THERMAL CONSTRAINTS ON GRAZING AND BROWSING HERBIVORES

Esther J. Finegan, MSc,[1*] James L. Atkinson, PhD,[1] Jock G. Buchanan-Smith, PhD,[1] John P. Cant, PhD,[1] Terry J. Gillespie, PhD[2]

[1]Department of Animal and Poultry Science, University of Guelph, Ontario, Canada; [2]Department of Land Resource Science, University of Guelph, Ontario, Canada

Abstract

There are five ways in which an animal may exchange heat with its environment: solar (shortwave) radiation gain, longwave radiation exchange, convective exchange, conductive exchange, and heat loss by evaporation.[2] This heat exchange, in combination with the metabolic heat produced by the animal, defines the animal's heat balance (Figure 1). When a homeothermic animal cannot lose sufficient body heat (generated by metabolism, or gained from the environment) to maintain a stable body temperature, the animal experiences heat stress. In a cold environment when the same animal loses heat to the environment faster than metabolic heat is generated, or heat is gained from the environment, the animal experiences cold stress. Under conditions of heat stress, animals may seek a cooler environment in the shade, while under conditions of cold stress animals find relief by sheltering from wind, rain, and snow.[4,6-7]

Grazing, and browsing herbivores spend many hours a day obtaining food and are frequently unable to use shade or shelter, and eat at the same time.[1] Most captive grazers and browsers, which spend some time out of doors, will experience at least short periods of heat or cold stress at some time during the year. For such animals it is important to know when periods of heat or cold stress may occur, and to provide shade or shelter at these times. If air temperature, relative humidity, wind speed, solar radiation, rain or snow fall, and the animal's metabolic heat production are known, the heat balance of the animal can be estimated .

As an initial demonstration of this approach, heat balance data generated for both a black and a white cow, on a hot summer day (Figure 2) and on a cold winter day are presented.[3] The expected heat balance for African elephants on outdoor exhibit (on grass, bare ground (Figure 3), and concrete) is then illustrated. Whether, to what extent, and for how long these animals are expected to be in positive (more heat gained than lost) or negative (more heat lost than gained) heat balance is investigated. The effect of providing shade (Figure 3) or shelter in reducing positive or negative heat balances is examined.[5]

LITERATURE CITED

1. Arnold, G.W., and M.L. Dudzinski. 1978. Ethology of free-ranging domestic animals. Elsevier Scientific Publishing Company, Amsterdam, The Netherlands.
2. Curtis, S.E. 1983. Environmental management in animal agriculture. Iowa State University Press, Ames, Iowa.
3. Environment Canada. 1993. Canadian weather energy and engineering data sets (CWEEDS files) and Canadian weather for energy calculations (CWEC files). Environment Canada, Atmospheric Environment Service, Toronto, Canada.
4. Fleming, J.R. 2002. The effects of strip grazing stockpiled permanent pasture on the performance of non-lactating, gestating beef cows. M.Sc. Thesis, University of Guelph, Guelph, Canada.
5. Langman, V.A., M. Rowe, D. Forthman, N. Langman, J. Black, and T. Walker. 2003. Quantifying shade using a standard environment. Zoo Biol. 22: 253-260.

6. Widowski, T.M. 2001. Shade-seeking behavior of rotationally-grazed cows and calves in a moderate climate. In: R. R. Stowell, R.R., R. Bucklin, and R.W. Bottcher (eds). Livestock Environment VI: Proceedin gs of the 6th International Symposium. The Society for Engineering in Agricultural, Food, and Biological Systems, St. Joseph, MI, USA. Pp. 632-639.
7. Wright, P.G. 1984. Why do elephants flap their ears? S. Afr. J. Zool.19: 266-269.

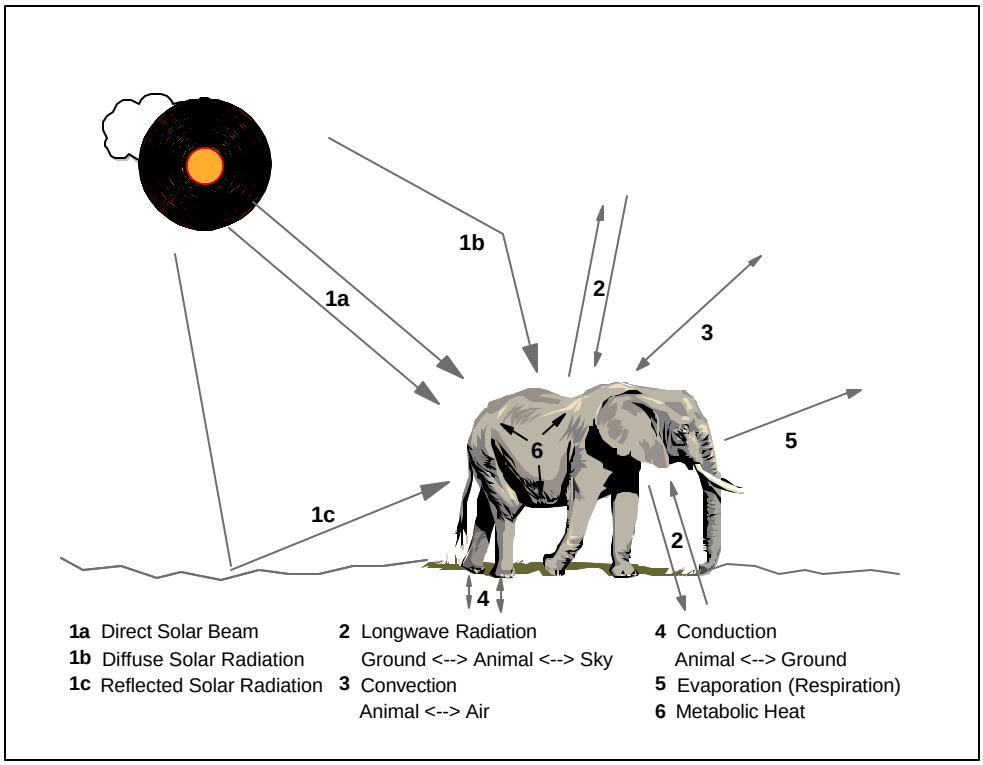

Figure 1. Heat exchange between an animal and the environment

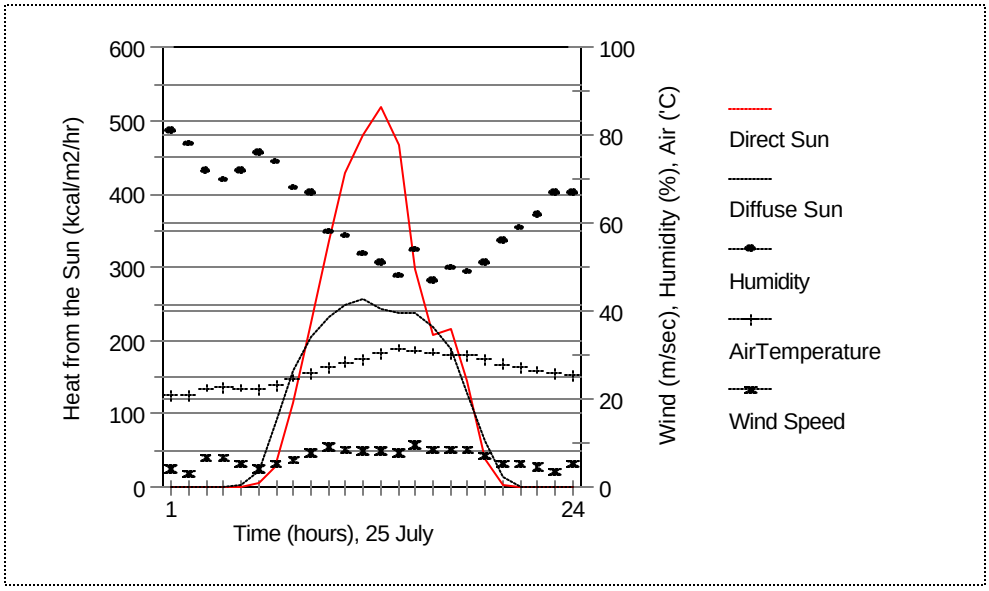

Figure 2. Weather on a Hot Summer Day (sunrise 4:59, sunset 19:49)

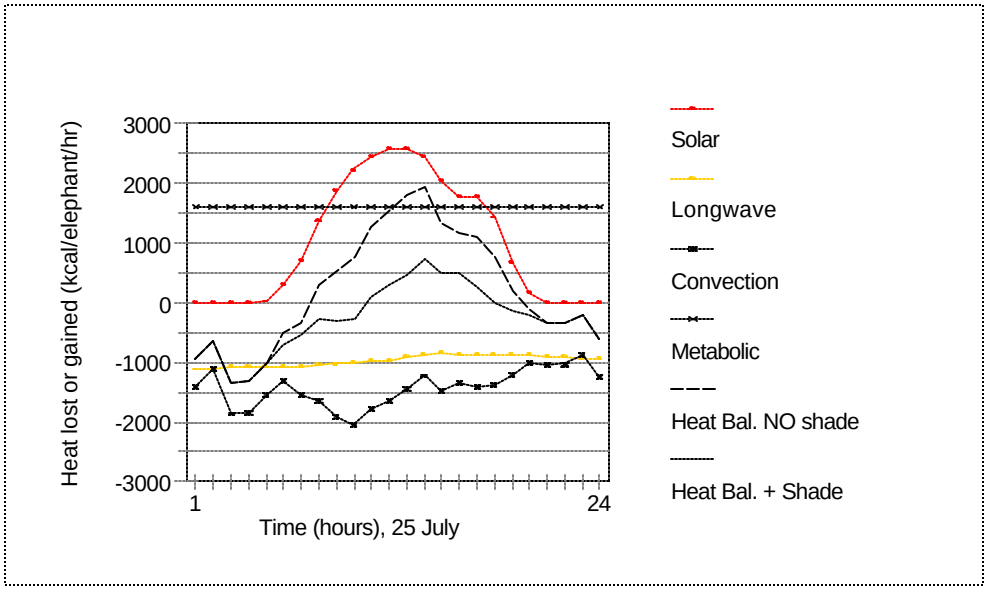

Figure 3. Elephant Heat Exchange on a Hot Summer Day (on bare ground)