

**Boardman N K.** Comparative photosynthesis of sun and shade plants.

*Annu. Rev. Plant Physiol.* 28:355-77, 1977.

[Division of Plant Industry, CSIRO, Canberra City, ACT, Australia]

Plants are adapted to their light environment. Plants that occupy shaded habitats perform efficiently at low light intensities but are incapable of high rates of photosynthesis in high light intensities. Plants that grow in sunny habitats have a high capacity for photosynthesis but are less efficient than shade plants at low light intensities. My paper reviewed the mechanisms underlying the differences in photosynthetic characteristics of sun and shade plants and the adaptation of a single plant species to growth at different light intensities. [The *SCI*<sup>®</sup> indicates that this paper has been cited in over 375 publications.]

## Adaptation of Plants to Their Light Environment

N. Keith Boardman  
Office of the Chief Executive  
CSIRO  
Canberra, ACT  
Australia

April 25, 1989

My interest in the adaptation of plants to their light environment was kindled by the visit to Canberra in 1971 of Dr. Olle Bjorkman from the Carnegie Institution at Stanford. Olle spent 10 months in Canberra as a visiting investigator at the Australian National University (ANU). His infectious enthusiasm for his research on the adaptation of plants to their environment stimulated the coalescence of scientists from CSIRO's Division of Plant Industry and ANU (whose scientists were specialists in different fields of photosynthesis) into a wonderful team. It was indeed an exciting and very productive time, and the success of our efforts over a relatively short time was a clear demonstration of the value of teamwork and the cross-fertilization of ideas.

The studies included a characterization of the light climate in the densely shaded habitat of the floor of the tropical rain forest of Lamington National Park, Queensland, and photosynthetic gas-exchange measurements of plants *in situ*, using a well-equipped mobile laboratory from ANU. At the same time, leaf samples were collected from the rain forest and flown to my laboratory at CSIRO in Canberra, where ultrastructural and anatomical measurements were carried out by David Goodchild and Alex Pylotiis. Biochemical and photochemical studies were made on isolated

chloroplasts and the separated photochemical systems of shade plants by Jan Anderson, John Thorne, and me.

In addition to the studies on plants grown in their native habitat, the team also investigated the adaptation of *Atriplex* plants to different light intensities in the CSIRO phytotron. Again a comprehensive set of measurements was made including gas-exchange studies on plants *in situ*, ultrastructure determination, photochemical studies, and cytochrome measurements on isolated chloroplasts.

These comparative studies on sun and shade plants conclusively demonstrated that several factors are modified when plants are adapted to different light intensities. It was concluded that there is an integrated adjustment of the component processes involved in CO<sub>2</sub> fixation to suit the available quantum flux, but the range of adjustment varies widely with different genotypes and reflects a genotypic adaptation to the particular conditions prevailing in the native habitat.

Olle was the catalyst for commencing the study, and his prodigious personal effort and enthusiasm stimulated all of us.

Unfortunately, I did not have the opportunity to visit the rain forest during the study because of the pressure of work in the laboratory at Canberra. But my wife and I had the great pleasure to spend four days at Lamington National Park in 1973 with Robin and Priscilla Hill from Cambridge. Robin was spending a few months in my laboratory at the time, and we decided to visit the experimental sites and do some hiking in the rain forest and learn something about the plants and birds of that wonderful tropical environment—a truly wonderful experience.

In 1987 the Research School of Biological Sciences at ANU decided to honour the role of Professor Sir Rutherford Robertson in biological research in Australia by establishing a series of symposia. The first Robertson symposium was an international one and was devoted to the ecology of photosynthesis in sun and shade plants. The proceedings, which were published<sup>1,2</sup> recently, coincide with a new wave of enthusiasm for function analysis of the photosynthetic apparatus in response to irradiance, and the attendant problems of acclimation and photoinhibition.

1. Evans J R, von Caemmerer S & Adams W W, eds. *Ecology of photosynthesis in sun and shade*. Australia: CSIRO, 1988.  
2. Ecology of photosynthesis in sun and shade. (Whole issue.) *Aust. J. Plant Physiol.* 15(1-2), 1988. 358 p.

A-14

CC/AB + ES