

officials recognized that the success of their allergenic products line was attributable largely to 1 person, Oren C. Durham. That success was a result of a unique combination of sales and enterprising scientific research. At the time of his death in 1967, Durham had authored, coauthored, or collaborated on more than 50 articles and 11 books in aeroallergen research. A member of the American Association for the Advancement of Science and the Sociedad Espanola de Allergia, an honorary member of the Société Française d'Allergie, and an affiliate member of the American Academy of Allergy, as well as an active participant in the Allergy Unit at the University of Illinois College of Medicine and a lecturer at the University of California School of Medicine, Durham, through meticulous research and organizational skill, did more than any other investigator to establish a sophisticated pollen surveillance network reaching across Canada, the United States, Mexico, Cuba, and Ecuador that has become an integral part of daily weather reporting and led to greater medical and public awareness of seasonal allergy and its causes. The comprehensiveness of the surveillance network he helped establish is clearly reflected in the 1955 book he coedited with Max Samter, *Regional Allergy of the United States, Canada, Mexico, and Cuba*.⁶

As Technical Chairman of the Pollen Survey Committee of the Research Council on Aeroallergens of the American Academy of Allergy from 1944 to 1960, and in cooperation with the Committee on Aerobiology of the National Research Council, Durham pioneered the development of a standardized technique and sampling device—the Durham Gravity Sampler—for obtaining accurate, reliable, and comparative data on pollen counts and indices for particular geographic regions within the United States. Beginning in the late 1940s, under the auspices of the Pollen and Mold Committee of the Research Council of the American Academy of Allergy and Abbott Laboratories, he compiled the popular booklet *Hay Fever Holiday* to help the person with allergy make summer travel plans. In the early 1950s, more than 10,000 copies were printed annually and distributed to physicians, motor clubs, travel agencies, pharmaceutical firms, air conditioning manufacturers, and the public.⁷ Durham also helped initiate the first instructional course on pollen and mold identification held in conjunction with the 1951 annual meeting of the American Academy of Allergy in New York. Because of the large physician demand for such information, a course on the identification and biology of fungi and pollen and on survey techniques was developed as part of the preannual Academy meeting postgraduate course offerings beginning in 1952. The success of the Pollen Survey Committee helped initiate further sections of the Research Council of the American Academy of Allergy, including the Council on Food Allergy, the Council on Contactants, and the

Council on Drug and Biologicals. Despite Durham's indefatigable efforts on behalf of the Academy, his lack of a medical degree or doctorate limited his status to that of an Affiliate Member. In 1963, the American Academy of Allergy found a way to honor Durham for his long-standing contributions to the Academy and the profession through the creation of its Distinguished Service Award, with Durham its first recipient.⁸

I thank Alice Holst for sharing unpublished papers of Oren Durham.

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A history of pollen mapping and surveillance: The relations between natural history and clinical allergy

In 1929, Oren C. Durham published in the founding issue of the *Journal of Allergy* the first national atmospheric pollen survey conducted in the United States. Through the cooperation of 28 physicians in 22 locations across the United States, Durham was able to discern the “outlines of a picture of the invisible pollen storm, which like a summer blizzard, fills the air of the eastern half of the United States each year with billions of toxic particles and lasts from twenty-five to fifty days.” Ragweed pollen was the specific toxic particle Durham had in mind. The national surveillance network of pollen sampling stations Durham helped establish became an integral part of the diagnostic and therapeutic methods of clinical allergy that persist to this day.¹

The picture of geographically and seasonally differentiated atmospheric pollen loads now integral to allergy clinics, daily weather reporting, and the antihistamine Web sites of pharmaceutical manufacturers reveals the extent to which allergy as a medical specialty has relied on the expertise and methods of

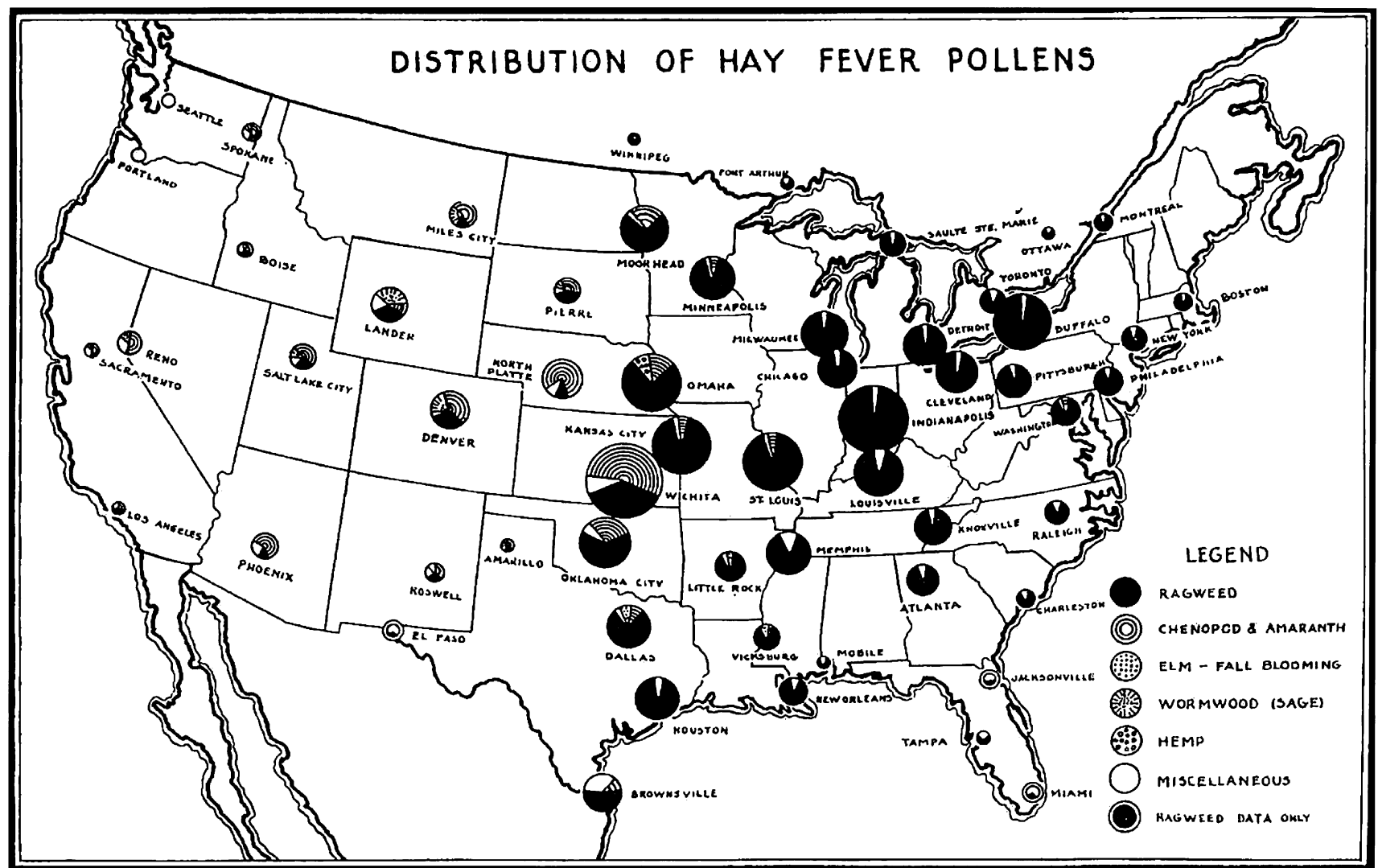


FIG 2. Durham's national pollen maps, like this one from 1935 produced in the *Journal of Allergy*, not only aided physicians in the regional diagnosis and treatment of allergy but also suggested how land use patterns were contributing to the prevalence of hay fever as a disease. Reprinted with permission.¹⁷

natural historical sciences such as plant ecology and systematics in its development.² Botanical knowledge was common among 19th century physicians, and it proved an asset in early studies of hay fever. In the United States, the precise onset in mid-August of a form of hay fever that the Boston physician Morrill Wyman described in 1872 as *autumnal catarrh* led him to suspect a vegetative origin for the watery eyes, flowing nose, sneezing fits, and attacks of asthma that developed with the “regularity of a previously calculated eclipse” among people with hay fever.³ More than 1 person with hay fever reported on the irritations provoked when walking along a road where Roman wormwood was present. *Ambrosia artemisiifolia*, more commonly known today as ragweed, flowered in the middle of August, grew abundantly in known hay fever regions, and was rarely present in the mountains, where relief was often found. Although Wyman refused to attribute the disease’s origin to ragweed, locating it instead in an individual predisposition to exciting causes that acted on the nervous system during particular seasons of the year, the maps of exempt and nonexempt regions of hay fever in the United States that Wyman drew on the basis of the accounts of people with hay fever pointed to the need for a more precise understanding of the geographical and seasonal factors that contributed to the disease.

The seminal 1873 treatise *Experimental Researches on the Nature and Causes of Catarrhus Aestivus (Hay Fever, or Hay-Asthma)*, written by the Manchester physician Charles H. Blackley, offered the first detailed studies documenting the relations between the presence of pollen in the atmosphere and the prevalence of hay fever symptoms. Blackley, who had hay fever, experimented with several instruments to sample the air for pollen, settling on a simple apparatus that consisted of 4 glass slides coated with a glycerine mixture, placed on a stage with a roof cover approximately 5 feet from the ground. The slides were exposed to the air over a 24-hour period, and the number of pollen grains per square centimeter was counted under a microscope on an almost daily basis from the early part of April until the first of August. To Blackley’s surprise, the greatest percentage of pollen collected belonged to the Gramineae, although he recognized that such results would vary by district: pollen loads were much less abundant in the town of Manchester than in the neighboring countryside, providing the reason hay fever symptoms seemed less severe while residing in the city. Indeed, Blackley’s focus on pollen content of the air in the spring and early summer months, in contrast with the initial focus on the fall season among American researchers, points to the importance of geographical differences in the understanding of allergy as a disease. Correlating his own recorded daily symptoms with the presence of pollen in the atmosphere, Blackley became convinced

of the “unmistakeable effect which seems to point to pollen as the most powerful if not the only cause of the malady.” Knowledge of the types and quantity of pollen in the atmosphere, Blackley argued, was important to the patient with hay fever. It enabled the person with hay fever to escape attacks by regulating “movements as to avoid certain districts,” but it was even “more important for a patient to know that his chance of escape will be much increased if it is shown that the pollen of one order of plants is the principal cause of his suffering.”⁴

In the late 19th century, as seasonal travel to exempt regions became the favored therapeutic treatment among middle-class and upper-class patients with hay fever, physicians and town boosters increasingly looked to scientific studies of the local atmosphere in promoting the benefits of particular resort towns hoping to attract the hay fever tourist trade.⁵ In Bethlehem, NH, the undisputed mecca of the annual hay fever pilgrimage in the United States, Samuel Lockwood, a New Jersey naturalist with hay fever, initiated in 1888 what he hoped would become a comprehensive scientific study of the hygiene of the atmosphere in exempt and nonexempt regions on behalf of the US Hay Fever Association. Enlisting the support of laymen, Lockwood gathered meteorologic records of temperature, wind velocity and direction, humidity, and barometric changes, along with microscopic analysis of atmospheric particles and experiences of patients under their local influence to arrive at “trustworthy” results “on the lines of comparative pathology.”⁶ After 3 consecutive seasons of scientific studies comparing the air around 3 White Mountain resorts to that of his nonexempt home in Freehold, NJ, Lockwood concluded that the tonic mountain air, coupled with the smaller quantity of vegetable matter and comparative absence of pollen in Bethlehem, went far in explaining the hygienic qualities of the White Mountains as a hay fever resort.⁷ Other places to the West, such as Petoskey and Mackinac Island in Michigan, Denver, and Colorado Springs, vied to attract wealthy people with hay fever and looked to atmospheric data to sell the therapeutic powers of place. In 1896, Denver’s Chamber of Commerce and Board of Trade invited the US Hay Fever Association to move their annual meeting to the “Queen City of the Plains,” a place known for its curative power over asthma, backed not only by individual testimonies but also by scientific studies on Colorado’s climate and health conducted by physician Charles Denison, president of the American Climatological Association.⁸

The introduction of immunotherapy in the 1910s was promoted as an alternative therapeutic treatment to escape to hay fever resorts, but it too only strengthened the need for more precise understanding of the regional, seasonal, and quantitative variability of plant pollens and their atmospheric distribution. When

Lederle Antitoxin Laboratories introduced its pollen vaccine in 1916, advertising to members of the US Hay Fever Association that for the “first time in years the possibility of remaining in town and at work” had become an option for people with hay fever, it assumed that it could establish a universal, standardized vaccine for the United State based on their success in marketing other biological agents to combat infectious diseases. Unlike microbes, however, pollen was not readily standardized. It varied according to geographic region, season, and local meteorologic and environmental conditions. In its letter to physicians, Lederle described its product as a “carefully standardized vaccine from the pollen of timothy, red top, June grass, orchard grass, wheat, sorrel, dock, daisy, maize, ragweed, goldenrod, all of which are known to be important factors in causing hay fever in the spring, summer, and fall.”⁹ Outside the northeastern United States, however, where Lederle Laboratories was located, their pollen vaccine proved of little use. Dr Grant Selfridge, the first physician in San Francisco to conduct clinical research on the diagnosis and treatment of hay fever, discouraged the use of vaccines like those produced by Lederle because they failed to take into account the regional specificity of hay fever as a disease. In comparing the plant species of Lederle’s pollen vaccine with plant species prominent in the Bay area, Selfridge found “no botanical relationship between them.”¹⁰ Other physicians also reported similar cases in which patients with hay fever were tested with negative results, only to learn that extracts used were made of pollens collected more than “a thousand miles from the patient’s home.”¹¹ By the 1920s, physicians had become convinced that “the establishment of the etiologic relationship between plant pollens and ... allergic diseases, such as asthma and hay fever” made “careful study of regional botany” an “essential requisite for intelligent treatment.”¹²

In the early establishment of allergy clinics, many physicians opted to work closely with botanists knowledgeable about the local flora in the region to develop their own pollen extracts for testing and treatment rather than rely on pharmaceutical companies that gave no thought to the “district where” their “standardized” vaccines were “to be sold.”¹³ The San Francisco otorhinolaryngologist, Grant Selfridge, for example, employed University of California botanist Harvey Monroe Hall to aid in conducting the first botanical and pollen survey of Western hay fever plants in 1916 and 1917. Financed by the Southern Pacific Co, which grew concerned about the amount of valuable time railroad workers lost to hay fever, Hall traveled along the railroad’s right-of-way through Utah, Nevada, Oregon, and California, collecting pollens from the most prevalent wind-pollinated species such as cockleburrs, sagebrushes, mugworts, and lamb-quarters, which Selfridge, who had hay

fever, tested on himself. Given the heterogeneity of local environmental conditions, Hall argued that only a “close botanical survey of the immediate vicinity” would give the allergist confidence in identifying the cause of the allergy patient’s affliction.”¹⁴ W. V. Mullin, whose own clinical practice in Colorado Springs was aided by the botanical knowledge of Frederic and Edith Clements, similarly remarked that as “hay fever becomes largely a regional problem” it will require ever more detailed “knowledge of the common offenders in our local fields.”¹⁵

Vegetation surveys like those conducted by Hall furnished physicians with detailed knowledge about the relative abundance of local and regional hay fever plants. However, such ecologic and taxonomic knowledge offered little information about the daily, monthly, and seasonal pollen counts in the atmosphere. The pollen morphology of different wind-pollinated plant species, along with daily, weekly, and seasonal weather patterns, including wind direction, rainfall, and temperature, all had an effect on the severity of the allergy season. William Scheppegegrell, chief of the Hay Fever Clinic at New Orleans Charity Hospital, was the first to begin regular aerial sampling of atmospheric pollen in the United States, from 1916 to 1922, by using glass slides coated with glycerin exposed for 24 hours outside the eighth floor of the Audubon office building in downtown New Orleans. In the early 1920s, he conducted a preliminary atmospheric pollen survey by airplane, sampling for pollen at regular 1000 foot intervals, to an altitude of 15,000 feet. The presence of hay fever pollens in large numbers at altitudes upwards of 6000 feet led Scheppegegrell to conclude that weed eradication efforts, such as that undertaken by New Orleans in the name of hay fever prevention, would be effective only if enacted at the state and federal level, because pollen readily traveled across municipal, county, and state lines.¹⁶

The coordination of these local vegetation and atmospheric surveys undertaken by private allergy clinics into a standardized national information and surveillance network through which physicians could better understand the regional differences and similarities that informed their practice owed much to Oren C. Durham. Sorting out the geographic distribution of hay fever plants was extremely important during the early days of skin testing, when the lack of botanical knowledge among physicians often resulted in unreliable, confusing, and useless results. In 1925, 1 year after Durham completed his vegetation survey of hay fever plants in Kansas City in conjunction with William Duke’s clinic, Durham developed a pilot pollen survey of Chicago in collaboration with University of Chicago physician Karl Koessler. By using the quadrant sampling methods developed in ecology by Frederic Clements, Durham and Koessler divided the city into 171 mile-square blocks. For each

square, the percentage of area occupied by vegetation, use of the area (for example, industrial, residential), and relative abundance of plants were noted. Atmospheric pollen plates were exposed on a daily basis at various sampling sites in the city from June through September, and pollen grains of grasses, ragweeds, chenopods, amaranths, wormwoods, composites, docks, plantains, and miscellaneous other plant groups were counted. On the basis of field and aerial surveys, Durham and Koessler calculated that the ragweeds accounted for 65% of the total pollen load in the city of Chicago and 80% during the fall hay fever season. Intensity of hay fever symptoms on a daily basis furnished by clinical data correlated closely with ragweed pollen counts in the atmosphere.¹⁷

As botanist at Swan-Myers, Durham had by 1928 secured the data of local atmospheric pollen surveys made by 28 clinics in 22 locations. However, the lack of a standardized technique of air sampling and discrepancies in climatic information gathered made comparative analysis difficult. To overcome the obstacles of private local studies, Durham enlisted the cooperation of the US Weather Bureau in arranging the first national atmospheric pollen survey. "The main purpose of this national study," Durham argued, was "to correlate local surveys and lay a foundation for comparative pollen studies." Without the "national panorama," Durham observed, "the value of careful individual atmospheric observations is lost."¹⁸

In looking to the US Weather Bureau, Durham built on a well-established infrastructure between medicine and government meteorology that dated back to the 1870s, when Western physicians like Charles Denison used the Signal Service's network of meteorologic stations to develop regional maps in the promotion of climatotherapy. Durham distributed through the US Weather Bureau uniform sampling devices, materials, and instructions to local meteorologists in 28 cities throughout the United States. At weekly intervals, he received a shipment of slides, which by 1936 totaled 18,000. Durham personally identified and counted pollen from all species of the ragweed family on every slide. Pollen counts were correlated with meteorologic factors including temperature, sunshine, and rainfall for each city. In 1936, the number of sampling stations exceeded 100 and extended from Winnipeg, Manitoba, Canada to Tampico, Mexico. The following year, the New York *World-Telegram* was 1 of the first newspapers to begin publishing a daily pollen count in its weather section, today a standard part of television weather forecasts. By 1950, as chairman of the American Academy of Allergy's Pollen Survey Committee, and with the assistance of Abbott Laboratories, Durham had extended that surveillance network to 260 localities across Canada, the United States, Mexico, Cuba, and Ecuador.

In the development of their allergenic products line, pharmaceutical companies such as Abbott

Laboratories began to furnish physicians with comprehensive data on the seasonal distribution and pollen content of the air across the United States to assist in the diagnosis and treatment of hay fever. Reminding doctors that "the variety and irregular distribution of hay fever flora" meant no "two physicians working in different cities" required "exactly the same pollens for local testing," Abbott offered a "comprehensive regional skin test" service that gave advice on the "practical selection of local pollen tests for any district."¹⁹ Lederle similarly abandoned the universal ideals of bacteriology in favor of standardized data gathering and mapping practices within natural history in marketing its pollen extracts. Encouraging the physician "to ascertain the exact date when his patient's hay-fever symptoms appear and to acquaint themselves with the hay-fever plants most common in the locality where his patient lives," Lederle included in its brochure on pollen antigens a booklet of known hay fever plants in the New England, Eastern, Middle Western, Rocky Mountain, and Southwestern districts, along with illustrations and time of bloom for physicians interested in purchasing pollen antigens.²⁰ Such information would not have been possible without the enterprising efforts and close collaboration of physicians and botanists in the development of allergy as a clinical field.

The national pollen maps Durham and others constructed of hay fever plants not only offered a regional picture of allergy, one still prevalent today, but also presented a picture of changes in historical patterns of land use that have influenced disease patterns. Durham himself pointed to the invisible storm of ragweed pollen located in the heartland of America, where agricultural practices that depleted soil and facilitated the spread of pioneer species like ragweed had become the subject of intense government and ecologic investigation as the Dust Bowl gripped the nation in a major agricultural and economic crisis (Fig 2).²¹ The recent report by the Harvard Medical School's Center for Health and the Global Environment documenting the role of increasing CO² levels in promoting higher pollen production among opportunistic weeds and trees like ragweed, maples, birches, and poplars, and its possible effect on urban dwellers with allergy and asthma, highlights the value such aerobiological studies have played and continue to play in the understanding, prevention, and treatment of allergic disease.²²

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The National Allergy Bureau: Pollen and spore reporting today

The National Allergy Bureau (NAB) is part of the Aeroallergen Network of the American Academy of Allergy, Asthma and Immunology (AAAAI). The mission of the NAB is to promote optimal pollen and

mold spore data collection for the public domain, medical profession, and scientific community through standardized pollen and mold counting. It is chiefly responsible for collecting, archiving, and reporting current pollen and mold spore levels to the media and the public.

The NAB is composed of a group of more than 80 pollen- and spore-counting stations throughout North America known as the Aeroallergen Network. The core functions of the NAB are funded by the AAAAI. The majority of the work of the NAB is performed by AAAAI member volunteers who donate the time and expertise necessary to supply the public with accurate estimates of airborne allergen containing pollen grains and fungal spores. The Aeroallergen Network member stations collect airborne pollen and spores for aerobiology research and to aid in the diagnosis and treatment of allergic diseases. Member stations electronically enter pollen and mold counts into a master database operated by Data Harbor under contract to the AAAAI. Summaries of these counts are made available to the public through individual Internet inquiries and through local and national media outlets.

Since Blackley¹ first linked airborne pollen grains and fungal spores to allergic disease, medical practitioners have realized the importance of accurate information regarding environmental exposures to the management of allergic disease. The data presented by the NAB provides a rough estimate whereby individuals and allergists can gauge allergen exposure. On the basis of data collected over several years, a scale for exposure has been developed (Table I).² For ease of interpretation, the scale is divided into exposure for trees, grasses, weeds, and molds, with 4 levels of exposure for each. Even though these values are based purely on statistical considerations and individual exposure thresholds will vary with individual sensitivities, they are still a practical guide for exposure and allow comparison between sites across the country.

The NAB provides the most accurate spore and pollen data available. To become a contributing station of the NAB, the persons performing the counts are required to become certified and to maintain their certification. The AAAAI certification program is administered through the AAAAI Aerobiology Committee. Certification currently requires participants to accurately identify and count pollen and mold spores on at least 3 quality control slides. Once certified, a station must sample a minimum of 3 days per week with a Burkard volumetric spore trap, a Kramer-Collins sampler, or a Rotorod sampler. The sampler must be situated on an unobstructed rooftop at least one story above ground with no unusual local sources of pollen spores, mold spores, or both in the immediate vicinity. The certification of counters and counting stations provides for a measure of quality control and standardization that is superior to any other aeroallergen-reporting source.