**1.5 Absorption and reflection of radiation**

Authors’ note: *We need to explain here the physics of absorption and reflection*

*from the point of view of optical properties. Photochemistry will be introduced in*

*a separate chapter.*

**1.6 Radiation interactions in tissues and cells**

Leaves function specifically as organ of light capture for plants, and such as their structure and arrangement maximises the possibility of light interception and capture within the confines of the specific architecture of species and as moderated by the light environment of the plant.

Epidermal cells facilitate transmittance of photosynthetically active radiation to the mesophyll where photons was absorbed by chlorophyll, while screening those wavebands that are not useful in photosynthesis such as UV radiation. Trichomes on the epidermis and wave blooms in the cuticle can also reduce the PAR penetrating the leaf in environments where irradiance is likely to exceed the leaf’s photosynthetic capacity.

The optical properties of leaves have been studied at the cellular level using fibre optics to detect penetration of radiation along transverse sections of the leaf.

**1.7 Radiation interactions in plant canopies**

The attenuation of visible and UV radiation by canopies is difficult to describe

mathematically because it is a complex phenomenon. The spatial distribution

of leaves is in most cases not uniform, the display angle of the leaves is not

random, and may change with depth in the canopy, and even in some cases

with time-of-day. Here we give only a description of the simplest approach,

the use of an approximation based on Beer’s law as modified by (**Monsi1953**),

reviewed by (**Hirose2005**). Beer’s law (Equation **??**) assumes a homogeneous

light absorbing medium such as a solution. However, a canopy is heterogenous,

with discrete light absorbing objects (the leaves and stems) distributed in a

transparent medium (air).

*Iz* = *I*0 · e−*K Lz* (1.16)

Equation **??** describes the radiation attenuated as a function of leaf area index

(*L* or LAI) at a given canopy depth (*z*). The equation does not explicitly account

for the effects of the statistical spatial distribution of leaves and the effects of

changing incidence angle of the radiation. Consequently, the empirical extinction

coefficient (*K*) obtained may vary depending on these factors. *K* is not only a

function of plant species (through leaf optical properties, and how leaves are

displayed), but also of time-of-day, and season-of-year—as a consequence of

solar zenith angle—and degree of scattering of the incident radiation. As the

degree of scattering depends on clouds, and also on wavelength, the extinction

coefficient is different for UV and visible radiation. Radiation extinction in

canopies has yet to be studied in detail with respect to UV radiation, mainly

because of difficulties in the measurement of UV radiation compared to PAR,

a spectral region which has been extensively studied.

Ultraviolet radiation is strongly absorbed by plant surfaces, although cuticular

waxes and pubescence on leaves can sometimes increase UV reflectance. The

diffuse component of UV radiation is larger than that of visible light (Figure

**??**). In sunlit patches in forest gaps the diffuse radiation percentage is lower

than in open areas, because direct radiation is not attenuated but part of the

sky is occluded by the surrounding forest. Attenuation with canopy depth is

on average usually more gradual for UV than for PAR. The UV irradiance

decreases with depth in tree canopies, but the UV:PAR ratio tends to increase

(**Brown1994**). In contrast, (**Deckmyn2001**) observed a decrease in UV:PAR

ratio in white clover canopies with planophyle leaves. (**Allen1975**) modelled

the UV-B penetration in plant canopies, under normal and depleted ozone

conditions. (**Parisi1996**) measured UV-B doses within model plant canopies

using dosimeters. The position of leaves affects UV-B exposure, and it has

been observed that heliotropism can moderate exposure and could be a factor

contributing to differences in tolerance among crop cultivars (**Grant1998**;

**Grant1999**; **Grant1999a**; **Grant2004**).

Detailed accounts of different models describing the interaction of radiation

and plant canopies, taking into account the properties of foliage, are given by

(**Campbell1998**) and (**Monteith2008**).

Authors’ note: *Add Chelle, Ross?*