

AIR-BORNE ALLERGENS IN THE NATIONAL PARKS*†

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POPULAR interest in the National Parks and popular demand for statistical data on the seasonal and geographic distribution of air-borne allergens in all parts of North America have made necessary a systematic study of the wind-pollinated plants, as well as the aerial incidence of pollens and fungus spores of these areas. Pollen investigations have now been made in all except four of the twenty-nine National Parks. In almost every park it has been possible to follow the plan of combined field and atmospheric study, including a personal examination of the wind-pollinated flora and daily tests of the pollen content of the air during the significant part of at least one season. In these studies much valuable assistance has been given by the personnel of the National Park Service, not only in the exposure of slides but in transportation and guide service during field surveys.

All field surveys, as well as the counting of pollen slides, have been done by the author. In all of the tabular data the figures, except those of the ragweed index, refer to the number of pollen grains per cubic yard of air. The standard technique¹ of gravity slide counting approved by the Council on Aeroallergens of the American Academy of Allergy has been used in all atmospheric studies made since 1945. A preliminary ragweed report was published in 1948.² Pine pollen figures are not included.

Acadia National Park, Maine.—No field survey made. Atmospheric tests were made in August and September, 1934, 1935, at Park Headquarters, Bar Harbor. The tests showed about three weeks of continuous, moderate air contamination with ragweed pollen, which constituted almost 96 per cent of all pollen caught on the test slides. This island park is too near the ragweed infested agricultural areas and highways on the mainland for adequate control of air-borne ragweed pollen by means of local weed eradication. Tree and grass pollens are no doubt abundant in season.

Big Bend National Park, Texas.—No data.

Bryce Canyon National Park, Utah.—Field survey made September, 1947. Atmospheric tests were made from April to October, 1948, at Park Headquarters, altitude 7,978 feet. Pollen of Utah juniper could cause allergy in April and May but I found no record that park employees or visitors have experienced symptoms that could be traced to this source. Oak is a possible though probably rare offender. The July grass record appears to be significant. Traces of rag-

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weed pollen, originating mostly outside the park boundaries, appeared on the slides during all seven months. Sagebrush pollen, which is also irritating to most ragweed sufferers, was more abundant than ragweed, but not excessive.

Summary of slide counts:

	APRIL	MAY	JUNE	JULY	AUGUST	SEP- TEMBER	OC- TOBER	TOTAL
Cedar (juniper)	1,116	605	22	11	36	11	16	1,817
Oak	0	123	60	4	0	0	0	187
Grass	0	10	30	256	12	8	4	320
Plantain	0	0	4	5	0	0	0	9
Miscellaneous								
chenopods	0	29	12	52	14	8	0	115
Sagebrush	0	14	0	2	86	114	100	316
Composite*	8	4	12	10	198	30	4	266
Ragweed	22	43	11	7	18	43	4	148
Miscellaneous	4	2	14	4	6	8	0	38

*Mostly in clumps.

Carlsbad Caverns National Park, New Mexico.—No data.

Crater Lake National Park, Oregon.—Field survey made August, 1947. Atmospheric tests were made June 26 to September 8, 1947, at Park Headquarters, altitude 6,500 feet (approximately 1,000 feet below Rim Village). No ragweeds or sagebrush plants were found in or near the areas frequented by tourists. Traces of ragweed pollen appeared on only four days. In fact, the total of all weed pollen grains caught during the seventy-five day test period averaged less than one-half of one grain per day. The record by species follows: alder 4, grass 50, ragweed 9, sagebrush 4, composite 4, chenopod 2, sedge 4, miscellaneous 10, grand total 87. Thus the park ranks with Lassen Volcanic and Sequoia National Parks as a practically perfect refuge not only from ragweed but from *all* types of air-borne allergens. However, the approaches to the park are not ideal. Sagebrush is abundant in Klamath Valley, also other hay fever weeds, such as Russian thistle and various saltbushes (*Atriplex spp.*).

Everglades National Park, Florida.—No atmospheric data. A casual examination of the flora during late October and early November along the Tamiami Trail, at Homestead, and on Key Largo did not reveal any ragweeds or other common hay fever weeds. Saw grass (*Mariscus jamaicensis*), a sedge, is dominant in open glades. It is unlikely that the atmospheric incidence of ragweed pollen could be higher at any point in the park than at Miami³ where the index is very low. Atmospheric tests are planned for 1949.

Glacier National Park, Montana.—Field survey made July, 1946. Atmospheric tests were made June 15 to September 15, 1946, at Park Headquarters, Belton, altitude 3,200 feet, and at the Many Glacier ranger station, altitude 4,860 feet, near Swiftcurrent Lake. No ragweed plants of any kind were found within the park or closer than fifteen miles to the south entrance. True sagebrush was not found. The broad-leaved trees are rare and their pollens evidently unimportant. The grass pollen season occurred during July and August. Most of the grass pollen evidently originated very close to the sampling site where common meadow grasses have been introduced. The only interesting weed pollen caught on the test slides was that of red sorrel (*Rumex acetosella*),

which was quite abundant at Many Glacier. Red sorrel plants grow abundantly near the ranger station but are rare elsewhere. It is unlikely that anyone is affected by red sorrel pollen. Ragweed and sage pollens are blown into the park in extremely small amounts. Thus Glacier proves to be the very best ragweed-sage refuge so far studied in the whole Rocky Mountain region.

	BELTON	MANY GLACIER
Broad-leaved trees	14	6
Grass	81	184
Red sorrel	1	552
Chenopod	13	33
Ragweed	11	9
Sage	7	15
Composite	2	10
Miscellaneous	29	43

Grand Canyon National Park, Arizona.—Field survey made October, 1946, at South Rim. Atmospheric tests were made July to October, 1947, at Park Headquarters Rim Village, altitude 4,900 feet. Field survey made September, 1947 at North Rim. Atmospheric tests were made June 9 to September 9, 1948, at ranger station, altitude 5,700 feet. Ragweeds seem to be entirely absent from the tourist frequented sections both on the north and south sides of the canyon. It is possible that some ragweed pollen may be blown into the area, particularly on the South Rim, during March, April, and May, but only traces of ragweed pollen were found on the July to October test slides. While sagebrush and other Artemisias are common in some parts of the park, and there is certainly some exposure to this pollen in approaching the tourist areas, the air tests failed to register more than token amounts. In fact, the only active pollen of any sort encountered in appreciable quantity was that of the grasses as recorded during late August and early September at North Rim.

Total figures for all types of pollen follow:

	SOUTH RIM	NORTH RIM
Ragweed	16	20
Chenopod	13	43
Grass	14	293
Sagebrush	24	18
Composite	3	108*
Miscellaneous	10	4

*Several large clumps.

Grand Teton National Park, Wyoming.—Field survey made September, 1947. Atmospheric tests were made July to September, 1948, at Park Headquarters four miles south of Jenny Lake. The grass season evidently began in June and continued heavy through most of July. It seems quite likely that most of the grass pollens recorded were from the immediate vicinity of the Park Headquarters. No ragweeds of any kind were seen in, or anywhere near, the frequented areas of the park. Sagebrush is the only local hay fever hazard of the summer and fall. It is abundant in the adjacent Jackson Hole area but air contamination with sagebrush pollen at Park Headquarters was extremely low. This may be explained because of low wind velocities during the fall season in

the park. There was even less sagebrush pollen on the test slides than at Mammoth station in Yellowstone Park and about the same amount as at West Yellowstone. However, it is impossible to approach the park without passing through an area where sagebrush is the dominant plant.

A summary of the atmospheric record follows:

	JULY	AUGUST	SEPTEMBER	TOTAL
Grass	485	31	0	516
Chenopod	4	11	1	16
Red sorrel	47	0	0	47
Composite	0	2	0	2
Sagebrush	2	29	48	79
Ragweed	10	2	2	14
Miscellaneous	7	0	0	7

Great Smoky Mountains National Park, Tennessee-North Carolina.—Field survey made July, 1947. Atmospheric tests were made August and September, 1947, at Park Headquarters near Gatlinburg, altitude 1,460 feet, and Newfound Gap, altitude 5,045 feet. This park contains a greater variety of broad-leaved trees than any other equal area in North America. Visitors during the months of February to May will encounter large amounts of pollen of numerous tree species. There is an abundance of grasses in the Gatlinburg area pollinating in late May and early July. During the fall season, August and September, ragweed pollen was found to constitute 94 per cent of the pollen content of the air. The total count for the Headquarters station was 582, for Newfound Gap, 206. Thus if facilities for camping and hotel accommodations were available at Newfound Gap, this high wooded area could be rated as a refuge from ragweed pollen. Gatlinburg is not good.

Hawaii National Park, T. H.—Field survey made September, 1948. No atmospheric data for the park areas. I found no short ragweed or giant ragweed in either of the two sections of the National Park or adjacent areas of Hawaii or Maui. Short ragweed grows in a very restricted prairie area, perhaps two miles in diameter, south of Waimea (Kamuela) on the northern part of Hawaii, some forty-five miles northwest of Park Headquarters. The prevailing northeast winds cannot possibly carry the relatively small amount of pollen from these weeds over Mt. Mauna Loa to the park or to any city or village on this island or any other island of the group. False ragweed (*Franseria strigulosa*) is a common roadside and wasteland plant in the central valley of Oahu, from Pearl Harbor northward to Waialua and Haleiwa, also along the shore road from these towns to the northern tip of Oahu. The total acreage of these ragweeds is comparatively small since they are not allowed to grow in cane or pineapple fields. Prevailing northeast winds carry the pollen away from Honolulu, rather than toward the city. Cockleburs grow sparingly in waste fertile soil in all islands, but their output of pollen is entirely negligible. Various wild and cultivated grasses, including Bermuda grass, may shed appreciable amounts of pollen in the vicinity of Park Headquarters and Volcano House on Hawaii and the grassy sides of Haleakala. The season of active grass pollination has not been determined but may extend through most of the year. Algarroba (*Prosopis*

juliflora) is a doubtful source of wind-blown pollen. The role of tropical wind-pollinated plants, such as palms, Australian pine (*Casuarina spp.*), ferns, club mosses, and so forth, has not been adequately investigated.

Hot Springs National Park, Arkansas.—Field survey made May, 1926. No atmospheric data from the immediate park area. Daily tests during the months of August and September, 1931, 1932, and 1933, at the U. S. Weather Bureau station in Little Rock, some forty-five miles from the park, have given figures which may be safely used to judge the conditions at Hot Springs. More recent figures, 1947, 1948, have confirmed the older data. Ragweed pollen grains begin to appear in the air during the second week of August. Highest concentrations are usually reached during the first or second week of September and the season continues well into October. Thus, being well within the ragweed belt, Hot Springs National Park should be avoided by ragweed sufferers during the months of August, September, and October.

Isle Royale National Park, Michigan.—No field survey made. Atmospheric tests were made August 13 to September 15, 1934, at Belle Isle Summer Resort. The ragweed season had evidently terminated by September 15. The highest maximum for any one day was 48 grains of pollen per cubic yard of air as recorded on September 10. For a number of years the Michigan Department of Health has made atmospheric tests on Isle Royale showing that ragweed pollen is present only on days of strong south winds. Whether ragweeds of any sort grow on the island, I have not had opportunity to learn. Judging from conditions on the Copper Peninsula, some sixty miles south of Isle Royale, there may be some western ragweed, but the island well deserves a reputation as the best ragweed refuge in the State of Michigan or in any of the states bordering the Great Lakes. It is probably better than any other National Park east of the Rocky Mountains, with the possible exception of Everglades National Park.

King's Canyon National Park, California.—Field survey made October, 1946. Because of the proximity of this park to Sequoia National Park and because of a scarcity of weeds and grasses in the two areas, it did not seem necessary to make atmospheric tests in King's Canyon. There are more willows, oaks, and incense cedars in King's River Canyon than in the Giant Forest area, but these trees shed pollen at a time when visitors are few. No important hay fever weeds were seen and no appreciable acreage of grasses. It may be safely assumed that this park is entitled to a ragweed rating fully as good as that of Sequoia. It is unlikely that there could be any allergic difficulty from pollen of any sort during the summer or fall. (See Sequoia National Park).

Lake Mead National Recreational Area, Nevada (adjacent to Boulder Dam).—Field survey made September, 1947. Atmospheric tests were made March 26 to October 31, 1947, at the ranger station in the public camp adjacent to Lake Mead Lodge, altitude 1,000 feet. April seems to be the most important pollen month at Lake Mead, although there may be small amounts of pollen from willow, groundsel (*Baccharis emoryi*), or arrowwood (*Pluchea sericea*) in January and February. Creosote bush (*Larrea tridentata*), the grasses and even the shrubby perennial form of false ragweed (*Franseria dumosa*) come

to bloom in the spring. If only the fall ragweed found in this study were considered, the ragweed index would be only 0.25 instead of 4. This is the only National Park where ragweed has occurred in appreciable amounts in the spring months. Pollen-sensitive visitors from the eastern and central parts of the United States should encounter very little difficulty from either grass or ragweed pollen, but those from Arizona and southern California may in some cases find conditions little, if any, better than at home.

Summary of slide counts:

	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEP- TEMBER	OC- TOBER	TOTAL
Creosote bush	161	435	0	0	0	0	0	0	596
Ragweed	49	244	43	15	0	2	32	4	389
Composite	2	5	4	0	0	0	2	2	15
Ephedra	4	10	3	0	0	0	0	0	17
Chenopod	0	12	32	14	2	15	28	1	104
Grass	0	240	116	22	8	0	9	1	396
Oak	0	22	13	1	0	0	0	0	36
Plantain	0	11	0	0	2	1	3	0	17
Cedar	0	25	6	3	0	0	0	0	34
Sedge	0	0	0	0	1	0	0	0	1
Sagebrush	0	0	0	0	0	1	38	4	43
Nettle	0	0	0	0	0	5	0	0	5
Miscellaneous	0	27	58	24	3	3	2	13	130

Lassen Volcanic National Park, California.—Field survey made August, 1947. Atmospheric tests were made July, August, and September, 1947, at Park Headquarters (top of seismograph shelter). The dominant vegetation of the park consists of coniferous trees, of which the only active species is incense cedar (*Libocedrus decurrens*) which flowers at a time when there are few, if any, visitors. Bluegrass, timothy, redtop, and other cultivated grasses are plentiful just outside the south edge of the park, but very little acreage within the park is devoted to grasses. No ragweeds, except a trace of cocklebur, were found, nor any sagebrush. However, sagebrush is abundant not far from the north and east boundaries of the park. The total count on all fall pollens proves this park to be a practically perfect refuge for ragweed hay fever victims. The figures follow: ragweed 3, grass 8, chenopod 2, composite 6, plantain 2, sagebrush 18, miscellaneous 6.

Mammoth Cave National Park, Kentucky.—While an examination of the local hay fever flora was made by the writer during the fall of 1934, it was not deemed worth while to carry out atmospheric studies. The flora of the region is not essentially different from that of central Kentucky and Tennessee where ragweeds are particularly abundant and where there is the usual exposure to grass and tree pollens. The index figure for this park is an estimate based on findings in the nearest points where atmospheric tests have been made.

Mesa Verde National Park, Colorado.—Field survey made September, 1947. Atmospheric tests were made June to September, 1948, at Park Headquarters weather station, altitude 6,930 feet. The mesa in the vicinity of the Headquarters building, lodge, and public camp supports an almost pure stand of juniper (*Juniperus utahensis*), frequently referred to as cedar. Oaks are abundant on the sides of the canyons. Various wild grasses and meadow grasses

are present but in very limited amounts. Shadscale (*Atriplex canescens*), sagebrush (*Artemisia tridentata*), and related Artemisias are the only local potential sources of hay fever pollen during the summer and fall. No ragweeds of any kind grow on the mesa. In the desert areas south and west of the park, also in virgin soil on the hills north and eastward, sagebrush is the dominant wind-pollinated plant. In the farmland near the north edge of the park, Russian thistle, Mexican fireweed (*Kochia scoparia*), and *Bassia hirsuta* are common. No active pollen appeared in sufficient quantities to be a menace to summer and fall visitors to this park, although some difficulty might be experienced in approaching the area from any of the three possible directions.

Summary of slide counts:

	JUNE	JULY	AUGUST	SEPTEMBER	TOTAL
Oak	6	0	0	0	6
Cedar	19	0	4	7	30
Wood rush	2	0	0	0	2
Grass	8	2	8	13	31
Russian thistle	8	24	37	6	75
Other chenopods	24	14	16	13	67
Composite	2	0	0	15	17
Sagebrush	0	0	3	74	77
Ragweed	0	11	14	72	97
Miscellaneous	4	4	0	2	10

Mt. McKinley National Park, Alaska.—No local examination of hay fever flora or atmospheric tests have been made within the borders of Mt. McKinley National Park. However, daily atmospheric tests were made through July, August, and September, 1939, at Fairbanks. No ragweed pollen was found on any of the slides nor was any appreciable amount of grass pollen found. Quite likely this park and its environs offer the best refuge from all types of aeroallergens of any of our National Parks.

Mt. Rainier National Park, Washington.—Field survey made August, 1947. Atmospheric tests were made July to September, inclusive, at Park Headquarters (Longmire), altitude 2,761 feet, Paradise ranger station, altitude 5,557 feet, and White River ranger station (Ohanapecosh), altitude 3,500 feet. Western red cedar and mountain juniper are possible sources of allergenic pollen during the latter part of the winter sports season. Alder, black cottonwood, and willow are potential but very unlikely sources of irritation. Around the camp areas it is not difficult to find plenty of specimens of timothy, velvet grass, and orchard grass. Mountain timothy (*Phleum alpinum*) is common in mountain meadows. Special attention was given to the distribution of English plantain which is regarded by allergists of the Pacific Northwest as the most important wind-pollinated weed of the area. This plant is present along roadsides at lower altitudes in the park but not abundant anywhere. No ragweeds of any kind were seen either in the park or in the surrounding areas. The Longmire zero record for ragweed is the only perfect record for any point where tests have been made in any of the National Parks. It is very difficult to account for the traces of ragweed pollen at the other two locations on Mt. Rainier.

Total figures are as follows:

	LONGMIRE	PARADISE	WHITE RIVER
Ragweed	0	12	4
Chenopod	2	7	0
Grass	929	45	3
Sage	1	2	0
Plantain	22	15	2
Sedge	0	55	0
Red sorrel	5	0	0
Miscellaneous	2	3	0

Olympic National Park, Washington.—Field survey made August, 1947. Atmospheric tests were made: July, August, and September, 1947, and July, 1948, at Elwha Station, altitude 50 feet; August and September, 1948, at Headquarters, altitude 50 feet; and July and August, 1948, at Hurricane Ridge, altitude 5,751 feet. The Olympic Peninsula is heavily wooded but the only possible offenders in the whole conifer list are western red cedar (*Thuja plicata*), Alaskan yellow cedar (*Chamaecyparis nootkatensis*), and two species of juniper. While these trees are abundant throughout the Pacific Northwest, their pollens are disregarded by allergists of the area. Thus, for purposes of this study, it may be assumed that they are inoffensive. Alder is the only potential source of allergenic pollen among the broad-leaved trees. Grasses are abundant in all open areas and English plantain wherever any cultivation has been carried on. English plantain is common in all waste places at Port Angeles, as well as at Park Headquarters and the Elwha Ranger Station. No ragweeds of any kind were seen within the boundaries of the park. A few scattered specimens of a species of false ragweed, known as beach bur (*Franseria bipinnatifida*), grow in the sand along the shore at Port Angeles. They are probably present elsewhere along the shore line of the Olympic Peninsula. Two species of sage, or wormwood, *Artemisia absinthium* and *Artemisia heterophylla*, are present along the shore in the same situations as bur ragweed. Neither the wormwoods nor the ragweeds are abundant enough to contaminate the air for more than a few yards along the beach. The season of grass pollination at Headquarters and Elwha is June and early July, on Hurricane Ridge, August. English plantain sheds pollen from early June until the second week of September.

Summary of slide counts:

	ELWHA 1947	ELWHA AND HEADQUARTERS 1948	HURRICANE RIDGE 1948
Cedar	6	10	0
Grass	37	1,426	944
English plantain	1,149	1,343	0
Sedge	0	0	54
Red sorrel	0	11	0
Chenopod	12	0	10
Sagebrush	0	2	4
Composite	4	4	88*
Ragweed	4	7	7
Miscellaneous	8	70	34

*86 of these on one single slide.

Platt National Park, Oklahoma.—While no survey work has been carried on within the borders of Platt National Park, the area is surrounded by farming country where hay fever weeds and grasses are abundant. The index figure given in the tabulation is an estimate based on atmospheric records for cities in central and southern Oklahoma and northern Texas. The park should be avoided by ragweed-sensitive persons during the months of August, September, and October.

Rocky Mountain National Park, Colorado.—Field surveys made September, 1944, and September, 1947. Atmospheric tests were made July to September, inclusive, 1944, at Park Headquarters in Estes Park village, altitude 8,000 feet, and at Grand Lake, altitude 8,000 feet. The summer and fall weeds of city vacant lots and of western farms do not grow in the park, although a few stray specimens of almost any of them may be found just outside the park in the villages of Estes Park and Allenspark. Existing records⁴ for Grand Lake show a complete absence of Russian thistle and of ragweed of any species. At Lyons, altitude 5,300 feet, sixteen miles east of the park, and thence eastward to the prairies of eastern Colorado, hay fever weeds are abundant, including Russian thistle, Mexican fireweed, short ragweed, giant ragweed, western ragweed, false ragweed, and burweed marsh elder. The only important hay fever menace within the park and in the resort village of Estes Park is sagebrush and related *Artemisias*. Sagebrush is said to be extremely common at Grand Lake. While the ragweed record is excellent for both Estes Park and Grand Lake, it must be remembered that sagebrush is a closely related species and that there is likely to be some irritation to ragweed victims on close exposure to the latter. Monthly totals of all summer and fall pollens are tabulated:

	JULY		AUGUST		SEPTEMBER		TOTAL	
	ESTES PARK	GRAND LAKE	ESTES PARK	GRAND LAKE	ESTES PARK	GRAND LAKE	ESTES PARK	GRAND LAKE
Wood rush	12	2	0	0	0	0	12	2
Maple	4	1	0	0	0	0	4	1
Ragweed	5	1	55	15	89	4	149	20
Chenopod	28	11	60	10	25	1	113	22
Grass	55	16	78	81	6	0	140	97
Sagebrush	0	0	188	45	164	71	352	116
Composite	1	0	7	1	12	2	20	3
Miscellaneous	57	15	15	7	4	0	76	22

Sequoia National Park, California.—Field survey made October, 1946. Atmospheric tests were made July to September, inclusive, 1947, at Park Headquarters, altitude 6,412 feet. The role of sequoia pollen as an allergen has not yet been assessed. It seems to be closely related morphologically to the pollens of mountain cedar and incense cedar, both of which are active. Air sampling was not begun until long after the sequoias had pollinated. Judging by the Yosemite records it would seem that the season occurs in March and April. No important weeds of any kind and very few grasses were found in the Giant Forest area. Only three ragweed pollen grains were caught in three months. Ragweed hay fever victims can be assured of complete relief in this park. Totals of all pollens for the three-month period were: sequoia 15, plantain 3, grass 15, chenopod 21, ragweed 3, composite 5, sagebrush 7, miscellaneous 21.

Shenandoah National Park, Virginia.—Field survey made autumn, 1939. Atmospheric tests were made June to September, inclusive, 1948, at Park Headquarters, altitude 1,120 feet, and at Big Meadows, altitude 3,550 feet. This park doubtless has a large volume of a good variety of tree pollens—elm, oak, alder, ash, and hickory. The acreage of ragweed is limited within the park, but in Shenandoah Valley, both short and giant ragweed are common. Summarized monthly totals show that grass, English plantain, and ragweed are the three significant pollens. Red sorrel is abundant enough at Big Meadows to be of some importance if it were an active pollen, which it is not. Some persons might find some relief from ragweed exposure at Big Meadows, certainly not at Headquarters. There might be seasons when the count would run even lower than here shown but it is just as likely that it would go higher. Monthly totals of all summer and fall pollens are tabulated:

	JUNE		JULY		AUGUST		SEPTEMBER		TOTAL	
	HEADQUARTERS	BIG MEADOWS								
Grass	198	324	30	1,522	66	2	61	4	355	1,852
English plantain	265	34	367	25	23	3	4	1	659	63
Red sorrel	52	297	0	226	0	0	0	0	52	523
Chenopod-Amaranth	2	0	0	0	2	1	6	1	10	2
Ragweed	0	3	11	7	1,358	354	797	283	2,165	637
Sage (wormwood)	0	0	0	0	2	2	3	0	5	2
Composite	0	0	0	8	43*	0	40*	26	83	34
Miscellaneous	0	0	0	20	1	14	0	4	1	38

*Single clump.

Wind Cave National Park, South Dakota.—If conditions at this National Park may be judged by findings at Rapid City, ragweed and Russian thistle are both active factors, possibly sagebrush also.

Yellowstone National Park, Wyoming.—Field surveys made August, 1940, and September, 1947. Atmospheric tests were made June to September, inclusive, 1940 and 1941, at the U. S. Weather Bureau station at Mammoth, altitude 6,387 feet, and August 1 to September 9, 1945, at West Yellowstone village, altitude 6,665 feet. Aspens and cottonwoods are the only common broad-leaved trees in the park. Their pollen matures early and is rarely active, so it need hardly be considered as a potential factor in allergy in this park. Since there is no cultivated land within the park, there is very little opportunity for the growth of weeds or meadow grasses. The only area where meadow grasses are at all frequent is in the immediate vicinity of Mammoth. Only traces of poverty weed (*Iva axillaris*) and burweed marsh elder (*Iva xanthifolia*) have been seen within the park boundaries. No other species of ragweed has been reported. While fourteen species of wormwood (*Artemisia*) are listed for the park, none of them approach the abundance of sagebrush (*Artemisia tridentata*), which, aside from the grasses, is the only important source of hay fever pollen in the area. However, ragweed victims visiting Yellowstone during

the summer and fall rarely experience any symptoms unless they deliberately expose themselves to sagebrush by hiking among the sagebrush plants. Total figures for all types of pollen follow:

	MAMMOTH JUNE-SEPTEMBER 1940 AND 1944	WEST YELLOWSTONE (MONTANA) AUGUST, SEPTEMBER 1945
	AVERAGE TOTAL	TOTAL
Ragweed	20	24
Grass	402	45
Russian thistle	58	23
Sagebrush	208	28
Composite	6	23
Miscellaneous	30	13

Yosemite National Park, California.—Field survey made October, 1946. Atmospheric tests were made from early December, 1946, until December, 1947, at Park Headquarters in Yosemite Valley, altitude 4,000 feet. At the time of my field survey I was informed that numerous residents and a few winter visitors to the park suffer severely with hay fever during December, January, and February. These persons have attributed their difficulty to the pollen of California incense cedar (*Libocedrus decurrens*). Their suspicions have been confirmed in a number of cases by skin tests which resulted in positive reactions to incense cedar pollen. The catch of this pollen was not as large as would be expected from the number of trees in the valley floor. The season of pollination may differ from year to year. This time there were very few cedar pollens before the first of January. The large amount of oak pollen recovered in the tests is doubtless due to the location of the instrument with respect to oak trees. The same can be said about the catch of 135 granules of sage (*Artemisia*) pollen. In fact, all the figures must be regarded as showing conditions only in the immediate vicinity of the exposure device. Since the wind velocity in the valley floor is very low, much of the pollen produced from all species must fall directly to the ground. The ragweed rating for Yosemite is excellent and it is hardly likely that enough sagebrush pollen could be contacted anywhere in the park to give ragweed victims more than an occasional reminder of their difficulty. Total figures follow:

POLLEN	TIME	TOTAL
Incense cedar	December-February	368
Sequoia	March-April	9
Alder	January-February	317
Oak	March-May	3,273
Maple	April-May	31
Sedge	June-July	8
Grass	June-August	34
Plantain	December-January	2
Chenopod	April-August	12
Ragweed	July-October	50
Composite	irregular	54
Sage	July	135
Miscellaneous	irregular	107

Zion National Park, Utah.—Field survey made September, 1947. Atmospheric tests were made from early spring to the end of October in the vicinity of Park Headquarters, 1947 and 1948, altitude 4,048 feet. The tests were repeated in 1948 because of the excessive amounts of *Atriplex* (chenopod family) pollen found on the 1947 slides. The testing apparatus had been set up within a few yards of numerous *Atriplex* bushes. The exposure device was moved to the Headquarters building and the catch of chenopod pollen was reduced in 1948 to 13 per cent of the 1947 figure. Pollens of the broad-leaved trees listed in the appended table, as well as of Utah juniper, are possible though probably rare causes of inhalant allergy, each in its particular season of pollination. Grass pollens are not abundant enough to be of more than academic interest. Desert shrubs are plentiful in the Virgin River Valley south of the park and well up into Zion Canyon. Most of these are shadscale (*Atriplex canescens*) and sagebrush (*Artemisia tridentata*). Dragon sage (*Artemisia dracunculoides*) appears in scattered clumps along the river in the canyon. Creosote bush (*Larrea tridentata*), rabbit brush (*Chrysothamnus mohavensis*), and water willow (*Baccharis emoryi*) are insect-pollinated but are possible sources of difficulty on close exposure.

Western ragweed (*Ambrosia psilostachya*) is the only ragweed in the official list⁵ of plants of Zion National Park. I found small amounts of false ragweed (*Franseria acanthicarpa*) from the south entrance of the park to St. George, Utah, some thirty miles down the Virgin River, mostly in cultivated land. Several shrubby species of false ragweed, particularly *Franseria dumosa*, shed pollen in the deserts of Arizona and southern Nevada during March, April, and May, but none of these plants were noted in the vicinity of the National Parks of southern Utah. Thus the geographic source of the spring ragweed pollen found in Bryce and Zion is uncertain. It is unlikely that ragweed sufferers will have any difficulty either in spring or fall unless they deliberately expose themselves in brushy areas off the highways.

Total figures for all types of pollen follow:

	1947	1948	SEASON
Juniper	150	7,700	March-May
Maple	68	33	March-May
Poplar	46	210	March-April
Willow	108	99	March-April
Ash	136	94	March-April
Oak	592	682	April-June
Grass	93	74	April-May
Chenopod*	1,047	148	May-September
Ragweed	56	169	March-April, July-September
Sage	98	104	September-October
Composite	33	298	September-October
Miscellaneous	73	101	

*Mostly shadscale (*Atriplex canescens*).

SUMMARY

Everglades and Isle Royale National Parks are the only ones east of the Rocky Mountains that can be recommended as refuges from ragweed pollen. Glacier National Park is a somewhat better ragweed refuge than the Colorado,

RAGWEED POLLEN INDEX⁶ FOR NATIONAL PARKS AND RECREATIONAL AREAS
 Revised January, 1949

NATIONAL PARK	DAYS OF HIGH INCIDENCE	MAXIMUM ATMOSPHERIC CONCENTRATION	AVERAGE SEASONAL TOTAL	RAGWEED POLLEN INDEX
Hawaii*	-	-	-	0.00
Mount McKinley*	-	-	-	0.00
Sequoia	0	2	3	0.03
King's Canyon*	-	-	-	0.03
Lassen Volcanic	0	2	3	0.032
Olympic				
Headquarters	0	4	7	0.09
Hurricane Ridge	0	4	7	0.09
Mount Rainier				
Longmire	0	0	0	0.00
Paradise	0	6	12	0.12
White River	0	2	4	0.036
Crater Lake	0	4	7	0.072
Glacier				
Belton	0	5	11	0.10
Many Glacier	0	2	9	0.07
Grand Teton	0	4	14	0.11
Grand Canyon				
South Rim	0	4	16	0.12
North Rim	0	5	20	0.15
Yellowstone				
Mammoth	0	6	20	0.16
West Yellowstone*	0	4	24	0.16
Sun Valley	0	15	20	0.25
Yosemite	0	4	50	0.29
Mesa Verde	0	9	97	0.52
Zion	0	14	112	0.68
Bryce Canyon	0	14	148	0.88
Rocky Mountain				
Estes Park	0	15	149	1.00
Grand Lake	0	8	19	0.18
Everglades*	-	-	-	1.00
Isle Royale	1	48	133	2.00
Lake Mead National Recreation Area	2	54	389	4.00
Acadia	5	76	426	8.00
Great Smoky Mountains				
Headquarters	9	79	582	13.00
Newfound Gap	3	32	206	4.00
Black Hills Area*	-	-	-	15.00
Shenandoah				
Headquarters	22	202	2,165	35.00
Big Meadows	7	94	638	10.00
Hot Springs*	-	-	-	38.00
Platt*	-	-	-	75.00
Mammoth Cave*	-	-	-	80.00

*Index figure based on incomplete or interpolated data.

Utah, and Arizona parks because of the presence of sagebrush in and near the latter. The California, Oregon, and Washington parks, and quite likely those in Hawaii and Alaska, are almost if not entirely free from air-borne ragweed and sagebrush pollens. (See accompanying revised index). Grass pollens are likely to be encountered in small amounts in the tourist frequented areas of all of the parks of the West and in larger quantities in the parks of the central and eastern states. Neither Russian thistle, chenopod, or other amaranth pollens were found in appreciable amounts in any park except Zion where at one counting station a considerable amount of shadscale (*Atriplex canescens*) pollen was found. English plantain was recorded in appreciable amount only in the lower altitudes of Olympic National Park (not in the mountains). Incense cedar is a winter problem in Yosemite National Park. Various species of juniper are potential winter and early spring factors in the parks of the Southwest. Pollens of the broad-leaved trees are abundant during the early spring in all parks east of the 100th meridian.

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