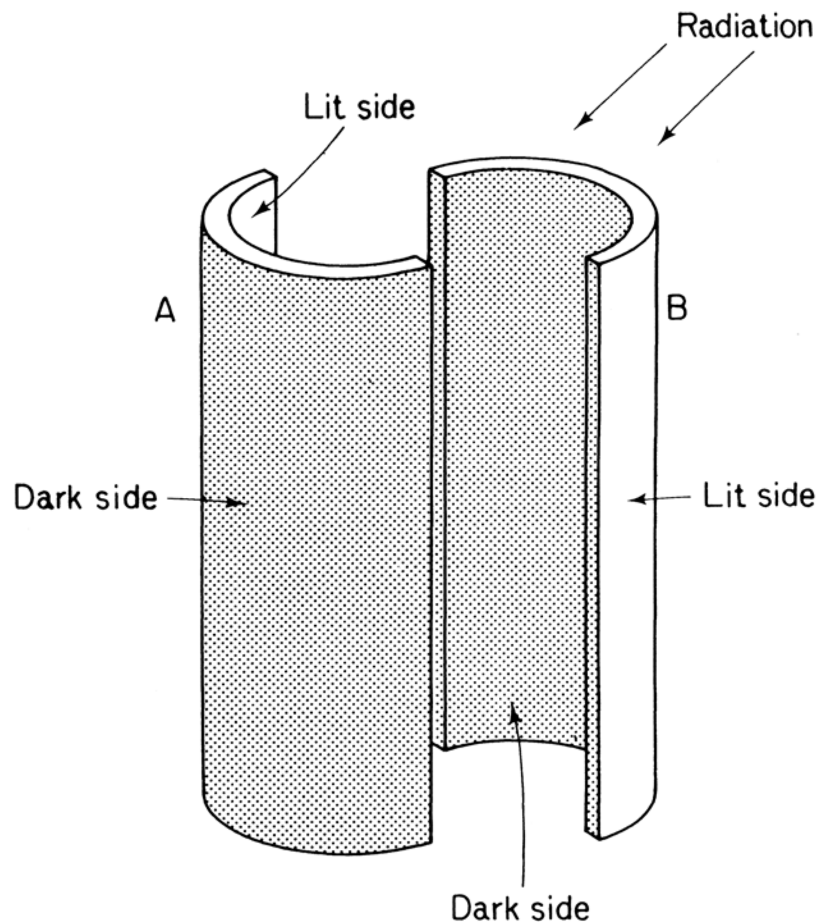


**Figure 8.1** The distribution of radiation over two surfaces of a cylinder representing the irradiance of a large number of vertical leaves.

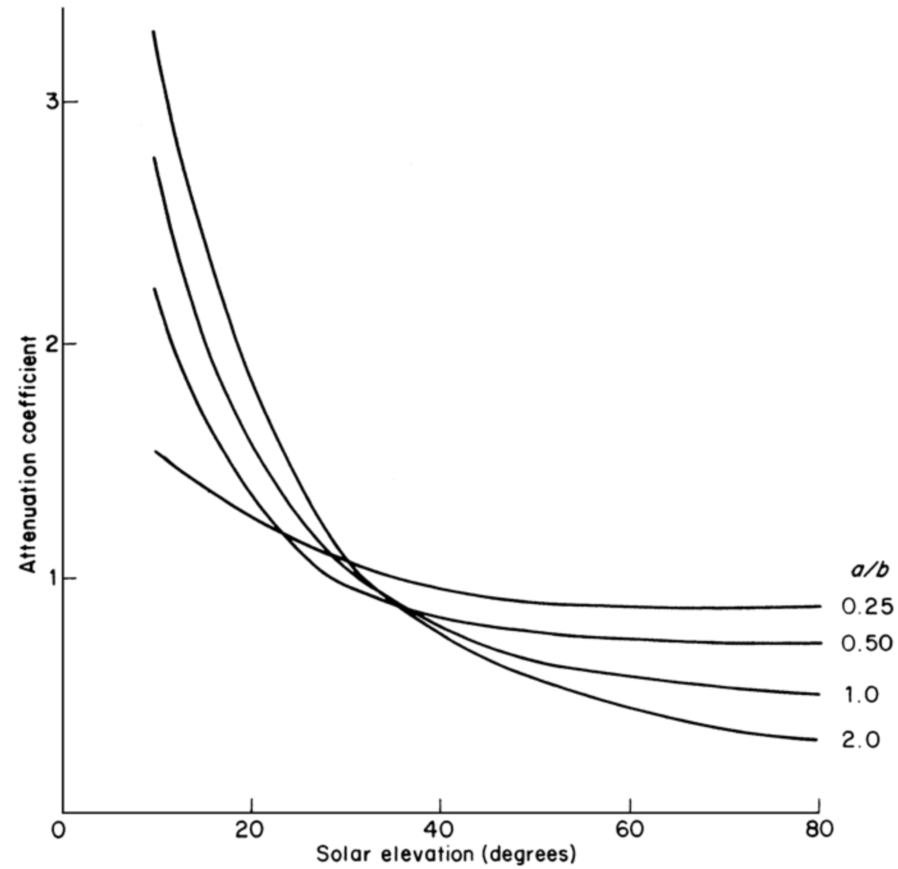


**Figure 8.2** Dependence of attenuation coefficient for direct radiation *K*s = 2*A*h/*A* on solar elevation when leaf angle distribution is ellipsoidal with *a/b* = ratio of vertical to horizontal semi-axis (see p. 97). The case *a/b* = 1 corresponds to a spherical distribution.

**Table 8.1** Attenuation Coefficients for Model and Real Canopies (from Monteith, 1969)

| **(a) Idealized leaf distributions** | $\mathcal{K}_s$ | | |
|---|---|---|---|
| | Solar elevation $\beta$ | | |
| | 90 | 60 | 30 |
| horizontal | 1.00 | 1.00 | 1.00 |
| cylindrical | 0.00 | 0.37 | 1.10 |
| spherical | 0.50 | 0.58 | 1.00 |
| conical $\alpha = 60$ | 0.50 | 0.50 | 0.58 |
| $\alpha = 30$ | 0.87 | 0.87 | 0.87 |

| **(b) Real canopies** | $\mathcal{K}$ |
|---|---|
| White clover (*Trifolium repens*) | 1.10 |
| Sunflower (*Helianthus annuus*) | 0.97 |
| French bean (*Phaseolus vulgaris*) | 0.86 |
| Kale (*Brassica acephala*) | 0.94 |
| Maize (*Zea mays*) | 0.70 |
| Barley (*Hordeum vulgare*) | 0.69 |
| Broad bean (*Vicia faba*) | 0.63 |
| Sorghum (*Sorghum vulgare*) | 0.49 |
| Ryegrass (*Lolium perenne*) | 0.43 |
| (*Loleum rigidum*) | 0.29 |
| *Gladiolus* | 0.20 |

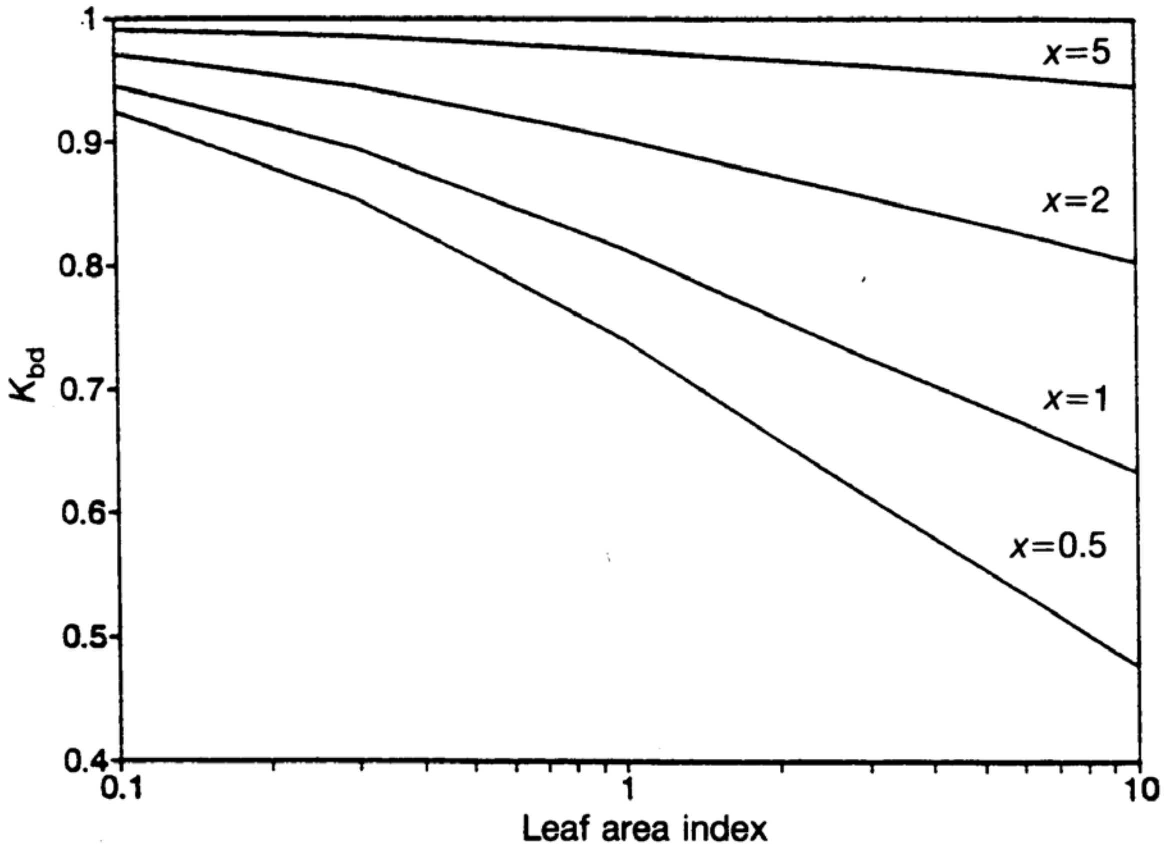


**Figure 8.3** Apparent attenuation coefficient for diffuse radiation from a uniform overcast sky in canopies with differing leaf angle distributions (*x* is the ratio of averaged projected areas of leaves on vertical and horizontal surfaces, so that *x* = 1 is a spherical leaf angle distribution, *x* = 0 for a vertical distribution, and *x* = ∞ for a horizontal distribution) (from Campbell and van Evert, 1994).

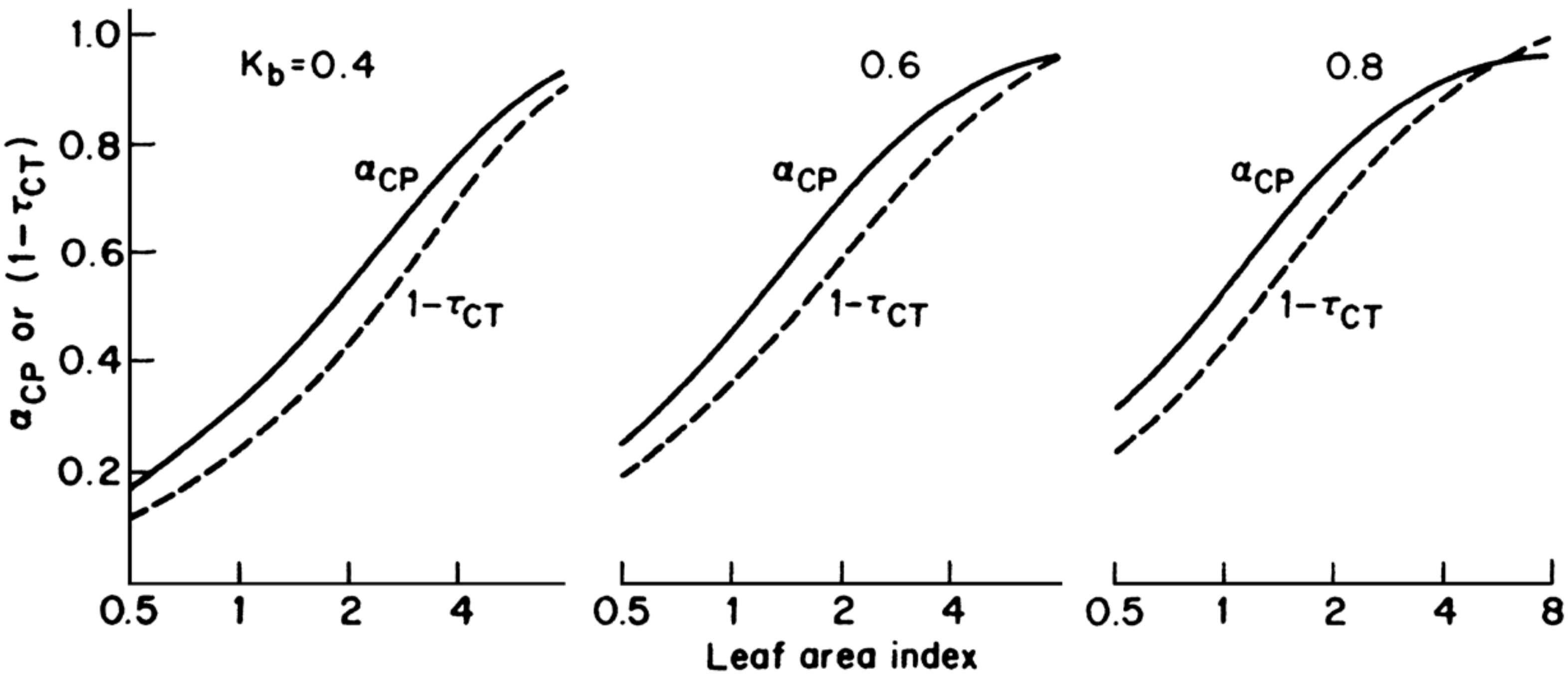


**Figure 8.4** Fractional absorption of visible radiation (or PAR) $\alpha$CP (full lines), and fractional interception of total radiation *(*1 − *τ*cT*)* (dashed lines) as functions of leaf area index for three values of the attenuation coefficient for black leaves *K*b (assuming *ρ*p = *τ*p = 0.05, giving *(α*p/*α*T*)*0.5 = 1.34*)*.

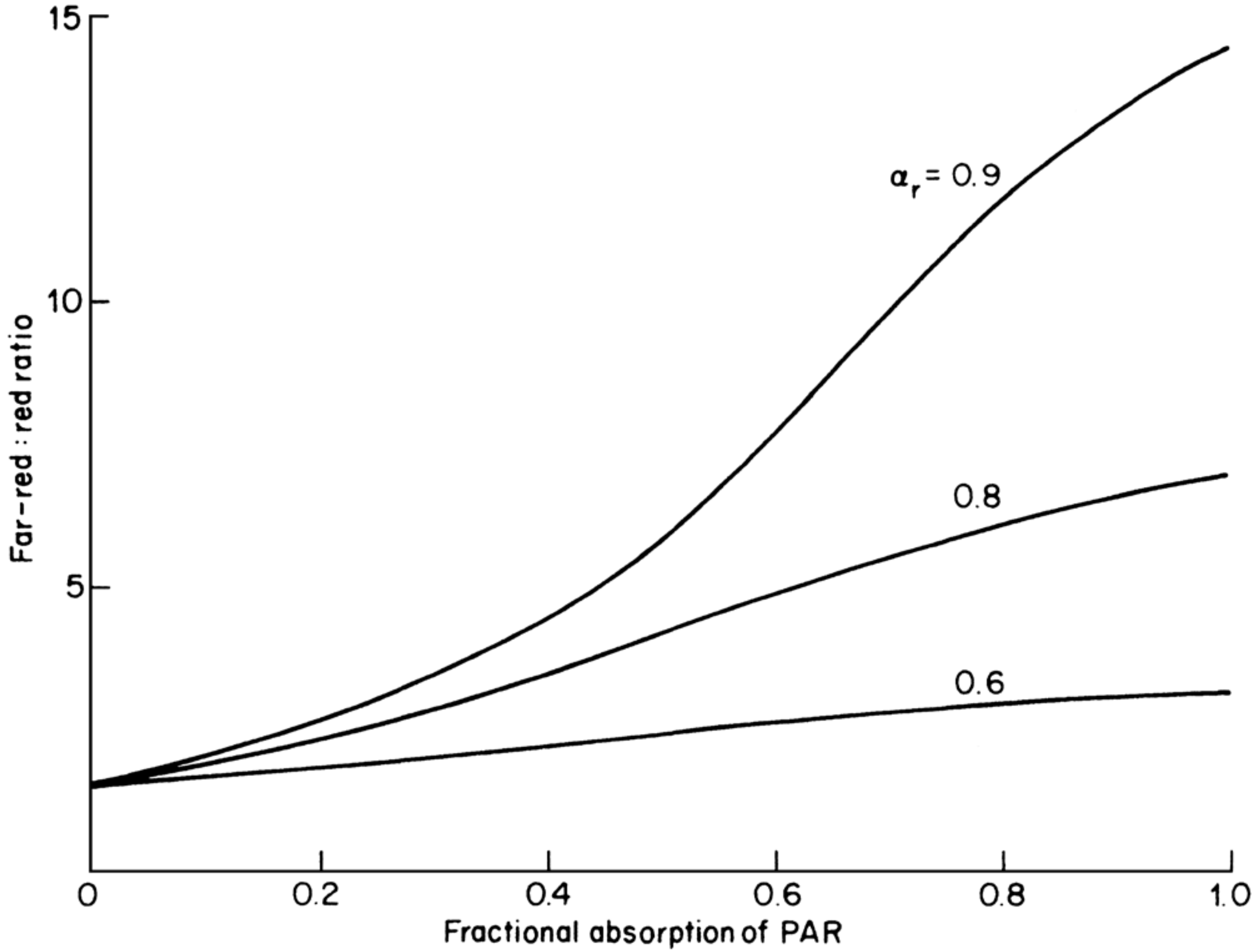


**Figure 8.5** Relation between far-red: red reflectivity ratio, *ρi/ρr*, for a canopy of vegetation and the fraction of PAR, *α*cP absorbed by the canopy. Leaf absorptivity specified.

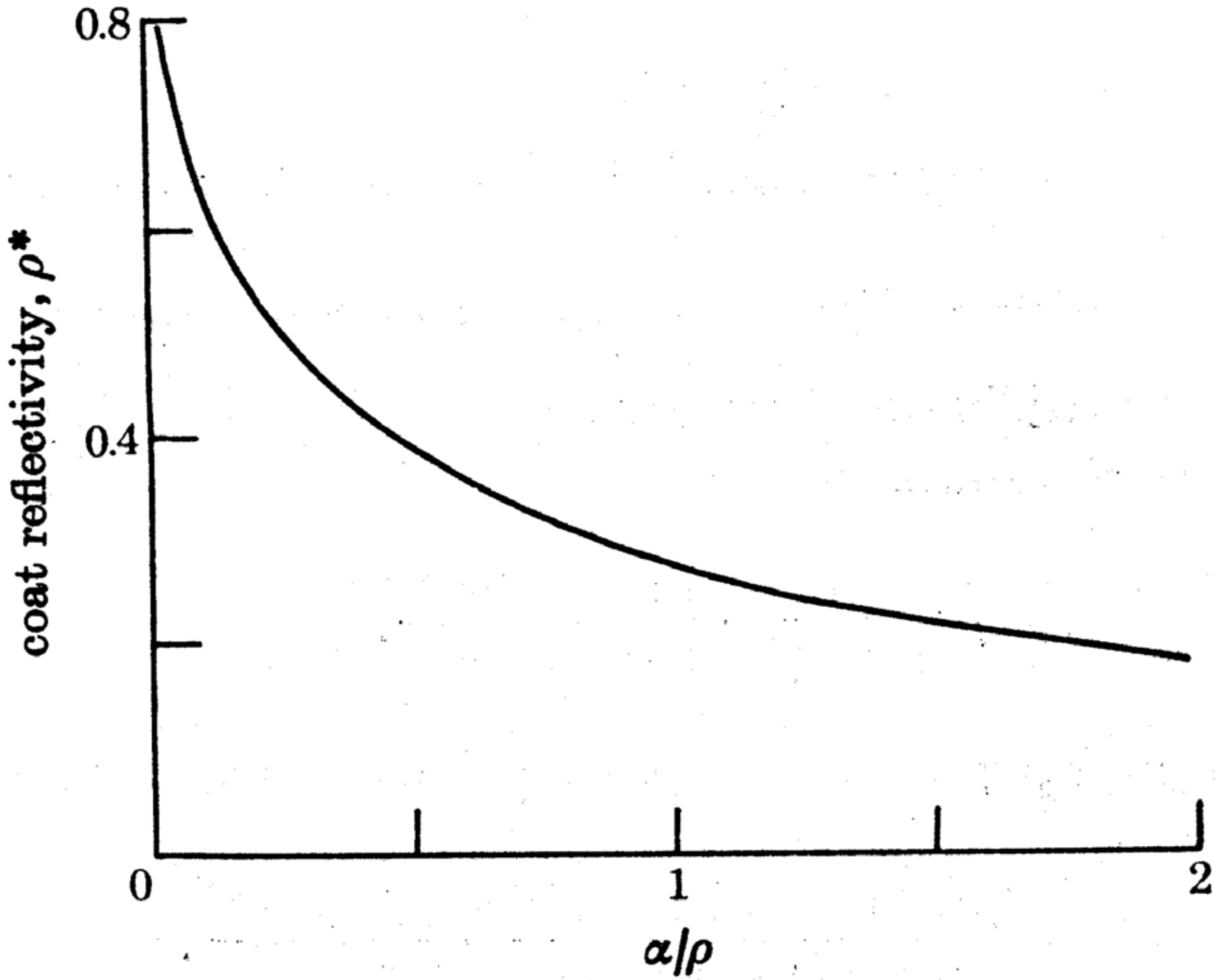


**Figure 8.6** Theoretical relation between a coat reflection coefficient $\rho*$ calculated from Eq. (8.22), and the ratio of absorption to reflection coefficients $\alpha/\rho$ for a single hair.

**Table 8.2** Values of Reflection and Absorption Coefficients for Animal Coats. $\rho^*$ is the reflection coefficient of the hair and skin together; $\alpha/\rho$ is the ratio of hair absorption coefficient to reflection coefficient (From Cena and Monteith, 1975)

| Coat | $\rho^*$ | $\alpha/\rho$ |
|---|---|---|
| Sheep, Dorset Down | 0.79 | 0.03 |
| Sheep, Clun Forest | 0.60 | 0.13 |
| Sheep, Welsh Mountain | 0.30 | 0.82 |
| Rabbit | 0.81 | 0.02 |
| Badger | 0.48 | 0.28 |
| Calf, white | 0.63 | 0.11 |
| Calf, red | 0.35 | 0.60 |
| Goat, Toggenburg | 0.42 | 0.40 |
| Fox | 0.34 | 0.64 |
| Fallow deer | 0.69 | 0.07 |

**Table 8.3** Relations Between Radiative Properties of Individual Hairs and the Radiation Budget of Whole Coats (From Cena and Monteith, 1975)

| | | Welsh Mountain clean | Dorset Down clean | Dorset Down soiled, light skin | Dorset Down soiled, dark skin |
|---|---|---|---|---|---|
| | **Hair parameters** | | | | |
| | $\rho$ | 0.240 | 0.066 | 0.240 | 0.240 |
| | $\alpha$ | 0.200 | 0.002 | 0.060 | 0.060 |
| | $\tau$ | 0.560 | 0.932 | 0.700 | 0.700 |
| | $\rho_S$ | 0.250 | 0.800 | 0.800 | 0.250 |
| **Coat depth** | | | | | |
| 1 cm | $\rho^*$ | 0.30 | 0.80 | 0.51 | 0.50 |
| | $\alpha^*$ | 0.66 | 0.03 | 0.45 | 0.40 |
| | $(1-\rho_S)\tau^*$ | 0.04 | 0.17 | 0.04 | 0.10 |
| 2 cm | $\rho^*$ | 0.30 | 0.80 | 0.51 | 0.50 |
| | $\alpha^*$ | 0.70 | 0.05 | 0.47 | 0.45 |
| | $(1-\rho_S)\tau^*$ | 0 | 0.15 | 0.02 | 0.05 |
| 4 cm | $\rho^*$ | 0.30 | 0.80 | 0.51 | 0.50 |
| | $\alpha^*$ | 0.70 | 0.09 | 0.48 | 0.47 |
| | $(1-\rho_S)\tau^*$ | 0 | 0.11 | 0.01 | 0.03 |

**Figure 8.7 (a)** Farmers at a cattle market in Andhra Pradesh, India. The bareheaded farmer needs the shade of an umbrella. The two with white turbans do not. (Would a white umbrella be more or less effective?).

**Figure 8.7(b)** Cattle in a field in Israel. The dark cattle have sought shade, but the white animals are apparently comfortable in full sunshine.

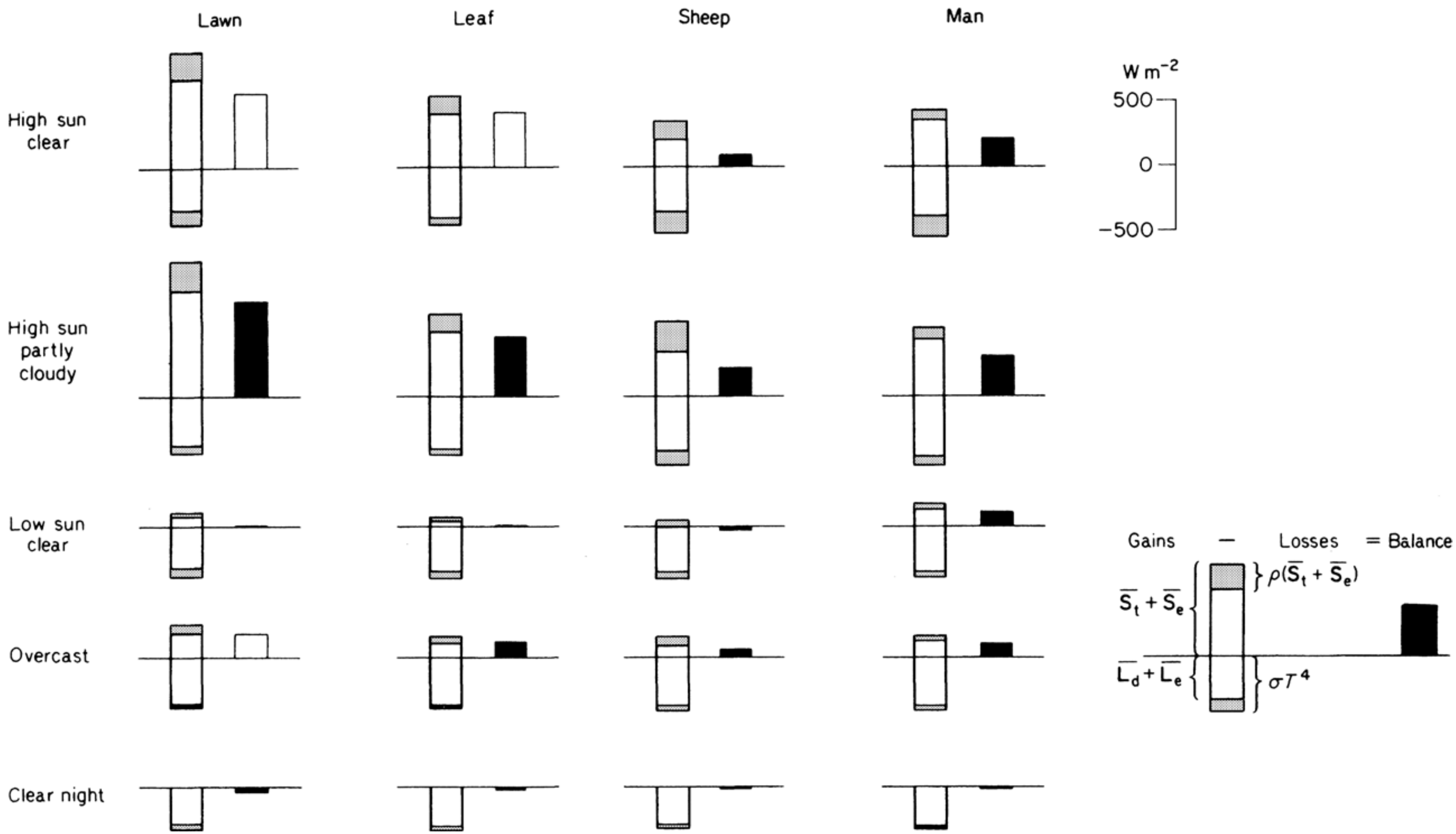


**Figure 8.8** Net radiation balance of different surfaces in a range of weather conditions as specified in Table 8.4.

**Table 8.4** Conditions Assumed for the Radiation Budgets in Figure 8.8

| | High sun clear | High sun partly cloudy | Low sun clear | Overcast day | Clear night |
|---|---|---|---|---|---|
| Solar elevation $\beta$ (degrees) | 60 | 60 | 10 | – | – |
| Direct solar radiation $S_b$ (W $m^{-2}$) | 800 | 800 | 80 | – | – |
| Diffuse solar radiation $S_d$ (W $m^{-2}$) | 100 | 250 | 30 | 250 | – |
| Downward long-wave radiation $L_d$ (W $m^{-2}$) | 320 | 370 | 310 | 380 | 270 |
| **Surface temperature (°C)** | | | | | |
| Air | 20 | 20 | 18 | 15 | 10 |
| Lawn | 24 | 24 | 15 | 15 | 6 |
| Leaf | 24 | 25 | 15 | 15 | 4 |
| Sheep | 33 | 36 | 15 | 20 | 10 |
| Man | 38 | 39 | 15 | 20 | 10 |
| **Reflectivities** | | | | | |
| Lawn | 0.23 | 0.23 | 0.25 | 0.23 | – |
| Leaf | 0.25 | 0.25 | 0.35 | 0.25 | – |
| Sheep | 0.40 | 0.40 | 0.40 | 0.40 | – |
| Man | 0.15 | 0.15 | 0.15 | 0.15 | – |