DATES OF FIRST FLOWERS OF ALPINE PLANTS AT EAGLE CREEK, CENTRAL ALASKA

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Information about flowering dates of species in northern North America is still very sparse. For a number of years I have spent most of the spring and summer at Eagle Creek, east-central Alaska (65° 27′ N, 145° 22′ W), studying ptarmigan (*Lagopus* spp.). I had a good opportunity to record flowering dates of the conspicuous plants in the area, and I did so. This report summarizes the results.

The area of study, 15 square miles of hilly land in the drainages of Eagle and Ptarmigan Creeks, flanks the Steese Highway 104 to 107 miles northeast of Fairbanks. Elevations vary from 2600 to 4400 feet above sea level. The rounded ridges and hills are part of an eroded peneplain of Precambrian schist, interrupted by masses of granite, quartz diorite, and allied Mesozoic rocks. The area apparently was not glaciated in the Pleistocene.

The climate is continental subarctic. Total annual precipitation averages 10-15 inches, with snow cover usually present from mid-September to mid-May. Summer days tend to be cooler, breezier, and more showery than in the valleys of the Tanana and Yukon Rivers to the southwest and northeast. Days from mid-June to mid-August generally are frost-free, but snow flurries and light frosts sometimes occur within this period.

Small stands of spruce (*Picea glauca*) occur on a few south-facing slopes between 2600 an 3300 feet; wood-cutting during the first 50 years of the century removed most trees from some stands, and regeneration has been slow. Spruces also occur as scattered, stunted individuals on favorable sites up to 4000 feet, or even slightly higher. However, treeless alpine-arctic tundra is the dominant vegetation on all areas above 3000 feet. This tundra complex grades to shrubby communities at lower elevations on mesic sites, and to a tussocky *Carex*-heath type on moist, gentle, lower slopes. Narrow bands of tall willows (*Salix* spp.) and alders (*Alnus crispa*) line the banks of streams below 3400 feet. These shrubs undoubtedly have prospered because of the disturbances wrought by placer miners, whose activities destroyed many stands of riparian spruce.

Eagle Creek and Eagle Summit are easily reached by car in summer. For that reason, plant collections have been made here more often than in adjacent parts of the Yukon-Tanana highlands. Scamman (1940) published one of the earliest lists of plants from this area, and established its reputation as a place to look for new species and interesting range extensions. Hanson (1950) discussed vegetation and soils (especially as related to congeliturbation and solifluction) of the Eagle Summit area. Gjaerevoll (1958, 1963 and 1967) added a significant number of new plant distribution records as a result of his collections on and around Eagle Summit. An unusual, small *Saxifraga* of unknown taxonomy was described by Porsild (1965) on the basis of specimens

TABLE 1. — Dates of first flowers of 84 alpine plants at Eagle Creek, Alaska

Species (Years of Record)	First Flowers			
	Earliest	Latest	Mean	*s* (days)
Douglasia gormanii Const. (5)	5/19	5/31	5/23	4.7
Arctostaphylos alpina (L). Spreng. (5)	5/20	6/9	5/29	7.4
Syntheris borealis Pennell. (6)	5/22	6/9	5/29	7.5
*Pedicularis lanata** Willd. (5)	5/21	6/9	5/29	6.9
*Anemone parviflora** Michx. (5)	5/21	6/10	5/30	7.0
*Anemone narcissiflora** L. (5)	5/27	6/8	5/31	4.9
*Oxytropis nigrescens** (Pall.) Fisch. (5)	5/22	6/9	5/31	6.5
*Petasites frigidus** (L.) Fries. (5)	5/29	6/9	6/1	4.5
Anemone multiceps (Greene) Standl. (5)	5/26	6/11	6/2	6.2
*Ranunculus nivalis** L. (6)	5/29	6/9	6/3	4.9
*Lupinus arcticus** Wats. (5)	5/27	6/8	6/3	4.3
*Parrya nudicaulis** (L.) Regel. (5)	5/29	6/10	6/4	5.4
*Loiseleuria procumbens** (L.) Desv. (6)	5/28	6/9	6/5	4.6
*Dryas octopetala** L. (5)	5/31	6/12	6/6	4.6
*Diapensia lapponica** F. Schmidt (Hult.) (6)	5/31	6/9	6/6	3.8
*Cardamine purpurea** C. and S. (6)	5/30	6/11	6/7	4.2
*Rhododendron lapponicum** (L.) Wahl. (6)	5/28	6/11	6/7	5.1
Cassiope tetragona (L.) D. Don. (5)	5/30	6/11	6/7	4.6
Senecio atropurpureus (Ledeb.) B. Feditsch. (5)	6/5	6/11	6/8	2.3
*Silene acaulis** L. (6)	5/28	6/15	6/8	7.4
Arenaria obtusiloba (Rydb.) Fern. (5)	5/30	6/15	6/10	5.5
*Astragalus umbellatus** Bunge. (6)	6/10	6/23	6/17	5.3
*Arnica alpina** (L.) Olin. (5)	6/7	6/27	6/18	7.4
Papaver macounii Greene (6)	6/9	6/25	6/18	5.7
Saxifraga punctata L. (6)	6/12	6/20	6/18	3.1
Viola epipsila Ledeb. (4)	6/12	6/20	6/18	3.7
Mertensia paniculata (Ait.) Don. (4)	6/12	6/20	6/18	4.0
*Lagotis glauca** Gaertn. (6)	6/10	6/28	6/18	6.6
Pedicularis capitata Adams (6)	6/16	6/21	6/18	2.1
*Claytonia sarmentosa** C. A. Mey. (5)	6/13	6/23	6/19	3.9
Pedicularis sudetica Willd. (5)	6/17	6/28	6/20	1.7
Castilleja hyperborea Pennell (5)	6/17	6/28	6/20	4.7
Crepis nana Rich. (5)	6/18	6/28	6/21	4.2
Epilobium latifolium L. (4)	6/17	6/28	6/22	4.1
Valeriana capitata Pall. (5)	6/15	6/28	6/22	5.9
Tofieldia coccinea Richards. (3)	6/20	6/27	6/23	3.6
Saxifraga hieracifolia Wallst. and Kit. (5)	6/16	6/28	6/23	5.0
Saxifraga bronchialis L. (5)	6/19	6/28	6/23	3.9
Potentilla biflora Willd. (4)	6/10	7/2	6/23	11.3
Tofieldia pusilla (Michx.) Pers. (4)	6/20	6/28	6/24	4.2
Senecio fuscatus (Jord. and Fourr.) Hayck. (4)	6/20	6/30	6/25	5.0
Potentilla fruticosa L. (5)	6/21	6/28	6/25	2.8
Pedicularis labradorica Panzer. (4)	6/17	6/30	6/25	5.7
Senecio lugens Rich. (5)	6/22	7/3	6/27	5.1
Claytonia tuberosa Pall. (6)	6/15	7/5	6/27	7.7
Saxifraga reflexa Hook. (5)	6/8	6/16	6/10	3.2
Geum rossii (R. Br.) Ser. (6)	6/7	6/15	6/10	2.7
Rubus chamaemorus L. (6)	6/8	6/15	6/11	2.5
Cardamine bellidifolia L. (5)	6/8	6/20	6/12	6.4
Lloydia serotina (L.) Wats. (6)	6/8	6/15	6/12	2.9
*Anemone richardsonii** Hook. (6)	6/5	6/16	6/12	4.2

TABLE 1. — (*Continued*)

Species (Years of Record)	First Flowers			
	Earliest	Latest	Mean	*s* (days)
Corydalis pauciflora (Steph.) Pers. (6)	6/8	6/15	6/12	3.1
Sedum rosea (L.) Scop. (4)	6/8	6/15	6/12	3.7
Andromeda polifolia L. (5)	6/10	6/14	6/12	1.6
Vaccinium uliginosum L. (4)	6/10	6/14	6/12	1.7
*Dodecatheon frigidum** C. and S. (6)	6/8	6/20	6/14	4.3
Rubus arcticus L. (6)	6/8	6/21	6/15	4.8
Cornus canadensis L. (5)	6/7	6/21	6/15	5.6
Androsace chamaejasme (Spreng.) Hult. (6)	6/10	6/19	6/15	3.7
Eretrichium aretioides * (C. and S.) DC. (5)	6/11	6/23	6/15	4.7
Pyrola grandiflora Radius. (5)	6/13	6/19	6/16	2.5
Vaccinium vitis-idaea L. (3)	6/14	6/18	6/16	2.1
Polemonium acutiflorum Willd. (5)	6/12	6/22	6/16	3.6
Myosotis alpestris Schmidt. (6)	6/10	6/22	6/16	4.4
*Pedicularis oederi** Vahl. (6)	6/10	6/23	6/16	5.3
Erigeron purpuratus Greene (5)	6/15	6/19	6/17	1.5
Polygonum viviparum L. (6)	6/14	6/19	6/17	1.8
Lychnis apetala L. (5)	6/12	6/19	6/17	3.0
Parnassia kotzebuei C. and S. (5)	6/22	6/30	6/27	3.4
Pedicularis verticillata L. (6)	6/19	7/3	6/27	5.7
Saxifraga davurica Willd. (6)	6/23	7/3	6/28	3.3
Gentiana glauca Pall. (6)	6/25	7/1	6/28	2.2
Campanula uniflora L. (5)	6/20	7/3	6/30	5.6
Claytonia scammaniana Hult. (6)	6/27	7/6	7/1	3.3
Aconitum delphinifolium DC. (5)	6/18	7/9	7/1	9.6
Campanula lasiocarpa Cham. (5)	6/30	7/3	7/1	1.6
Spiraea beauverdiana Schneid. (4)	6/28	7/12	7/3	6.5
Senecio resedifolius Less. (5)	6/28	7/11	7/5	4.9
Saxifraga flagellaris Willd. (6)	7/3	7/18	7/8	5.9
Delphinium brachycentrum Ledeb. (6)	7/5	7/17	7/9	5.0
Saxifraga hirculus L. (5)	7/3	7/18	7/9	6.1
Zygadenus elegans Pursh (5)	6/28	7/25	7/16	10.8
Epilobium angustifolium L. (3)	7/10	7/24	7/18	7.1
Gentiana algida Pall. (4)	7/21	7/26	7/23	2.2

*Asterisks denote species used for phenological characerization of season (short method – see text).

collected at Eagle Summit. The efforts of several students and botanists from the University of Alaska have resulted in a representative collection of Eagle Creek plants in the herbarium of that institution.

METHODS

Each year from 1962 through 1967 I recorded the dates on which I saw the first fully-displayed flowers of many species at Eagle Creek. This report lists dates for 84 species, excluding plants with inconspicuous flowers (i.e. *Chrysosplenium tetrandrum*, *Empetrum nigrum*, *Ligusticum mutellinoides*); rare species such as *Saxifraga oppositifolia*, *Moneses uniflora*, *Viola biflora*, *Oxytropis mertensiana;* certain plants that were hard to tell from earlier-flowering species (*Pedicularis langsdorfii*); and species for which fewer than three years of flowering dates were obtained.

Voucher specimens of all but the commonest, most easily distinguished species were collected. Mr. John Crow, Department of Botany, Washington State University, Pullman, kindly verified my identifications in 1967. Plant names follow Anderson (1959).

RESULTS

Douglasia gormanii usually is the first flower to appear at Eagle Creek (Table 1). Found at elevations above 3500 feet, this low plant is restricted to slopes where wind and sun combine to expose the ground early in spring. Other early-blooming species (*Synthris borealis*, *Pedicularis lanata*, *Oxytropis nigrescens*) occur in this habitat also, but their mean first-flower dates are six to eight days later than *Douglasia* because of longer delays of development in late springs.

At the other extreme, *Gentiana algida* usually flowers after all others studied. This gentian grows in moist places at moderate to high elevations, and is most common in sedge meadows in saddles on ridges at 3900-4100 feet. Other plants in this habitat, like *Claytonia tuberosa*, *Senecio atropurpureus*, and *Saxifraga hirculis*, appear much earlier.

Some idea of annual variation in flowering dates can be obtained from standard deviations from mean first-flower dates listed for each species in Table 1. *Erigeron purpuratus*, *Andromeda polifolia*, *Campanula lasiocarpa*, *Pedicularis sudetica*, and *Polygonum viviparum* showed the smallest standard deviations (less than two days). *Potentilla biflora* and *Zygadenus elegans* had the largest deviations, with more than ten days on each side of the mean. There are ten species in Table 1 with standard deviations of two to three days, 15 with three to four days, 20 with four to five days, 15 with five to six days, eight with six to seven days, six with seven to eight days, and one species with a nine to ten-day standard deviation.

The number of species flowering in each five-day period from May 20 to July 23 is plotted in Figure 1. The curve is unimodal and quite symmetrical, except for an upsurge of flowering dates occurring June 14-18. One-fourth of all species studied had mean first-flower dates in that five-day period.

PHENOLOGICAL IMPLICATIONS

The flowering dates I recorded can be used to characterize seasons phenologically. One way is to sum deviations from mean first-flower dates, and to list the number of species blooming later and earlier than usual and the cumulative number of days earlier and later for all species. This is done in Table 2. The results suggest that there were two very "early" springs between 1962 and 1967, and four moderately or very "late" years. The phenological characteristic of each year, derived from these data, correlated well with at least one other event at Eagle Creek, the mid-point of hatching of rock ptarmigan (*Lagopus mutus*) eggs.

The method just described demands that data be gathered all summer. The season can be characterized only in retrospect. For convenience in other biological studies, it is desirable to limit the effort to a shorter span of time,

preferably early in the summer. I attempted this by selecting a few common, conspicuous species that generally flower in June and show moderate variation in flowering dates from year to year (suggesting that their growth is fairly sensitive to short-run weather conditions). The species chosen are those with asterisks in Table 1. I expressed the flowering date of each species as the number of days after April 30 that first blossoms appeared in a given year. These were summed for all species, by year, and a mean was calculated. The mean was then converted to calendar date, starting with the April 30 base. The mean flowering dates are as follows: 1962, June 9 (22 species); 1963, June 6 (22 species); 1964, June 13 (22 species); 1965, June 9 (21 species); 1966, June 5 (22 species); 1967, June 13 (13 species). Like the method using all 84 species, this technique yields a consistent relationship between flowering dates and nesting of ptarmigan, except that 1967 flowering dates were as late as those in 1964, whereas ptarmigan nested much earlier in 1967. This could be a result of the small number of plants seen at the time of the first flowering, (due to a change in the pattern of my work at Eagle Creek) or it could reflect an imperfect correlation between the two phenologic events last year.

Discussion

It is clear that simply stating when first blossoms appear falls far short of fully describing the effect of environmental conditions on vernal plant development. The technique emphasizes individual plants, with all their inherent variabilities; it gives no clue about rates of development in populations. Furthermore, it hides the important variation within a species due to the plant's occurrence in a range of biotopes. For the biologist busy with other studies, however, first-flower dates offer a simple way of getting some insight into phenological progression.

Bliss (1956) emphasizes site variation in his paper on plant development in low arctic and alpine tundras. Although he gives no data on first-flower dates, he concluded from other criteria that " . . . the same species frequently reaches an equivalent level of phenological development on different dates at the various stations . . ." (p. 323). Later, (p. 324) he says "Most species at a given location appear to break dormancy, bloom, and fruit together. These

Table 2. — Phenological summations at Eagle Creek, Alaska, 1962-67.

Year	No. (percent) species earlier than average	No. (percent) species later than average	Cum. No. days earlier	Cum. No. days later	Seasonal character	Peak of hatch, *Lagopus*
1962 (78*)	24 (31)	45 (58)	83	143	mod. late	June 23
1963 (73)	51 (70)	20 (28)	269	82	very early	June 19
1964 (81)	8 (10)	65 (80)	29	288	very late	July 1
1965 (73)	30 (41)	40 (55)	83	131	mod. late	June 23
1966 (82)	64 (78)	10 (12)	242	21	very early	June 20
1967 (45)	19 (42)	24 (53)	66	85	mod. late	June 22

*Number of species for which records were available.

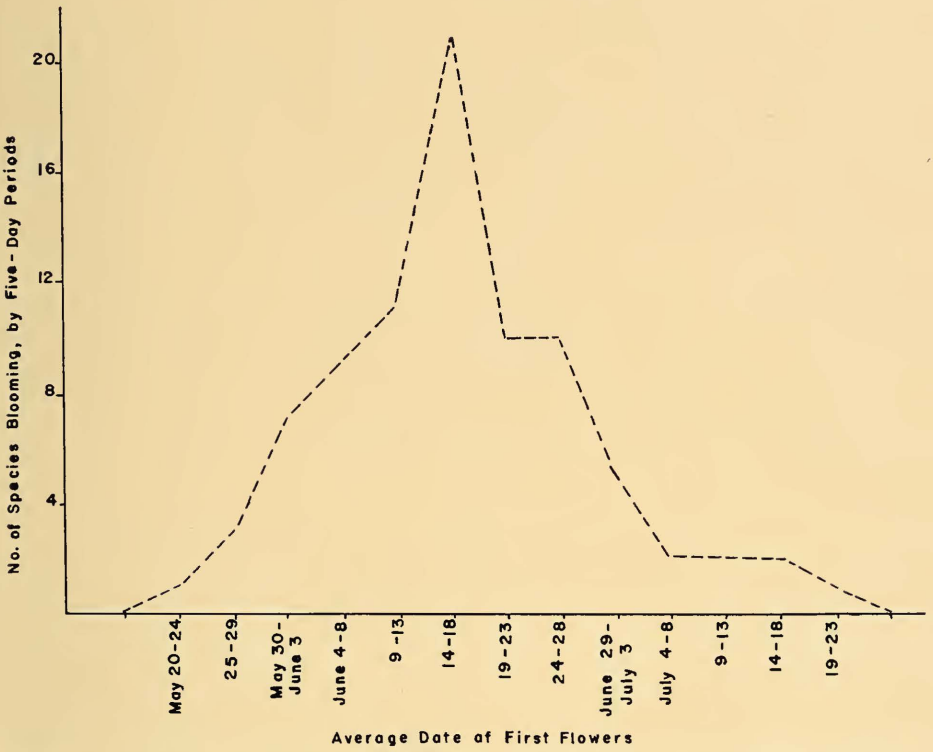

FIGURE 1. Number of species with average dates of first blossoms in five-day periods, May 20-July 23, Eagle Creek, Alaska.

same species show different phenological cycles in other microenvironments." Sorensen (1941) came to a similar conclusion in northeast-Greenland. He felt that the nearly simultaneous flowering of most species on a site could actually help ecologists to distinguish ecotopes. My experience at Eagle Creek suggests, nevertheless, that variation among species on the same site is considerable. For example, in openings in the shrub communities on south-facing slopes at timberline, different species achieve first anthesis as early as late May (*Arctostaphylos alpina*, *Anemone narcissiflora*) and as late as early July (*Spiraea beauverdiana*). The same is true of many other habitats at Eagle Creek, as was pointed out earlier in the discussion of *Gentiana algida*.

Some phenological studies have shown that early-flowering species vary more from year to year than do later flowering plants in the same area. There is not much information about this in the North, although Criddle (1927) obtained evidence for it in Manitoba, and Moss (1960) thought the phenomenon probably occurred at Edmonton, Alberta. If this were true, I would expect early-flowering species at Eagle Creek to have larger standard deviations than plants that develop later. This does not appear to be the case. Nineteen species with mean first-flower dates between May 20 and June 8 (Table 1), had an average standard deviation of 5.23 days. Forty-three

species blooming between June 9 and June 23 showed an average standard deviation of 4.15 days, and 22 late species, blooming after June 23, had a mean standard deviation of 5.16 days. A more rigorous analysis, including more years of data, certainly would be advisable. Sorensen's (1941) data indicated that there was no general tendency for greater deviations among early species in years of different weather conditions; in fact, he noted that late-flowering species showed a slightly greater retardation than early-flowering ones, when a "normal" and an "early" year were compared.

There is a real temptation to compare flowering dates with those reported in other studies, especially when species are common to both areas. Sorensen (1941), for example, gave flowering dates in 1935 for 18 species in northeast Greenland that I studied at Eagle Creek. However, detailed comparisons are not meaningful unless an estimate of annual variation is available from both areas. Interpretation of the comparisons would have to be based on good meterological and soil temperature data, which I do not have.

SUMMARY

Among 84 species of conspicuous flowering plants at Eagle Creek, east-central Alaska, the earliest (*Douglasia gormanii*) showed its first blossoms about May 23, on the average. The latest species to flower, *Gentiana algida*, began blooming July 23 most years. About 25 percent of the species studied achieved first anthesis between June 14-18. Site variation within species was not studied, but considerable variation in flowering dates among species on the same site was observed. The annual progression of flowering correlated well with hatching dates of rock ptarmigan. As far as the data allowed an examination of the subject, I found no evidence that year-to-year variations in flowering dates were greater among early than among late species.

ACKNOWLEDGMENTS

I wish to thank my wife, Judith S. Weeden, and field assistants Thomas Dean, David Hatler, Philip Headley, Rodney Herrick, and John Trent for pointing out many early flowers during this study. I am indebted to John Crow, Washington State University, for checking my identifications, and to Dr. Leslie Viereck, Forest Science Laboratory, University of Alaska, for reviewing the manuscript.

This paper is a contribution from Federal Aid in Wildlife Restoration Project W-13-R, Alaska Department of Fish and Game.

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Accepted January 18, 1968