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Measurement of Xylary Fluid Movement in Elm by the Thermoelectric Method

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Discussion

The retention of chlorophyll in virus-produced lesions is of interest in better understanding the effects of viruses on the host plant. The reason that chlorophyll is not broken down in certain areas of lesions remains obscure. Possibly the chlorophyll is somehow fixed by the virus so that it is resistant to the action of chlorophyllase. Inclusion bodies have been reported in trichomes of virus infected plants on numerous occasions (Littau and Black, 1952; Thaler, 1956; Milicic and Plavsic, 1956). Retention of chlorophyll in basal cells of trichomes of infected plants might be due to a high concentration of virus in these cells that inhibits bacterial destruction of chlorophyll.

Disruption of cells in the periphery of lesions on detached cotyledons in which bacteria are active suggests the possibility that damage in this area might be due more to bacteria and bacteria-produced enzymes than to the virus.

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Measurement of Xylary Fluid Movement in Elm by the Thermoelectric Method[1]

Harold S. McNabb, Jr. and John H. Hart[2]

Abstract. The thermoelectric method was used to determine the effect of external conditions and diurnal variation on the direction of xylary fluid movement in elm branches. Upward movement was detected under conditions favoring normal transpirational rates. No movement was detected during darkness or rainy conditions. Possible downward movement of branch fluid was indicated during late afternoon. Further refinement of the technique is needed for clarifying the latter observation.

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[2] Recipient of a 1960 National Science Foundation Summer Fellowship for Graduate Teaching Assistants.

The thermoelectric method has been used to measure the rate of flow of sap in herbaceous (Bloodworth *et al,* 1955; 1956) and woody (Dixon, 1937; Huber, 1932; Huber and Schmidt, 1937) stems. The assumption that the rate of movement of the sap is identical with that of the heat pulse has been questioned (Marshall, 1958a; 1958b).

Our study was concerned with the effect of external conditions and diurnal variation on the direction of xylary fluid movement in elm branches. In a previous study (Hart, 1960), a decrease in transpiration and a decrease in water level of elm leaves was indicated for the period between 9 P.M. and 3 A.M. A reversal of the flow of sap or the utilization of water in metabolic activity could account for this drop of water level not associated with increase in transpiration. A reversal of the movement of sap would help explain rapid colonization of elm by *Ceratocystis ulmi* (Bruism.) C. Moreau.

Materials and Methods

The thermoelectric method consists of brief local application of moderate heat to a small portion of a branch and subsequent measurement of branch temperature at points above and below the portion heated. The heating element consisted of four "S" shaped loops made from No. 22 chromed wire. The element was bent in a semi-circular form in order to fit closely around one-half of a branch. Branch diameter ranged from ½ to 1½ cm. Heat was applied from two 1½ volt No. 735 dry cell batteries. A switch was inserted in one of the conducting leads. Heat was applied for 25 to 100 seconds and did not appear to be injurious to plant tissues.

Surface-type thermistor probes were used to measure temperature. In most cases four probes were used. Two thermistors were placed above the source of heat, one and two inches respectively, one placed one inch below and one used as a control to measure air temperature. Time required for transfer of warmed fluid up and down the branch was recorded. By plotting time against temperature for each thermistor, the direction of fluid movement could be determined. A multi-range, multi-probe thermistor thermometer made by the Yellow Springs Instrument Co. was used to record the temperatures.

Both the heating element and the thermistor probes were secured externally to the branches by clothes pins which had been nailed one inch apart to a small board. The heating element and thermistors were always placed in a horizontal position so that air heated by the element rose clear of the probes.

Results

Upward movement of xylary fluid was detected by a heat

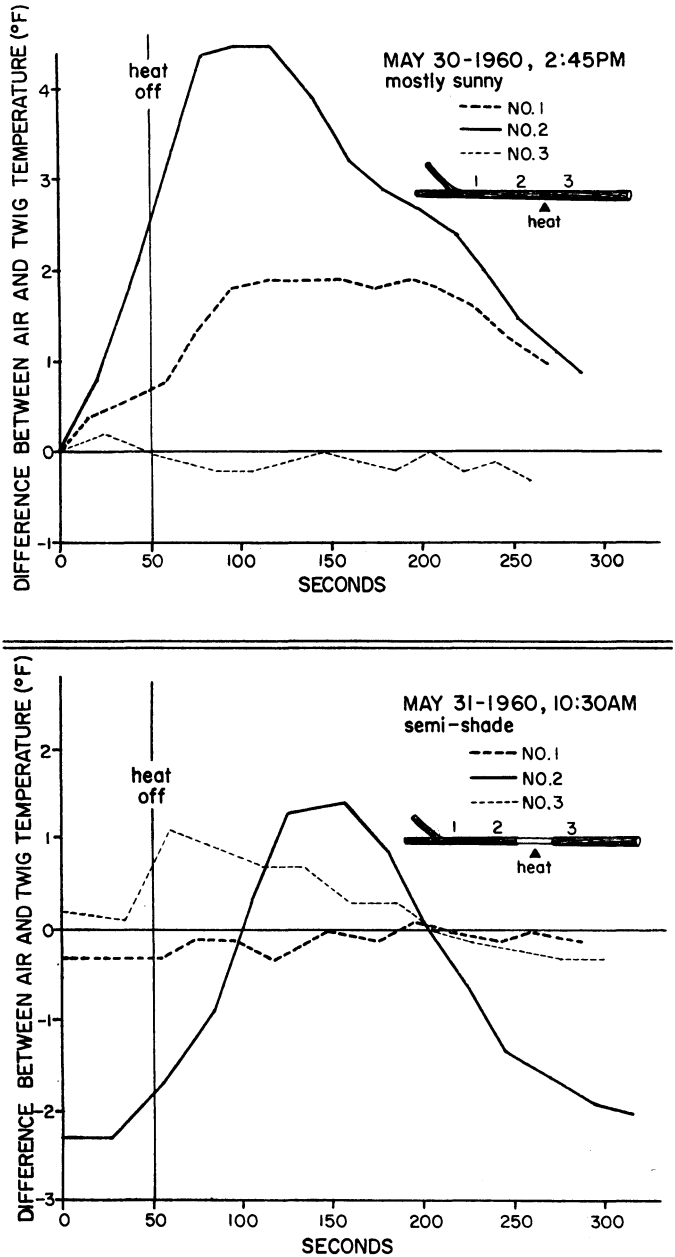

Figure 1. Temperatures of elm branches following application of moderate heat; top—heat applied to intact bark, bottom—heat applied to peeled area (Courtesy R. Albertson).

pulse during conditions favoring normal rates of transpiration (Figure 1). In addition, the bark was peeled beneath the heat source in order to break the phloem. In these cases, the initial temperature of the probe one inch above the peeled area was 2-5°F. cooler than one inch below (Figure 1). If the bark on the branch was slipped at the cambium but left intact, results duplicated those with firm bark. Removal of bark caused evaporation of moisture at the surface of the xylem. As the xylary fluid passed through the peeled area, the evaporation cooled the fluid.

No movement of xylary fluid was detected during and immediately after a misting rain (Figure 2). If the end of the branch was cut, movement also was absent. These conditions would not favor normal transpirational rates.

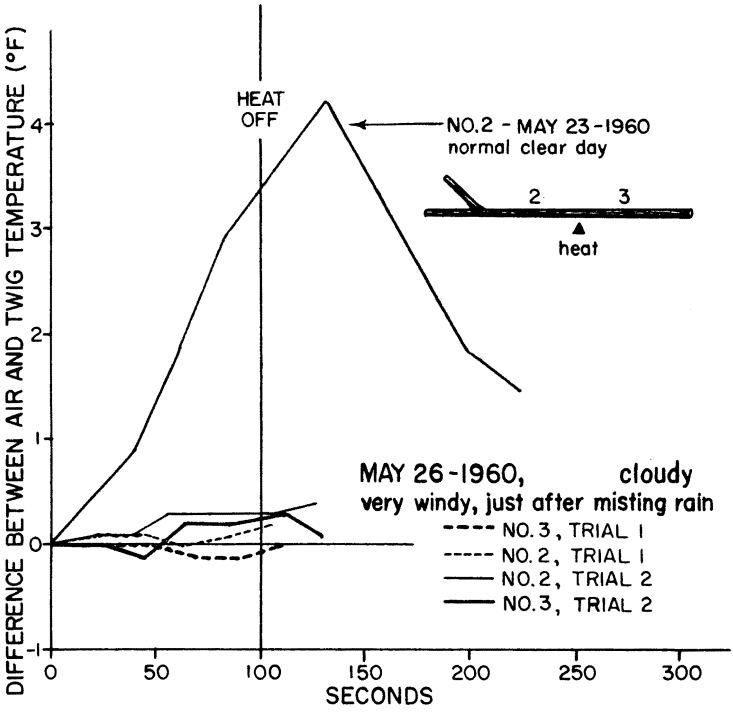

Figure 2. Temperatures of elm branch following application of moderate heat during conditions unfavorable to normal transpirational rates (Courtesy R. Albertson).

Diurnal variation in movement of xylary fluid was determined (Figure 3). Upward movement was detected during daylight hours. Possible downward movement of fluid in the branch was indicated in late afternoon. The peak of the heat pulse in the latter case could not be credited to heat diffusion alone. During darkness, movement of fluid was not detected.

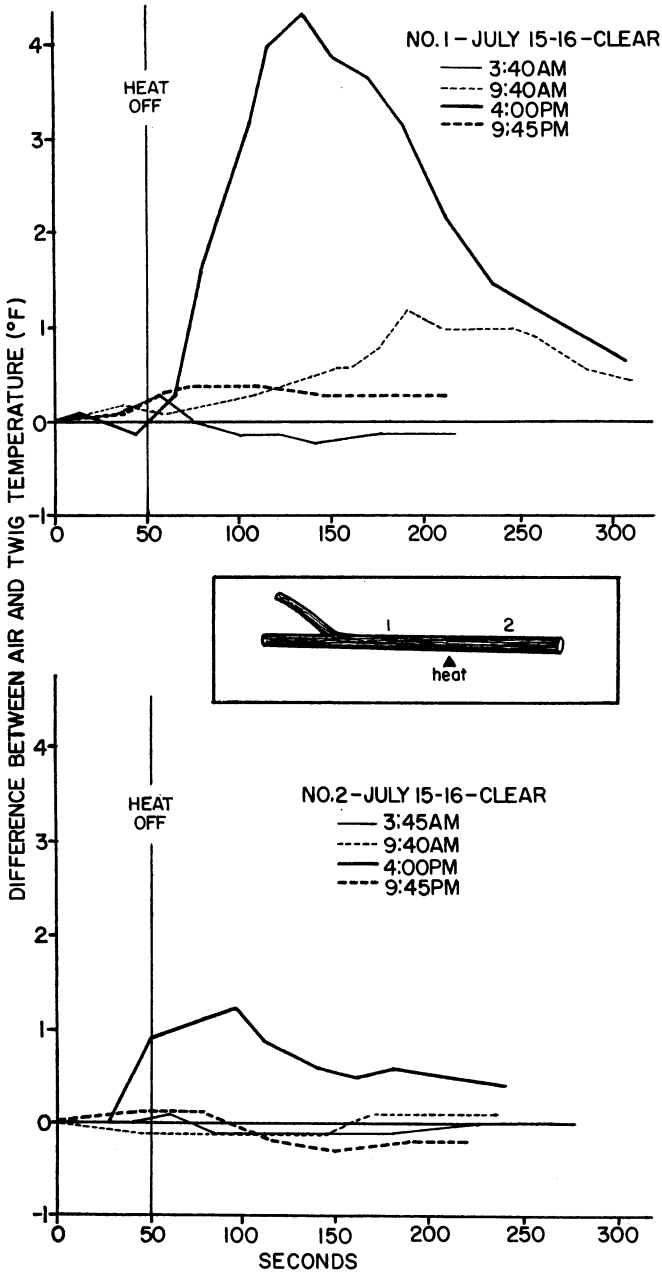

Figure 3. Temperatures of elm branch following application of moderate heat during a single diurnal period (Courtesy R. Albertson).

Discussion

The thermoelectric method enabled the detection of upward movement of xylary fluid in elm branches under conditions favoring normal rates of transpiration. In our opinion, possible downward movement of branch fluid also was indicated in a limited number of trials. Further refinement of the technique is needed in order to determine definitely the location and magnitude of this downward movement. Relationships between rapid colonization of elm trees by *C. ulmi* and possible downward movement of xylary fluid remains unknown.

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Culture of Excised Embryos of Pinus Ponderosa[1]

Virgil K. Howe[2]

Abstract. Embryos of *Pinus ponderosa* Laws. were excised and placed on a nutrient agar medium to which auxins in varying concentrations had been added. Results indicated that when the auxins were dissolved in and diluted with 40 per cent alcohol there was inhibition of seedling growth and development. Techniques were devised which eliminated the use of alcohol. In the absence of alcohol, morphologically normal seedlings were produced which were transferred to quartz sand after 60 days and at 113 days were transplanted into soil. Apparent normal growth and development continued throughout the duration of the experiment. The addition of auxins produced no significant stimulation to the growth and development of the seedlings.

[1] From a thesis submitted in partial fulfillment of the requirements for the Degree of Master of Science in Biology from the University of New Mexico, Albuquerque, New Mexico, 1961. Sincere appreciation is due Dr. Loren D. Potter and Dr. Eugene W. Rypka for their advice and encouragement during the course of this study.

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