XEROPHYLLUM TENAX, SQUAWGRASS, ITS GEOGRAPHIC DISTRIBUTION AND ITS BEHAVIOUR ON MOUNT RAINIER, WASHINGTON[1]

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The objectives of the present study of *Xerophyllum tenax* are twofold; to compile information regarding its geographic distribution and to study the specific environmental requirements necessary for its vegetative growth and blossoming on Mount Rainier, Washington. Since the field observations have been confined to a single season, the results presented must be considered as tentative. In order to study the environmental requirements fully, stations with permanent protected plots would have to be established throughout the range of the species and observations made over a period of years.

Xerophyllum tenax (Pursh) Nutt. (fig. 1) is a tufted, herbaceous, graminoid, perennial hemicryptophyte having a tuber-like woody rootstock bearing cord-like roots. It bears numerous grass-like, keeled, rigid leaves 5–10 dm. long, 5–10 mm. wide at the base and gradually tapering to a narrow, stiff and wiry tip, the margins rigid and serrulate (Peck, 1941; Jepson, 1951). According to Dr. D. B. Lawrence (personal communication), the young seedlings can be distinguished from those of *Carex* species by a grey-white bloom which covers the leaves of the *Xerophyllum*. Flowering occurs between May and September. The inflorescence stalks, 3–15 dm. high, are covered by leaf-like bracts which are reduced toward the top, and the raceme, 1–2 dm. long, is very dense, with slender pedicels 2–5 cm. long. The perianth is cream-colored, with lanceolate segments 6–10 mm. long, the stamens surpass the perianth, and the capsule is broadly ovoid, acute, 5–7 mm. long.

Xerophyllum tenax is found from west-central California northward to northwestern Washington, and from Yellowstone National Park northwestward to southwestern Alberta and southeastern British Columbia. Along the coast, at least in northwestern Washington where habitat conditions are specifically recorded, it is found at sea level on bogs, and in the rain-shadow of the Olympic Mountains on gravelly "prairies" (Jones, 1936). It occurs again high in the coast ranges, and from approximately 2000 feet to 7000 feet in the Sierra-Cascade and Rocky Mountain ranges. Thus it is widely separated geographically from the eastern North American species, *X. asphodeloides* (L.) Nutt., which grows at low altitudes on sandy acid pineland of the Atlantic Coastal Plain from North Carolina

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FIG. 1. *Xerophyllum tenax* with an abnormal stunted inflorescence, beside trail, Station 2, Mount Rainier. Normal inflorescence from another plant held in hand.

to New Jersey, and again in the Blue Ridge Mountains and Appalachian Plateau in acid woods of Georgia, North Carolina, Tennessee, and Virginia (Fernald, 1950; Small, 1933).

The geographic distribution of *Xerophyllum tenax* is shown in a map (fig. 2), data for which was compiled from information supplied by staff members of various herbaria (Univ. Calif., Univ. Idaho, Univ. Oreg., Oreg. St. Coll., Univ. Wash., Wash. St. Coll., Nat. Mus. Canada, Univ. Alberta, Univ. Brit. Col.). The species occurs very sparingly in the coastal region near sea level from west-central California to northwestern Washington, and again just below the summits of the coast mountains over almost the same latitudinal range. In the Sierra-Cascade range, it is found from Placer County, California, northward 700 miles to Stampede Pass, Washington, ranging in altitude from approximately 2000 to 6000 feet. It is not known to occur on Mount Shasta. In the Rocky Mountains complex it occurs from 2000 to 7000 feet, with the southernmost limit of its range along the southern boundary of Yellowstone National Park, whence it extends northwestward about 450 miles to Crow's Nest Pass on the British Columbia-Alberta boundary. Westward it extends from the Rocky Mountain divide approximately 200 miles to northern Idaho, reaching its western limit on the summit of Mount Spokane, Washington, at 5800 feet. In Idaho it ranges from southern Lemhi and Valley counties northward to the International Boundary and on in British Columbia to Kootenay Lake, a northwestward extent of 380 miles.

Judging from the differences in habitat that have been reported in the literature, and the broadness of the geographic distribution pattern, it would be reasonable to expect that several races exist within the species. There appear to be definite distributional gaps between the plants growing at sea level along the immediate coastal strip and those growing high in the coast range; similarly a distributional gap exists between the coast ranges and Sierra-Cascades, and another large one between the latter and the Rocky Mountains complex. Although the distribution map (fig. 2) would suggest continuity within the groups running north and south, it is quite possible that the plants growing in the north belong to quite different races from those growing in the outposts along the California coast, the southern Sierras, and the Rocky Mountains in northern Wyoming. It would be very interesting to take individuals from widely different geographical areas and grow them adjacent to each other in experimental plots at several places within the distribution range. Dissimilarities would almost certainly be found.

Xerophyllum tenax on Mount Rainier

Between July 13 and August 23, 1955, field work was carried on at Mount Rainier National Park, Washington, and thirty-four stations were established where the species was studied. Figure 3 and Table 1 present the data for these stations and show through description and symbol those characteristics of the plants and of their local environments which were

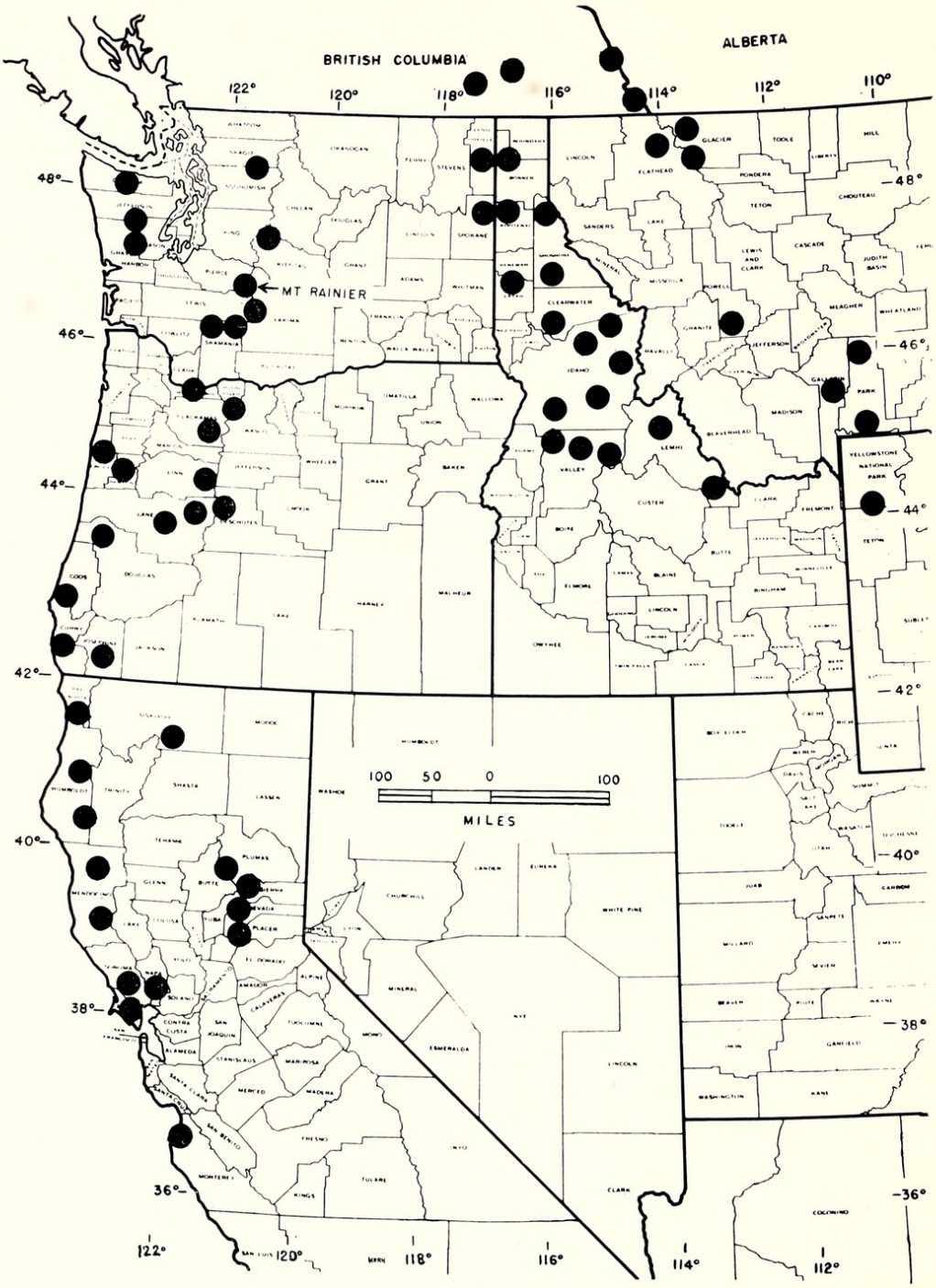


FIG. 2. Distribution map of *Xerophyllum tenax*.

considered significant in determining causes of local distribution. At thirty-three field stations detailed data were recorded as follows: date, time of day, location, elevation, degree and direction of slope, density of spacing measured as minimum distance between *Xerophyllum* clumps, presence of new or old flower stalks, composition of the adjacent vegetation, and history of fire. Where flowering was in progress the following were also recorded: root temperatures in degrees centigrade of flowering and of non-flowering plants three inches below ground surface, height in centimeters of the flower stalk up to base of the raceme, and diameter of flowering stalk in millimeters measured just above basal leaves.

From the data accumulated at these field stations, it appears that the distribution of *X. tenax* within Mount Rainier National Park seems to be influenced by a number of factors, including soil temperature, elevation, and direction and angle of slope.

There are some factors, for example soil water content, which seem to have no apparent influence on its distribution. Individuals were found thriving equally well on dry sunny hillsides and on moisture saturated soil immediately below rapidly disappearing snow banks. This latter observation seems related to the occurrence of *X. tenax* on bogs near sea level. The amount of shading by an overstory also does not seem to be a limiting factor for vegetative growth. Although all the plants found blooming in 1955 were growing in open meadows, light woods, or shrubby areas, and not in dense forests, the ability of the adult plants to survive did not seem to be affected by the amount of shading they received. Plants were found growing well vegetatively in dense forests where little or no direct sunlight filtered through the canopy and also on slopes exposed to the sun for as long as twelve hours a day.

Most of the stations were visited between 10 A.M. and 3:30 P.M. on days of roughly equivalent fair meteorological conditions over a period of about forty days between July 13 and August 25. Recorded air temperatures ranged from 13°C. to 30°C., and soil temperatures three inches below the surface beneath the leaf crowns of *X. tenax* ranged from 9°–18°C.

Within the Park, only the upper limit of distribution could be ascertained, as plants were found growing at the lowest easily accessible boundaries of the Park at 2000 feet and also somewhat lower outside. Although most of the plants were found below 6000 feet, one group of plants was found near Panhandle Gap, Station 22, at 6800 feet. This elevation was the upper limit of all vascular plant growth here, with only lichens and mosses occurring higher. Within this area there were numerous perennial snow fields.

The chief factor that did appear to affect the distribution was direction of slope, and this in turn influences length of snow-free growing season and soil temperature. *Xerophyllum tenax* was found growing on south-facing slopes, one as steep as 55 degrees, at ten stations, on southeast slopes at seven, on southwest slopes at four, on west slopes at three, on east slopes at two, and on north slopes at only one station. In this last

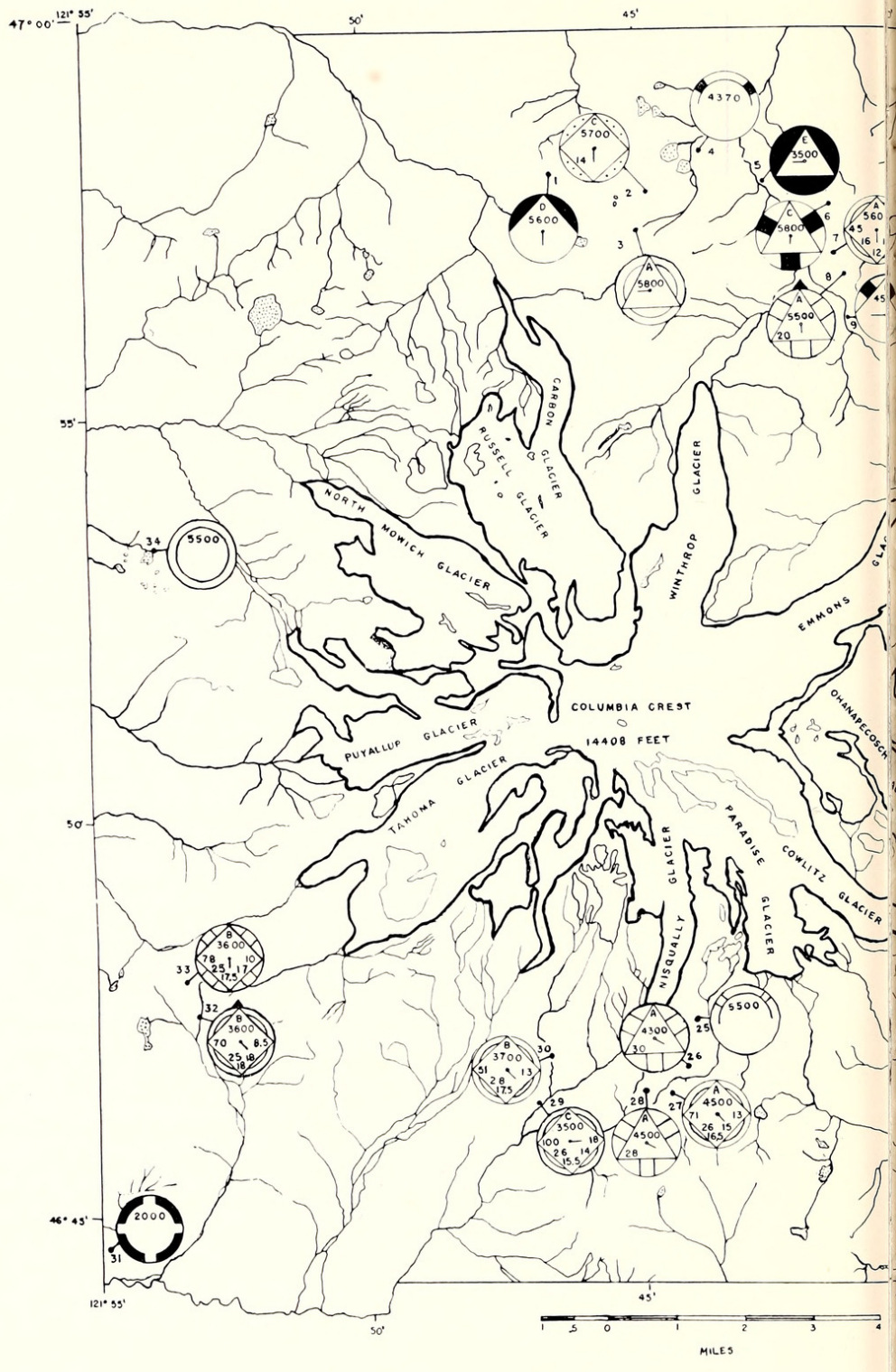
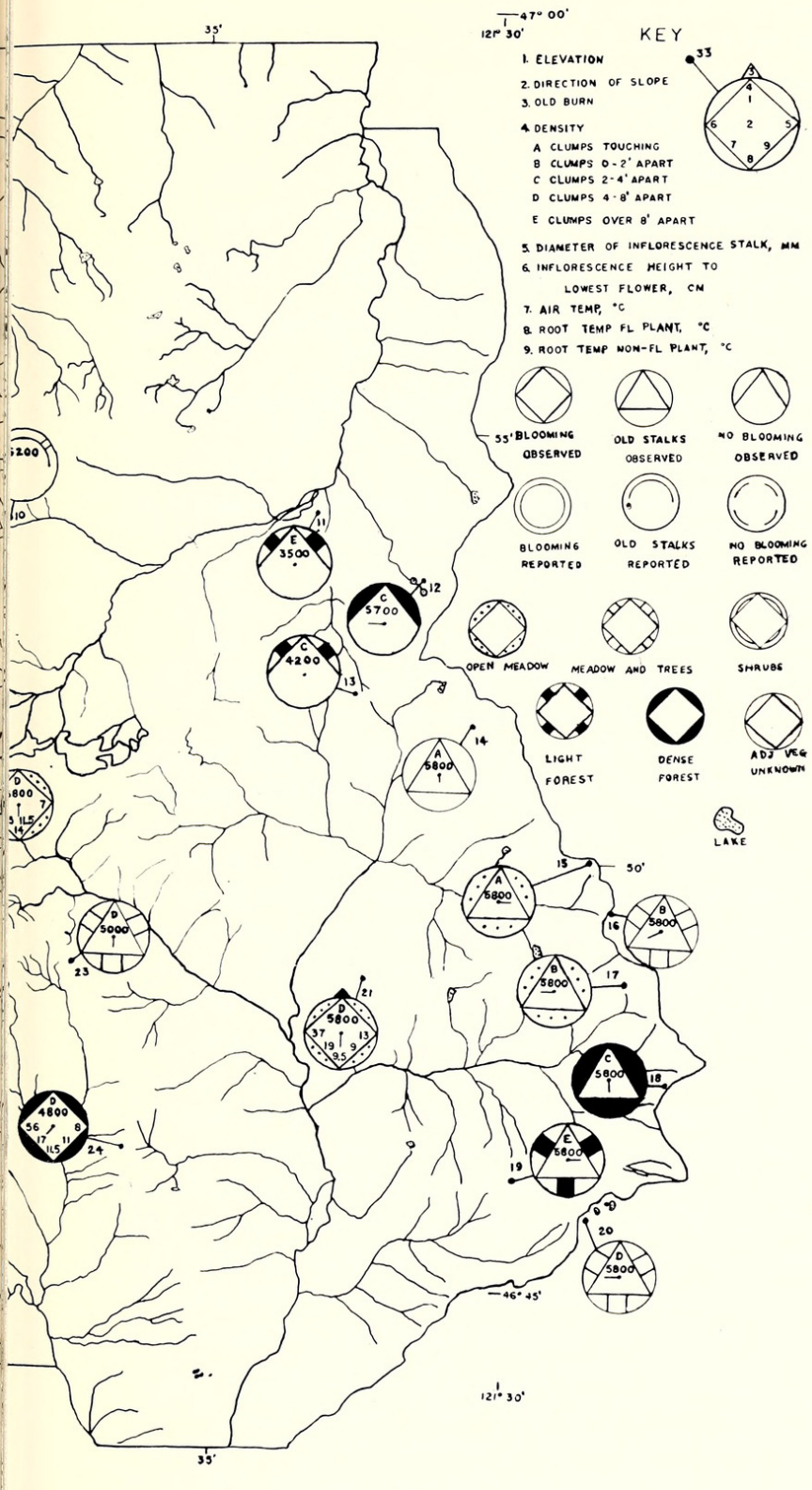


FIG. 3. Map of Mount Rainier National Park showing distribution of *Xerophyllum tenax* (based on observations and reports in 1955). The stations, numbered clockwise beginning in the northwest, are represented by circles connected to black dots (the actual sites).



One or more study sites was established at each station. Traced from USCG topographic map, Mount Rainier National Park, Washington, 1954.

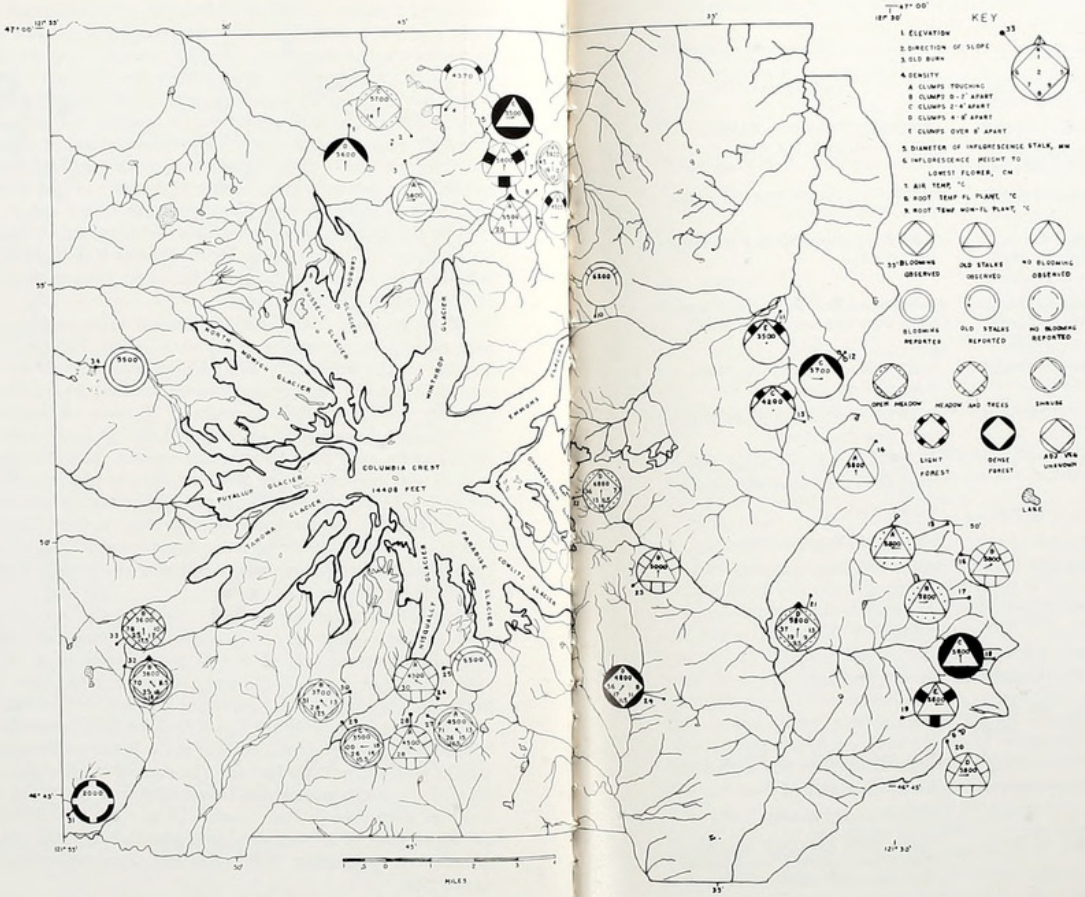


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TABLE 1. DESCRIPTIONS OF FIELD STATIONS WHERE STUDY PLOTS OF XEROPHYLLUM TENAX WERE ESTABLISHED ON MOUNT RAINIER IN 1955

STATION NO.	DATE	TIME	SLOPE	LOCATION, SNOW AND SOIL CONDITIONS
1	Aug. 2	3:30 p.m.	15° south	1 mile west Yellowstone Cliffs, North Loop trail; soil wet.
2	Aug. 2	3:15 p.m.	45° south	Yellowstone cliffs, North Loop trail.
3	Aug. 2	2:45 p.m.	10° west	Windy Gap, North Loop trail; large snow fields adjacent.
4	Aug. 2	11:30 a.m.		Lake James, North Loop trail; snow areas present.
5	(See Fig. 3)			
6	Aug. 1	3:45 p.m.	15° south and also gentle north	West slope Grand Park, North Loop trail; numerous snow fields nearby.
7	July 25	12:15 p.m.	10° south	South edge of Grand Park, North Loop trail; no snow.
8	July 25	12:00 m.	18° south	South edge of Grand Park, North Loop trail; snow fields present.
9	July 25	11:00 a.m.	25° west	1 mile north Berkeley Park shelter, North Loop trail; snow fields present.
10	July 25		18° east	Yakima Park.
11	Aug. 25	12:00 m.		White River Entrance Station.
12	Aug. 22	2:20 p.m.	south	Deadwood Lakes; very wet.
13	Aug. 22		south	Ghost Lake.
14	Aug. 23	9:00 a.m.	5° south	Cascade Crest trail.
15	Aug. 23	10:45 a.m.	45° east	"
16	Aug. 23	12:30 p.m.	southwest	"
17	Aug. 23	1:00 p.m.	40° west	"
18	Aug. 23	2:15 p.m.	south	"
19	Aug. 23	4:30 p.m.	west	Three Lakes-Ohanapecosh trail.
20	Aug. 23	2:45 p.m.	40° west	Cascade Crest trail.
21	Aug. 5	12:00 m.	5° south	Shriner's Peak Lookout.
22	Aug. 17	10:45 a.m.	18° south	0.5 mile south Panhandle gap, Wonderland trail; highest elevation at which flowering plants were found.
23	Aug. 16	2:45 p.m.	10° south	Cowlitz Divide, 1 mile south Indian Bar, Wonderland trail.
24	Aug. 16	10:15 a.m.	15° west	2 miles east Nickel Creek patrol cabin, Cowlitz Divide, Wonderland trail.
25	Aug. 25		south	Paradise Valley.