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BIOLOGIE D'UNE CANOPÉE DE FORÊT ÉQUATORIALE - II

RAPPORT DE MISSION : RADEAU DES CIMES OCTOBRE / NOVEMBRE 1991 RÉSERVE DE CAMPO, CAMEROUN

(AVEC LE PARRAINAGE DU MINISTÈRE DE LA RECHERCHE ET DE LA TECHNOLOGIE)

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PHOTOSYNTHETIC ACTIVITIES IN FOLIAR AND NON-FOLIAR ORGANS ; CHANGES IN THE PHOTOSYNTHETICALLY ACTIVE RADIATION FROM CANOPY TO GROUND LEVEL. PRELIMINARY RESULTS

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1/ INTRODUCTION

During my visit to Campo from 22 to 30 october 1991, I was able to complete the following brief investigations at Radeau I et II and in the surrounding forest and secondary vegetation :

a) A survey of relative photosynthetic activity of on-ground and canopy plant leaf and bark tissue.

b) A through-canopy to ground profile of photosynthetically active radiation (PAR) at two sites.

Due to my continued absence overseas since the end of February on an extended consultancy, I have been unable to complete any detailed assessment of results. Part of the aim of my study at Campo was to collate data which could be analysed and compared with similar data collected from North Queensland rain forests. The following results are therefore very skeletal and a more complete report will be completed later on.

2/ A SURVEY OF RELATIVE PHOTOSYNTHETIC ACTIVITY OF ON GROUND AND CANOPY PLANT LEAF AND BARK TISSUE

Aim : to determine patterns of relative photosynthetic activity in a range of plants from canopy to ground level and to compare activities between chlorophyllous tissue in both leaves and green stems.

METHODS

A Brancker SF-30 fluorescence meter was used to detect P/S activity. The meter focusses a 670 nm light pulse through a lens on tissue which has been dark-adapted (usually about three minutes). The resulting excitation in chlorophyll results in energy release through three pathways : loss in heat, loss due to photosynthesis and loss due to fluorescence. The fluorescence emission is captured via the same lens through which the light pulse is transmitted. The data are recorded at 1/100 sec intervals over a period of 30 seconds which is usually sufficient to record a decay curve to a useful terminal point. The resulting fluorescence induction curve is known as the Kautsky effect. The present meter is capable only of recording slow kinetics and gives only a crude estimation of photosynthetic activity. Three critical points on the curve allow some comparative estimates to be made. By convention these are O, P and T, which are the initial rise time (Fo), Fmax (the Peak) and the Terminal value. The quantity Fv is Fmax or Peak value - Fo. The ratio Fv/Fmax is used to indicate a relative estimate of photosynthetic activity in the plant.

The kinetics of these reactions are complex and

data must be used with caution. Apart from the OPT values listed in the accompanying table, the general nature of the fluorescence induction curve is itself characteristic of individual plant behaviour. In the field, leaves were removed from the plant and a curve extracted usually within 20 minutes of collection. A 25 cm x 20 cm x 1 cm thick rubber collar was placed firmly around the light probe as a light seal and applied to the surface of the leaf to facilitate dark-adaptation. The light probe was mostly calibrated to provide a light pulse of 75 Dw/m^2 which appeared to produce a measurable curve in most plants. For green stem tissue the probe was either strapped to the stem *in situ* or else a portion of bark was removed and measured *ex situ* in the laboratory. There was limited opportunity on the raft to obtain leaves from the top and lower side of tree crowns and from canopy lianas.

In most cases two and sometimes three readings were taken on each specimen. As these took upwards of 15 minutes each, to process was time consuming. Erratic results were discarded. In this way approximately 90 specimens were recorded (see Table I). Data were downloaded into a COMPAQ 386/s portable computer, (courtesy of RANDOM Computer Company) and stored on 31/2 floppy disc. In Australia, modified software was used to generate fluorescence induction curves for each recording. Examples of these are attached.

RESULTS

Further laboratory analyses of curvilinear data are necessary to provide a more complete discussion. Superficial results indicate that appart from a few isolated instances such as semi-aquatics, (Araceae), some ground succulents (*Palisota*), lithophytes (*Streptocarpus*) and epiphytic orchids (CAM), there are no readily predictable characteristics that distinguish leaves of understorey plants from upper canopy leaves or of changes through canopy in individual trees other than in certain species. Analyses so far indicate there are repeatable trends within species which may be more characteristic of guild structures as a whole. This requires further investigation. Fluorescence data obtained from stems and leaves of the same plant showed interesting response patterns. The most significant of these was obtained from *Musanga cecropioides* where, in one case, photosynthetic response from bark exceeded that of the leaves. Response patterns from plants in secondary vegetation habitats (*Alstonia boonei*), whereas 'ant-plants' *Barteria fistulosa* and *Leonardoxa africana* were extremely variable. Position (exposure) in successional status also seems to play a part as leaves of *B. fistulosa* collected in the forests were more variable than that of those collected on the forest edge.

3/ A THROUGH CANOPY TO GROUND PROFILE OF PHOTOSYNTHETICALLY ACTIVE RADIATION (PAR) AT TWO SITES

Aim : to determinate changes in quantum flux density of photosynthetically active radiation (PAR) through canopy to ground level.

METHODS

Two quantum flux sensors Q1 (Delta-T type QS) and Q2 (custom-made sensor built on a Telefunken BPW light cell) were calibrated in Australia where a linear relationship between the two was found to be of the level $r^2 = 99,4$. Q1 was mounted on a supporting metal cup and placed on an outer arm of the raft approximately one metre above the raft edge and away from any reflecting surface. A marlin fishing rod was mounted one metre away on a specially prepared laminated wooden base. The second sensor Q2 was attached to a weighted cord and lowered via the fishing rod approximately 1,5 m out from the raft edge and down through the canopy to ground level. Care was taken to

Table 1 - Fluorescence Induction Curve Data*

Record #	Ang no	Taxon	O	P	T	FV-MAX
1	0	*Anthocleista*	3156	6815	3988	0.54
2	0	*Anthocleista*	3221	6680	3571	0.52
3	0	*Glochidion ?*	3348	5824	4147	0.43
4	0	*Glochidion ?*	3230	4852	3949	0.33
5	0	*Glochidion ?*	3488	5489	4395	0.36
6	0	*Alstonia boonei*	3051	5723	3401	0.47
7	0	*Alstonia boonei*	3104	6151	3699	0.50
8	0	*Barteria fistularia (bar)*	2932	3447	3443	0.15
9	0	*Barteria fistularia (bar)*	2950	3685	3678	0.20
10	0	*Barteria fistularia (bar)*	2918	3207	3207	0.09
11	0	*Macaranga*	5439	5763	3656	0.06
12	0	*Trema*	2453	4190	3067	0.41
13	0	*Trema*	2692	5235	4135	0.49
14	0	*Passiflora*	3347	4864	4338	0.31
15	0	*Passiflora*	3167	4622	4285	0.31
16	0	*Cissus*	2849	5101	3360	0.44
17	0	*Cissus*	3100	6128	3858	0.49
18	0	*Geophila*	3425	6024	3664	0.43
19	0	*Geophila*	3533	6242	3776	0.43
20	0	*Geophila*	3679	6300	3749	0.42
21	0	*Bulbophyllum*	2457	3952	2774	0.38
22	0	*Bulbophyllum*	2429	3395	2591	0.28
23	0	Sapotaceae	3112	6040	4008	0.48
24	0	Sapotaceae	3311	6367	4053	0.52
25	0	*Palisota ambigua*	3072	6339	4077	0.52
26	0	*Chlorophytum*	3200	5125	3435	0.38
27	0	*Chlorophytum*	3304	5880	3624	0.44
28	0	*Cyrtosperma*	2745	3714	3284	0.26
29	0	*Cyrtosperma*	3146	5247	3923	0.40
30	0	*Streptocarpus*	3002	5776	4026	0.48
31	0	*Streptocarpus*	2930	5605	3741	0.48
32	0	Marantaceae	3683	6478	4994	0.43
33	0	Marantaceae	3832	6010	5025	0.36
34	0	Icacinaceae (garlic)	3317	4773	3959	0.31
35	0	Icacinaceae (garlic)	3364	5043	4234	0.33
36	0	Bamboo	3724	4598	4310	0.19
37	0	Bamboo	3469	5191	4082	0.33
38	0	Aroid (semi-aquatic)	3075	4029	3315	0.24
39	0	Aroid (semi-aquatic)	3008	4357	3357	0.31
40	0	*Palisota*	3317	5910	4264	0.44
41	0	*Palisota*	3621	6067	4719	0.40
42	0	*Anthocleista nobilis*	2668	3668	2979	0.27
43	0	*Anthocleista nobilis*	2249	3241	2722	0.31
44	0	*Anthocleista nobilis*	2535	3363	2786	0.25
45	06	*Barteria fistularia (edg)*	2758	2916	3223	0.05
46	06	*Barteria fistularia (edg)*	2722	3306	3188	0.18
47	02	*Barteria fistularia (for)*	3013	4434	3259	0.32
48	02	*Barteria fistularia (for)*	2819	4276	2912	0.34
49	05	*Rhektophyllum*	3090	5039	3948	0.39
50	05	*Rhektophyllum*	2829	4953	3724	0.43
51	05	*Rhektophyllum*	3067	5745	3992	0.47
52	04	Annonaceae	2716	4439	3053	0.39
53	04	Annonaceae	2666	3347	2859	0.20
54	04	*Annonacea*	2926	3977	3069	0.26
55	03	Caesapliniaceae	3098	4598	3666	0.33
56	03	Caesapliniaceae	3085	4179	3568	0.26
57	01	Rubiaceae	2972	5049	3905	0.41
58	01	Rubiaceae	3428	6502	4426	0.47
59	01	Rubiaceae	3064	5145	3849	0.40
60	11	*Anthocleista nobilis*	3524	5742	3512	0.39
61	11	*Anthocleista nobilis*	3127	5218	3137	0.40
62	11	*Anthocleista nobilis*	3148	5587	3222	0.47
63	08	*Macaranga*	3382	4840	3778	0.30
64	08	*Macaranga*	3447	5861	3862	0.41
65	08	*Macaranga*	2506	4522	3198	0.45
66	09	*Macaranga*	3188	3360	3211	0.05
67	09	*Macaranga*	2868	3053	2930	0.06
68	09	*Macaranga*	3156	3282	3051	0.04
69	10	*Musanga*	2718	3156	3098	0.14

Table 1 - Suite.

Record #	Ang no	Taxon	O	P	T	FV-MAX
70	10	*Musanga*	2834	3652	3259	0.22
71	10	*Musanga*	2798	4133	2973	0.32
72	12	*Tetracera alnifolia*	2404	3621	2754	0.34
73	12	*Tetracera alnifolia*	2506	4522	3198	0.45
74	12	*Tetracera alnifolia*	2790	4591	3597	0.39
75	15	*Leonardoxa*	2420	5569	5242	0.5?
76	15	*Leonardoxa*	2246	4974	4679	0.53
77	15	*Leonardoxa*	2039	4759	4370	0.57
78	16	Apocynaceae ?*rejoua*	2662	6060	4856	0.56
79	16	Apocynaceae ?*rejoua*	2527	5967	4012	0.58
80	16	Apocynaceae ?*rejoua*	2614	6048	4280	0.57
81	20	Lauraceae ?*Beilschmedia*	2438	3837	2951	0.36
82	20	Lauraceae ?*Beilschmedia*	2393	4099	2768	0.42
83	20	Lauraceae ?*Beilschmedia*	2495	4796	3000	0.48

*Indicative values of a partial set of fluorescence. Induction curves y material form Campo I. O = Initial rise time. P = Peak value. T = Terminal value. FVF-MAX = FV/FMAX, a relative indication y photosyntetic response.

ensure compression effects on the canopy from the raft were avoided. In each case readings were commenced at noon. The sensors were connected via a resistor to a meter which produced cumulative, integrated output over a time interval of five minutes. The process was repeated on both rafts where a total of four sets of readings were taken.

RESULTS

While further analysis is pending some trends are apparent. In every case there was a sudden decrease in flux density in the first metre within crown as if due to a crown "monolayer". Values then increased to below crown (ca. 7m) where a sudden increase occurred beyond crown base to about 7m above ground where decreasing values tended to coincide with denser understorey growth. Evidence of inversion effects will not be clear until remaining data are analysed. An example is given in Table 2.

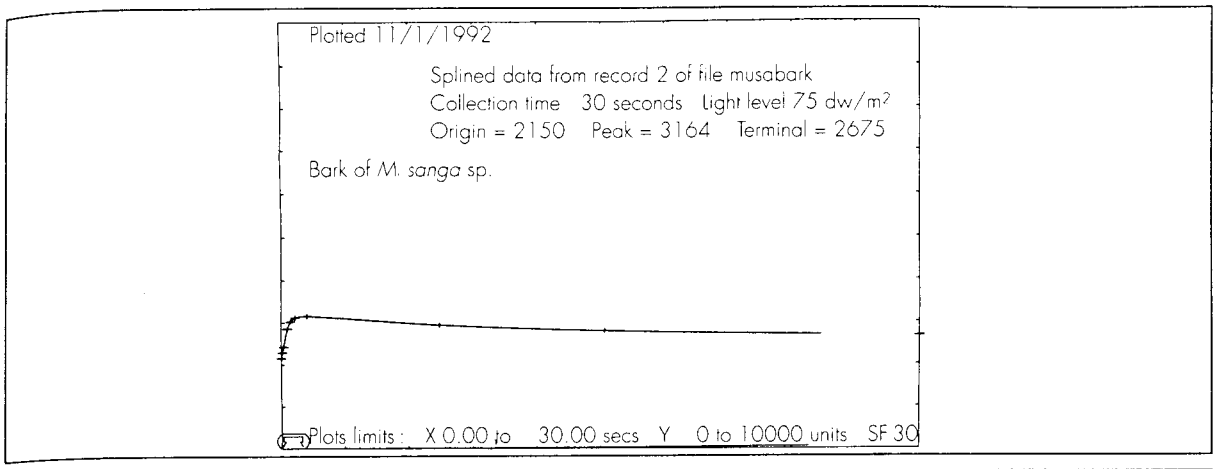
ACKNOWLEDGEMENTS

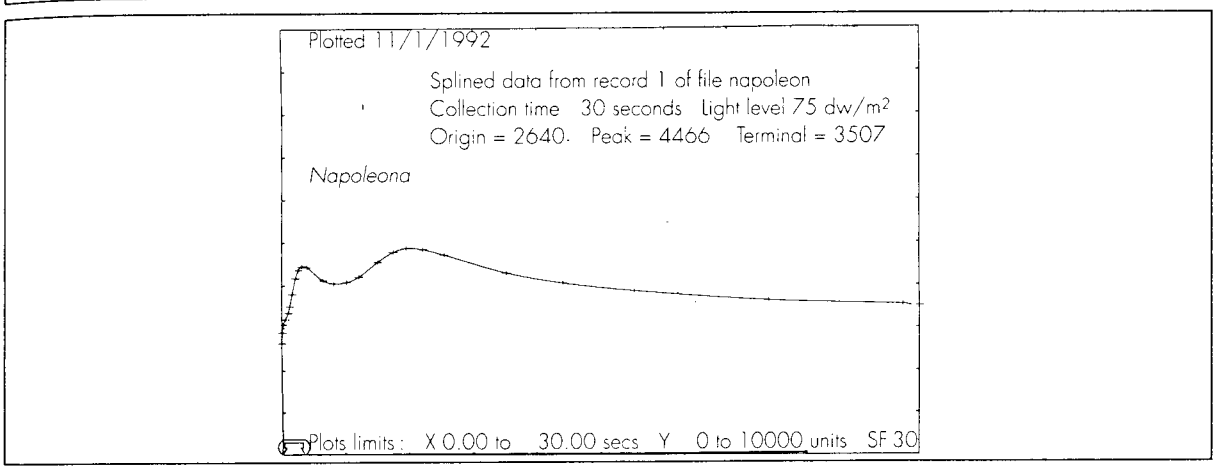
I am particularly indebted to Prof. Francis HALLÉ and team at Campo I for making this visit possible. Dr. P. GRARD of IRCT/CIRAD kindly assisted with the marvellous computing facilities at the camp. The COMPAQ 386/s portable computer was kindly supplied by the RANDOM Computer Co. and was invaluable in downloading and transferring data. Fondation ELF is to be congratuled in sponsoring this notable expedition and their generosity in assisting with my visit is much appreciated.

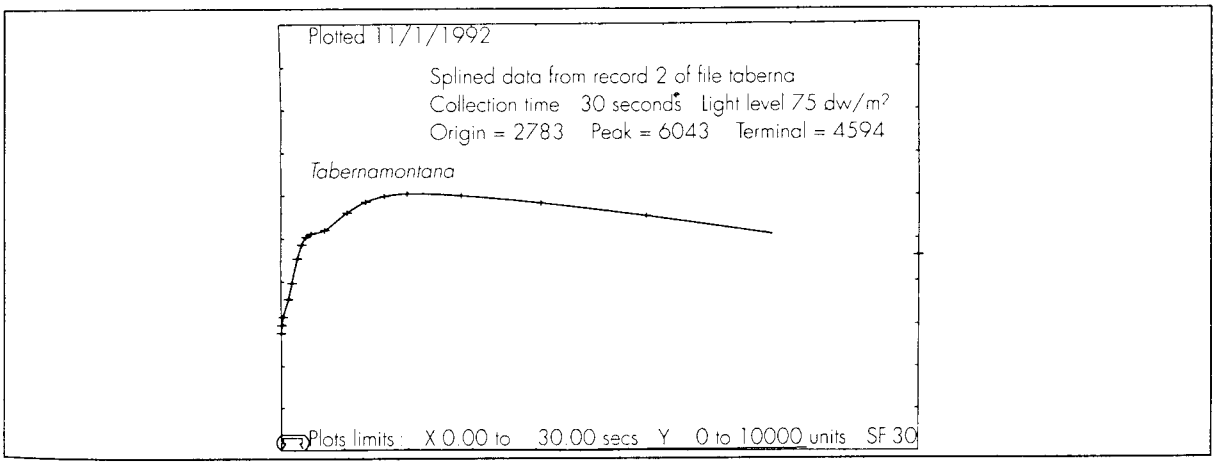
Table 2 - Photosynthetically Active Quantum Flux Densities From Canopy to Ground Level - Radeau I West Side.
Date : 23 Oct. 1992.

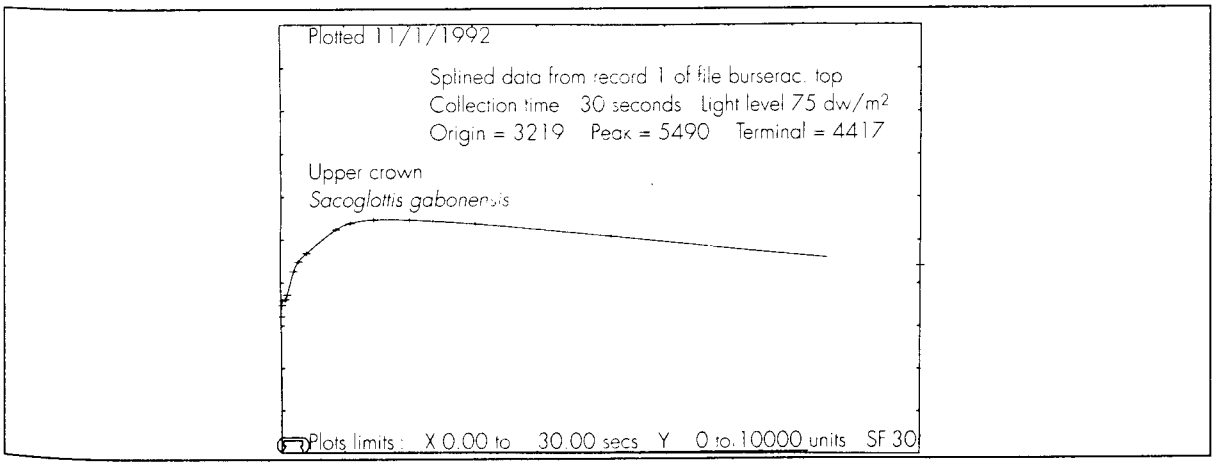
Time	Interval mins.	Height m	Q1 meter	Q2 meter	Q1 PPFD (µmol $m^{-2}s^{-1}$)	Q2 PPFD (µmol $m^{-2}s^{-1}$)	External conditions
1207	5	40	431	501	71,83	157,74	Sunny top
1214	5	39	289	13	48,17	4,09	Sunny top
1221	5	38	278	17	46,33	5,35	Cl. bright
1227	5	33	262	21	43,67	6,61	Cl. bright
1233	5	28	356	26	59,33	8,19	Cl. bright
1240	5	23	222	16	37,00	5,04	Cl. bright
1246	5	18	252	12	42,00	3,78	Cl. bright
1252	5	13	260	12	43,33	3,78	Cl. bright
1258	5	8	232	6	38,67	1,89	Cl. bright
1316	5	3	279	4	46,50	1,26	Cl. bright

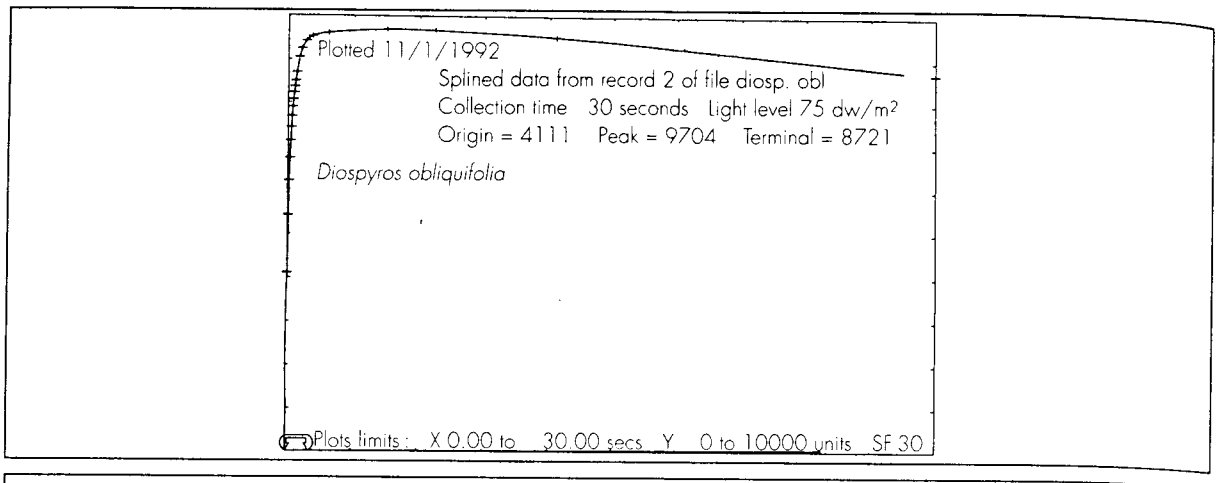
Q1 = Quantum sensor 1 attached to radeau above canopy. Q2 = Quantum sensor 2 attached to line lowered down through canopy. Conversion for Q1 sensor = reading x 5 (mins) = millivolt seconds/0,1 = µmol m^{-2} (integral)/300 (secs) = µmol m^{-2} s^{-1}(average flux). Conversion for Q2 sensor = reading x 5 (mins) = millivolt seconds/0,052935 = µmol m^{-2} (integral)/300 (secs) = µmol m^{-2} s^{-1}(average flux). Note : calcultated flux densities are yet to be standardised for comparative purposes.

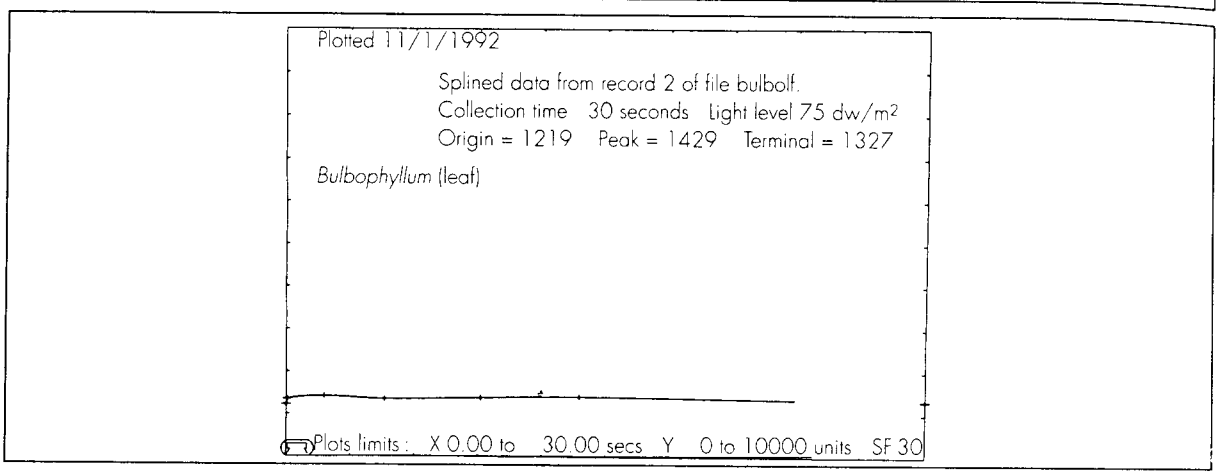

Plotted 11/1/1992
Splined data from record 2 of file musabark
Collection time 30 seconds Light level 75 dw/m²
Origin = 2150 Peak = 3164 Terminal = 2675
Bark of M. sanga sp.
Plots limits : X 0.00 to 30.00 secs Y 0 to 10000 units SF 30

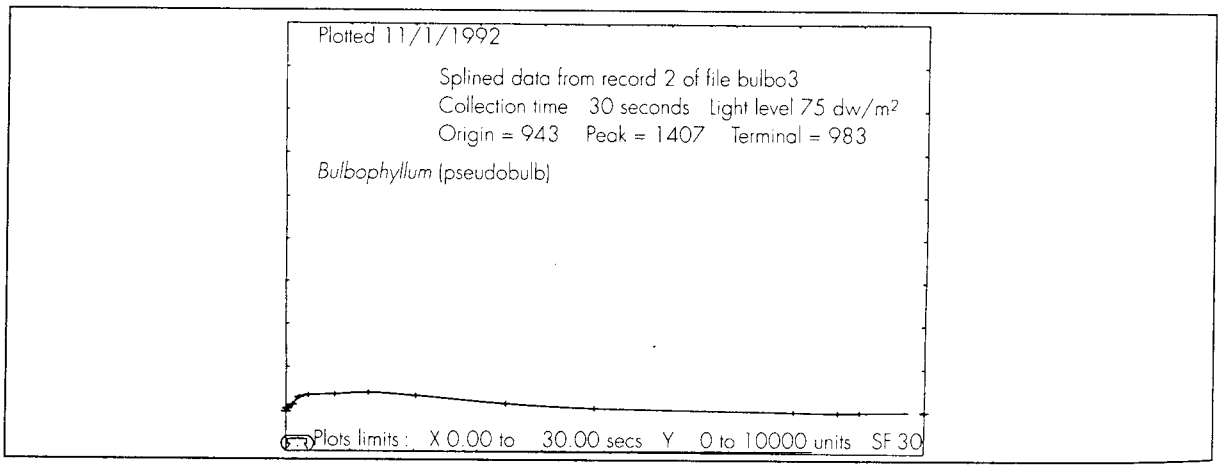

Plotted 11/1/1992
Splined data from record 1 of file napoleon
Collection time 30 seconds Light level 75 dw/m²
Origin = 2640. Peak = 4466 Terminal = 3507
Napoleona
Plots limits : X 0.00 to 30.00 secs Y 0 to 10000 units SF 30

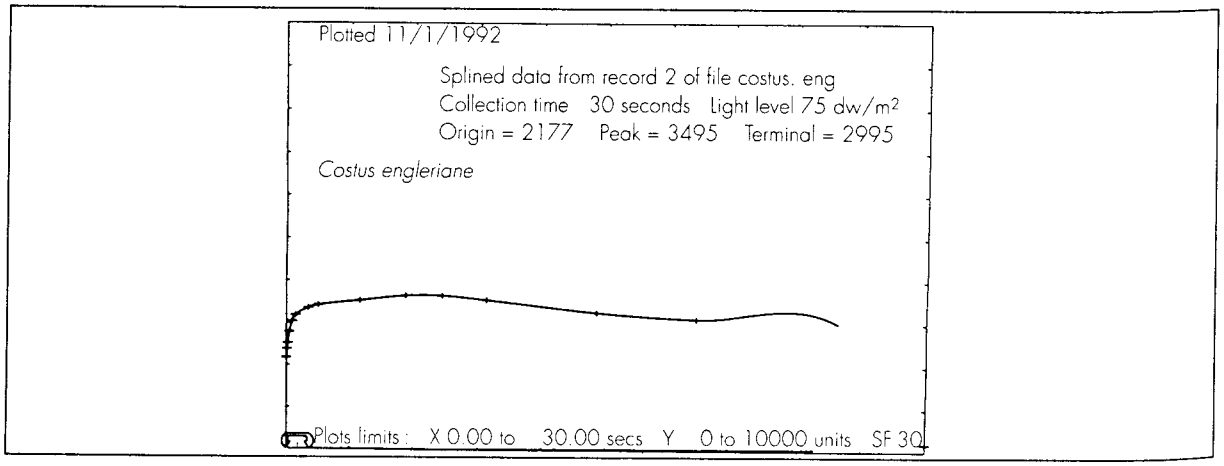

Plotted 11/1/1992
Splined data from record 2 of file taberna
Collection time 30 seconds Light level 75 dw/m²
Origin = 2783 Peak = 6043 Terminal = 4594
Tabernamontana
Plots limits : X 0.00 to 30.00 secs Y 0 to 10000 units SF 30


Plotted 11/1/1992
Splined data from record 1 of file burserac. top
Collection time 30 seconds Light level 75 dw/m²
Origin = 3219 Peak = 5490 Terminal = 4417
Upper crown
Sacoglottis gabonensis
Plots limits : X 0.00 to 30.00 secs Y 0 to 10000 units SF 30


Plotted 11/1/1992
Splined data from record 2 of file diosp. obl
Collection time 30 seconds Light level 75 dw/m²
Origin = 4111 Peak = 9704 Terminal = 8721
Diospyros obliquifolia
Plots limits : X 0.00 to 30.00 secs Y 0 to 10000 units SF 30


Plotted 11/1/1992
Splined data from record 2 of file bulbolf.
Collection time 30 seconds Light level 75 dw/m²
Origin = 1219 Peak = 1429 Terminal = 1327
Bulbophyllum (leaf)
Plots limits : X 0.00 to 30.00 secs Y 0 to 10000 units SF 30


Plotted 11/1/1992
Splined data from record 2 of file bulbo3
Collection time 30 seconds Light level 75 dw/m²
Origin = 943 Peak = 1407 Terminal = 983
Bulbophyllum (pseudobulb)
Plots limits : X 0.00 to 30.00 secs Y 0 to 10000 units SF 30


Plotted 11/1/1992
Splined data from record 2 of file costus. eng
Collection time 30 seconds Light level 75 dw/m²
Origin = 2177 Peak = 3495 Terminal = 2995
Costus engleriane
Plots limits : X 0.00 to 30.00 secs Y 0 to 10000 units SF 30