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INTEGRATING PHOTOCHEMICAL LIGHT MEASUREMENT, AN ECOLOGICAL STUDY IN THE MIDDACHTEN WOODLAND IN THE NETHERLANDS

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CONTENTS

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1. Introduction

The purpose of this article is to describe integrating light measurements in different forest types of the Middachten woodland, which have been extensively described earlier from the ecological view-point (Maas, 1959, Westhoff, 1957).

It appeared highly desirable to have an integrating method, which renders possible to measure light in canopies and might also be useful for crop plants, green houses, etc. in investigations of the light climate of the plants over a period of time.

Until now, low priced and practical methods for integrating light measurements were almost non-existant. The anthracene method of Dore (1958) opened new ways for ecological research. In this report, the practical value of the anthracene method for our purpose will be tested and discussed.

2. Some considerations regarding the requirements of the method of measuring light

Schulze (1956) states that the plant is no physical instrument, but a living organism being in constant interaction with its environment. Therefore, the plant's reaction to the light received is very complicated, and depends on a complex of many environmental factors. Generally, a simple relation between a special environmental factor and the production of dry matter cannot be expected to exist over a prolonged time. Photosynthesis e.g. is not directly proportional to the amount of radiation received, and the spectral composition of the light is also an important factor in various photobiological processes.

Tranquillini (in Ruhland, 1960 p. 304–305) characterizes the problem of light measurement in three basic questions which we will discuss under the following headings:

a. Is the purpose of the light measurement physical or biological and is the interest mostly concerned with radiation upon a surface or into a space?
b. Is a selective or a non-selective light measurement technique required?
c. What role does time play in the measurement?

Ad a.

While physicists and meteorologists are interested in the separate direct and diffuse radiation, for the ecologist, the total radiation received by a plant is more relevant. In principle one can choose between measurements with a flat or a spherical light receiver. The first type answers to the question of light influx onto a surface, the latter to that of light influx into a certain space. Which type of measurement the biologist will prefer depends largely upon the relation between horizontal and vertical extension of the object. We prefer the first type to characterize radiations in plant communities with a preferent horizontal extension, the latter in cases in which the vertical extension of the object is relatively important (Wassink and Van der Scheer, 1951).

Wassink (1954) and Wassink and Van der Scheer (1951) described a photo-electrical spherical light meter, consisting of two photo-electric cells positioned back to back, each covered with a nearly half-sphere shaped opaline glass in such a way that the instrument as a whole is insensitive to the direction of the incident light.

Ad b.

Light energy of all wavelengths is measured with a non-selective radiation meter. On the other hand, energies in specific wavelength intervals can be measured with a selective meter or with a non-selective light meter adapted with filters. Radiation measurement has been based on the measurement of temperature increase either in a black body (thermocouple method) or in a material subject to distillation (e.g. BELLANI's sphere-pyranometer). MÖRIKOFER (1949) defines selective radiation meters as photometers. Examples are instruments based upon photochemical principles (e.g. the anthracene method of DORE, 1958, the transformation of oxalic acid in the presence of uranyl salts, VAN EMBDEN and LAOH, 1953), upon the photographical principle (blackening of silver-halogen compounds, which method has been widely used in the past) or upon the photo-electric principle (alcali cells, semiconductors and light sensitive electronic tubes).

Ad c.

The distinction between momentary and integrating light measurement is to be made when time has to be introduced as an important factor. The integration of the amount of energy received with time is of great importance, when light intensity fluctuates per unit time and area. For the ecologist, the momentary light measuring method thus is certainly insufficient and moreover unpractical, especially during strongly fluctuating cloudiness. Speaking about integrating light measuring methods, directly indicating systems are strongly preferent, but very expensive and rather elaborate for ecological purposes. Therefore, much attention has been given to simple and accurate integrating methods, which are discussed e.g. by DORE (1958), VAN EMBDEN and LAOH (1953), FRIEND (1959), MARQUIS and YELENOSKY (1962) and MARYNEN and DE SLOOVER (1963).

In an attempt to apply a simple integrating method to the as such difficult light measurements under a canopy, the following questions had to be considered:

- Are the basic principles underlying the method sufficiently understood?
- Which are the possible influences of the environment on the method (e.g. sensitivity to temperature)?
- Is the apparatus economical and practical (e.g. weather-proof), and does it easily permit simultaneous measurements at different locations?

A persual of the relative literature revealed that the anthracene method answered fairly well most of the requirements and seemed worth trying. With a view to the ultimate measurements as such, we have moreover considered the following points:

- Is the integrated light measurement really preferable to a momentary system?

- Are the size and the location of sampling places properly representative for the canopy?
- Is the light intensity measured representative for a certain period of time?
- Is the calculated relative light intensity[1] (in German literature: relativer Lichtgenuss) at a certain place in the canopy relevant for the underlying physiological processes?

3. THE ANTHRACENE METHOD FOR PHOTOCHEMICAL LIGHT MEASUREMENT

3.1 *Abstract from literature*

The chemistry of photodimers extends back to 1867, when the first synthetic photodimer was obtained by FRITZSCHE who observed the formation of insoluble dianthracene when a benzene solution of anthracene was irradiated with sunlight (MUSTAFA, 1952). The photochemical process is a diradical dimerization, activated by light quanta. The formation of the dianthracene molecule is explained as follows: excitation by light quanta changes a normal anthracene molecule in a diradical on the ninth and tenth positions of the molecule. When an excited and a non-excited molecule collide, the dianthracene molecule comes into existance. The dianthracene formation is directly proportional to the number of absorbed light quanta.

This reaction takes place in a great number of solvents, e.g. xylene, toluene, ethyl alcohol, acetic acid, nitrobenzene or ethyl benzoate (MUSTAFA, 1952). The photochemical reaction should take place in an oxygen-free environment, otherwise the anthracene may polymerize and become yellow.

The influence of the temperature on the reaction speed is very complicated as the quantum yield increases with increasing temperature. At very high temperatures the polymerization is reversed. In darkness dianthracene in boiling phenetole or anisole is completely converted into anthracene (MUSTAFA, 1952, SUZUKI, 1949). With increasing concentrations of anthracene, the rate of photopolymerization to dianthracene increases at first, then remains independent of concentration (SUZUKI, 1943, 1949, 1950).

In conclusion, we can state that the total process is an equilibrium reaction in which at very high temperatures the balance shifts to the anthracene side and at lower temperatures to the dianthracene side. One or more of the partial processes involving the dianthracene formation are temperature-dependent and obviously not photochemical. The reaction dianthracene-anthracene is non photochemical, but merely a result of temperature increase.

For ecological purposes the anthracene-dianthracene reaction has been applied by DORE (1958), MARQUIS and YELENOSKY (1962), FRIEND (1959) and DE SLOOVER and MARYNEN (1963). In 1958 DORE used this method with benzene as a solvent. In his short article he describes the method as inexpensive,

[1] Relative light intensity is the amount of radiation received at a certain location in the canopy expressed in % of the amount of radiation received in the open field.

simple to use and very suitable for ecological work. He used screw-cap vials with bakelite caps. Before and after light exposure, the concentration of anthracene is measured with a spectrophotometer. The logarithm of the anthracene concentration after light exposure proved to be proportional to the absorbed light energy.

In 1962, an accurate report of the research by MARQUIS and YELENOSKY appeared. At that time the research described in this paper was already finished. MARQUIS and YELENOSKY (1962) used an anthracene concentration (3-6 gram per liter) similar to the one used in the present case (4 gram per liter). DE SLOOVER and MARYNEN (1963) working independant of the present author, state that the anthracene method will only be valid if the amount of energy absorbed by the anthracene receiver represents an almost constant fraction of the total radiation of the whole solar spectrum. They found a very satisfactory correlation between the residual concentration of anthracene after light exposure and the total radiation of the whole spectrum during the same time measured by the Radiation Laboratory of the Royal Meteorological Institute of Uccle in Belgium. This statement holds true for overcast weather (diffused radiation) as well as for a clear sky (predominant direct radiation).

We found the absorption of anthracene dissolved in benzene to be entirely below 390 mμ with maxima at 326, 341, 359 and 378 mμ, indicating that only ultra-violet radiation can be held responsable for the transformation of anthracene into dianthracene. As the light absorption by the leaves below 400 mμ is very great, almost no ultra-violet radiation will reach the undergrowth. Thus, the anthracene method may be expected to be slosely related to the cover-density.

3.2 *Methods*

This research was started as a result of the fact that no practical light measuring system for ecological purposes existed. The author's interest in the experimental work with the anthracene method was aroused by DORE's (1958) short communication.

The starting point was a light sensitive solution of chemically pure anthracene in benzene. The concentration of this solution during all experiments was 4 g/liter benzene to prevent crystallization of anthracene at low outside temperatures. The solution was made at 20 °C and was continuously checked spectrophotometrically and stored for a short time in a dark chamber at 20 °C.

Sphere-shaped glass containers were filled with the light sensitive solution. The glass sphere, measuring 55 cc, ended in a stem which could be closed with a cork. The containers were filled with 49 cc light sensitive solution by means of a buret. The remaining volume of the containers was filled up with distilled water. By turning the containers upside down, the anthracene solution was made to float on the water in the stem, thus preventing the benzene from corroding the cork. A temperature of 25 °C proved to be the upper limit for breaking the glass of the containers due to expansion. The containers were stored at room temperature and transported in a light-proof box (see photo 1), padded with foam plastic to prevent breaking.

Under the canopy the containers were positioned on the top of wooden poles (see photo 2). During the whole season, the poles stood in the same position. At the top of each pole was a metal clip, which fitted around the glass stem of the container in such a way that even during stormy weather no dammage occurred. The light meters were mounted exactly 25 cm above ground level as the light intensity under the canopy is strongly determined by the height above the ground. The coverage of the ground in the open field (control) was shortly cut grass, while in the woodland a small amount of the herb layer was removed around the container to prevent overgrowing. Positioning and removal of the light meters took place at such times of the day that incident light quantities before placing and after removing were equal and negligible as far as possible. Herewith is assumed that the light distribution during the day is symmetric which is not quite true.

The light quantity received over a certain period and over a certain wavelength area can be determined in two ways:

- By spectrophotometrical determination of the anthracene concentration before and after the illumination.
- By determining the quantity of dianthracene precipitate formed after the illumination.

The second method was chosen, as it was the most simple and economical. The quantity of precipitate was determined as soon as possible after the light exposure to avoid an underestimation resulting from possible thermic decomposition of the dianthracene in darkness (see also DE SLOOVER and MARYNEN, 1963). The precipitate was removed under suction (waterjet pump) on a previously weighed filter which was weighed repeatedly until the weight remained approximately constant. The remaining dianthracene on the walls of the containers was removed by rinsing with alcohol.

The relative light intensity was calculated as follows:

Symbols used: E = relative light intensity = 100.Ew/Ev %
Ew = amount of radiation received in the canopy
Ev = amount of radiation received in the open field
K = constant
Co = original concentration of the anthracene
Cv = concentration of the anthracene after light exposure in the open field
Cw = concentration of the anthracene after light exposure in the canopy
Nv = concentration of the dianthracene after light exposure in the open field
Nw = concentration of the dianthracene after light exposure in the canopy
All concentrations expressed in gram per liter.

The relation between E and log C is linear (DORE, 1958); therefore

$$Ew = (\log Cw - \log Co) \, . \, K \text{ and}$$
$$Ev = (\log Cv - \log Co) \, . \, K$$

$$\frac{Ew}{Ev} = \frac{(\log Cw - \log Co) \, . \, K}{(\log Cv - \log Co) \, . \, K} = \frac{\log Cw/Co}{\log Cv/Co}$$

Because $Cw = Co\text{–}Nw$ and $Cv = Co\text{–}Nv$, it can be stated, that the relative

$$\text{light intensity} = 100 \, \frac{\log (1\text{–}Nw/Co)}{\log (1\text{–}Nv/Co)} \, \%$$

(in German literature: relativer Lichtgenuss).

The integrated amount of light received at a certain place in the canopy is expressed in relation to the light received in the open field i.e. in relative proportion. The absolute amount of light received on a certain location may also be calculated when a calibration curve is available (see DE SLOOVER and MARYNEN, 1963). Summarizing, the following can be stated in accordance with DORE (1958) and MARQUIS and YELENOSKY (1962):

Advantages:

- The method is inexpensive and relatively simple.
- The method is suitable for experimental ecological work because a cumulative amount of light reaching a particular location during a period of time is measured.
- The method is reliable when the temperature in the container is not too high.
- The method can be applied simultaneously and at different locations and offers real possibilities for estimating the cover-density.
- An electric power supply is not needed and there is little danger of damage from the weather; readings can even be made in underwater habitats.

Disadvantages:

- The absorption spectrum of anthracene dissolved in benzene leans strongly towards the ultra-violet side, so that only light which is of little importance for photobiological processes is measured. But MARYNEN and DE SLOOVER (9) have found that the absorbed light fraction between 350 and 400 mμ seems to be well representative for the total radiation in overcast as well as clear weather.
- Many consider the solvent benzene a bad choice because it is poisonous, inflammable, chemically agressive and has a freezing point of 4°C. Perhaps a solvent other than benzene can be chosen.
- The interaction between reaction speed and temperature is a complication which should be examined more extensively.

4. LIGHT INTENSITY STUDIES IN THE MIDDACHTEN WOODLAND

4.1 *Description of the investigated area*[1]

The area investigated is situated along the railroad track from Arnhem to Dieren in the province of Gelderland in The Netherlands.

This area was extensively described earlier from the ecological point of view by MAAS (1959) and WESTHOFF (1957). MAAS (1959) described the *Irido-Alnetum* (springwood) south of the railroad and WESTHOFF (1957) the *Querco-Betuletum* north of it. In our work the light regime in these types of woodland and in a *Pruno-Fraxinetum* was investigated by the anthracene method. In the investigated area a great number of different forest types are found as a result of big differences in the character of the soil. Simultaneous light measurements were a very real possibility as all measuring points were situated in an area of one km^2.

The flora in the area north of the railroad is very poor and belongs to only one association i.e. the *Querco-Betuletum*. The occurrence of the trees is not spontaneous; they have been planted (WESTHOFF, 1957). Undergrowth is very scarce. The terrain is hilly and planted beeches are often found on the slopes. The highest points of the terrain consist of sand on which one occasionally finds *Quercus robur* (oak-coppice), but more often *Pinus sylvestris*. The soil profile is called brown-podzolic.

The forest complex south of the railroad is situated on the lowlands (MAAS, 1959) in the valley of the river IJssel. The thick underlayer consists of peat resting on fluviatile low terras. A heavy forest grows on the forest peat which is famous for a great number of plant species rare in The Netherlands. From an ecological point of view this woodland belongs to the *Querco-Fagetea*, broad-leaved forests on fertile soil.

During this investigation, light was measured on 18 different locations in the forest and in the open field on various dates during the year 1962 and under various weather conditions. In the following, a short description according to the situation on 27-IV-1962 of the investigated vegetation in which light was measured is given.

Location A: alder-ash forest (photo 3).

Association		: *Pruno-Fraxinetum*	
Soil		: peaty swamp	
Tree layer	(15 m)	: *Alnus glutinosa*	3
		Fraxinus excelsior	3
Shrub layer	(6 m)	: *Prunus padus*	2.2
		Prunus avium	2.2
Herb layer	(40 cm)	: *Anémone némorosa*	4.5
		Ranunculus ficaria	2.2

[1] According to the BRAUN-BLANQUET system of vegetation classification. The names of the different associations used in this article, are derived from the work of DOING (1962).

	Primula elatior	2.2
	Arum maculatum	+.2
	Urtica dioica	1.1
	Filipendula ulmaria	+.2
	Lamium galeobdolon	+.2
	Rumex obtusifolius	+.1

Location B: alder forest (photo 4).

Association		: *Irido-Alnetum*	
Soil		: peaty swamp	
Tree layer	(8 m)	: *Alnus glutinosa*	5
Herb layer	(30 cm)	: *Caltha palustris*	2.2
		Cardamine pratensis	1.2
		Iris pseudacoris	1.1
		Anémone némorosa	2.3
		Deschampsia cespitosa	+.2
		Galium palustre	+.1
		Glèchoma hederacea	1.1
		Ranunculus ficaria	2.2
		Angelica sylvestris	+.1
		Urtica dioica	+.1
		Chrysoplenium alternifolium	+.1
		Chrysoplenium oppositifolium	2.3
		Lamium galeobdolon	+.1
		Carex remota	2.2
		Cardamine amara	2.3
		Filipendula ulmaria	+.2
		Rumex obtusifolius	+.1
		Valeriana officinalis	2.2
		Poa trivialis	1.2
		Phalaris arundacea	+.2
Moss layer	(4 cm)	with : *Brachythecium rivulare, Chilocyphus polyanthus, Mnium rostratum, Mnium undulatum, Mnium hornum, Fissidens adianthoides.*	

Location C: beech forest (photo 5).

Association		: *Querco-Betuletum*	
Soil		: sour loam, poor in lime and nutrients	
Tree layer	(40 m)	: *Fagus sylvatica*	5
Moss layer	(4 cm)	with : *Leucobrium glaucum, Brachythecium rutabulum.*	

Location D: oak-coppice forest (photo 6).

Association	: *Querco-Betuletum*

Soil		:	loamy sand, poor in lime	
Tree layer	(10 m)	:	*Quercus robur*	5
Shrub layer	(1,5 m)	:	*Pteridium aquilinum*	5.1
Herb layer	(30 cm)	:	*Vaccinium myrthillus*	+.1
			Deschampsia flexuosa	2.2

Location E: open field

In the forelands of the river IJssel south of the woodland, where on the measuring points no shadowing was possible.

To obtain a more complete picture of the vegetation many phaenological observations were made in the investigated forest types during the year. For all plants observed the following data were gathered: start of germination or sprouting, bud condition, leaf development, flower formation and flowering, fruiting time and time of dying off.

The weather in the spring and summer of 1962 was very cold. The temperature stayed far below normal and there was a shortage of sunshine. The spring was especially very cold and was considered as one of the coldest of the past century. Therefore the advent of the different phaenological phases was very retarded. The weather on the measuring dates was accurately described in order to determine its influence on the light measurements.

4.2 *Experimental results*

The results of the light measurements are given in Table 1 below:

The relative light intensity (r.l.i.) expressed in % of the relative light intensity on 13-IV (r.l.i. on 13-IV = 100%) is given in parenthesis.

TABLE 1

Measuring dates:	13/IV	27/IV	6/V	17/V	1/VI	22/VI	2/VIII	– 1962
Locations:								
A. Alder-ash forest	47	41	31	24	13	5	1	– r.l.i.
(Pruno-Fraxinetum)	(100)	(87)	(66)	(51)	(28)	(11)	(2)	– r.l.i. 13/IV
B. Alder forest	47	33	17	10	4	2	1	– r.l.i.
(Irido-Alnetum)	(100)	(70)	(36)	(21)	(9)	(4)	(2)	– r.l.i. 13/IV
C. Beech forest	39	34	4	1	1	1	1	– r.l.i.
(Querco-Betuletum)	(100)	(87)	(10)	(3)	(3)	(3)	(3)	– r.l.i. 13/IV
D. Oak-coppice forest	55	53	36	34	8	7	3	– r.l.i.
(Querco-Betuletum	(100)	(96)	(66)	(62)	(15)	(13)	(5)	– r.l.i. 13/IV
E. Open field	100	100	100	100	100	100	100	– r.l.i.
	(100)	(100)	(100)	(100)	(100)	(100)	(100)	– r.l.i. 13/IV

Integrating the relative amount of received light energy over the different periods, the following picture is obtained in Table 2:

Table 2 gives only an approximate picture, as its mathematical value is doubtful due to the measuring dates not being fully representative for the period.

Concerning the influence of the weather type on the light measurements the

TABLE 2. Estimation of the relative amount of light energy over the following periods:

Locations	A	B	C	D	E
13/IV–27/IV	616	560	511	756	1400
27/IV– 6/V	324	225	171	401	900
6/V – 17/V	303	149	28	385	1100
17/V – 1/VI	278	105	15	315	1500
1/IV–22/VI	189	63	21	168	2100
22/VI– 2/VIII	123	61	41	205	4100
13/IV– 2/VIII	1833	1163	787	2230	11100

following can be said: because the anthracene method works very selectively (300–400mμ), it could be expected that the dianthracene formation would be influenced by the weather type. This expectation hardly seemed to be true as the correlation between the total radiation and the spherical radiation measured with the anthracene method was rather high. Although this preliminary conclusion was based on a small sample of data, it appeared to be totally in agreement with the experimental results of DE SLOOVER and MARYNEN (1963).

The light relations in the 4 different forest types in the course of 1962 are given in figure 1.

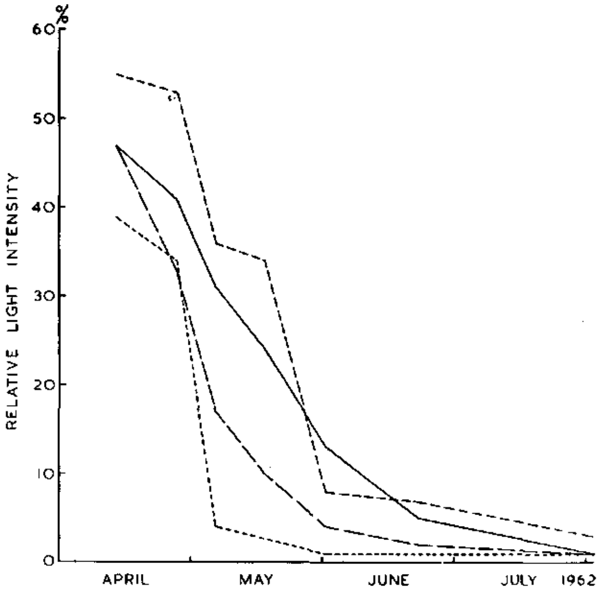

FIG. 1. Course of the relative light intensity during 1962 in the four earlier described forest types:

Location:

A. Alder-ash forest *(Pruno-Fraxinetum)* ————————

B. Alder forest *(Irido-Alnetum)* — — — — — — —

C. Beech forest *(Querco-Betuletum)* ....

D. Oak-coppice forest *(Querco-Betuletum)* - - - - - - - - -

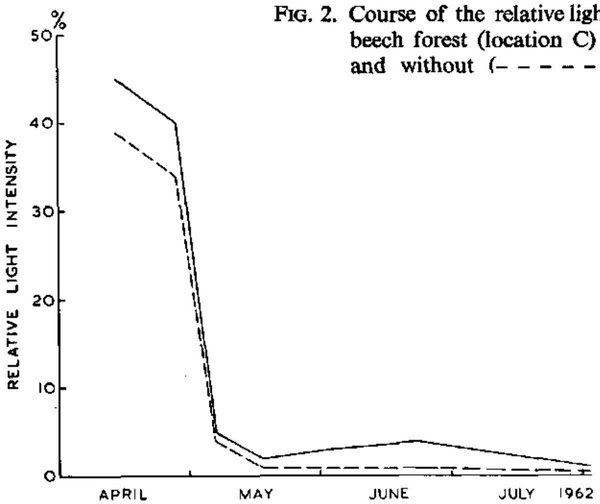

FIG. 2. Course of the relative light intensity during 1962 in the beech forest (location C) with (——————) and without (- - - - - - - - - -) border effect.

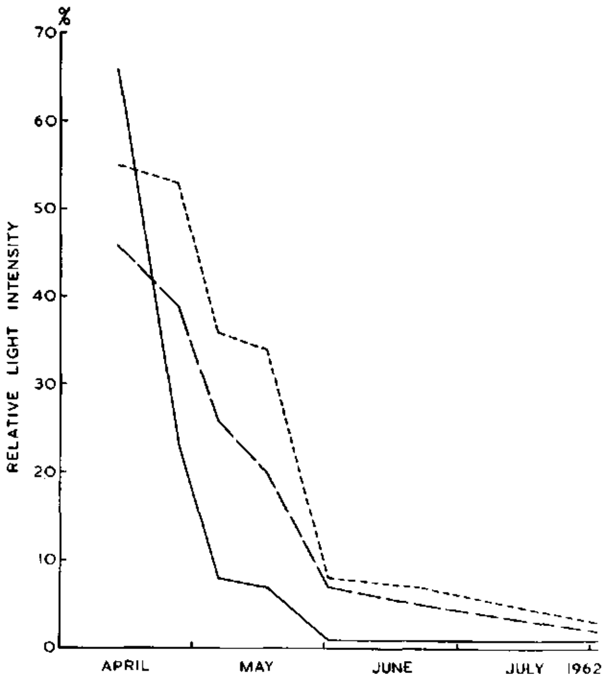

FIG. 3. Course of the relative light intensity during 1962 in three different oak forests:

—————————— *Quercus robur* with a closed and heavy shrub layer *(Prunus avium, Corylus avellana)*

- - - - - - - - - - - *Quercus robur* with *Pteridium aquilinum* (location D)

— — — — — — — — *Quercus robur* with an open shrub layer *(Corylus avellana, Sorbus aucuparia, Prunus padus, Lonicera periclymenum)*

In the beech forest (location C) there was no herb layer, only some mosses were found. In a different part of the same beech forest where a more favourable light regime reigned, herbs were found. This leads to the hypothesis that the quantity of light could be a limiting factor for the growth and development of herbs. In figure 2 the influence of the border effect on the light climate in the beech forest is given. This border effect favoured the presence of herbs in the undergrowth.

Comparing three different oak forests from which one is described earlier (location D), it appeared that the relative light intensity in the herb layer was strongly influenced by the presence of a shrub layer. The shrub layer strongly reduced the relative light enjoyment in the herb layer as can be seen in figure 3.

5. Discussion and conclusions

To get a complete picture of an environmental factor, it is necessary that year-round simultaneous measurements at different locations are made. Measuring light in the vegetation with the anthracene method has given satisfactory results. In the future this method will be valuable for analysing the relations between plant and light regime because this integrating light measurement is preferable to a momentary method. The anthracene method has the additional advantage that it is economical and practical.

In addition to the advantages and disadvantages given in Chapter 3.2 the following can be stated:

- More thorough research in the field of the physical and chemical aspects of the photochemical reaction anthracene-dianthracene should be initiated.
- Because of the disadvantages of benzene other solvents should be tested.
- Other photochemical processes with light absorption in the more visible part of the spectrum should be sought.

Comparing the light relations in the four different forest types (Figure 1), we come to conclusions, which are given in the following outline:

Locations	A.	B.	C.	D.
Associations	*Pruno-Fraxinetum*	*Irido-Alnetum*	*Querco-Betuletum*	*Querco-Betuletum*
Major species in the tree layer	*Alnus glutinosa* *Fraxinus excelsior*	*Alnus glutinosa*	*Fagus sylvatica*	*Quercus robur*
Relative light intensity before leaf development	high (47%)	high (47%)	average high (39%)	very high (55%)

Locations	A.	B.	C.	D.
Relative light intensity after complete leaf development	low (1 %)	low (1 %)	low (1 %)	high (3 %)
Decrease in relative light intensity after leaf development	very slow	gradually	very quick	gradually
Total received radiation (relative) during the period 13/IV till 2/VIII in 1962	1833	1163	787	2230

SUMMARY

The purpose of this research was to test the practical value of a photochemical light meter, based upon the polymerization of anthracene dissolved in benzene into insoluble dianthracene under the action of sunlight. The relative light intensity on a certain location in the vegetation can be estimated by determining the quantity of formed dianthracene precipitate and using the given formula. The glass containers used for the light measurements and filled with the light sensitive solution (starting concentration 4 gram per liter) were sphere-shaped in order to obtain spherical light measuring.

The light measurements have been carried out in the Middachten woodland in The Netherlands. This woodland has already been extensively described from the phytosociological point of view. In the investigated area a large number of different forest types are found as a result of great differences in the character of the soil. Simultaneous light measurements were made during the period April till August 1962 in the following associations – *Pruno-Fraxinetum*, *Irido-Alnetum* and *Querco-Betuletum*. The results of the light measurements are always expressed relatively i.e. in relation to the quantity of light fallen in the unshaded open field. The trend of the relative light intensity in the course of 1962 in the different forest types is given.

For this ecological research the anthracene method has given very satisfactory results and in the future this method will be valuable for analysing the relations between plant and environment.

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the Laboratory of Plant Physiological Research of the Agricultural University, Wageningen.

SAMENVATTING

Het doel van dit onderzoek vormde een lichtmeetmethode volgens een fotochemisch principe op practische bruikbaarheid te toetsen, waarbij onder invloed van zonlicht antraceen opgelost in benzeen wordt omgezet in onoplosbaar diantraceen. Door meting van de hoeveelheid neergeslagen diantraceen kan met behulp van een ontwikkelde formule de relatieve lichtintensiteit bepaald worden op een bepaalde plaats in de vegetatie. De lichtgevoelige oplossing met een uitgangsconcentratie van 4 gram antraceen per liter benzeen, bevond zich tijdens de lichtmetingen in glazen bolletjes om op deze wijze de sferische lichtmeting te benaderen.

De lichtmetingen werden verricht in het bosgebied van Middachten in Nederland. Dit onderzoekgebied is in vegetatiekundig opzicht reeds goed beschreven en bevat een groot aantal verschillende bostypen als gevolg van een grote verscheidenheid in bodemgesteldheid. Simultane lichtmetingen werden verricht in de periode april tot augustus 1962 in de volgende associaties: *Pruno-Fraxinetum*, *Irido-Alnetum* en *Querco-Betuletum*. De uitkomsten van de lichtmetingen zijn steeds relatief uitgedrukt ten opzichte van de lichthoeveelheid, die in het open veld zonder beschaduwing viel. Het verloop van de relatieve lichtintensiteit in de loop van 1962 in afhankelijkheid van de bladontwikkeling werd besproken.

De toegepaste antraceen-methode heeft voor dit oecologische onderzoek goed voldaan en zal voor de analyse van de betrekkingen tussen plant en milieu zeer bruikbaar zijn.

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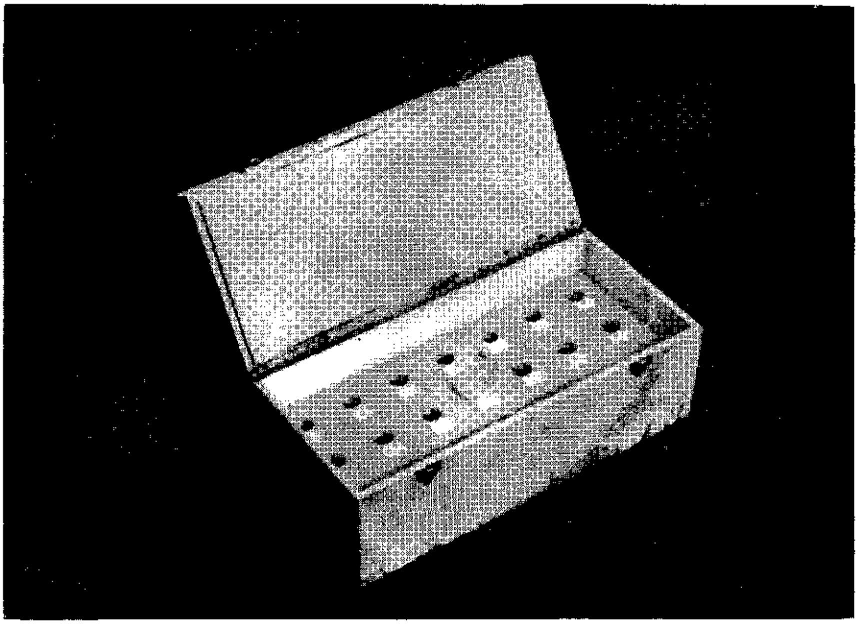

PHOTO 1. Light-proof box padded with foam plastic to prevent breaking for the transport of the light meters.

PHOTO 2. Positioning of the light meter on the top of a wooden pole. On the top of the pole is fastened a metal clip which fits around the glass stem of the light meter.

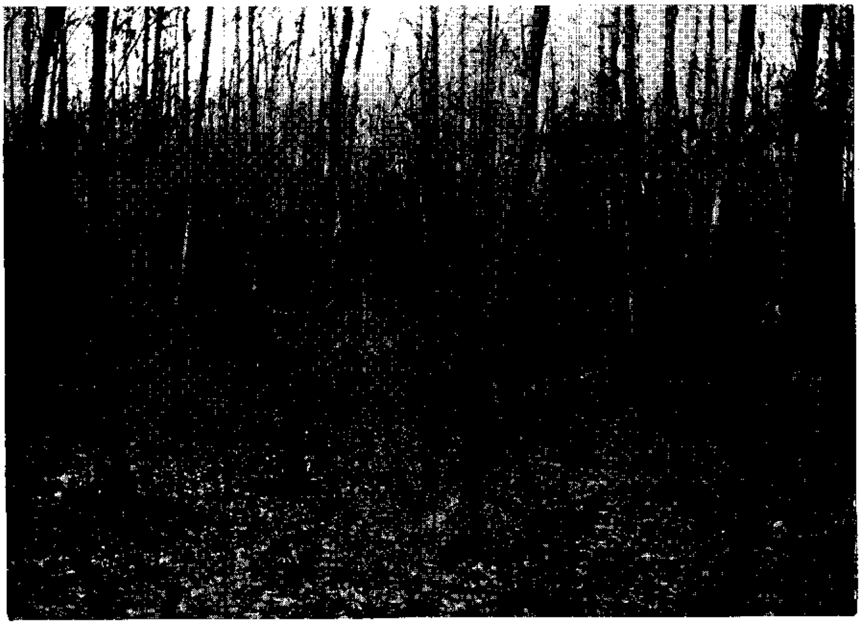

PHOTO 3. A picture of the alder-ash forest (location A: *Pruno-Fraxinetum*), on the foreground *Alnus glutinosa* and *Prunus padus*.

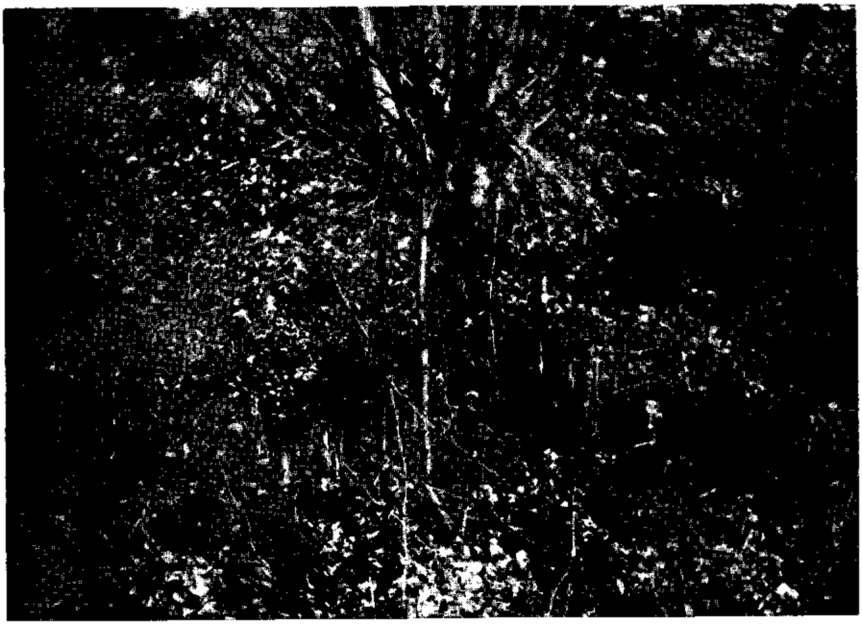

PHOTO 4. A picture of the springwood (location B: *Irido-Alnetum*).

PHOTO 5. A picture of the beech forest (location C: *Querco-Betuletum*). The tree layer only consists of *Fagus sylvatica*.

PHOTO 6. A picture of the oak-coppice (location D: *Querco-Betuletum*), in the tree layer *Quercus robur*, in the shrub layer *Pteridium aquilinum*.