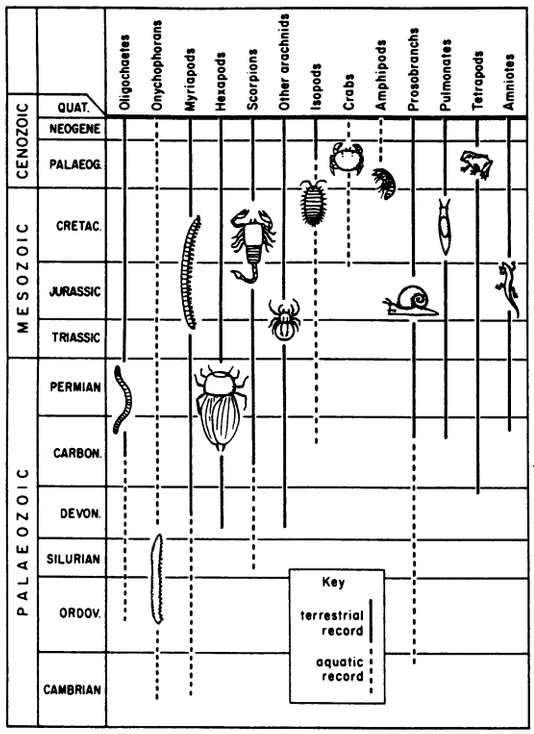
Metazoan Transitions

Invasions of the Land. The Transitions of Organisms from Aquatic to Terrestrial Life. MALCOLM S. GORDON and EVERETT C. OLSON. Columbia University Press, New York, 1995. xix, 312 pp., illus. $65 or £49.

Few events during the history of life on Earth have had greater impact on organismal design than the transition from aquatic to terrestrial habitats. In part because of the radically different physical characteristics of air and water as media, the biomechanical problems faced by terrestrial plants and animals differ radically from those present in aquatic environments. On land, gravitational loads must be resisted and problems of buckling circumvented. Water loss on land may occur very rapidly, diel temperature variation is much greater than in the water, and waste products must be disposed of by different methods from those available to aquatic organisms. Both sensory and motor systems of animals on land must function in a medium that is substantially less dense and viscous than the ancestral aquatic habitat, and modes of reproduction that allowed dispersal of young in the water must be altered to accommodate constraints imposed by the terrestrial environment.



"Approximate sequence of major events in the invasions of the land by animals, as known from the fossil record. Dotted lines indicate aquatic record; solid lines terrestrial record." [From *Invasions of the Land*; after Selden and Edwards, 1989]

Comparative biologists are fortunate that the invasion of land has occurred multiple (independent) times during the history of life. This allows the analysis of convergent solutions to problems of life on land and facilitates the search for general evolutionary responses to the invasion of a novel and stressful habitat. However, successful investigation of aquatic-to-terrestrial transitions is predicated on our ability to identify clades in which such transitions have been made and to obtain sufficient phylogenetic resolution within those clades to compare close relatives that differ in habitat. Without adequate phylogenetic control, comparisons of grade groups suffer from the conflation of primitive and derived traits, lack the ability to isolate habitat as the primary dependent variable, and do not permit the reconstruction of historical sequences by which novel structural and functional traits were acquired during the transition from one habitat to another.

In this volume, Malcolm Gordon and Everett Olson (with contributions by David Chapman on plants) review the many "invasions" of land that have occurred during the evolution of multicellular life. The book begins and ends with a general overview and synthesis of the authors' views of the problem of terrestrial invasion. The body of the book is divided into two main parts: an overview of the fossil record and what it tells us about metazoan transitions, and an analysis of the physiological literature on extant organisms that belong to clades in which environmental transitions are presumed to have taken place. The authors describe clearly the difficulty of identifying from the fossil record alone the extent to which any clade has achieved completely terrestrial life and the relative paucity of information that can be retrieved on physiological evolution. Thus, successful treatment of the literature on extant taxa is especially important for a volume on this transition to be of general utility. Unfortunately, the coverage of this topic here is uneven conceptually and is made difficult to follow by the lack of illustrations and the tendency to review many studies without considering any in depth. A more successful strategy would have been the presentation of general principles followed by the illustration of each principle by detailed discussion of a few specific examples. Of greatest concern is the assumption by the authors of the polyphyletic origin of many taxa (including amphibians, reptiles, arthropods, and pulmonate gastropods), a view arrived at as a result of failing to consider the relevant recent primary literature on the phylogenetic relationships of these clades and by an over-reliance on outdated secondary sources. Also disappointing is that the very conceptual tools most likely to have offered new insights into this critical issue in metazoan evolution have been ignored, as though the last 20 years of progress in systematic biology and its continuing integration with comparative physiology (to form the new subdiscipline of evolutionary physiology) had never happened.

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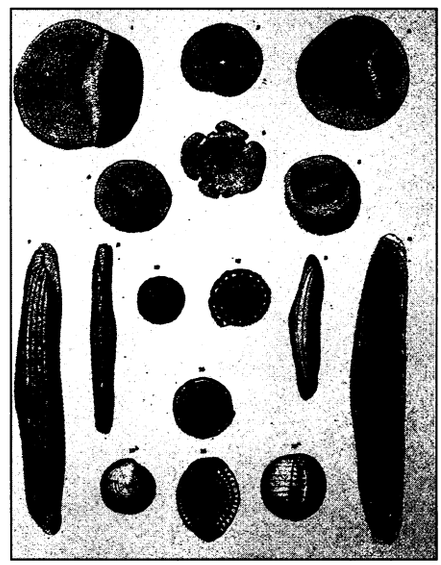
A Famous Dredge Haul

The *Challenger* Foraminifera. ROBERT WYNN JONES. Oxford University Press, New York, 1994. x, 151 pp., illus., + plates. $275 or £175.

The HMS *Challenger* set sail from Portsmouth, England, in December 1872 and, after circumnavigating the world, returned in May 1876. This scientific expedition marks the beginning of the discipline of oceanography. Our comprehension of



Orbitolites and *Alveolina* as assigned by H. B. Brady. One of the 115 plates from the 1884 *Challenger* volumes on foraminifera.