

ALLERGY TO THE POLLEN OF THE COMMON SUGAR BEET (*BETA VULGARIS*)

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IT IS well known that pollens produced by a few members of the *Chenopodiaceae* and by most members of the related *Amaranthaceae* are significantly antigenic. The pollens of *Salsola kali* (Russian thistle), *Kochia scoparia* (burning bush), and the several species of *Amaranthus* (pigweed) are particularly bothersome, and the distribution of these plants is quite widespread. Other species, such as the many *Atriplexes* (saltbushes), *Sarcobatus vermiculatus* (greasewood), *Allenrolfea* (iodine bush or pickleweed), *Suaeda* (inkweed or sea blite), and *Bassia hyssopifolia* (smotherweed), produce pollens which probably are clinically antigenic in certain instances.

The prevailing concept of the antigenic relationship of the various species of the chenopod and amaranth families was stated recently by Wodehouse¹: "It has long been known that the pollens of the various species of these two families cross-react to a large extent, showing a high degree of antigenic similarity both within the family and across the family boundaries." Wodehouse's recent antigenic analyses with gel diffusion techniques indicate, however, that there is a remarkable degree of heterogeneity within the *Chenopodiaceae* and that the antigens of the *Amaranthaceae* are probably identical for each of the several members of that family.

The common sugar beet (Fig. 1), *Beta vulgaris*, is a member of the *Chenopodiaceae*. It belongs to the subtribe *Beteae* and to the tribe *Cyclolobeae*.² Horticultural varieties of *Beta vulgaris* include the sugar beet, garden beet, fodder beet, and chard or foliage beet (spinach beet). In locations where it is cultivated strictly for the production of the vegetative sugar-containing beet, it has no antigenic significance, since the plant does not pollinate. In certain areas of the United States, however, the plant is grown entirely for the purpose of seed production, and the pollens produced there should be capable of sensitizing a certain number of persons.

Allergy to the pollen of the sugar beet was first reported by Dutton³ in 1938. Small acreages of the plant had been grown experimentally in the Mesilla Valley of New Mexico and Texas for several years prior to her report. The plant was grown in abundance in 1935, as a result of which large quantities of sugar-beet pollen became airborne in the spring of 1936. During the ensuing two years, Dutton observed approximately 100 patients with respiratory allergy which seemed clearly due to the pollen of *Beta vulgaris* and with positive skin tests to that pollen. It was Dutton's feeling that, "the antigenicity of the pollen is maximal and that treatment is less successful than for the other pollens

Received for publication Oct. 13, 1958.

of this region." Cultivation of sugar beet for seed production was discontinued in the El Paso region in 1940; therefore, this pollen is no longer a problem in that area.⁴

In 1939, Phillips⁵ reported similar findings in the Phoenix area. Approximately 1,800 acres of sugar beets were planted in Phoenix in 1936, and by 1938 there were 5,500 acres, all of which went to seed. Apparently there were no reports of definite manifestations of clinical sensitivity to beet pollen in 1936 and 1937, but in 1938 there was a sharp increase in the number of hay fever sufferers at the time that *Beta vulgaris* was pollinating. Many positive skin test reactions to sugar beet pollen were found and there seemed to be a great deal of cross-reaction with pollens of other species of the *Chenopodiaceae*. Phillips found,

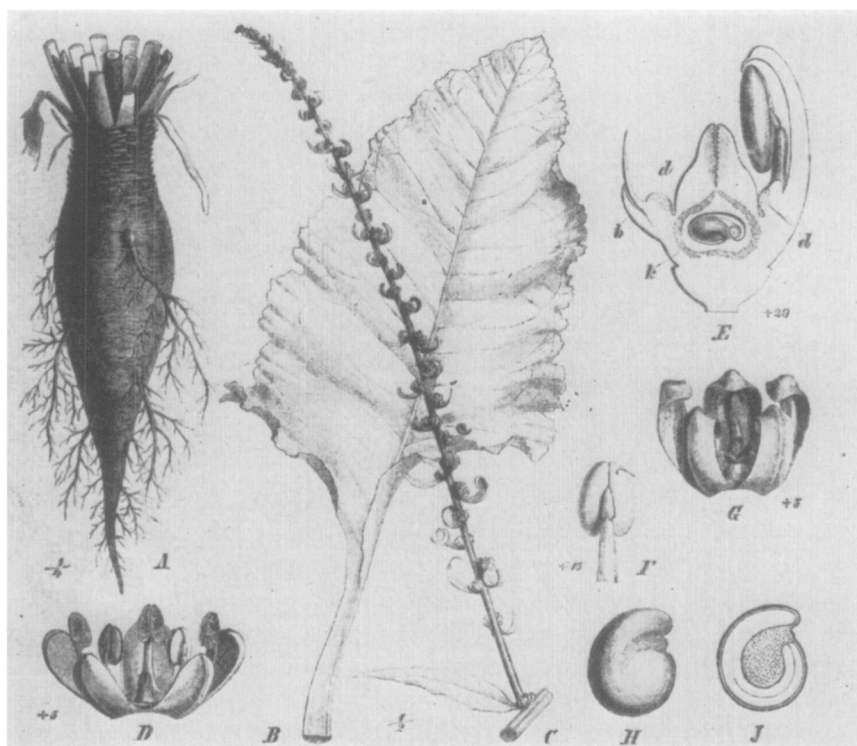


Fig. 1.—*Beta vulgaris* (common sugar beet). A, Root (sugar beet); B, leaf; C, part of the inflorescence; D, male flower; G, female flower. (From Engler-Prantl: *Natürliche Pflanzen-Familien*, 1894.)

however, that treatment directed "against the pollens of amaranth and Russian thistle did not provide a defense against sugar beet pollen." He concluded that "the sugar beet has, in addition to the group atopen common to the Chenopodiales, a highly potent specific atopen of its own." In a recent communication, Phillips⁶ recalled his earlier experiences: "When it first appeared in our local pollen picture, I collected it personally. Emerging from rows higher than my head, I would be covered from head to foot with the pollen." This presents a vivid description of the voluminous quantity of pollen produced at that time by the plants in that area.

Sugar beet was cultivated for seed in the Safford area of Arizona (southeast of Phoenix) in the 1930's^{7, 8} but its cultivation was discontinued, ostensibly because of the widespread protest about its allergenic qualities. Gatterdam⁷ cites as an example of the strenuous objection to sugar-beet pollen on the part of some residents the deliberate planting of "stock beet" near the commercial fields, in the hope of causing cross-pollination with the commercial sugar beet and thus producing an inferior seed. Apparently, the pollen continues to have clinical significance in the Phoenix area, causing difficulty particularly in the spring. Vivian⁸ feels that it is a very potent sensitizer, and he undertakes hyposensitization when indicated.

Sugar beet is grown commercially for seed production in numerous areas in the United States. These data in Table I show that the greatest acreage is in Arizona, which has approximately six times as much area under cultivation as Utah.

TABLE I

STATES	ACREAGE HARVESTED IN 1956	YIELD PER ACRE (POUNDS)
Arizona	2,061	2,760
California	674	3,233
Oregon	255	2,470
Utah	340	967
Other states	4	532

O'Toole⁹ has found the pollen of sugar beet grown in Arlington and Hemet, California, to be as toxic as English walnut and olive. He is "continually surprised at the frequency of clinically significant skin tests to sugar beet in these areas, and in many instances this is the only pollen to which patients react." O'Toole has approximately sixty patients under treatment for allergy to sugar-beet pollen, which is comparable to the figure given by Phillips.⁵

Sugar beet is grown for seed production in appreciable amounts in Europe, particularly in Holland, England, Sweden, and Germany. Owen^{*10} kindly communicated with four sugar-beet-plant investigators in England, Holland, and Sweden to inquire about the general frequency of allergy to sugar-beet pollen in those countries. These investigators, some of whom have had as much as twenty years' experience in the cultivation of *Beta vulgaris*, cited only five known instances of allergic rhinitis clearly due to sugar-beet pollen among the many persons constantly working closely with the plants. Two of these instances occurred in Sweden, two in Holland, and one in England. While these informal reports bear no statistical significance, and we have not obtained opinions from allergists in those countries, one is tempted to infer that sensitization to the pollen of *Beta vulgaris* probably is less common in England, Holland, and Sweden than in Phoenix, Arizona, or in the Hemet-Arlington region of California.

Reports received by Owen from sugar-plant investigators in this country indicate, in a most general way, that allergy to sugar-beet pollen is not prevalent in the beet-seed-producing areas of Salem, Oregon; East Lansing, Michigan; and

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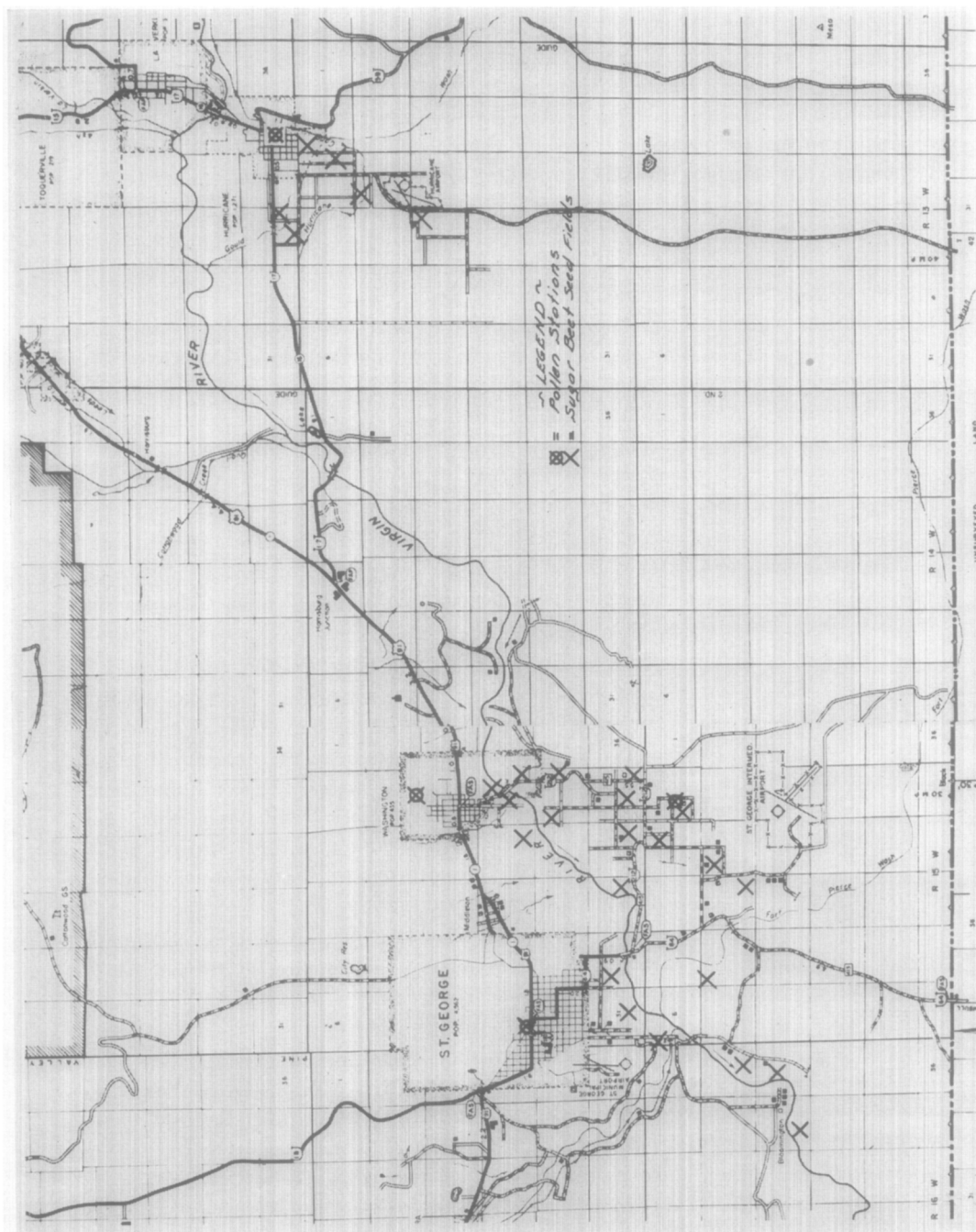
Rocky Ford, Colorado. Other reports to Owen from investigators at Beltsville, Maryland, and Phoenix, Arizona, indicate, however, that such allergy is not uncommon in those two areas.

H. Savitsky of the Sugar Beet Experimental Station, Salt Lake City, Utah (formerly of Kiev, Russia), has been an active sugar-plant investigator for thirty years. It is interesting that she had not heard of a single instance of allergic rhinitis or asthma caused by sugar-beet pollen in Russia, Poland, or Germany; nor had she, herself, experienced any such symptoms prior to 1955. She has been in intimate contact with pollen at Salt Lake City since 1948, but it is only since 1955 that she has had classical allergic rhinitis symptoms when near the pollinating plants. A few other investigators in the local Sugar Beet Experimental Station, including Owen himself, have become allergic to the plant and repeatedly have typical nasal symptoms when working closely with the pollinating sugar-beet plants. It is not known whether soil or other differences in such widely separated locations can account for significant variation in the antigenicity of the plant. Cooke¹¹ doubts that it is possible to alter the chemistry of pollen appreciably with respect to its antigenicity as a result of different chemical compositions of the soil. Lowell¹² is also skeptical as to the possible effect of geographic location on the antigenicity of plant products.

Hampton¹³ agrees essentially with Cooke and Lowell. He feels, however, that investigation in this field is warranted and suggests doing neutralization in passive transfer with whole extracts of beet pollen obtained from different soils, using a single sensitive serum.

Production of sugar-beet seed in Utah is largely limited to the extreme southwestern corner of the state and extends into southeastern Nevada. Cultivation of sugar-beet plants for seed was begun in that area in 1931, at which time only six acres were planted in the Washington fields near St. George. The total yearly average since 1935 has been approximately 500 acres, but this has varied considerably from year to year. While there are many localities in other parts of Utah and in Idaho where the plant is cultivated strictly for the production and harvest of the sugar beet itself, the climate of the southwestern corner of the state has been most favorable for seed production.

In the Utah and Nevada areas the beet seed is planted early in September, and the plants usually attain a height of only 5 to 7 inches before frost. The following spring the plants produce seed stalks that attain a height of 5 to 7 feet by early summer. Prior to 1956, the pollination of the plants in late May or early June invariably filled the air with a sickening-sweet smell that could be detected for long distances. Since 1956 most of the varieties grown have been commercial hybrids. For production of these hybrids, approximately 95 per cent of the plants are male sterile monogerm beets that produce no pollen. About 5 per cent of the plants are pollinators, which produce sufficient pollen to fertilize the male steriles. This cross-fertilization produces a vigorous hybrid variety. The seed is usually threshed in August and is cleaned in September and October. Crop rotation is practiced, and a given field is used for beet-seed production no oftener than once every five years.



In 1955 the curiosity of one of us (G. A. P.) was aroused by frequent reports of respiratory allergy due to sugar-beet pollen in the St. George area. This motivated the establishment of three pollen-counting stations in May and June, 1955, in and near St. George and Washington, Utah, as shown in Fig. 2. United States Weather Bureau wind data for southwestern Utah were studied, and the stations were situated to reflect the volume of sugar-beet pollen blown on St. George and surrounding areas. The sugar-beet field station was placed on a fence immediately adjoining a vigorous acreage of sugar-beet plants in the Washington Fields section near St. George. A station was placed on the roof of a tall building in St. George to measure the amount of pollen blown into the town itself. The station in Washington, Utah, was approximately 7 miles downwind from the Washington Fields. Table II shows the pollen counts (in grains per cubic yard of air) from May 19 through June 13, 1955. It would seem that relatively little pollen was carried over the town of St. George, although there was somewhat more effective dispersal of the pollen downwind to Washington, Utah.

TABLE II. SUGAR-BEET POLLEN COUNTS (IN CUBIC YARDS OF AIR), 1955

DATE	ST. GEORGE	SUGAR BEET FIELD	WASHINGTON
May 19	0	301	0
May 20	0	29	3
May 21	0	128	3
May 22	0	44	5
May 23	0	61	3
May 24	5	--	0
May 25	0	82	3
May 26	5	668	3
May 27	0	216	0
May 28	0	1,328	2
May 29	0	1,054	2
May 30	0	1,447	9
June 1	0	541	0
June 2	2	425	0
June 3	3	7	2
June 4	12	75	0
June 5	41	190	0
June 6	0	187	0
June 7	0	31	0
June 8	0	17	0
June 9	0	85	0
June 10	2	583	0
June 11	3	71	0
June 12	0	182	0
June 13	0	54	3

In 1956 one of us (G. A. P.) became interested in sampling public opinion concerning allergy to sugar-beet pollen in a small community in southwestern Utah. Questionnaires were distributed to every family in Hurricane, Utah, a town of 1,271 persons, located 18 miles northeast of St. George in the sugar-plant region. A high percentage of the families in Hurricane are, or have previously been, concerned with the cultivation of sugar-beet seed. Completed questionnaires were returned by 919 persons, representing 228 families. Twenty-four per cent of these persons indicated that they have a major allergy. If the

answers given in the questionnaires were reasonably accurate, we must conclude that the incidence of allergy in this southwestern Utah community is somewhat higher than the national average. Twenty per cent of these persons limited their symptoms to the respiratory tract, while 12.6 per cent blamed sugar-beet pollen for part or all of their trouble. Fifty-one of the 181 persons (28 per cent) complaining of respiratory tract allergy incriminated sugar-beet pollen as the sole cause of their trouble. From the layman's standpoint, then, it would seem that sugar-beet pollen in southwestern Utah is suspected of causing more than its share of allergic rhinitis and asthma.

TABLE III. RESULTS OF SKIN TESTING IN THIRTY-NINE PATIENTS WHO GAVE HISTORY OF ALLERGY TO SUGAR-BEET POLLEN

SUGAR BEET	WINGSCALE	PIGWEEED	RUSSIAN THISTLE
+	-	-	-
+	+	+	+
+	-	+	+
+	-	+	+
+	+	+	+
+	-	+	+
-	-	-	-
-	-	+	-
-	-	-	-
-	-	+	+
-	-	-	+
+	+	+	+
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-	+	+	+
-	+	+	+
-	-	-	+
-	-	+	-
+	+	+	+
+	+	-	-
-	-	-	+
-	-	-	+
-	-	+	+
-	-	-	-
+	-	+	-

It would have been completely impractical to attempt to skin test each of the 1,271 inhabitants of Hurricane, Utah. It was felt, however, that a cross section of that population might be tested to some advantage, and on Jan. 19, 1957, one of us (D. A. M.) skin-tested fifty-eight of the persons who had answered the questionnaire. Thirty-nine of these were selected because they

blamed their respiratory allergy entirely on sugar-beet pollen. Nineteen were selected as controls whose histories indicated no trouble from sugar-beet pollen, but definite respiratory allergy from other causes. We would have preferred a total of thirty-nine controls, but many who had previously agreed to be tested failed to appear. Each of the thirty-eight patients was tested intradermally to *Beta vulgaris*, *Atriplex canescens* (wingscale), *Amaranthus retroflexus* (rough pigweed), *Salsola kali* (Russian thistle), and a saline control. The *Beta vulgaris* pollen, obtained from a commercial laboratory, was collected in the vicinity of Rocky Ford, Colorado. Comparative data are presented in Tables III and IV.

TABLE IV. RESULTS OF SKIN TESTING IN NINETEEN PATIENTS WITH SEASONAL RESPIRATORY ALLERGY AND NEGATIVE HISTORY FOR ALLERGY TO SUGAR-BEET POLLEN

SUGAR BEET	WINGSCALE	PIGWEEED	RUSSIAN THISTLE
+	+	+	+
-	+	-	-
-	-	+	+
-	-	-	-
+	-	+	+
-	-	-	-
+	+	+	+
-	-	+	-
+	-	-	+
+	+	-	+
-	-	+	-
-	-	-	+
-	-	-	-
+	+	+	+
-	-	-	+
-	-	+	+
+	+	+	+
-	-	-	-
+	-	+	-
Control	-	-	-

In the group of thirty-nine patients who felt that sugar-beet pollen caused allergic symptoms, only nineteen (48 per cent) showed a positive reaction to *Beta vulgaris*. Fourteen (74 per cent) of the nineteen persons who showed such positive reactions to *Beta vulgaris* also reacted to Russian thistle, fifteen (79 per cent) reacted to pigweed, and nine (47 per cent) reacted to wingscale. Seven (35 per cent) of the twenty persons who showed negative reactions to sugar-beet pollen failed to react to each of the other test antigens.

In the group of nineteen controls who suffer from respiratory allergy but feel that they are not bothered by sugar-beet pollen, the following data are pertinent:

1. Eight (42 per cent) exhibited positive reactions to sugar-beet pollen.
2. Fifteen (79 per cent) exhibited positive reactions to one or another of the test antigens.
3. Each of the eight who showed positive reactions to sugar-beet pollen reacted to at least one of the other test antigens.

Considering the entire group of fifty-eight persons tested, it is apparent that eleven (19 per cent) failed to react to *any* of the chenopod-amaranth antigens. Probably the respiratory tract allergies in these thirty cases are caused by pollen antigens not used in this particular testing, such as grasses, English plantain, and others. Focusing attention upon the forty-seven persons who reacted to one or more of the chenopod-amaranth antigens, we find the following:

1. Twenty-seven (57 per cent) reacted to sugar-beet pollen.
2. Thirty-five (75 per cent) reacted to Russian thistle.
3. Thirty-three (70 per cent) reacted to pigweed.
4. Seventeen (36 per cent) reacted to wingscale.

These figures indicate that sugar-beet pollen has an average capability to sensitize, as compared with three related pollens. These data further indicate

TABLE V. POLLEN COUNTS (IN CUBIC YARDS OF AIR), HURRICANE, UTAH, 1957

DATE	SUGAR BEET	OTHER CHENOPODS	PECAN	GRASSES	PINE
June 1	0	0	10	13	0
June 2	0	0	3	3	1
June 3	0	0	7	5	1
June 4	0	0	2	11	1
June 5	2	0	0	5	1
June 6	0	0	1	5	0
June 7	9	0	0	2	1
June 8	0	0	0	0	0
June 9	2	0	0	0	0
June 10	0	2	0	2	0
June 11	3	9	1	2	0
June 12	2	2	0	3	2
June 13	0	3	1	2	0
June 14	3	2	0	2	2
June 15	2	2	0	2	0
June 16	0	3	0	5	1
June 17	0	0	0	2	2
June 18	2	2	0	3	1
June 19	10	5	0	11	9
June 20	0	0	0	0	0
June 21	0	2	0	0	0
June 22	2	2	0	0	3
June 23	0	3	0	0	2
June 24	0	2	0	0	3
June 25	2	7	0	0	12
June 26	2	3	0	0	4
June 27	0	0	0	0	3
June 28	2	0	0	0	1
June 29	3	5	0	5	0
June 30	0	0	0	0	1
July 1	0	0	0	0	0
July 2	3	2	0	3	9
July 3	5	3	0	0	6
July 4	0	0	0	2	4
July 5	0	0	0	0	2
July 6	0	0	0	0	0
July 7	0	2	0	2	0
July 8	0	7	0	6	2
July 9	0	0	0	3	0
July 10	0	3	0	0	0
July 11	0	2	0	0	0
July 12	0	0	0	0	2

that in many instances sugar-beet pollen in southwestern Utah is blamed for respiratory allergy symptoms which in all probability, are caused by other pollens.

While there is some indication that sugar-beet pollen is less antigenic in southwestern Utah than in Phoenix, Arizona,⁵ or in the vicinity of Riverside, California,⁹ there is not a good basis for comparison between our work and that of O'Toole, Phillips, and Dutton. The reports made by Phillips and Dutton referred to apparently high sensitization rate as well as to unusually severe symptoms. However, their studies were not oriented toward determining the approximate incidence of allergy to sugar-beet pollen. O'Toole's observations are made on patients seen in consultation for diagnosis and treatment; they point to considerable specificity in the antigenicity of *Beta vulgaris* and also indicate unusually severe symptoms from the pollen. Our observations, on the other hand, were made on a group of persons who were not our patients. This precluded detailed histories; hence, we knew almost nothing about the relative intensity of their symptoms. Our tests indicate, however, that in our series sugar-beet pollen was less antigenic than Russian thistle and probably was less antigenic than pigweed.

Pollen counts were instituted in Hurricane, Utah, beginning April 6, 1957, and continuing through the month of September, 1957. Pollen counts from June 1 through July 12, 1957, are summarized in Table V. The relatively low pollen counts for *Beta vulgaris* are partly the result of a small sugar-beet crop in that area in 1957, but principally they are due to the planting of male sterile hybrid beets in southwestern Utah during the past three growing seasons. The substitution of the male sterile monogerm hybrids probably reduces the amount of sugar-beet pollen to 5 per cent of the original figure encountered in 1955. With the change to production of the male sterile hybrids, it is quite likely that in future years there will be insufficient amounts of *Beta vulgaris* pollen in southwestern Utah to be of any particular antigenic significance.

SUMMARY AND CONCLUSIONS

1. A study has been made of allergy to sugar-beet pollen (*Beta vulgaris*) in southwestern Utah.
2. The entire town of Hurricane, Utah, in the sugar-beet-cultivation area, was surveyed by questionnaire. Answers to the questionnaire indicated that a large number of persons in that community incriminate sugar-beet pollen as the cause of respiratory allergy symptoms. Intradermal tests done in fifty-eight persons indicated, however, that in 52 per cent of the cases, sugar-beet pollen is blamed for symptoms which must be caused by other antigens.
3. The sugar-beet pollen used in our intradermal tests exhibited average sensitizing ability when compared with related pollens. Considerable cross reaction to the related pollens was exhibited.
4. Information obtained from a number of sugar-plant investigators indicates that allergy to sugar-beet pollen may be comparatively uncommon in

Europe and Russia. Whether this can be explained on the basis of a difference in antigenicity due to soil composition or other factors is unknown. Further investigation of this question may be warranted.

5. The amount of sugar-beet pollen in southwestern Utah has been greatly decreased since 1956 by the introduction of male sterile hybrids in which only 5 per cent of the plants in the seed fields produce pollen.

We wish to acknowledge the invaluable help given by Mr. O. C. Durham, Dr. W. P. Cottam, Dr. F. V. Owen, Dr. and Mrs. Clark McIntire, Mr. Gordon Clark, and Mrs. Willis Hall.

REFERENCES

1. Wodehouse, R. P.: Antigenic Analysis by Gel Diffusion. III. Pollens of the Amaranth-Chenopod Group, *Ann. Allergy* 15: 527, 1957.
2. Engler-Prantl: *Natürliche Pflanzen-Familien*, Leipzig, 1894, vol. 3, pp. 52-58.
3. Dutton, L. O.: Beet Pollen and Beet Seed Dust Causing Hay Fever and Asthma, *J. ALLERGY* 9: 607, 1938.
4. Don, R. L.: Personal Communication, 1956.
5. Phillips, E. W.: Time Required for the Production of Hay Fever by a Newly Encountered Pollen, Sugar Beet, *J. ALLERGY* 11: 28, 1939.
6. Phillips, E. W.: Personal Communication, 1956.
7. Gatterdam, E. A.: Personal Communication, 1953.
8. Vivian, C. W.: Personal Communication, 1955.
9. O'Toole, J. S.: Personal Communication, 1957.
10. Owen, F. V.: Personal Communication, 1957.
11. Cooke, R. A.: Personal Communication, 1957.
12. Lowell, F. C.: Personal Communication, 1957.
13. Hampton, S. F.: Personal Communication, 1957.

535 EAST FIRST SOUTH ST.