Response to “Growth–Maintenance Component Models Are an Inaccurate Representation of Plant Respiration”

I welcome the opportunity to comment on this letter, having reviewed earlier versions. First I will make a few general remarks, and then address specifically some of the issues raised by Hansen et al.

Editorial/reviewing processes are often problematic (Lock, 1985). Principal issues are readability, comprehensibility, not a trivial repeat of already published work, and usually, brevity. Evaluating originality and quality of science is more difficult, never wholly objective, and can offer much scope for fruitless argumentation, although an assessment must be attempted. My initial position, on receiving a manuscript for review, is: good, another contribution to science, how can it be improved? Inappropriate or unduly harsh reviewing can do much harm, to science, and to individuals. It is better to err in the opposite direction. The scientific community has its own way of sorting out wheat from chaff. It is also entirely reasonable for a reviewer to believe that the science presented may be poor, but the manuscript should be published. A sound argument can be presented quietly, using moderate language; it need never be shouted about.

McCree (1970) presented an equation similar to Eq. [1] of Hansen et al. as a possibly useful phenomenological equation. Phenomenological equations are always approximate, with inaccuracies, but can nevertheless be useful. With unsuitable parameters, a phenomenological equation may be in conflict with basic scientific laws. The position that growth and maintenance can be rigorously regarded as separate processes has never been sustainable, other than as a first approximation. Maintaining the status quo of cells, tissues, or plants is not really possible. However, as McCree (1970) remarked, “the idea of a ‘basal metabolism’ has been used in animal physiology for many years,” where it is still of value. In microbiology, work at the whole-cell level makes use of the maintenance concept (Pirt, 1975), whereas detailed modeling of a single cell at the molecular level does not require specific use of the idea of maintenance, but simulation results can be plotted and interpreted in terms of a growth yield (Yg) and maintenance coefficient (Domach et al., 1984). Similar work has been done on plant metabolism, where Dewar recently presented a model at a level of aggregated biochemistry which does not use the idea of a growth and a maintenance respiration per se. His model can be used to interpret empirically derived growth and maintenance coefficients. He shows that what is sometimes estimated as a maintenance coefficient can be rather a movable feast. The growth–maintenance paradigm is essentially a pragmatic method.

Hansen et al. suggest that energy costs resulting from applying the second law of thermodynamics (entropy) increase over the temperature range of 15 to 25°C from 8 to 16 J g⁻¹ K⁻¹, and that this is significant. These values seem rather negligible in terms of what is generally regarded as a maintenance coefficient (Domach et al., 1984). Similar work has been done on plant metabolism, where Dewar recently presented a model at a level of aggregated biochemistry which does not use the idea of a growth and a maintenance respiration per se. His model can be used to interpret empirically derived growth and maintenance coefficients. He shows that what is sometimes estimated as a maintenance coefficient can be rather a movable feast. The growth–maintenance paradigm is essentially a pragmatic method.

With Eq. [2], parameter Y must be treated as a variable. It value depends in rather a complicated way on growth rates. Equation [1], with two parameters, is an attempt to rationalize some of that variability. It has been used successfully in many plant and animal simulators, frequently using the maintenance coefficients as empirical rather than a theoretical construct. I agree that Eq. [2] has had similar successful applications.

In summary, Hansen et al. are largely tilting at windmills of their own creation, using dubious weapons. The growth–maintenance paradigm can be extended progressively towards, increasing accuracy and often blurring the distinction between a growth and maintenance interpretation (Cannell and Thornley, 2000). The endpoint of such work is a biochemical model with kinetic equations which allow formulation, reflect thermodynamic constraint, and will not lead to any maintenance language is not part of this detail. It is shown, which, as explained by Domach et al. (1984) and Dewar (2000), can be used to interpret and illuminate growth–maintenance phenomenology. Hansen et al. say “A change in direction is needed if progress is to be made towards a better understanding of the respiration-growth relation.” They are wrong. What is needed is an appreciation of the value in attacking the problem from both ends: from above, with phenomena, and from below, with more detailed mechanistic analysis. The choice, as always, depends on objectives.

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References

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