THERMAL GRADIENTS AS CONTROL FACTORS FOR LEAF SIZE VARIATIONS AT DIFFERENT ALTITUDES IN MOUNTAINS

A.N. PUROHIT and P.P. DHYANI

High Altitude Plant Physiology Research Centre, Garhwal University, Srinagar-246 174, U.P., India

(Received 2-III-1987; 2nd version 4-II-1988)

ABSTRACT

The two parameters of leaf dimension namely, length and width, show inverse correlation with the third parameter, the thickness. A thermal diffusion model is proposed which explains the inverse relationship between these and envisages that while leaf length and width are directly influenced by the microclimate the thickness is affected by the microclimate through endoclimate and energy balance in the leaves. The significance of the model is discussed in the light of its importance in assessing the survival range of plant species along the altitudinal gradient.

1. INTRODUCTION

Variations in leaf morphology are generally coupled to the environment (Bailey & Sinnott, 1916; Raunkiaer, 1934; Taylor, 1971). It has often been assumed that the leaf morphological modifications are more of adaptive significance than of survival value (Lewis, 1972). More recent studies on the relationships between leaf structure, the environmental complex and the physiological functioning in quantitative terms, using physical principles, have revealed that the structural parameters of leaves have profound influence on their physiological behaviour and energy budget which in turn determine the acceptable environmental limits of a plant species. In other words, flexibility of the leaf dimensions is an indicator of both adaptability and survival potential.
However, the interesting point in most of the papers dealing with biophysical analysis of form and function of leaves in relation to their environment is that invariably only two parameters of the leaf dimension, namely length and width, are taken into consideration. Both these parameters are the expressions of the plasticity of the leaves. Although, the leaf size is known to be inversely associated with the leaf thickness (Taylor, 1975), no explanation has been given by anyone as to why these parameters are inversely correlated and what can be the significance of this inverse correlation between leaf size and thickness in relation to adaptability and survival of plants. The answer to this question will help in developing a better framework for the application of fundamental physical principles in understanding the biological systems.

2. MATERIAL AND METHODS

The variations in the leaf length, width, area and thickness in Potentilla atrosanguinea, Rumex nepalensis, Plantago major and Bergenia ciliata grown at 550 m, 2576 m and 3600 m altitude in Central Himalaya were studied. Six months after their growth at these altitudes, the parameters - relative humidity (%), photosynthetically active radiation (µE s⁻¹ m⁻²), diffusion resistance (s cm⁻¹), transpiration rate (µg cm⁻² s⁻¹) air temperature (°C), leaf temperature (°C) and flow rate (cm⁻³ s⁻¹) were recorded with the help of LI-1600 Steady State Porometer in three randomly selected leaves of each species at 8 am, 12 noon and 4 pm on a clear day in June, August and October, 1984. Wind speed near the leaves was measured with the help of a Photoelectric Air Flow Meter as and when readings were taken with a Porometer. The leaf dimensions were recorded as length and width at the longest and broadest points. The area of leaves was measured with the help of a LI-3000 Leaf Area Meter. Free hand sections were used to measure the thickness of leaves with the help of a Microscope and the average values of 30 cross sections of each species were used in calculations. The correlation coefficients were worked out