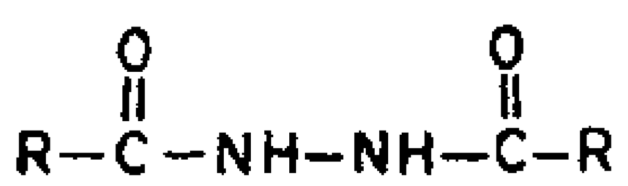
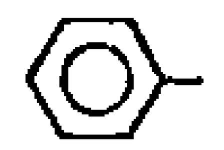
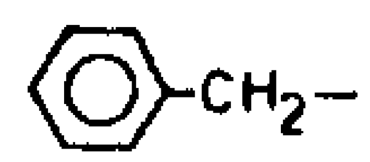
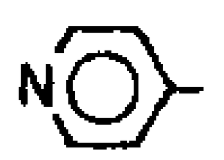
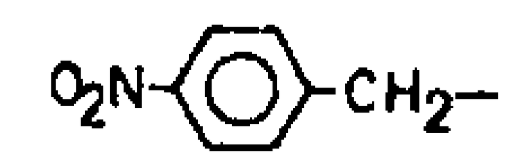
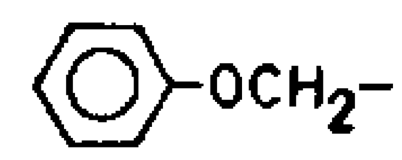
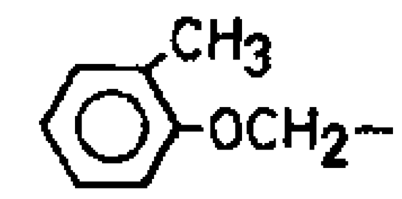
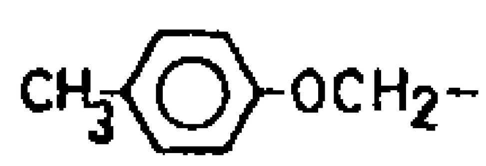
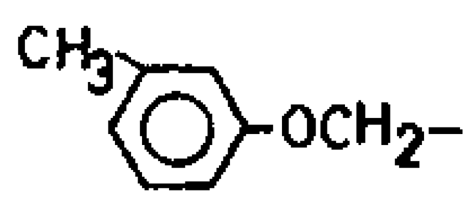
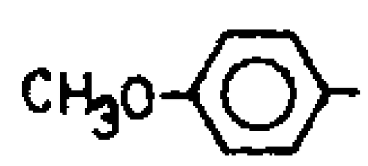


	R	Yield %	M. P. °C
1		95	240 (lit 241)
2		95	220
3		92	225
4		90	280
5		90	241
6		90	250
7		92	190
8		90	140
9		90	175
10		92	185
11		90	210

and ether (2 × 100 ml) and dried overnight at 40°C and 1 mm Hg.

Capacity was determined by iodometry and was found to be 2.5 mmol.

Oxidation of hydrazides: Hydrazide (5 mmol) in ethanol (50 ml) was stirred with the periodate form of Amberlyst A26 (5.5 mmol) for 6 hr at room temperature. After completion of the reaction, the resin was filtered off and washed with ethanol (150 ml). The distillation of the combined filtrate furnished corresponding diacyl hydrazines essentially in pure form. The products were characterized by NMR, IR, mass spectral studies, C, H, N analysis and comparison with authentic samples.

One of us (DGS) is grateful to UGC, New Delhi and Shri Swami Vivekanand Shikshan Sanstha, Kolhapur for financial support.

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OPTICAL PROPERTIES OF LEAVES OF SOME INDIAN PLANTS

D. W. LEE, K. P. PALIWAL*, K. A. PATEL** and D. N. SEN†

Department of Biological Sciences, Florida International University, Miami, Florida, USA.

** School of Biological Sciences, Madurai Kamaraj University, Madurai 625 021, India.*

*** Botany Department, Bhavan's College, Andheri West, Bombay 400 058, India.*

† Botany Department, University of Jodhpur, Jodhpur 342 001, India.

LEAVES function as optical filters, selectively absorbing different wavelengths of electromagnetic radiation[1-3]. Leaf optical properties vary, depending upon the environments in which the plants live. These properties must be measured if the photosynthetic efficiencies[4] and the thermal properties and thus water relations[5] of individual species are to be understood. Of the few species measured[2,6,7], none are native to the Indian subcontinent. Here we report the leaf optical properties of 22 taxa native to different vegetation types of India.

Leaves were collected from trees of: (1) a wet evergreen forest in Kanyakumari district of South India (lat. 8° 28′ N, long. 77° 18′ E—KK); (2) a moist deciduous forest in the Thane District of Maharashtra (lat. 19° 13′ N, long. 73° 01′ E—TD); and desert plants from the Botanical Garden of the University of Jodhpur (lat. 26° 17′ N, long. 73° 02′ E—JP). Mature, sun-exposed leaves were collected and kept moist, and measured within 2 hr of collection. Measurements were performed with a Li-Cor ≠ 1800 spectroradiometer (Li-Cor Instruments, Lincoln, Nebraska, U.S.A.) with integrating sphere attachment. Diffuse

Table 1 *Leaf optical properties of 22 Indian species; values are the means ± standard deviations of five leaves. Location abbreviations are in the text.*

Species	Location[1]	PPFD Abs.[2]	350–1100 nm Abs.[3]	Refl./trans	PPFD trans.	R:FR trans
Artocarpus hirsuta Lamk.	KK	0.893 ± 0.028	0.579 ± 0.030	1.46 ± 0.14	0.036 ± 0.014	0.065 ± 0.020
Aerva persica (Burm. f.) Merrill	JP	0.804 ± 0.005	0.544 ± 0.004	1.71 ± 0.06	0.031 ± 0.003	0.068 ± 0.011
Albizzia procera Benth.	TD	0.912 ± 0.009	0.584 ± 0.005	1.08 ± 0.01	0.030 ± 0.003	0.044 ± 0.005
Bauhinia variegata L.	JP	0.832 ± 0.016	0.543 ± 0.012	1.39 ± 0.10	0.041 ± 0.004	0.064 ± 0.025
Butea monosperma (Lamk.) Taubert	TD	0.887 ± 0.008	0.579 ± 0.005	1.01 ± 0.03	0.047 ± 0.005	0.124 ± 0.006
Calotropis procera R. Br	JP	0.868 ± 0.010	0.563 ± 0.008	2.18 ± 0.11	0.009 ± 0.002	0.003 ± 0.001
Careya arborea Roxb.	KK	0.866 ± 0.008	0.547 ± 0.006	1.35 ± 0.11	0.042 ± 0.008	0.078 ± 0.015
Cordia rothii Roem. and Schutt.	JP	0.855 ± 0.010	0.551 ± 0.006	1.48 ± 0.10	0.032 ± 0.004	0.059 ± 0.009
Cryptostegia grandiflora R. Br.	JP	0.847 ± 0.023	0.547 ± 0.022	0.97 ± 0.09	0.068 ± 0.016	0.132 ± 0.033
Dalbergia latifolia Roxb	TD	0.866 ± 0.014	0.567 ± 0.005	1.15 ± 0.05	0.056 ± 0.004	0.135 ± 0.017
Erythrina indica Lamk.	TD	0.846 ± 0.024	0.535 ± 0.017	0.86 ± 0.07	0.082 ± 0.019	0.123 ± 0.036
Garcinia indica (Dupetit-Thouars) Choisy	TD	0.921 ± 0.007	0.599 ± 0.008	1.71 ± 0.07	0.018 ± 0.005	0.046 ± 0.012
Gordonia obtusa Wall.	KK	0.905 ± 0.017	0.578 ± 0.025	1.10 ± 0.10	0.040 ± 0.016	0.063 ± 0.043
Morinda tinctoria Roxb.	TD	0.909 ± 0.003	0.602 ± 0.008	1.51 ± 0.04	0.021 ± 0.001	0.036 ± 0.007
Salvadora oleoides Decne.	JP	0.869 ± 0.008	0.572 ± 0.006	1.29 ± 0.08	0.028 ± 0.002	0.025 ± 0.003
Salvadora persica L.	JP	0.875 ± 0.007	0.575 ± 0.005	1.36 ± 0.04	0.020 ± 0.001	0.013 ± 0.002
Syzygium phyllyraeoides (Trim.) Santapau	KK	0.898 ± 0.010	0.580 ± 0.012	0.95 ± 0.01	0.046 ± 0.007	0.055 ± 0.012
Tecomella undulata (Smith) Seem.	JP	0.817 ± 0.018	0.533 ± 0.003	1.21 ± 0.25	0.067 ± 0.017	0.132 ± 0.023
Tectona grandis L.f.	TD	0.894 ± 0.010	0.601 ± 0.013	1.21 ± 0.01	0.030 ± 0.003	0.086 ± 0.039
Terminalia tomentosa W. A.	TD	0.895 ± 0.006	0.581 ± 0.009	1.35 ± 0.06	0.036 ± 0.005	0.073 ± 0.011
Trewia nudiflora L.	TD	0.897 ± 0.005	0.602 ± 0.018	1.14 ± 0.05	0.047 ± 0.005	0.089 ± 0.010
Ziziphus mauritiana Lamk.	TD	0.908 ± 0.006	0.590 ± 0.005	1.71 ± 0.07	0.028 ± 0.005	0.096 ± 0.017
Mean of all species		0.875 ± 0.032	0.572 ± 0.022	1.33 ± 0.31	0.039 ± 0.017	0.073 ± 0.039

[1] relative absorptance of PPFD; [2] relative absorptance of solar energy 350–1100 nm; [3] ratio of solar energy 350–1100 nm reflected to that transmitted through the leaf; [4] fraction of PPFD transmitted through the leaf; and [5] spectral quality of transmitted radiation as indicated by the quantum ratio between 660 and 730 nm. The means and standard deviations are given for all species at the bottom of the table.

transmittance and reflectance were measured from five leaves of each species, at 2 nm intervals, 350–1100 nm, in comparison to a barium sulphate reference (≠ 6084, Eastman Kodak, Rochester, New York, U.S.A.). Absorptance was calculated as 1-transmittance reflectance for each leaf. To calculate leaf properties in natural sunlight, these curves were multiplied by the mean of five measurements at solar zenith in Thane District on 10 October 1984. The instrument's micro-computer calculated the integrations of these spectra for photosynthetic photon flux density (PPFD, as μ mol sec^{-1} m^{-2}, 400–700 nm), and radiant energy 350–1100 nm as W m^{-2}. Leaves absorb differently at 660 and 730 nm, and changing quantum flux densities at these wavelengths affect phytochrome equilibria and developmental processes in plants[8]. This ratio (the R:FR of Smith[8]) was also calculated with the instrument.

A brief discussion of data for one species, *Tectona grandis*, will help in understanding the data for all of the species listed in table 1. Teak leaves (figure 1) transmit and reflect little (and thus absorb much: 0.894 ± 0.010) in the visible wavelengths of 400–700 nm, and transmit and reflect almost all radiation above 750 nm. Thus, the total absorptance 350–1100 nm (0.601 ± 0.013) from the leaf is greater from reflectance than from transmittance (a ratio of 1.21 : 1.00).

The spectral properties of the leaves of these plants are similar to others measured[2,5,6]. Although desert species, (e.g. *Aerva persica*), absorb less than those from other habitats, there is consderable variation among species from each habitat. These data can assist in other studies on these ecologically important species. Percentages of absorptance of PPFD will allow calculations of quantum efficiencies from photosynthetic measurements. Although differences in energy absorptance at wavelengths 350–1100 nm help to describe the thermal properties of the leaves, 25 % of solar energy (1100–3000 nm) was not measured. Ehleringer *et al*[5] determined the relationship between absorptance of PPFD and absorptance 400–3000 nm for 38 desert species: absorptance between 400 and 3000 nm equals 0.73 times absorptance between 400 and 700 nm minus 11.9. From these results an absorptance in the range of 400–3000 nm of 0.52 is calculated for the mean of 22 species in this sample.

These leaves allow a little PPFD to be transmitted (0.039 ± 0.017), and the spectral quality of sunlight, at R:FR = 1.15 is radically changed (R:FR = 0.073 ± 0.039). These results could assist in the calculation of spectral properties of radiation immediately beneath foliage. For these species reflectance and transmittance

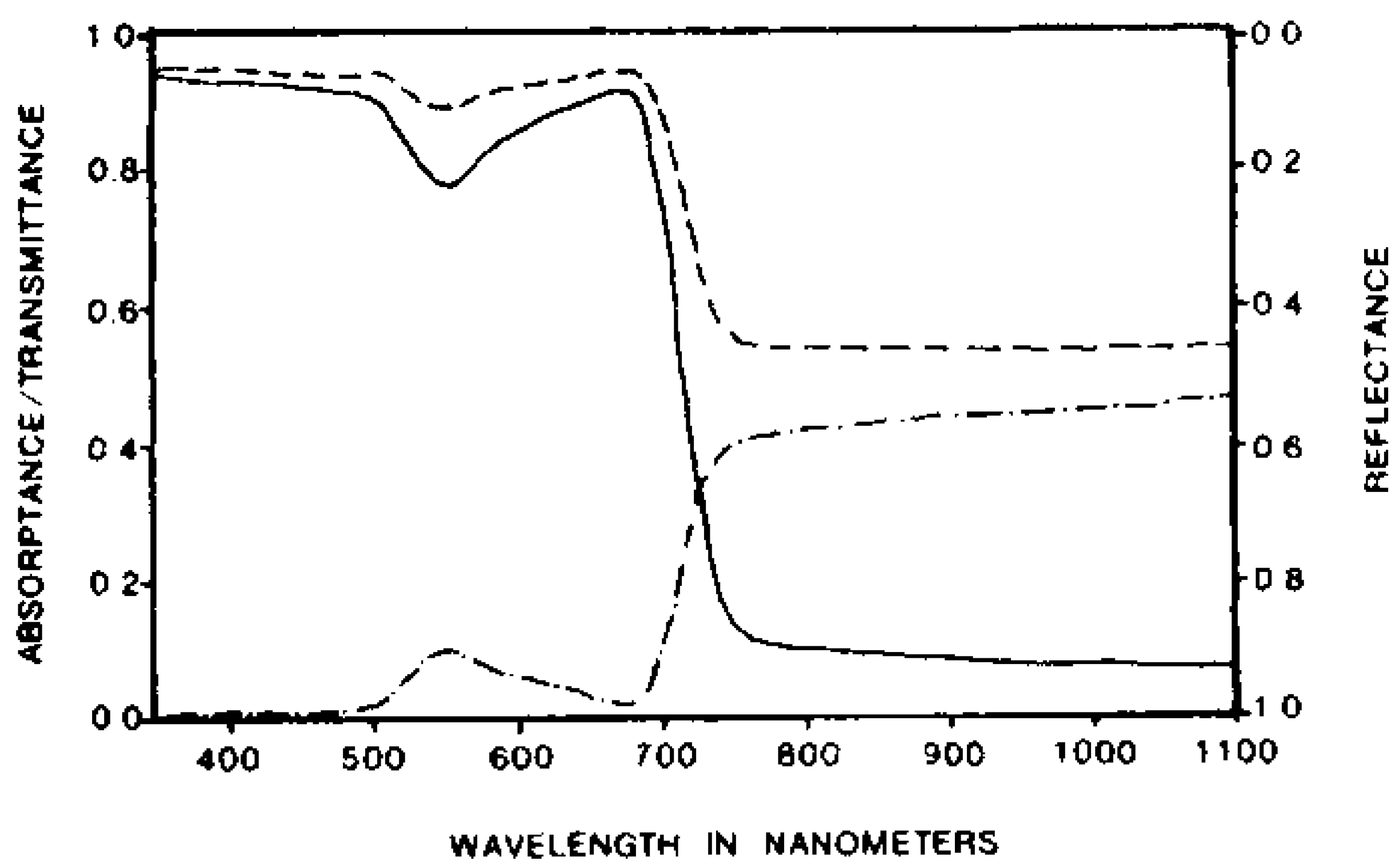

Figure 1. Leaf optical properties of *Tectona grandis*. (———) denotes absorptance; (– – –) diffuse reflectance; and (–. –. –) diffuse transmittance.

vary in their contribution in limiting absorptance, and this could certainly correlate with the anatomical comparison of the leaves, such as the extent and distribution of intercellular spaces, as well as pigment concentration and composition. Although greater reflectance compared to transmittance would be expected from desert plants (from leaf surface features), no clear trend is seen in the data. Further studies, anatomical and physiological, would reveal the importance of leaf optical properties for each species' particular ecological requirements.

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