Zusammenfassung

Es wird eine Methode beschrieben, welche die Messung von Photosynthese oder Atmung kleinster Objekte, zum Beispiel einzelner Moosblättchen, erlaubt, mit einer Genauigkeit im Bereich von 10^{-3} μl. Die verwendete Apparatur, die eine ständige Beobachtung des Objektes gestattet, ist nach dem Prinzip des Differentialkapillarenrespirometers gebaut. Das zu untersuchende Objekt befindet sich in einem hängenden Tropfen, ohne direkten Kontakt mit der Carbonatpufferlösung, die als CO_2-Quelle dient. Mit Hilfe einer Kontrollkammer und einer besonderen Auswertungsmethode lassen sich durch Temperaturschwankungen verursachte Fehler ausgleichen.

The Dependence of Photosynthesis on the Arrangement of Chloroplasts

Little attention has so far been given to the influence exercised on photosynthesis by the arrangement of chloroplasts, although it has been established that the different positions occupied by the chloroplasts in the plant cell are not without effect on the amount of absorbed light energy (SCHANDERL and KAEMPFERT[1], ZURZYCKI[2]). To explain in what way the arrangement of chloroplasts modifies the rate of photosynthesis the course of photosynthesis with simultaneous observation of chloroplast position for 3 species, *Mougeotia sp.*, *Funaria hygrometrica* and *Lemna trisulca*, was investigated with the aid of the method described in the foregoing report.

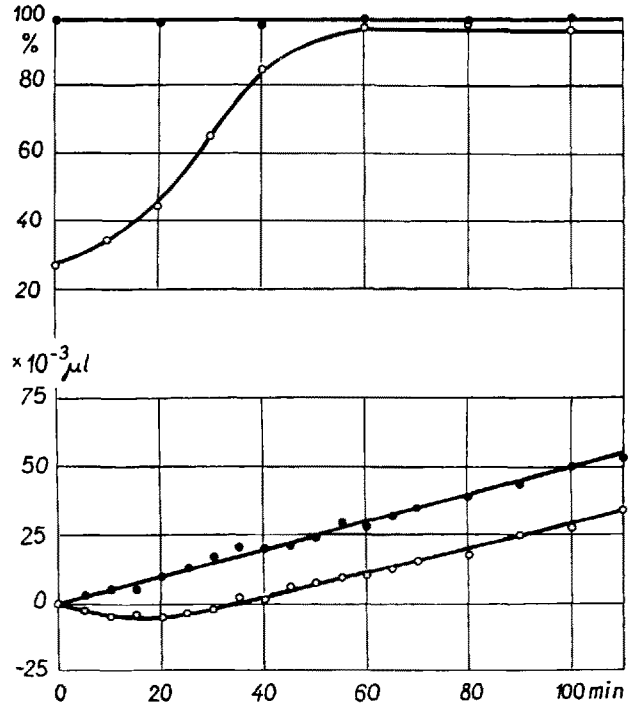
The change from weak light to darkness causes in the cells of *Lemna* or *Funaria* a transition of chloroplasts from a flat position (epistrophe) to the side cell walls (apostrophe). Respiration takes place at an unchanged rate all the time the leaf is in darkness. The movement of the chloroplasts to apostrophe is not connected with any measurable change in the rate of respiration.

The displacement of chloroplasts from apostrophe to a flat position in weak light had an influence on the rate of photosynthesis. The assimilation is at first markedly lower, quickens after some time and reaches a constant value after 15–30 min. The time when the change of assimilation rate takes place corresponds fairly well with the time when chloroplast arrangement changes. The relation between assimilation and the chloroplast arrangement is extremely well visible in the case of *Mugeotia*. In this alga it is possible in the dark to keep both the flat and profile position of the chloroplast. Figure 1 shows the course of photosynthesis in the same alga filaments when the object is illuminated with light 430 lux after a dark period. In one case the chloroplasts are in a flat, and in the other in a profile position.

Very similar changes in photosynthesis may be observed when the chloroplasts move in weak light to epistrophe from a profile position caused previonsly by strong light (parastrophe).

When the chloroplasts are in epistrophe, strong light causes their quick movement to a profile position. The rate of photosynthesis does not change during the whole time the strong light acts. The rate of O_2 production is the same in the first minute when chloroplasts are still in a flat position as after 30 min, when all of them are already in parastrophe.

This phenomenon may be explained by the light curve of photosynthesis and the curve recording chloroplast arrangement. The light intensities which cause parastrophe lie within the range of light intensities which have no further influence on photosynthesis. The movement of chloroplasts from a flat to a profile arrangement is always connected with a change of light absorption, but such a change influences the rate of photosynthesis only in low light intensities when light is the limiting factor (GÓRSKI[1]). In strong light, the displacement of the chloroplasts has no such influence.



Mugeotia sp. Total lenght of filaments approximately 53 mm. Light 430 lux (before in darkness). —●— chloroplasts in darkness in flat, —○— in profile position. Upper curve: The change int he mean area of chloroplast expressed as percentage of cell areas. Lower curve: The oxygen production or consumption in 10^{-3} μl in time.

For all 3 investigated species the shape of the light intensity-photosynthesis curve shows some relation to the chloroplast arrangements. As long as the photosynthesis rate increases proportionally to the light intensity the chloroplasts are in epistrophe. Full parastrophe is reached approximately in those light intensities in which a further increase of intensity has no influence on photosynthesis.

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Zusammenfassung

Der Zusammenhang zwischen Chloroplastenstellung und Photosynthese wird durch gleichzeitige Messung des Gasaustausches und Registrierung der Chloroplastenstellung untersucht. Die Bewegungen der Chloroplasten in Dunkelheit haben keinen Einfluss auf die Atmungsintensität. Die Bewegungen, welche im schwachen Licht zur Vergrösserung der Assimilationsfläche führen (Bewegung der Chloroplasten von Profilstellung, hervorgerufen durch Dunkelheit oder starkes Licht, zur Flächenstellung), bringen eine Steigerung der Assimilationsintensität. Dagegen schreitet die Photosynthese im starken Licht mit unveränderter Intensität fort. Sie ist unabhängig von den gleichzeitig verlaufenden Chloroplastenverlagerungen. Die Ergebnisse werden auf Grund des Minimumgesetzes diskutiert.

[1] H. SCHANDERL und W. KAEMPFERT, Planta *13*, 700 (1933).
[2] J. ZURZYCKI, Acta Soc. Bot. Pol. *22*, 299 (1953).

[1] F. GÓRSKI, Acta Soc. Bot. Pol. *22*, 1 (1953).