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# TWO PROBLEMS IN SALIX DISTRIBUTION

Carleton R. Ball

Two peculiar problems in the distribution of certain North American species of *Salix* have confronted the writer for several years. The first problem is presented by two unrelated species having an extremely extended, but fairly continuous, distribution from south to north. The second problem is concerned with two unrelated species which have a fairly extensive, but finally discontinuous, distribution from east to west. By "unrelated" is meant that the two members of each pair belong to quite widely separated sections of the genus *Salix*.

The geographical direction of distribution given above is from the region of greater abundance to that of increasing scarcity and final disappearance. It is hoped that some one may throw light on the physiological and/or ecological factors governing these peculiar plant distributions.

## A. Extremely Extensive South-North Ranges

The two species of *Salix* with greatly extended south-north distribution are *S. lasiandra* (accompanied by its hairy-twigged variety *lancifolia*) and *S. interior* (with its narrow-leafed variety *pedicellata*). Both species range from the latitude of northern Mexico (30°–32° N.) to the Arctic Circle or beyond (67° N.), or some 2500 miles or more. In each case, the species and its variety occur together throughout almost the entire distance.

1. *Salix lasiandra* Bentham, the Pacific or western shining

FIG. 1. Distribution of *Salix lasiandra* and its var. *lancifolia* (hatching) and *S. interior* and its var. *pedicellata* (fine dotting). Localities of marginal collections indicated by letter "x" and large dots, respectively.

willow, and its hairy-twigged variety *lancifolia* (Andersson) Bebb, occur from northwestern Mexico to Alaska and Yukon. From the hot climate of Baja California and southern California, they pass northward abundantly throughout California, Oregon, Washington, western Nevada, and Idaho. In the south, a long finger of sparse distribution projects eastward across the northern portions of Arizona and New Mexico and the adjoining southern parts of Utah and Colorado (fig. 1).

In Canada, the species and variety extend northward, with decreasing abundance, across British Columbia and mountainous

western Alberta and eastward into the prairies as far as east-central Saskatchewan and thence north at least to the west end of Lake Athabaska in northern Alberta. Farther north and west, the species occurs on the lower Stikine River in northwestern British Columbia near the International Boundary north of Wrangell, and again on the headwaters of the Chilkat River at the northern tip of the Alaskan "Panhandle".

Species and variety occur together at several points on the Yukon and Klondike rivers in the Dawson area of Yukon (64° N.). In Alaska proper, the variety occurs alone at Matanuska, at the head of Cook Inlet in south-central Alaska. It has been found also along the Yukon River at Fort Yukon (Arctic Circle), Blackburn, and even Holy Cross (62° N., 160° W.), as well as on the tributary Tanana River at Salcha Slough, Fairbanks, and Nenana.

The distribution from northwestern British Columbia across Alaska and western Yukon is sparse but fairly continuous. Similar continuous distribution from Lake Athabaska northwestward across the wide expanse of the Peace River and Liard River drainage is in doubt, but collecting has not been sufficient to prove its absence.

The total recorded range covers about 35 degrees of latitude (32° N. to almost 67° N.). It extends across the Lower and Upper Sonoran, Transition, Canadian, and Hudsonian Life Zones, and almost touches the Arctic Zone at various points on the Yukon River from Dawson to Holy Cross.

2. *Salix interior* Rowlee, and its slender-leafed variety (*pedicellata* (Andersson) Ball, range northward from the mouth of the Mississippi River (30° N.) across the United States and Canada to slightly beyond the Arctic Circle in Alaska. Westward of the Mississippi, they (and especially the variety), fan out across the Great Plains almost to the foothills of the Rocky Mountains in the United States and Canada. Eastward, the species ranges up the Ohio Valley, across the mountains, down the Potomac Valley to the District of Columbia, and thence northeastward to Delaware, New Hampshire, New Brunswick, and Quebec. Then the line runs west to southern Manitoba and northwestward to Lake Athabaska, the species and variety occurring together in the Prairie Provinces (fig. 1).

In the Mackenzie River (Arctic) drainage basin of southern Mackenzie, the species (and occasionally the variety) occur on the Slave River (Fort Smith), on Great Slave Lake (Hay River), and on the Mackenzie River (Fort Simpson, Fort Wrigley, 63° N., 123° W.). Westward, on tributaries of the Mackenzie, the species has been found at the mouth of the Nahanni River (61° N., 124° W.), at Fort Liard on the Liard River (60° N., 124° W.),

and on the Upper Liard River at 60° N. This is at about 128° W. and near the British Columbia—Yukon Boundary.

In Pacific drainage, the species and variety occur in British Columbia, Yukon, and Alaska. In northwestern British Columbia, the species has been found once on the Stikine River, near the Alaskan border north of Wrangell. In Yukon, species and variety occur at several points on the Yukon and Klondike rivers within some 20 miles of Dawson (64° N., 140° W.). In Alaska, species and variety follow the Yukon River westward, occurring at Circle (66° N., 144° W.), on Porcupine River 40 miles above the mouth (67° N., 144° W.), Fort Yukon (66° 30′ N., 145° W.), between Rampart and Tanana, between Fort Gibbon and Tanana (65° N., 152° W.), and at Nulato (158° W.). On the tributary Tanana River, the species occurs at Fairbanks and Hot Springs and the variety at Nenana. Outside the Yukon drainage, the species has been found at but one point in Alaska, namely, Paxson's (Roadhouse), just south of the divide separating the north-flowing Tanana and the south-flowing Gulkana-Copper River drainages.

The range recorded above covers 37 degrees of latitude (30°–67° N.) or some 2600 miles, and 90 degrees of longitude (68° W. in New Brunswick to 158° W. in Alaska). The Life Zones covered are the Carolinian, Alleghanian, Canadian, and Hudsonian, with the Arctic Zone almost reached at points on the Yukon River.

One striking fact regarding both *S. lasiandra* and *S. interior* is that there is little or no more observable variation in characters between plants collected at the two extremes of this range than between plants collected at any one point within the range.

In these vast ranges, wide differences occur in temperature, precipitation, humidity, length of season, and length of day. Yet these two species seem to show complete ability to adapt themselves to these differences without observable change in characters.

### B. Extensive, but Discontinuous, East-West Ranges

Different species of *Salix* which occur commonly in our northeastern and north-central States and adjacent Canada penetrate westward to very different distances. Some, like *S. interior* Rowlee, *S. rigida* Muhl. (*S. cordata* Muhl.), and *S. discolor* Muhl., are replaced in the Rocky Mountains and westward by related species. Others, like *S. amygdaloides* Anders., reach but do not pass the Sierra-Cascade barrier. Still others, like *S. Bebbiana* Sargent, *S. candida* Fluegge, and *S. pedicellaris* var. *hypoglauca* Fern., extend practically to the Pacific Ocean. Two species which penetrate only to the front range of the Rocky Mountains, and that only by discontinuous distribution, are discussed below.

1. *Salix serissima* (Bailey) Fernald, related to *S. lucida* Muhl. of the East and to *S. caudata* (Nuttall) Heller and *S. lasiandra*

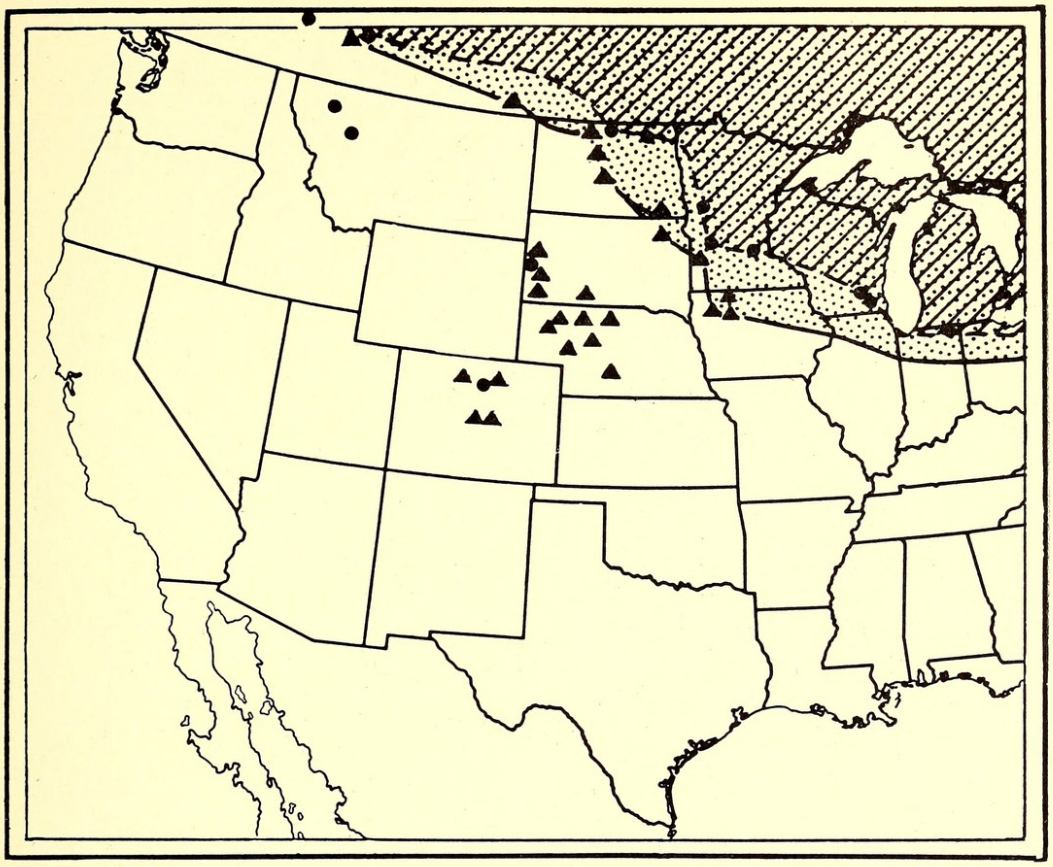

FIG. 2. Southwestern portion of the distribution of *Salix serissima* (hatching and large dots) and of *S. petiolaris* (fine dotting and triangles) in North America, showing relation of the continuous northeastern distribution of these two species to their marginal and discontinuous distributions.

Bentham of the West, occurs commonly from New England and Lower Canada westward. The southern boundary of its range lies along the southern edge of the Great Lakes area to St. Paul and Kandiyohi County, Minnesota, thence northward through Ottertail and Clearwater counties, and westward in North Dakota, in the northern tier of counties (Pembina, Rolette). From here the line runs northwestward to Calgary and the Banff area in southern Alberta. Northward the range extends to Lake Athabaska and southern Mackenzie (fig. 2).

By discontinuous distribution, the species occurs in three separate areas to the south and west of its continuous distribution. The first area includes Flathead (Glacier Park) and Chouteau counties in northwestern Montana, some 150 and 230 miles, respectively, south of Calgary. Far to the west and south of the main distribution are two mountain outposts in South Dakota and Colorado, respectively. In the Black Hills of South Dakota, Professor A. C. McIntosh found it in sedge moor at two localities near Deerfield, Pennington County, in 1928 and 1929. In the Front Range of the Rocky Mountains, Professor Ernest C. Smith

collected it at Longs Peak Inn, elevation 9000 feet, on Longs Peak, Larimer County, Colorado, in 1935, 1936, and again in 1943.

The writer previously had presented the known distribution of this species in the United States and Canada in two different papers (Bot. Gaz. 72: 220–22. 1921; Canadian Field Nat. 40: 147–48. 1923). The first paper brought forth a statement from Francis Welles Hunnewell (Rhodora 25: 67–68. 1923) that he had collected *S. serissima* on Longs Peak in 1913 and that the determination had been verified by Dr. Fernald. In the second paper, and again in Deam's Shrubs of Indiana, the writer erroneously credited this collection to Pikes Peak instead of Longs Peak.

The Black Hills locality is about 450 miles from the nearest North Dakota station, and about 500 and 600 miles, respectively, from the two Montana stations far to the northwest. The Longs Peak station is 600 miles from Rolette County, North Dakota, and 600 and 700 miles, respectively, from the two Montana stations. The species has not been found in the intervening expanse of Rocky and Big Horn mountains. Are these few southern plants the remnants of its farthest southern push during glacial times and its wide northern distribution a reoccupation of territory lost during the Glacial Epoch?

2. *Salix petiolaris* J. E. Smith has much the same eastern distribution (fig. 2) as *S. serissima.* It ranges slightly farther south, occupying the northern third of Indiana and the two northernmost tiers of counties in Iowa as far west as the Mississippi-Missouri divide. The line then runs northwest to west-central Minnesota (Chippewa County), northeastern South Dakota (Day County), and adjacent North Dakota (Richland County), and thence passes through McLean, McHenry, and Bottineau counties, of central and north-central North Dakota, and on into Canada. The western border of its continuous distribution is somewhat farther to the south and west than that of *S. serissima.* It is a low clumpy shrub southward, becomes gradually larger northward, and is often a small tree in the Prairie Provinces, where it extends at least to Lake Athabaska.

Correlated with the somewhat greater western extension of its continuous distribution is its broader and deeper discontinuous penetration far to the south and west. Four separate areas are occupied by *S. petiolaris,* as verified by the following collections. 1.) The sandhills of northwestern Nebraska and adjacent South Dakota. Cherry County: Rowley Ranch near Kennedy, 1892, *Smith* and *Pound,* 1910–1914, *Bates;* Bear Creek and Dewey Lake, 1941, *Tolstead;* Oasis, 1912, *Pool* and *Nelson.* Bennett County (southwestern South Dakota adjacent to Cherry County, Nebraska): 1924, *Over.* Sheridan County: near Ellsworth, 1933, *Sandoz.* Brown County: Ainsworth, 1941, *Tolstead.* (The preceding three Nebraska counties are contiguous in north-central Nebraska west-

ward; the following are farther south.) Thomas County: Purdum, 1901, *Baker.* Dawson County: 1943, *Kiener,* Arthur County: 1943, *Kiener.* 2.) The eastern face of the Black Hills of southwestern South Dakota in Custer, Pennington, Lawrence, and Meade counties: Jim Creek (T. 2 N., R. 5 E.) 1913, *Setzer;* Bear Butte Creek (T. 4 N., R. 4 E.), 1919, *Murdoch;* Castle Creek, 1924, *Over;* Castle Creek near Deerfield, 1928, *McIntosh;* near Merritt, 1924, *Over;* Squaw Creek, 12 miles above Game Lodge, 1926, *McIntosh;* Sylvan Lake, 1926, *McIntosh;* Custer, 1928, *McIntosh.* 3.) Estes Park, northern Colorado. Larimer County: Estes Park, elevation 7500 feet, 1933, 1934, *Ernest C. Smith* (seven collections). 4.) The Pikes Peak area in east-central Colorado. Teller County: east of Divide, 1935, *J. H. Christ.* El Paso County: Black Forest, 1935, *J. H. Christ.*

The sandhills area of Nebraska-South Dakota, and the Black Hills area of South Dakota, lie some 300 to 400 miles west-southwest of the margin of the continuous eastern distribution. The two mountain localities in Colorado are about 100 miles apart and 300 to 350 miles southwest of the Nebraska and South Dakota areas and therefore some 600 to 700 miles southwest of the margin of continuous distribution.

In the case of *Salix serissima,* there are four isolated and distant localities of discontinuous distribution, in three States. In the case of *S. petiolaris,* there are two relatively extensive areas and two isolated mountain localities of such distribution, also in three different States.

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# SEED GERMINATION IN GILIA CAPITATA AND ITS RELATIVES

Verne Grant

The discovery that seeds of *Gilia capitata* Douglas (Polemoniaceae) collected from a recently burned hillside in the California Coast Ranges germinated twice as well as seeds from an unburned site in the same immediate area posed both the practical problem: how to obtain the highest percentage of germination from the seeds available for experimentation; and the theoretical problem: whether fire is a factor in the distribution of *Gilia capitata.* The observation, again, that the closely allied races, *G. chamissonis* Greene and *G. staminea* Greene, are confined in nature to pure sands on the California coast and in the San Joaquin Valley raised the question whether the distribution of these entities is related to the germination requirements of their seeds or the tolerances of their seedlings at establishment. Numerous germination tests,