 29 December 1970; a and b are from summer-germinating seeds and c, d and e from autumn-germinating seeds. Note open flowers and large flower buds on a and large flower buds on b. Flower buds were not present on c, d and e. (Drawings by Jasper Sumner, Jr.)

February did not set seeds. Peduncles of 50 open flowers on 50 different plants were marked with red thread in a population of *L. stylosa* in the cedars of Lebanon State Park on 27 February. Of the 50 flowers marked, 43 of them were found on 2 April 1971 and checked for seed set. Thirty-five of the 43 had set seeds. Therefore, unlike flowers that opened from late December to early February, flowers that opened in late February set seeds. Apparently, insects do effect cross pollination at this time.

Although time of germination, flower bud formation and beginning of flowering in July-germinating plants differed markedly from plants produced from seeds that germinated in September and October, there were no obvious differences in time of fruit and seed maturity and seed dispersal in May. The obvious reason for this is that plants which flowered earlier than their normal time did not set seeds.

Were *L. stylosa* self-compatible then it seems possible that summer-germination such as occurred in 1970 would allow plants to complete their life sycle (i.e., set seeds) perhaps in early spring rather than late spring, assuming that the physiological events of fruiting and seed set in *L. stylosa* could take place at lower temperatures and shorter protoperiods than they normally do. Fruits and seeds of *Draba verna* L., a self-pollinated, self-compatible species (Baskin and Baskin, unpub. data) occurring abundantly in the cedar glades, mature in late winter, and seeds are dispersed in early spring (Baskin and Baskin, 1970). However, since *L. stylosa* is self-incompatible and because pollen vectors generally are inactive during December, January and much of February, it can be expected that fruit and seed set and seed dispersal will take place at about the same time each year, even if seeds germinate and plants begin their life cycle in summer.

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Literature Cited

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