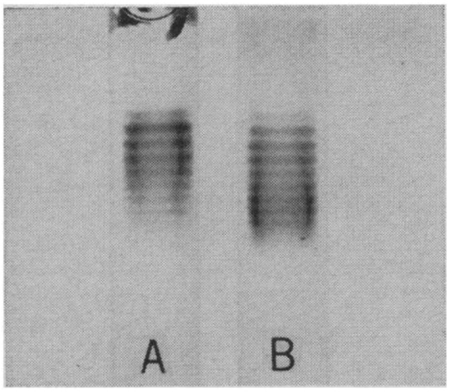

Fig. 2. LDH isozyme patterns in splake muscle (*A*) and heart (*B*).

ance of only nine bands on gels to which extracts from the various tissues were added together.

It was not possible to discriminate between the isozymes on the basis of differential activity with α-hydroxybutyrate, α-hydroxyvalerate, and the acetylpyridine analogue of NAD (*3, 8, 9*). Each form of LDH showed approximately the same response to these agents as judged by the deposition of formazan at the appropriate site on the gel. In all cases, lactate was the preferred substrate (five times more active as measured by the time required for bands to appear on gels), and NAD the preferred coenzyme (three times more active than with acetylpyridine

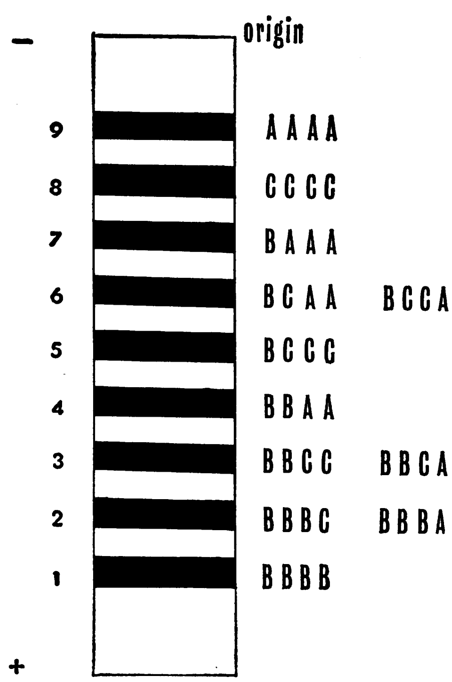

Fig. 3. Diagrammatic representation of LDH isozymes showing proposed subunit composition of LDH-1 to LDH-9.

adenine dinucleotide). All of the isozymes were inhibited by $2.5 \times 10^{-2}M$ sodium oxalate and by $1 \times 10^{-3}M$ sodium pyruvate (*9*). Activity of each isozyme was decreased by about 50 percent in the presence of 2*M* urea (*10*).

Two other members of the family Salmonidae, *Salvelinus namaycush* (lake trout) and *Salmo gairdneri* (rainbow trout), were examined for LDH isozyme pattern. *Salvelinus namaycush* showed LDH bands with mobilities similar to those from tissues of the closely related species *S. fontinalis*. Extracts of lake trout testes contained LDH forms coincident with LDH-1 to -4, heart LDH coincident with LDH-1 to -5, and muscle LDH coincident with LDH-1, -2, -5, -6, and -7 of brook trout tissues. The hybrid (splake) obtained by crossing a lake trout female with a speckled trout male had LDH components in heart and muscle extracts comparable to those of the speckled trout male (Fig. 2). Embryos obtained from a cross between the female splake and the male speckled trout also contained nine forms of LDH. Rainbow trout tissues contained a completely different isozyme pattern in heart, muscle, and ovary, with two, or at best three, forms of LDH poorly resolvable in this system.

In order to fit these data within the framework of the subunit hypothesis of LDH structure it is necessary to postulate the activity of a third gene participating in the synthesis of the multiple forms of this enzyme. The tissue differences in activity of the isozymes is an argument in favor of such a subunit scheme. If there is an interaction of three subunits to form tetramers, one would predict the formation of 15 forms of LDH. Therefore, the fact that only nine forms are resolved in this system must be accounted for. There are at least three possibilities: (i) A-C or A-B-C combinations of monomers are not formed; (ii) A-C or A-B-C combinations are enzymatically inactive, perhaps due to problems of conformation; or (iii) the charge difference between A and C subunits is too small for electrophoretic resolution of their constituent tetramers. The third proposal seems most likely, with the scheme presented in Fig. 3 as one possibility to account for the patterns obtained. However, no matter what the monomer composition, the suggestion of a third genetic locus seems reasonable, particularly in view of the observations cited concerning the control of the spermatozoan-specific LDH in mammalian and avian testes.

One may speculate that the mechanism by which this C gene is repressed is not operative, or perhaps has not evolved in the fish species studied here. My data require further refinement before the results obtained with the lake trout and the hybrids can be interpreted, except that the data do support my observations on speckled trout since there is some indication of nine isozymes in *S. namaycush* (*11*).

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12. Supported by NSF grant GB-1771. I thank J. P. Cuerrier, chief limnologist, Canadian Wildlife Service, for providing the speckled trout and splake.

25 January 1965

Convection Plumes from Ulmus americana L.

Abstract. *An unusual example of convection was recently seen above large elm trees shortly after sunset. The condensation of transpirational moisture in air that was cooler than that within the tree crowns is believed to account for the readily visible convective motion above the trees.*

Although exchange processes between plants and air occur throughout the biosphere (*1*), rarely can we see such phenomena with the unaided eye. In this report we describe the circumstances under which convection plumes were recently observed above large, broad-leaved trees.

While traveling on 22 July 1964, we saw columns rising vertically from several elms (*Ulmus americana* L.) on the floodplain of the Saint John River near Fredericton, New Brunswick (45°50′N, 66°30′W). The plumes rose slowly, wavering only slightly in the relatively still evening air. They became visible within approximately 20 cm of the tree tops and gradually dissipated about 1 m above. The phenomenon was photographed at 2030 hours A.S.T. (Fig. 1).

Convection phenomena from plants in still air have been demonstrated previously with the schlieren photograph technique (*2*), and we think that the plumes above the elm trees were simply a macroscopic example of processes that until now have been seen only with special photographic aids.

The phenomenon occurred on open-grown, scattered elms beside the highway. Water supply for the trees was probably unlimited because they grew within 30 m of the river on a site that was only about 3 m above the July river level. The trees were approximately 18 m tall and about 100 years old.

Weather conditions for that evening are summarized in Table 1 from data from a weather station at the Fredericton airport, about 3 km southeast of the trees. Sunset occurred at 2008 hours, approximately 20 minutes before the plumes were photographed. At 2000 hours, 70 percent of the sky was covered with clouds at 2700 m, and at 7600 m the sky was entirely overcast; it is not known when the sun had last shone directly on the tree crowns that day. Illumination at 2030 hours was approximately 33 lux (slightly over 3 ft-ca) according to theoretical calculations (*3*), but a photographic light meter pointed at the eastern sky above the trees registered an equivalent of 110 lux. Apparently the cover of sunlit clouds increased the light above the theoretical normal for this time of day (*3*).

Visibility at the nearby airport was reported as 10 miles (16 km), and there were no local concentrations of smoke or insects in the air that could have contributed to the phenomenon. Although hydrocarbons given off by plants are invisible as long as they are molecularly dispersed, they may have been partially responsible for the visible plumes. Hydrocarbons may become visible in strong light if given sufficient time to become aggregated, or if hydrocarbon particles serve as condensation nuclei for mist droplets a vapor trail may appear. Our hypothesis is that the stomata of the elm leaves were not yet closed, and that the plumes consisted of condensed transpirational moisture or possibly a combination of water vapor and hydrocarbon emissions.

Literature on the environmental circumstances that result in leaf temperatures greater or lesser than air temperature (*4*) suggests that with overcast skies, low insolation, and active transpiration individual leaves would be cooler than the surrounding air. However, in the early evening the entire tree crown, as a unit, would be a reservoir of relatively warm air (*5*). Figure 1 shows that in a layer of air near the tree tops there was apparently sufficient warming from the trees to prevent condensation, but the closeness of the dew-point temperature to the air temperature (Table 1) indicates that condensation could readily occur in cooler air a short distance above the tree crowns.

If a similar phenomenon were observed again and if it were combined with precise measurements, our knowledge of exchange processes between plants and air could be improved. The suggestion that there was active transpiration from the leaves of elm trees 20 minutes after sunset should be tested. The precise composition of the visible plumes also remains unknown.

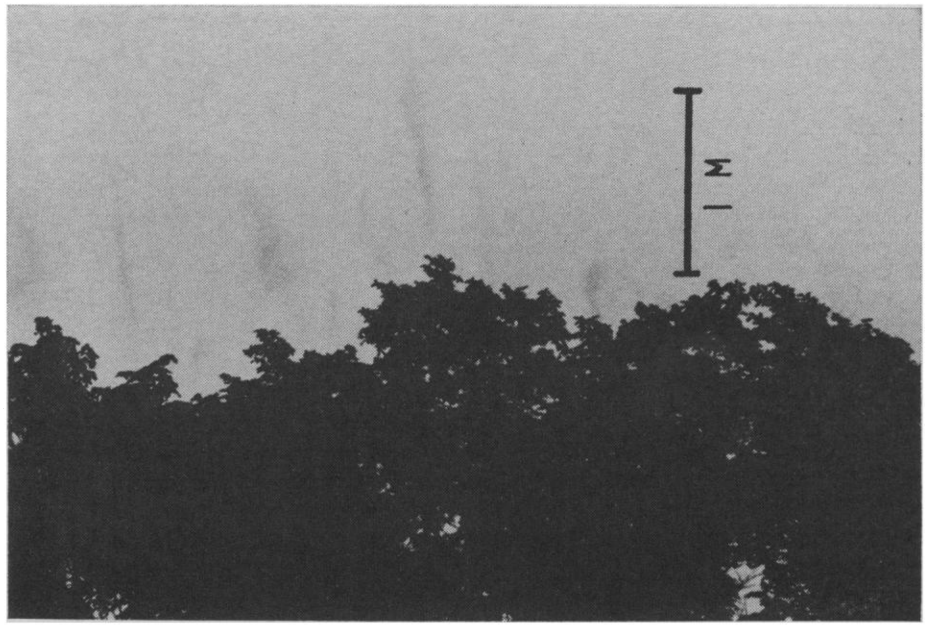

Fig. 1. Convection plumes above *Ulmus americana* L.

Table 1. Relative humidity (RH), temperature, and wind velocity 30 minutes before and after convection plumes were noted on 22 July 1964.

Time (hr)	RH (%)	Temperature (°C)		Wind velocity (km/hr)
		Air	Dew point	
2000	86	23	20	8
2100	92	20	19	9.5

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6. We thank D. M. Gates and D. F. Parkhurst, University of Colorado, and F. Went, Washington University, for comments on the manuscript.

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