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Community structure of benthic foraminifera in the Gulf of Mexico

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Abstract

The classic papers of Phleger [Phleger, F.B, 1951. Foraminifera Distribution, Part I. Geological Society of America Memoir 46, 1–88.] and Parker [Parker, F.L., 1954. Distribtuion of the foraminifera in the Northeastern Gulf of Mexico. Bulletin of the Museum of Comparative Zoology 111, 453–588, 13 plates.] form the benchmark foraminiferal data sets for the northwestern and northeastern Gulf of Mexico, respectively. These pioneer researchers occupied stations from shelf to abyssal depths. SHE analysis, a method examining the distribution of cumulative sample values of species richness (S), the information function (H) and evenness (E) with increasing number of individuals (N), was used to establish 18 foraminiferal communities and evaluate their community structure. Regression analyses, as well as plots of ln$S$, H and ln$E$ versus ln$N$ (Biodiversitygrams, BDGs), indicate that the majority of the communities exhibit a log series pattern. Theoretical log series values of S, H and E are similar to the regression estimates from observed values in the northeastern Gulf. In the northwestern Gulf, however, observed values of species richness are lower and evenness higher than those expected for a log series, indicating a dramatic difference in community structure between east and west. Since the sampling time of Phleger, subsequent workers have found higher values of species richness and lower values of evenness in the northwestern Gulf. Either biodiversity values have changed since Phleger's 1947 (1951) sampling suggesting a fundamental change in the environmental regime of the northwestern Gulf of Mexico or, as has been suggested, Phleger's data are incorrect due to some sampling methodology. A comprehensive study with suitable experimental design including downcore samples will be required to resolve this dichotomy.

Keywords: foraminifera; Gulf of Mexico; community structure; SHE analysis; biodiversity; BDG

1. Introduction

Because of the new approach for evaluation of species diversity called SHE analysis (Hayek and Buzas, 1997) and the advent of recent theoretical ecological models for community structure, a renewed interest in the relative abundance distribution (RAD) has occurred (Hubbell, 2001; Volkov et al., 2003; Magurran, 2005; Shipley et al., 2006; Wagner et al., 2006). The ubiquitous, abundant and species rich foraminifera are an ideal marine organism for quantitative examination of the RAD. However, such studies, especially in offshore open-ocean environments, are almost non-existent (Buzas et al., in press).

The distribution of foraminifera in the Gulf of Mexico has been extensively documented (Culver and Buzas, 1981a; Murray, 2006). Much of the distributional and biodiversity analysis in the Gulf (e.g., Gibson and Buzas, 1973; Poag, 1981) is based on two seminal

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works. In the northwestern Gulf of Mexico, Phleger (1951) published his classic paper on foraminiferal distribution based on 550 bottom samples from 12 traverses. In the northeastern Gulf of Mexico, Parker (1954) published her classic study on foraminiferal distribution based on 201 samples from 11 traverses. The data in the papers can readily be compared because Parker, who was one of the most outstanding foraminiferal taxonomists of the last century, was the principal taxonomist on both studies. The northwestern study consists of two parts: Phleger (1951), which is mostly ecology and distribution, and Phleger and Parker (1951) which consists mostly of taxonomy.

The distribution of all species encountered in the Gulf of Mexico up until 1980 is given in Culver and Buzas (1981a). The present study uses the Parker and Phleger data in the Gulf of Mexico to document quantitatively the community structure exhibited in the RAD through SHE analysis for community structure identification (SHECSI).

2. Methods

The traverses used in this study are shown in Fig. 1. The percentage data for the total population given in Phleger (1951) and Parker (1954) were converted to number of specimens per species per sample and entered into an Excel program for SHE analysis. Ideally, we would have preferred to analyze each of the living, dead and total populations. Horton and Murray (2006) discuss the advantages and disadvantages of using each of these populations. Observations of the living population over a considerable period of time are required to assess the vicissitudes of seasonal and yearly fluctuations, and only through use of the living population can we be certain that transport or other kinds of taphonomic loss or gain did not influence the dead or total population. The total and dead population are often equivalent, because the dead population is often an order of magnitude larger than the living population (Buzas, 1965). Many authors point out that the total or dead population can be thought of as integrating temporal fluctuations (Scott et al., 2001), and because it often resembles downcore fossil assemblages, it is the most useful for environmental assessment (Culver and Horton, 2005). The community structure evaluated from fossil populations through SHE analysis thus far does resemble modern living and total populations (Buzas, 2004; Hayek et al., 2007). Thus, although we cannot be certain, we feel confident that the

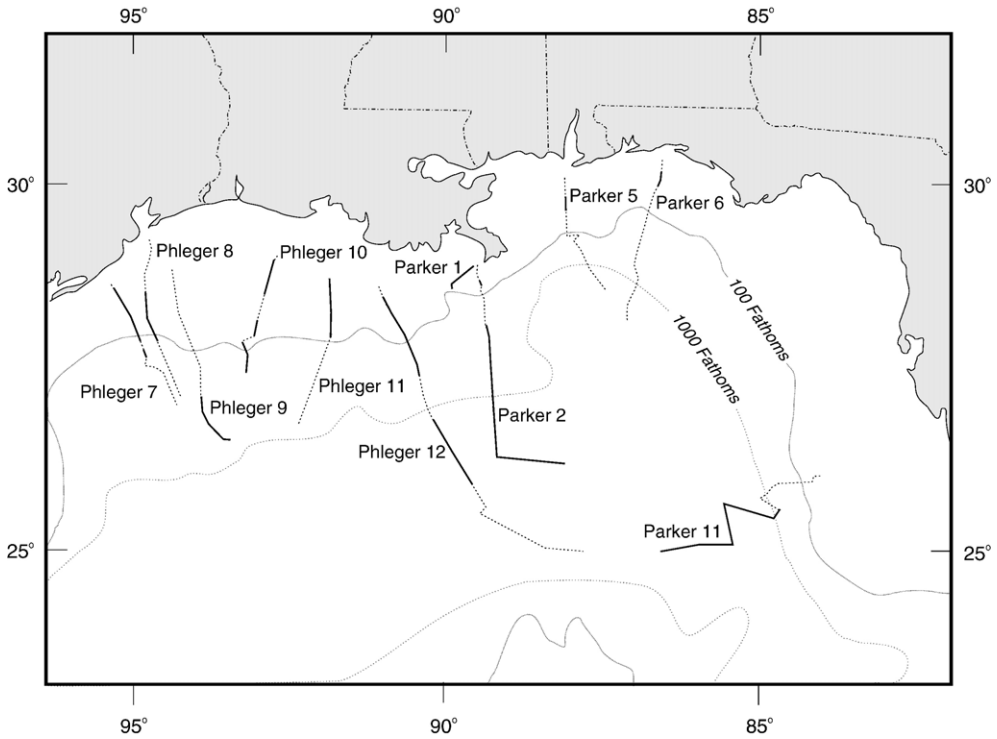

Fig. 1. Location of Phleger (1951) and Parker (1954) traverses in the Gulf of Mexico. Dashed lines indicate position of traverses. Solid lines along traverses indicate positions of communities analyzed in this study.