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**RELATIVE LIGHT INTENSITY MEASUREMENTS IN A
SECONDARY FOREST (CAPOEIRA) NEAR MANAUS —
AMAZONIA — BRAZIL**

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Relative light intensity was studied in a capoeira at about km 18 of the Manaus-Itacoatiara Road. The capoeira was 7 to 9 years old, dense and unthinned. The stand was about 8 to 11 m high, mixed up with some emergent trees (15-18 m). The stem diameter (DBH) was always below 12 cm. The ground flora development was somewhat negligible.

Equipment

The relative light intensity was observed with 2 Standard Lux-Meters II ¹⁾, provided with a high quality taut suspension band system and a switch selectable for 0 — 100 Lux or 0 — 1000 Lux respectively.

The Standard Lux-Meters II were operated with 8 selenium elements S 60 ²⁾ in spray-waterproof housings. The interconnecting cables were of a length of about 30 m each. Two selenium elements were fitted with increased infrared sensitivity. The

¹⁾ B. LANGE GmbH, Berlin.

²⁾ JENAER GLASWERK SCHOTT & GEN., Mainz, Germany.

selenium elements were supplied with various filter systems in clip-on mount to facilitate filter exchange in the field.

1) The maximum readout of the Standard Lux-Meters II (1000 Lux) was extended by plug-in opal platinum filters (absorbance 1 : 10 and 1 : 100 respectively) up to 100 000 Lux. These filters are said to have the additional advantage of yielding obliquely incident light somewhat in accordance with the Cosine Law.

2) The spectral distribution of relative light intensity was analyzed by various glass filters²⁾ as BG 12, BG 12 + VG 9, VG 9, RG 630, RG 665, RGN 9, all in clip-on mount to the selenium elements. These filters cover at least the spectral range from 3600 Å to 7800 Å.

3) Ultraviolet light was studied by 2 filter systems. UV-1): Black glass filters UG 5²⁾ were used at wavelengths between 2000 Å and 3000 Å. These filters are coated with a special fluorescent layer to convert ultraviolet light into visible light as stated by the factory¹⁾. UV-2): To cover the spectral range from 3000 Å to 4000 Å, the filter combination UG 2 + BG 23²⁾ was applied. By the friendly support of NCAR, Boulder, Colorado, the detailed filter transmissivity graphs were obtained with the Gary-Model 14 Spectograph. (table 1)

Methods and results

Two selenium elements, mounted on tripods, were exposed horizontally on a clearing, about 120 cm above the ground. Six selenium elements, however, were distributed all over the capoeira in representative plots in a zone of 30 m distance from the fully sun-exposed elements. During 3 days of the dry season 1968 (June — October), light-intensity was recorded in minutely intervals between 8,30 h and 16,30 h, i.e. a total of 9 405 readings. The relative light intensity at the floor of the secondary forest was

calculated as the ratio stand/clearing (%) for various filter sets (table 2).

All observations cover different weather conditions, excluding rainfall.

1.) The half hourly mean over 3 days for the relative light intensity, operating the selenium elements with opal platinum filters only, show, that light must be a considerably limited factor near the floor of the capoeira (table 2 A).

At the sky completely covered with clouds, the relative light intensity ranged from 0.7 to 1.1 %. Under hazy conditions, including some remarkable short-term variations in light intensity, the relative light intensity was in the order of 0.6 to 1.3 %. In full sunlight, the data varied between 1.1 and 1.9 %. As shown above, the assimilation may be seriously affected in early morning, late afternoon, and under hazy and cloudy conditions. An insufficient light supply results in an unusually sparse undergrowth development.

2.) The relative light intensity, operating 2 selenium elements with increased infrared sensitivity, shows a typical daily march of red and near-infrared light, with one peak in the morning and one in the afternoon, and a minimum at about high noon. (table 2 B) At the sky completely covered with clouds, the relative light intensity near the ground of the capoeira was at about 7.1 to 9.6 %. Under hazy conditions it was in the order of 4.1 to 8.2 %. Short-term variations were considerably pointed and frequent. With the sun fully exposed, the relative light intensity varied between 8.5 and 12.2 %.

3.) The relative ultraviolet light intensity at the ground of the stand showed the typical daily march with a peak in the early afternoon and strongly descendant slopes. (table 2 C D). At the sky completely covered with clouds, the relative ultraviolet light intensity was at about 0.0 to 2.1 % (UV - 1) and 0.0 to

0.2 % (UV - 2). Under hazy conditions there was a variation between 0.4 and 2.9 % (UV - 1) and 0.0 to 0.6 % (UV - 2). In full sunshine the relative ultraviolet light intensity near the ground of the capoeira was about 4.3 to 8.6% (UV - 1) and 0.0 to 1.1 % (UV - 2).

In comparison to the relative ultraviolet intensity data, obtained by a detailed study on the Acapu - and - Andiroba seedbeds of Reserve Florestal Ducke, km 26 of the Manaus-Itacoatiara Road, the ultraviolet light input of the capoeira is quite insufficient (Brinkmann and Vieira, 1970). The ultraviolet light near the bottom of the stand may be of some importance under blue sky conditions only.

4.) The relative light intensity, calculated as an average of 3 days for every filter region (BG 12, BG 12 + VG 9, VG 9, RG 630, RG 665, RGN9) show a noticeable rise in red and near-infrared (table 3 A). The optical stand characteristics agree very well with the spectral distribution of the scattered reflection and absorption data of tropical tree-leaves. (Brinkmann 1970 a, 1970 b, 1970 c). At a sky completely covered with clouds, the maximum relative light intensity for all filter regions was considerably low, even at noon (table 3 B). In full sunlight the maximum relative light intensity near the bottom of the capoeira was slightly more significant (table 3 C).

Conclusions

The relative light intensity at the site under study in the visible region of the spectrum was in the order of 0.7 to 1.9 %, i. e. definitely low. Within this range some modifications, owing to different weather conditions, occur.

The relative ultraviolet light intensity near the ground of the stand is extremely low and may have some importance as an ecological factor only under blue sky conditions at about noon

The relative light intensity is somewhat higher in the red and near-infrared region of the spectrum. The high scattered

reflection of tropical tree-leaves at these wavelengths may be the main source. The light intensity, with its spectral composition, its daily and yearly march, is an important ecofactor in the development of undergrowth pattern and dynamics, although root and stem competition seem to be more essential.

Resumo

Em uma capoeira de 7-9 anos de idade no Km 18 da Estrada Manaus-Itacoatiara foi medida com dois aparelhos Lux Meter II a radiação, usando-se 8 elementos de selênio. Sobre êsses elementos foram colocados Filtros ultra-violeta (UV-1 e UV-2) alternando-os com 5 filtros de vidro. Essas medidas foram realizadas em 3 dias de verão de minuto a minuto de 8,30 às 16,30 h. num total de 9 504 leituras. Estas foram feitas na capoeira e na clareira respectivamente, sob condições climáticas variáveis (sol claro, cortina de vapor, parcial e totalmente nublado), porém com ausência de chuva.

A penetração relativa da luz na capoeira é pequena (0,6 — 1,9%) para os filtros e para as fotocélulas sensitivas em infra-vermelho (4,1 — 12,2 %) e para as ultra-violetas (UV-1 0,0 — 8,6 %) e UV-2 0,0 — 1,1 %). Para os processos de assimilação na capoeira a luz não é bastante.

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	1)													2)						
A	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00	39.00	40.00	41.00	42.00	67.00	68.00	69.00	70.00	71.00	72.00
UV-1	0.01	0.30	0.80	1.45	2.00	2.30	2.65	2.65	2.58	2.40	1.82	1.00	0.38	0.10	0.10	0.38	0.96	1.50	1.50	0.10
(%)																				
UV-2	-	-	0.10	1.84	10.00	24.00	36.50	44.60	45.80	35.10	13.20	13.00	0.20	-	-	-	-	-	-	-

TABLE -1 Transmissivity (%) of the UV-1 and UV-2 filters (CARY-MODEL 14 Spectograph).
 (UV-2 - 1) 3660A = 46.00; 2) 3918A = 95.00).

h	8.30	9.00	9.30	10.00	10.30	11.00	11.30	12.00	12.30	13.00	13.30	14.00	14.30	15.00	15.30	16.00	16.30
A	1.1	0.9	1.0	1.4	1.3	0.8	0.6	1.1	0.5	0.9	1.3	1.5	1.4	0.7	0.5	0.7	0.5
B	9.6	9.6	7.3	9.1	7.5	7.3	6.8	4.9	4.2	4.9	5.1	7.3	9.9	8.9	11.9	12.0	9.1
C	1.6	1.7	1.9	2.0	2.1	2.3	3.1	3.4	3.5	4.2	4.1	4.4	5.3	4.9	2.2	1.9	1.7
D	-	-	0.1	0.1	0.1	0.5	0.6	1.2	0.9	0.9	0.9	1.3	1.3	0.7	0.2	0.2	-

TABLE. 2

The relative light intensity (3 day half-hour mean) calculated for (A) selenium elements, (B) selenium elements with increased infrared sensitivity and selenium elements with clipped - on (C) UV-1 filters and (D) UV-2 filters.

<u>Filters</u>	<u>BG 12</u>	<u>BG 12 + VG 9</u>	<u>VG 9</u>	<u>RG 630</u>	<u>RG 665</u>	<u>RGN 9</u>
A	0.7	0.8	1.1	1.5	2.6	3.0
B	1.0	1.1	1.3	1.9	3.0	6.4
C	5.2	1.3	1.7	8.2	9.2	12.2

TABLE. 3 . Relative light intensity (3 day mean) of all filter regions (A) and maximum relative light intensity near the ground of the "ca-poeira" for (B) sky completely covered with clouds and (C) full sunlight.

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