Of What Stuff Are Animals Made?

Body Composition Analysis in Animals: A Handbook of Non-Destructive Methods

Edited by John R. Speakman

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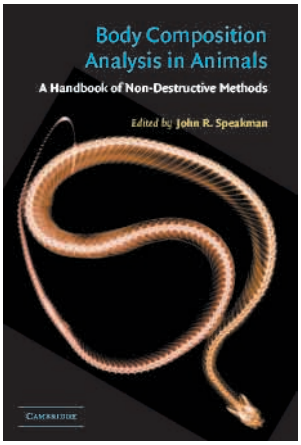

Living organisms run on energy that they harvest from the environment, either as radiant energy or food. Because energy income can be highly variable and not always perfectly aligned with energy needs, animals and plants alike rely on some form of energy storage to buffer income deficits. In animals, fat is the principal form of energy storage, so the size of fat reserves has long been of interest in ecology, wildlife management, animal science, and related fields. Animals with a large fat reserve have often been termed 'in good condition' and those with a low or no reserve 'in poor condition'. The concept of body condition pervades so much of ecology and related fields that it becomes important for students and researchers to understand first, what exactly is meant by body *condition*, and second, how body *composition* can be measured to provide access to information on the size of energy reserves. *Body Composition Analysis in Animals: A Handbook of Non-Destructive Methods* is designed to provide just such an overview. This book provides a comprehensive coverage of methods for quantifying and interpreting data on body composition.

The book is organised in four basic sections: an introduction, a single chapter on condition indices, another chapter on destructive methods for measuring body composition, and finally six chapters dealing with non-destructive methods. Below I will treat these sections separately, but I first want to provide an overview of the strengths and weaknesses of the book.

In my view, the main strength of this book is that it pulls together for the first time in one place information on an wide array of methods that are used to measure body composition in vertebrates. I had heard of, but not read about, many of the methods, so having a single source is truly informative. The book also benefits from the fact that chapters are organized in a more or less uniform fashion, providing an underlying cohesion. Finally, most authors appear to have taken to heart instructions to provide details on validation studies and accuracy. This makes it *relatively* easy to judge whether a given method is likely to be sufficiently accurate to be applicable in a given situation.

If I can correctly assume that most, but admittedly not all, readers will be primarily interested in methods that allow them to quantify fat mass rather than other body components, then one weakness of the book is that many authors have not directly addressed this topic. It is true that most methods do not *directly* measure fat, but rather infer the quantity of fat from measures of other body components, such as total body water or lean mass. Although most authors analyse the precision of their methods with regard to the non-fat components, most do not go the final step towards addressing the accuracy of estimates of fat. For example, Chapter 6 on bioelectrical impedance analysis never mentions fat. Chapter 3 (isotope-dilution methods) devotes only a half page out of 35 to estimating fat mass and Chapter 7 (ultrasound scanning) makes only a passing mention of fat.

Another problem is the inherent difficulty of interpreting the significance of fat reserves once they have been measured with some degree of precision. A simplistic view of fat would be that it serves as a compact energy source for fueling metabolism during periods of energy shortfall; the fatter the fitter. However, an increasing body of literature shows that the size of a fat reserve is shaped by a cost-benefit trade-off, where the cost is enhanced risk of predation when transporting a cargo of fat and the benefit is the ability to survive and even initiate reproduction when food is limiting. Because habitats that are productive and predator-free (benign) or offer highly variable and unforeseeable cycles of food abundance (stressful) can both select for large fat reserves, there may be no simple and universal interpretation of data on fat mass. Although Speakman discusses this problem in the introduction, this may well be overlooked by readers who flip directly to the chapters of interest. Despite this caveat, there is no doubt that fat reserves serve a purpose and that many lines of research will necessarily involve some measure of the size of a fat reserve.

These problems aside, the book is well-organised and provides for interesting and easy reading. The introduction (J. R. Speakman) addresses the problem of fat reserves being shaped by an adaptive trade-off and provides the context for each of the following chapters. Chapter 1 (J. P. Hayes and J. S. Shonkweiler) presents a detailed, comprehensive, and thought-provoking analysis of body condition indices. Focusing on the various ways that condition indices are generated and the implicit statistical assumptions and biases associated with these indices, the authors make practical suggestions on how best to use measures of body size to infer *condition.* This chapter should be mandatory reading for graduate students embarking on any studies that involve seasonal or habitat-related changes in body condition. Chapter 2 (D. S. Reynolds and T. H. Kunz) presents the standard destructive (chemical) methods for body composition analysis. Although this chapter may seem out of place in a book on non-destructive methods, it must be remembered that any non-destructive method must ultimately be calibrated and validated using destructive methods. Inclusion of this chapter in the book, rather than simply

referring the reader to other publications, makes it a complete one-stop handbook.

The following six chapters each present a single method of body composition analysis that either directly or indirectly provides access to information of fat and other body components. The methods that are treated are: isotope dilution for estimating total body water, gas dilution for directly quantifying lipids, the TOBEC method for measuring lean mass, bioelectrical impedance analysis for measuring intra- and extra-cellular water, ultrasound imaging, and finally dual-energy X-ray absortiometry for directly measuring bone, fat and lean-tissue mass. Each has a short introduction, followed by sections presenting the chemical or physical principles underlying the method. Most chapters present, at least briefly, the most commonly used instruments, discuss confounding variables, and offer practical suggestions as to how to get the most accurate and repeatable results. Most chapters then provide an analysis of the accuracy of the method relative to the specific body components that it measures. I find this analysis particularly useful because it allows potential users to determine whether the method is applicable in their specific situation. I would have liked to see the authors go one step further by incorporating sensitivity analysis that would estimate the compound error on fat determinations, but then one can't have everything.

In summary, this is a well-structured book that provides a sufficiently complete overview of methods for the analysis of body composition that are potentially applicable to field studies of wild animals. I do not hesitate to recommend *Body Composition Analysis in Animals: A Handbook of Non-Destructive Methods* as a worthy addition to the library stacks and your own personal library.

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