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Marine Micropaleontology and Global Change Research

Global change studies are receiving widespread attention and research funding due in large part to the possibility of future climatic and environmental changes. Earth scientists have shown previously that dramatic changes have occurred in the past with a significant number of these studies focused on the analysis of marine microfossils. The basis for much of this work began with the pioneering biogeographical studies of planktonic foraminifera from plankton tows and surface sediments and these studies demonstrated that foraminifera have zonal distributions which are related to sea-surface temperature (SST) patterns. These studies were followed by papers quantitatively relating microfossil data to SST and showed in the CLIMAP reconstructions that marine environments of the ice-age Earth were dramatically different from modern conditions. The many studies which have followed have provided information on the nature and timing of climatic change and the ramifications of these changes. Clearly, the initial ecological studies were critical in the development of these paleoclimatic reconstructions.

Ecological studies of planktonic and benthic foraminifera are continuing today in a number of new directions and will provide the basis for new approaches to paleoceanographic studies dealing with global change. The seasonal nature of foraminiferal production is being studied using sediment trap data from a number of locations in the open ocean and marginal seas and these data highlight the importance of seasonality in oceanic processes. Geochemical and morphometric studies of specimens from traps and surface sediments are documenting ontogenetic changes in a number of important taxa. These investigations will provide the basis for future reconstructions of upper ocean hydrographic conditions and a more detailed look at seasonal variability in the past.

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Studies of living (stained) deep-sea benthic foraminifera, largely based on box core samples, show that species have microhabitat preferences, which affect the carbon isotopic composition of the shells. These microhabitats are occupied by taxa with distinctly different test morphologies, suggesting that the different morphologies of benthic foraminifera are adaptations to microenvironments within the surficial sediments. The flux of organic carbon to the seafloor and dissolved oxygen levels in the bottom and pore waters have been shown to be important variables influencing distributional patterns and shell chemistry. If these initial observations are verified by on-going work, they will enable paleoceanographers to use faunal and isotopic data to reconstruct organic carbon flux and primary productivity patterns in the world ocean.

Laboratory culturing studies of planktonic foraminifera have provided unique ecological information, as observations based on manipulation of environmental variables provide insights into foraminiferal ecology that cannot be easily made with field studies. Culturing of shallow-water benthic foraminifera has been done for many years as well, but no serious attempt has been made until recently to culture deep-sea species. Initial results show that deep-sea taxa can be maintained in the lab for a period of many months and indicate that more complex culturing studies are possible, and indeed likely, in the next decade. The culturing work on both planktonic and benthic foraminifera will enable researchers to study foraminiferal biology and will create new ecological questions that can be tested by field studies.

These ecological and culturing studies will help researchers to refine the use of foraminifera in paleoenvironmental reconstructions and will foster new applications in paleoceanography. It is thought by some that micropaleontology does not have a critical role to play in global change research. The record shows otherwise.

—BRUCE H. CORLISS