Probabilistic Aspects of Micropaleontologic Assemblage Zones

Isamu Hattori

A micropaleontologic assemblage zone is defined by occurrence of some characteristic species among many coeval species. When number of assemblage-defining species and total number of species observed are designated as A and N, respectively, the ratio, $A/N$, is strongly dependent on duration of the assemblage. Theoretical consideration on the basis of a micropaleontologic cohort model shows that, when origination rate and extinction rate of species are obtained, the most reasonable ratio $(A/N)$ and duration of the assemblage can be determined. The probabilistic model described in this paper provides a theoretical relation between the ratio and the duration. Inaccuracy in correlating micropaleontologic data to certain assemblage zones established can not be avoided because of many natural sorting and artificial biases. Ambiguity arising when data with a small number of characteristic species are correlated with a certain assemblage is numerically estimated.

KEY WORDS: biostratigraphic zone, species longevity, assemblage duration, probabilistic model, correlation

INTRODUCTION

Micropaleontology is very powerful in correlating rock units of sedimentary origin, because many planktomic organisms such as radiolarians, conodonts, and diatoms have the attributes of index fossils; that is, wide geographic distribution, facies independence, richness of species and individuals, rapid evolutionary rates, distinct morphologic features, and so on. These advantages plus the ability to work with faunal assemblages enable us to improve the accuracy of correlations. Most biostratigraphic zones used in micropaleontology are defined as zones characterized by the common occurrence of several species. In order to characterize a certain assemblage zone, micropaleontologists generally select species on abundance, longevity, widespread occurrence, and ease of identification. The number of species ($A$) characterizing an assemblage is much smaller than the number of all species ($N$) existing in a zone. In radiolarian data sets, the number, $N$, often

1 Manuscript received 19 December 1983; revised 16 March 1984.
2 Geological Laboratory, Fukui University, 910 Fukui, Japan.
reaches hundreds (Mizutani, 1981; Riedel and Sanfilippo, 1978; Takahashi and Honjo, 1981; Yao, 1979), whereas $A$ of established assemblages generally is no more than 10. The ratio, $A/N$, is dependent, in part, on the duration of assemblage zones; $A/N$ can be maximized by dividing a geologic period into suitable intervals. This consideration suggests that a mathematical relation exists between the ratios and the durations of assemblages. The author offers a theoretical relation linking them.

This study addresses probabilistic facets of micropaleontologic assemblage zones and proposes a viable solution for micropaleontologic correlation. Inaccuracy in stratigraphic correlation of micropaleontologic assemblages, which is often encountered in practical situations, also is discussed on the basis of the results from the numerical estimates.

**DEFINITION AND ASSUMPTION**

**Definition**

Consider 10 species which belong to a certain micropaleontologic group such as radiolarians, conodonts, or diatoms existing in a time span $(t_1, t_2)$. Their range chart is shown in Fig. 1. The time markers, $t_0$, $t_1$, $t_2$, and $t_3$ on the time axis are not necessarily placed at equal intervals ($t_0 = 0$ for simplification). Obviously, we can not establish an assemblage representing duration $(t_1, t_2)$ using species 1, 3, 5, 6, and 8. An assemblage can be defined here only by choosing species 2, 4, 7, and 10. Thus, an assemblage representing $(t_1, t_2)$ is composed of

Fig. 1. Hypothetical paleontologic range chart. An assemblage zone representing a time span $(t_1, t_2)$ can be defined by cooccurrence of sp. 2, sp. 4, sp. 7, and sp. 10. In this case, $A/N = 0.4$. 