Chloroplast movements are one of the mechanisms which plants use to optimize photosynthetic efficiency. In leaves illuminated with low light, chloroplasts move within the cells to maximize light capture. In high light, they avoid excess radiation by moving to shaded parts of the cells. Chloroplast movements in most plant species are controlled by phototropins, blue and ultraviolet (UV) sensitive photoreceptor proteins. However, the impact of the UV part of the spectrum on chloroplast movements has not been studied as extensively as the blue part of the spectrum, despite the unique biochemical, physiological, and morphological effects of this radiation. The aim of the project is to understand how chloroplasts respond to sunlight, which contains ultraviolet, using model light conditions in the laboratory and by investigating plants growing in an ultraviolet intensity gradient naturally occurring in the Tatra Mountains due to varying altitudes. Such studies will provide valuable insights into how chloroplasts respond to natural sun irradiation. The obtained results will allow us to improve research on chloroplast positioning performed in controlled laboratory conditions, making it more physiologically relevant.

UV radiation is an important component of the solar spectrum which is not used in standard artificial illumination of growth chambers due to safety reasons. Most of the ultraviolet in the sunlight spectrum falls into the UV-A band, which is radiation with wavelengths a bit shorter than blue light. However, a physiologically important amount of UV-B, characterized by even shorter wavelengths, is also present in sunlight. We will investigate the long- and short-term impact of UV radiation on chloroplast movements in model species grown in environmental chambers. Studies of the long-term effects will be focused on the leaf anatomy and the content of screening compounds that plants form to absorb ultraviolet. The studies on the short-term effects of ultraviolet will focus on a detailed characterization of chloroplast movements in response to short-wavelength radiation. We will investigate how phototropins, photoreceptors responsible for movements, perceive different wavelengths and control the chloroplast behavior within the cell. In the second part of the project, we plan to investigate how mountain species of plants adapted their chloroplast movements to an altitude gradient of UV radiation. We will investigate the physiological and morphological responses of plants growing at different altitudes in the Tatra Mountains, in the range of 700-2000 m above sea level. The amount of UV in the solar spectrum increases 5-7% every 1000 m. We will investigate species showing a broad ecological amplitude, capable of growing at the lower montane and alpine belts or rock communities, which differ in UV exposure. We will also use pairs of closely related species (sister species), with one growing in the mountains and the second occupying low altitudes.

Investigations of light and temperature effects on chloroplast movements will improve our understanding of how complex interactions between environmental factors affect biomass production in natural environments. This may be translated in the future to enhance the performance of crop species in the field.