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An atmospheric pollen survey conducted during the winter in Minneapolis, Minnesota, USA

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Few atmospheric pollen surveys have been conducted during the winter months in cities located in the midlatitudes. The purpose of this present investigation was to study pollen conditions during the winter in Minneapolis, Minnesota, a city that experiences cold temperatures and develops substantial snow cover. One hundred thirty-three atmospheric samples were collected with a Rotorod Sampler between 11 October 1995 and 1 May 1996. Pollen was recovered in 109 samples, including 27 of the 40 samples collected in December and January. Twenty-five types of pollen were observed during the study period; Cupressaceae (cedar/juniper), *Ambrosia* (ragweed) and *Artemisia* (sage/sagebrush) grains were most abundant during the period when local plants were not flowering. The weed pollen was most likely contributed by local sources, perhaps by dried flowers on dead plants. In contrast, the Cupressaceae pollen recovered in October and the early winter months is thought to have originated in the southern United States where several species of *Juniperus* flower late in the year. This study demonstrated that low but measurable concentrations of pollen occurred in the atmosphere throughout the winter.

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Most pollen surveys conducted during the winter have occurred in warm climates or cities where the local vegetation was flowering (Laurent et al. 1994, Mandrioli et al. 1980, Ruiz de Clavijo et al. 1988). Only Janzon's (1981) work in Stockholm, Sweden, occurred when plants were not pollinating and substantial snow cover had developed. Similar studies have not been conducted in cities with harsh winters in the United States.

Previous atmospheric surveys indicated that the pollen season in Minneapolis, Minnesota, begins in March and concludes in October (Schoenwetter 1994, Schoenwetter 1995). The earliest and latest pollen counts for the year often contained appreciable amounts of pollen, however, suggesting that pollen may be suspended in the atmosphere outside of the traditional allergy season. Despite this possibility, no data exist for the winter months.

The purpose of this present investigation was to sample the atmosphere for pollen during the winter months in Minneapolis. These data were used to explore the end and beginning of the 1995 and 1996 pollen seasons, respectively, as well as consider pollen recovery during the period in between.

MATERIALS AND METHODS

Climate and Vegetation

Minneapolis (44°58'N, 93°15'W; population 368,383) is located in a moist continental climate (Strahler & Strahler 1987). Winter temperatures can often be extremely cold; snowfall is generally abundant.

Grimm (1984) demonstrated that Minneapolis bordered the eastern edge of a large area called the Big Woods prior to the influx of Europeans in the 1800s. Vegetation in the Big Woods consisted of

various tree taxa including elm (*Ulmus*), basswood (*Tilia americana*), sugar maple (*Acer saccharum*), ironwood (*Ostrya virginiana*), bitternut hickory (*Carya cordiformis*), butternut (*Juglans cinerea*), and ash (*Fraxinus*). A zone consisting of mixed species of oaks (*Quercus*) separated the Big Woods from prairie lands to the east. Although these areas are now primarily agricultural or urban, a recent biological survey found that the present vegetation continued to reflect the native vegetation of east-central Minnesota (Aaseng et al. 1993).

A number of weed taxa are common in Minnesota (Ellis & Rosendahl 1932, Lewis et al. 1983). Various members of the Aster (*Asteraceae*) family are found throughout the state, in particular several species of ragweed (*Ambrosia*). Representatives of the Amaranth (*Amaranthaceae*), Goosefoot (*Chenopodiaceae*), Plantain (*Plantaginaceae*) and Nettle (*Urticaceae*) families are also common but are less important than ragweed as causes of pollinosis.

Atmospheric Samples

A Rotorod Sampler (Model 40; Sampling Technologies, Inc.; Minnetonka, MN, USA) was installed 1.5 m above the flat rooftop of a three-story office building (44°58'N, 93°25'W) located in Minnetonka (a suburb of Minneapolis). The building measured 23 × 55 m; its roof was 12 m above grade. The Rotorod was placed 5 m from the north edge of the roof and 9 m from the west edge. A hatch that allowed access to the roof was located 4 m to the southeast of the sampler.

The Rotorod Sampler was operated according to the standard conventions suggested by the manufacturer (Brown et al. 1993). The clock was programmed to operate the Retracting Head 1 min out of every 10 min (10% duty cycle). Clear polystyrene collector rods (1.5 × 1.5 × 32 mm) coated with silicone grease (G-697; General Electric Co.; Waterford, NY, USA) were installed at approximately 09:00 h Monday through Friday. After removal from the Retracting Head, rods were stored at room temperature in dust-proof Transit Vials (Sampling Technologies) prior to analysis.

Collector rods were permanently mounted on glass microscope

slides prior to visual analysis. Briefly, a thin layer of Canada balsam (Spectrum Quality Products; Gardena, CA, USA) was applied to the surface of standard microscope slides (Chase Scientific Glass; Norcross, GA, USA). Twelve collector rods were arranged on the surface of each slide in a manner parallel to the slide's long dimension; the rods' sample surfaces were oriented up.

Warmed glycerin jelly (Ogden et al. 1974) with basic fuchsin (Allied Chemical and Dye Corp.; New York, NY, USA) added was applied to the surface of a piece of 24 × 40 mm cover glass (No. 1; Chase). The glass was then inverted and gently rocked onto the collector rods, taking care to prevent air bubbles from developing. Additional jelly was then applied around the perimeter of the mount to fill the space between the microscope slide and the cover glass. After 10 min, Cytoseal 60 (Richard-Allan Scientific; Kalamazoo, MI, USA) was applied around the perimeter of the mount; a second layer of the compound was applied 24 h later.

The collector rods were systematically analyzed with a light microscope at 400 × for pollen grains. The entire surface of each rod was generally analyzed except in several cases where heavy pollen accumulation permitted sub-sampling (Frenz et al. 1996). All pollen data were converted to volumetric expressions (pollen grains/m³; henceforth abbreviated p/m³).

The Rotorod's head speed was measured with a stroboscopic tachometer (Strobotech Model 1531-AB; General Radio Co.; Concord, MA, USA) at the beginning and end of the study to test proper performance (Frenz & Elander 1996). The sampler was also observed during the initial duty cycle each time collector rods were changed to confirm day-to-day functioning.

Meteorological Data

Weather data were obtained from the National Weather Service observatory at the Minneapolis International Airport (44°53'N 93°13'W). The distance between the study site and the airport was approximately 19 km by air.

RESULTS

Pollen Data

One hundred thirty-three atmospheric samples were obtained between 11 October 1995 and 1 May 1996. One hundred three samples were collected over 24-h periods, while the remaining 30 samples represented periods several days long (e.g., weekends).

In general, the Rotorod performed satisfactorily during the study period. The device's motor operated throughout the winter and did not drift from the prescribed speed of 2400 RPM. The only mechanical failure occurred during a blizzard; the Retracting Head's pivot blocks froze open so that the collector rods were exposed to the atmosphere for an indeterminate amount of time. Data from that sampling period (22–25 March) were not analyzed. The Rotorod did not appear to be affected by other adverse weather conditions including a sleet storm and cold temperatures.

Pollen was recovered in 109 samples, including 27 of the 40 samples collected in December and January. The longest period when pollen was not recovered from the atmosphere was for two consecutive samples, an event which occurred three times (11 and 12 December, 22 and 23 January, 7 and 8 February).

After approximately one week of pollen counts ranging from 30 to 40 p/m³, the pollen concentration on 19 October decreased to 9.4 p/m³ and did not exceed 15 p/m³ in consecutive samples in the spring until 10 April. During the

intervening period, the pollen concentration was less than 1 p/m³ in 71 of the 112 samples analyzed. The 24-h sample obtained on 9 November offered the highest pollen count during the five-month period of November through March (tree = 12.3 p/m³; weed = 8.4 p/m³).

Prior to 10 April, the tree pollen count exceeded 15 p/m³ on two days (12 March, 3 April) when temperatures approached or exceeded 10°C during the day. Little pollen was recovered from the atmosphere during the intervening periods when temperatures were near or below freezing. The sample obtained on 17 April offered the first tree pollen count in 1996 that exceeded 90 p/m³.

Twenty-five types of pollen were recovered during the study period (Table I). Cupressaceae pollen appeared in the largest number of samples (n = 60), some of which occurred during October (n = 8). *Ambrosia* pollen appeared in 58 samples; forty-two of these samples were obtained during the period November through March. Of the types of pollen that could be identified, 17 were from trees, six were from weeds, and two were from grasses.

Table I. Number of grains of each pollen type recovered by month.

Month→ No. of samples→	Oct 14	Nov 17	Dec 20	Jan 20	Feb 21	Mar 19	Apr 22
Aceraceae	0	0	0	0	2	1	54
Betulaceae							
<i>Betula</i>	1	1	0	0	0	3	1026
<i>Corylus</i>	0	0	0	2	0	0	0
Cupressaceae	706	39	5	15	25	132	1113
Fagaceae							
<i>Castanea</i>	0	2	0	0	0	0	0
<i>Fagus</i>	0	0	0	0	0	0	1
<i>Quercus</i>	0	0	0	0	0	0	78
Juglandaceae							
<i>Carya</i>	0	0	0	0	0	0	3
<i>Juglans</i>	0	0	0	0	0	0	2
Moraceae	0	0	0	0	0	3	17
Oleaceae							
<i>Fraxinus</i>	0	0	0	0	0	0	20
Pinaceae	2	6	6	9	9	7	19
Platanaceae	0	0	0	0	0	0	6
Salicaceae							
<i>Populus</i>	0	0	0	0	0	1	768
<i>Salix</i>	0	0	0	0	0	1	49
Ulmaceae							
<i>Celtis</i>	0	0	0	0	0	0	16
<i>Ulmus</i>	0	0	0	9	3	9	1376
Cyperaceae	0	0	0	0	0	0	9
Poaceae	5	2	3	0	0	0	6
Amaranthaceae/ Chenopodiaceae	23	3	2	3	2	3	1
Apiaceae	1	0	0	0	0	0	1
Asteraceae							
<i>Ambrosia</i>	201	82	44	25	6	10	7
<i>Artemisia</i>	23	9	4	3	4	9	0
Other aster types	3	1	0	0	0	0	0
Urticaceae	0	0	0	0	0	1	0
Unidentified grains	20	9	2	9	11	18	138
Damaged grains	3	22	13	6	2	0	0

Of the pollen grains recovered on collector rods during the study period ($n=6,287$), 207 grains could not be identified with certainty. These grains, which were in good condition, were tallied in a separate category than grains that could not be identified with confidence because they were damaged ($n=46$).

Meteorological Conditions

The mean temperature (-2.7°C) during the seven-month study period of October through April was 1.6°C colder than the 30-year normal (1961–90). Temperatures were below normal during six months, but not December (Table II). The highest and lowest recorded temperatures were 29.4°C and -35.6°C on 12 October and 2 February, respectively.

A total of 253.3 mm of precipitation (water equivalent) fell during the study period—27.2 mm less precipitation than the 30-year normal. The largest daily precipitation total occurred on 23 October (25.7 mm) and the most snow fell on 8 December (18.0 cm).

DISCUSSION

In the midlatitudes, it is traditionally assumed that little, if any, pollen is suspended in the atmosphere during the winter because plants are not flowering and the ground is covered with snow. We tested this assumption in Minneapolis, Minnesota, a city that typically experiences cold temperatures and develops significant snow cover during the winter.

Our data indicated that the 1995 pollen season ended in the middle of October when minimum temperatures were near or below freezing. After several days of weed pollen counts considered “moderate” in Burge’s (1992) system ($\geq 10 \text{ p/m}^3$), counts entered and remained in the “low” range starting 19 October. Approximately five months passed until the first moderate pollen count (tree $\geq 15 \text{ p/m}^3$) occurred in the spring (12 March).

Cupressaceae pollen was frequently recovered in October and in lower concentrations during the winter. Although indigenous and introduced members of this family only flower in the spring in Minnesota (E. J. Cushing 1996, 1997: pers. comm.), some species of the genus *Juniperus* (juniper) pollinate in the autumn (*J. pinchotti*) and winter (*J. ashei*) in the southern United States. Lewis et al. (1983) indicated that juniper trees shed enormous quantities of pollen that can

travel long distances. It is possible that the grains we recovered originated in Texas or other states in the south-central where *Juniperus* flowers late in the year. Long-distance transport of other types of pollen has been well documented by investigators working in Scandinavia (Franzén et al. 1994) and both polar regions (Johansen 1991, Wynn-Williams 1991).

Ragweed pollen was also frequently recovered in October and subsequent months. Schoenwetter’s (1994) data indicated that the ragweed pollen season begins in Minneapolis in late July or early August and reaches a seasonal peak in late August or early September. Pollen was recovered from the atmosphere until he discontinued sampling for the year in November.

Our data demonstrated that ragweed pollen persisted in the atmosphere through the winter and was recovered in low concentrations as late as April. Although some species of ragweed flower in the winter in Florida, Arizona and California (Lewis et al. 1983), it is likely that the pollen we observed originated locally. Bright (1981) reached similar conclusions while working with snow samples from Wyoming and Idaho. He suggested that pollen from dried flowers on dead ragweed plants contributed most of the pollen that accumulated in his study sites during the winter months.

Pollen grains from other weed taxa were less frequently recovered during the winter months. Amaranthaceae/Chenopodiaceae (pigweed/goosefoot) and *Artemisia* (sage/sagebrush) pollen occurred in low concentrations throughout the study period. Since these weeds generally do not flower later than October even in the south (Lewis et al. 1983), it is unlikely the pollen we recovered was recently shed by distant sources. Like the ragweed pollen we captured, these pigweed/goosefoot and sage/sagebrush grains most likely originated from local sources.

In addition to the pollen types already discussed, grains from a number of other tree and grass taxa were occasionally recovered from the atmosphere during the winter. Since none of these pollen types were clearly exotic, it is difficult to ascribe their origin with any certainty. We speculate that the most likely sources for this pollen were local.

The 1996 pollen season appeared to start several weeks later than in recent years. Moderate tree pollen counts did not occur in consecutive samples until mid-April, compared to late March in 1994 (Schoenwetter 1995). The mean temperature (-3.7°C) in March 1996 was 5.2°C colder than in 1994 and 3.0°C colder than the 30-year normal. These data suggest that the end of bud dormancy and subsequent flowering occurred later during our study period than in 1994. This finding was consistent with work by Frenguelli et al. (1991) that demonstrated winter weather caused the start of the *Alnus* pollen season to vary by up to one month in The Netherlands.

In contrast, the first “high” tree pollen count ($\geq 90 \text{ p/m}^3$) on 17 April was similar to pollen conditions at the same time of year in 1994. This suggests that cold temperatures in March may have delayed the start of the tree pollen season but did not preclude significant pollen shed after flowering began.

This study demonstrated that low but measurable concen-

Table II. Temperature and precipitation (water equivalent) normals and 1995/96 conditions.

	Mean Temperature ($^{\circ}\text{C}$)		Total precipitation (mm)	
	1961–90	1995/96	1961–90	1995/96
October	9.3	9.2	55.6	93.5
November	0.6	−2.6	39.4	22.4
December	−7.9	−7.2	27.4	29.2
January	−11.3	−12.1	24.2	47.5
February	−5.2	−7.6	22.4	6.1
March	−0.7	−3.7	49.3	35.3
April	7.9	5.2	62.2	19.3

trations of pollen occurred in Minneapolis throughout the winter. The amount of pollen suspended in the atmosphere was similar to Janzon's (1981) findings for Stockholm (0.1–15 p/m³), although fewer taxa were recovered. We identified 25 types of pollen compared to 44 and 32 types in the successive winters (1977–78, 1978–79) he sampled.

Although it seems unlikely that humans suffered from pollinosis during the winter in Minneapolis, investigators in Paris have demonstrated that pollen events and hay fever symptoms can occur outside the traditional allergy season (Laurent et al. 1994). Comtois' (1988) exceedingly low threshold (3 p/m³) for ragweed symptomatology suggests that additional work will be required to determine the clinical implications of pollen conditions during the winter.

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REFERENCES

- Aaseng, N. E., Almendinger, J. C., Dana, R. P., Delaney, B. C., Dunevitz, H. L., Rusterholz, K. A., Sather, N. P. & Wovcha, D. S. 1993. Minnesota's native vegetation: a key to natural communities (Biological Report No. 20). – Minnesota Department of Natural Resources (Section of Wildlife), St. Paul, MN.
- Bright, R. C. 1981. Pollen in high-mountain snow, western United States. – *Striae* 14: 55–57.
- Brown, T. A., Frenz, D. A., Wimpsett, T. L., Barr, D. W. & Hokanson, J. M. 1993. Operating instructions for the Rotorod Sampler. – Sampling Technologies, Inc., Minnetonka, MN.
- Burge, H. A. 1992. Monitoring for airborne allergens. – *Annals of Allergy* 69: 9–18.
- Comtois, P. 1988. Concentration pollinique et fréquence des symptômes de pollinose: une méthode pour déterminer le seuil clinique. – *Revue Française d'Allergologie* 28: 279–286.
- Ellis, R. V. & Rosendahl, C. O. 1932. Fall hay fever in the Upper Mississippi Valley with special reference to Minnesota and the Dakotas. – *Journal-Lancet (Minneapolis)* 52: 369–373.
- Franzén, L. G., Hjelmroos, M., Källberg, P., Brorström-Lundén, E., Junnto, S. & Savolainen, A.-L. 1994. The "yellow snow" episode of northern Fennoscandia, March 1991—A case study of long-distance transport of soil, pollen and stable organic compounds. – *Atmospheric Environment* 28: 3587–3604.
- Frenguelli, G., Spieksma, F. Th. M., Bricchi, E., Romano, B., Mincigrucci, G., Nikkels, A. H., Dankart, W. & Ferranti F. 1991. The influence of air temperatures on the starting dates of the pollen season of *Alnus* and *Populus*. – *Grana* 30: 196–200.
- Frenz, D. A. & Elander, J. C. 1996. A calibration program for Rotorod samplers. – *Annals of Allergy Asthma and Immunology* 76: 245–246.
- Frenz, D. A., Scamehorn, R. T., Hokanson, J. M. & Murray, L. W. 1996. A brief method for analyzing Rotorod samples for pollen content. – *Aerobiologia* 12: 51–54.
- Grimm, E. C. 1984. Fire and other factors controlling the Big Woods vegetation of Minnesota in the mid-nineteenth century. – *Ecological Monographs* 54: 291–311.
- Janzon, L.-Å. 1981. Airborne pollen grains under winter conditions. – *Grana* 20: 183–185.
- Johansen, S. 1991. Airborne pollen and spores on the Arctic island of Jan Mayen. – *Grana* 30: 373–379.
- Laurent, J., Decoux, L., Ickovic, M. R., Le Gall, C., Gacouin, J. C., Sauvaget, J. & Lafay, M. 1994. Winter pollinosis in Paris. – *Allergy* 49: 696–701.
- Lewis, W. L., Vinay, P. & Zenger, V. E. 1983. Airborne and allergenic pollen of North America. – J. Hopkins University Press, Baltimore.
- Mandrioli, P., Negrini, M. G., Scarani, C., Tampieri, F. & Trombetti, F. 1980. Mesoscale transport of *Corylus* pollen grains in winter atmosphere. – *Grana* 19: 227–233.
- Ogden, E. C., Raynor, G. S., Hayes, J. V., Lewis, D. M. & Haines, J. H. 1974. Manual for sampling airborne pollen. – Hafner Press, New York.
- Ruiz de Clavijo, E., Galán, C., Infante, F. & Domínguez, E. 1988. Variations of airborne winter pollen in southern Spain. – *Allergologia et Immunopathologia* 16: 175–179.
- Schoenwetter, W. F. 1994. Pollen reports; Minneapolis, Minnesota. – In: Pollen and spore report 1993 (ed. J. D. Segale), pp. 92–93. – American Academy of Allergy and Immunology, Milwaukee.
- Schoenwetter, W. F. 1995. Pollen and spore reports; Minneapolis, Minnesota. – In: Pollen and spore report 1994 (ed. J. D. Segale), pp. 116–119. – American Academy of Allergy and Immunology, Milwaukee.
- Strahler, A. N. & Strahler, A. H. 1987. Modern physical geography, 3rd ed. – John Wiley & Sons, New York.
- Wynn-Williams, D. D. 1991. Aerobiology and colonization in Antarctica—the BIOTAS Programme. – *Grana* 30: 380–393.