COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
Dorothy Conroy, Executive Secretary
901 Sherman Street, Denver, Colorado 80203

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Preliminary Air Analyses in the Denver Area

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On November 19, 1968, a series of air samples were taken in the Denver metropolitan area. The locations, with exception of samples 2 and 3, are shown in Fig. 1. An arrangement with the California Statewide Air Pollution Research Laboratory, Dr. Edgar R. Stephens, permitted the samples to be shipped to Riverside, California, and analyzed for a number of hydrocarbons by means of gas chromatrography. Table 2 gives the conditions, Table 3 the concentrations for 7 out of the 30 different gases detected and analyzed in each sample.

The atmospheric conditions varied widely: from no wind to a stiff breeze, from freezing to about 65°F, from definite overcast with smog to clear skies. About the only thing that can be said, in general, is that the gases detected are present part of the time, some at undesirably high levels.

The compounds methane, ethane and propane are the most important constituents of natural gas. None of these appear to be of major importance at present. According to Dr. Stephens, the proportion of ethane to methane is about half of what they normally experience in California, with propane concentrations being attributed, probably, to gasoline evaporation or LPG losses. Toxic levels of these gases, with time required for effect, have not been definitely determined.

Ethylene, propylene, and acetylene are primarily attributed to automobile exhaust. Many of these materials, in the presence of sunlight, undergo conversion to compounds that may be more toxic to plants. Several highly reactive materials were found in the air samples, showing typical patterns for automobile exhaust. Some samples indicated evaporated gasoline rather than production by car exhaust.

The primary reason for sampling was to determine presence or absence of ethylene in significant quantities. The most sensitive plants show damage from ethylene at 10 ppb (parts per billion). Orchids may be damaged by 2 ppb for 24 hours, or 100 ppb for 8 hours. Recent English research [1] has shown that carnations will irreversibly wilt when subjected to 100 to 200 ppb for 48 hours in the absence of CO_2. Sleepiness occurred in 16 to 24 hours. However, there are reports showing that keeping life of the cut flower is significantly reduced by exposure for 2 days to 50 ppb [2]. Most of this work has been done at room temperatures in water. Addition of CO_2 to the atmosphere apparently suppresses both the production of ethylene by the flower and its effects on keeping life. There is a very definite interaction between concentration of ethylene, time of exposure, temperature, and whether the flower is on the plant, in water, or in dry storage. Unfortunately, definitive work in this area, applicable to Colorado conditions, is non-existant.

At least two Denver locations (Samples 8 and 12) had ethylene concentrations in excess of 100 ppb (0.1 ppm). These levels are undesirable, and quite likely affect the carnation if they exist for any length of time within the greenhouse. At least one other location had levels, that if maintained with any consistancy for two days, at ordinary greenhouse temperatures, would reduce keeping life (Sample 11). The levels of ethylene found in a dry storage box, and in a main carnation cooler, were significant. The high amount of other compounds found in Samples 2 and 3 was surprising (Table 3).

It is likely that pollution problems in Denver will become worse before better. Despite the stringent controls imposed in California, the increase in numbers of cars has merely resulted in maintaining the *status quo*. No definite improvement has been noted. Location of greenhouses in accordance with the prevailing wind directions will become more important in the Denver area in order to avoid high pollutant concentrations. Although extensive measurements have not been made, it may be expected that high concentrations of ethylene, and other photoreactive contaminants, will be found near arterial roadways and large shopping centers. As a general rule, the location of Denver in the South Platte basin results in increased accumulation of pollutants along the river valley. The smog tends to move

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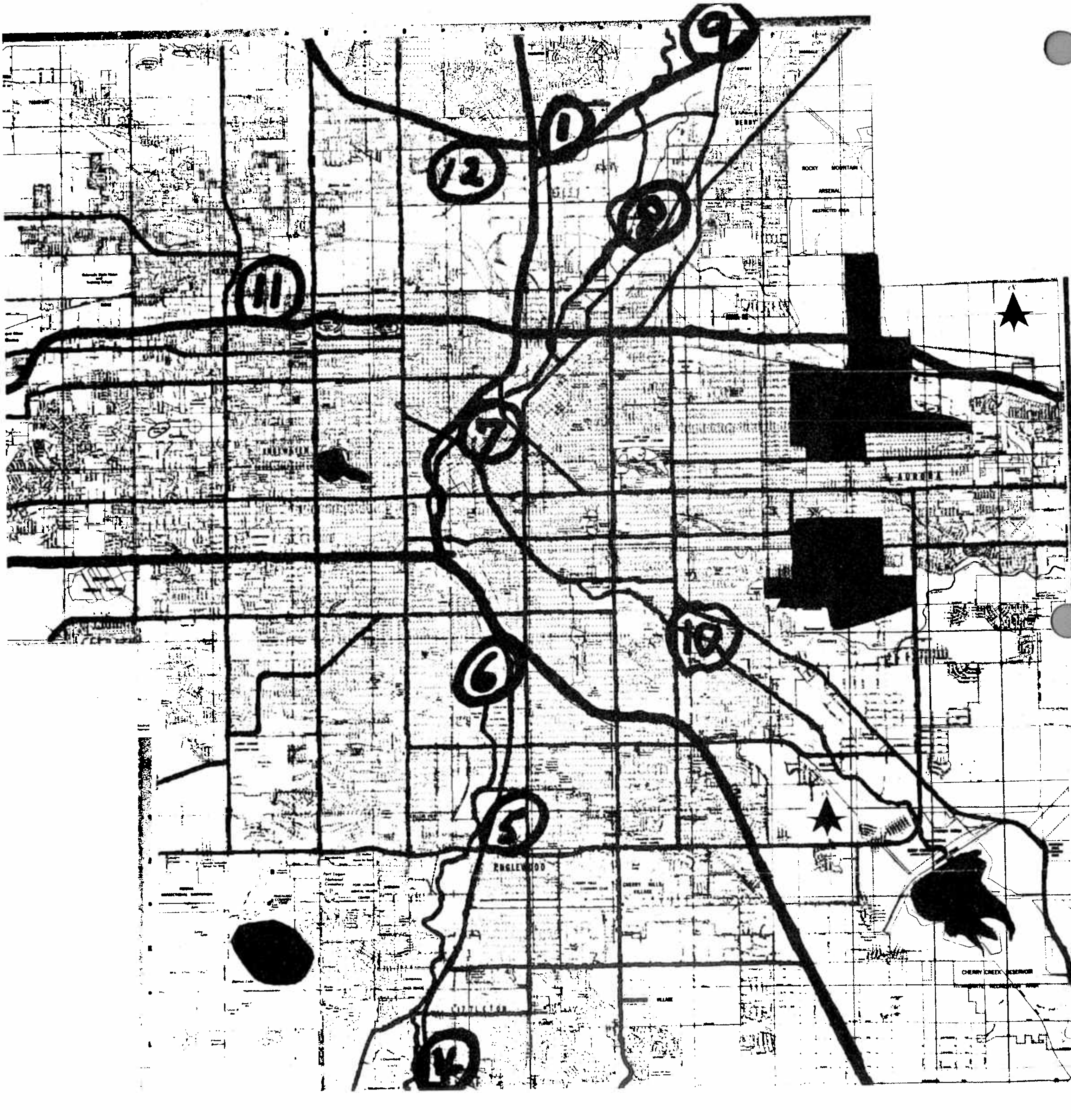

Fig. 1. Location of sampling sites for Denver air analysis, November 19, 1968. Refer to Table 1 for conditions. Samples 2 and 3 not included.

Table 1. Denver air analysis for ethylene: November 19, 1968

Locations selected for proximity to greenhouse concentrations
Wind conditions: Calm to 10-15 mph.
Sky: Overcast to clear
Temperature: Between 32 and 65°F.
Smog: Downtown area obscured early morning, becoming clear with light haze, moving to the north toward noon
Wind: Out of the south

Sample No.	Time of Sampling	Conditions	Location
1	1215	Clear skies, light haze, wind 5-10 mph	Washington and Hgwy 224
2	0830	Cut flower storage box, tube put in place 11/11/68, stored at 33F with other flowers in boxes, wrapped in polyethylene, dry.	
3	0835	Main carnation walk-in cooler, about 30 x 50', 35-40F, full of carnations, one door open, 3-4 personnel present.	
4	1040	Clear, brisk breeze out of south, 10-15 mph	Santa Fe and Ridge Road, Littleton.
5	1050	Clear, brisk breeze	Hampden Ave. and Jason St.
6	1025	Slight haze, slight breeze	Mississippi and Jason St.
7	1015	Hazy, no breeze	Wazee and 18th Street
8	1200	Hazy, slight breeze, definite ordor of sulfur	Steel and E. 60th Ave.
9	1225	Clear, smog to north, slight breeze	E. 88th and Hgwy 6, 85
10	1105	Clear, breeze	Gill and S. Colorado, Glendale
11	0810	Smoggy, calm	Marshall and W. 52nd, Arvada
12	0750	Downtown Denver obscured, calm	Pecos and 69th Avenue

Table 2. Analysis of Denver Air, November 19, 1968. Figures in parts per billion (ppb) by volume. See Figure 1 for sample site location. Figures rounded to nearest whole number.

Gas	Location												
	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Methane	1360	1972	2060	1330	1265	1725	1790	1486	1310	1353	1744	2240	1336
Ethylene	25	45	63	2	4	23	39	122	7	26	54	111	47
Ethane	10	29	34	3	5	16	21	26	5	9	24	25	17
Acetylene	24	76	78	3	3	29	95	92	7	25	88	145	55
Propane	25	24	27	1	2	12	30	40	2	3	11	15	16
Propylene	11	18	22	1	2	7	11	38	2	8	14	31	14
Isobutane	37	126	81	5	8	14	24	48	7	10	13	19	33
Time of sampling	1215	0830	0835	1040	1050	1025	1015	1200	1225	1105	0810	0750	

Table 3. Gaseous components found in significant quantities in Denver air samples, with concentrations measured in Samples 2 and 3. Concentrations in parts per billion.

Compound	Sample 2	Sample 3
Methane	1972	2060
Ethylene	45	63
Ethane	29	34
Acetylene	76	78
Propane	24	27
Propylene	18	22
Isobutane	126	81
N-Butane	193	115
1-Butene	5	5
Isobutene	7	7
Trans-2-butene	7	5
Isopentane	145	88
Cis-2-butene	4	4
N-Pentane	98	60
1,3-Butadiene	3	5
Methyl acetylene	2	3
2,2-Dimethyl butane	4	2
2-Methyl Butene-1	5	4
Trans-2-pentene	5	4
2,3-Dimethyl butane	9	5
2-methyl pentane	51	35
2-Methyl butene-2	6	4
3-Methyl pentane	33	25
Cyclo pentane	11	7
N-Hexane	48	36
Cyclo pentene	10	14

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up and down the valley in accordance with prevailing winds—quite often moving north during midday and late afternoon, and returning. Under stable atmospheric conditions, most frequently occurring during winter, accumulation may occur over a period of days. High levels of undesirable pollutants can be expected.

Numerous measurements, taken over a number of years, have definitely shown the climate around large metropolitan areas such as Denver to be completely different from the surrounding countryside. The presence of smog increases precipitation and cloudiness. Wind direction and average temperatures may be significantly effected. Any decrease in number of clear days would affect the carnation industry adversely.

Literature cited

1. Nichols, R. 1968. The response of carnations (*Dianthus caryophyllus*) to ethylene. *J. Hort. Sci.* 43:335-349
2. Smith, W. H. 1967. Prevention of ethylene injury to carnations by carbon dioxide. *BFIA Journal*. May, 1967. page 19.

Your editor,

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