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Water Balance in Land Arthropods

With 109 Figures

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The cover design depicts adult male and female desert cockroaches *(Arenivaga investigata)* superimposed on histograms showing changes in the water content of these insects as they dehydrate and (in the case of females) rehydrate by absorbing water vapour. Fig. 97 in the text is relevant.

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Preface

Writers on arthropod water relationships range from biophysicists and biochemists to population ecologists—a fact that gives cause to wonder whether the field is already too heterogeneous to be written about in a single book by a single author. I have partly avoided the problem by concentrating largely on physiological mechanisms and by omitting most aspects of behavioural regulation and most aspects of heat balance and body temperature, except when these impinge directly on water balance.

Even within this limited field there has been a lot of work during the past twenty years, as a result of which some problems have been solved (or at least more clearly defined), and many others have been opened up. On the whole there has been a welcome change to a more rigorous experimental approach and it is now possible for water balance people to state their problems in physiological terms.

Good progress has been made towards understanding the mechanisms involved in nearly all avenues of water uptake and loss, although problems indeed remain. The cuticle has yielded part of its secrets to electron micrography, but exploration by means of lipid biochemistry among other techniques is necessary for a real understanding of cuticle permeability. Recognition that water exchange through the cuticle is nearly always a two directional process has come with the introduction of isotopically labelled water to study the component movements. Work on respiratory water loss has led to the discovery of intermittent carbon dioxide release and to a much better understanding of spiracular control mechanisms and of their effects. But several aspects of the relationship between oxygen uptake and water loss are still unexplored.

The most important means of water uptake are usually by feeding and drinking, and problems concerning the control of these processes have proved to be interesting and quite obstinate. Perhaps the most intriguing of all uptake mechanisms is that of water vapour absorption. Here, there is much more information about rates and limiting conditions, and a strong suggestion that the site of uptake in some instances at least is the rectum or mouth rather than the cuticle, but the central mechanism itself still eludes description and poses an attractive

problem for cooperation between biologists and biophysicists. The significance of metabolic water production is better appreciated, and some integration of this with other avenues of gain and loss in field conditions has been attempted.

Great strides have been made in understanding what is perhaps the central problem: the internal mechanisms for osmotic and ionic control. Elegant experiments have yielded much information about the details of Malpighian tubule and rectal function at the organ level, and this in turn has led to an attack on the mechanisms of transepithelial transport, in both iso-osmotic and in contra-osmotic situations, in terms of fine structure. Exploitation of this area demands the cooperation of general physiologists with arthropod physiologists, and the results so far have been exciting and encouraging. In this connection, the need to eliminate excess water, e.g. by blood suckers and plant sap feeders, has become recognised and forms a useful counterweight to the usual emphasis on water conservation mechanisms. The water balance of eggs has received relatively little attention, although some important and interesting problems seem to be involved.

Most of the recent work has been concerned with the exploration of particular mechanisms, and there is now both a need and an opportunity to take a wider view and attempt to synthesise such knowledge into an understanding of water balance in whole animals in natural situations. Work along these lines should be innovative and productive; and would encourage a useful exchange of ideas between laboratory physiologists and field ecologists. I have tried to enlarge on this idea in the final chapter of the book.

Los Angeles, 1977 E. B. EDNEY

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The book is dedicated to Sir Vincent Wigglesworth—a pioneer in this and many other fields.

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