QUANTITATIVE STRATEGIES FOR DETERMINING THE RELIABILITY OF BIOSTRATIGRAPHIC DATA

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Biostratigraphers typically base their interpretations on qualitative analyses of observed first and last occurrence patterns recorded from cores and outcrop sections. However, there has been much recent discussion of the limitations of this approach in those instances where high resolution time control is needed. Sampling phenomena such as the Signor-Lipps effect have long been know to bias observed biostratigraphic occurrence patterns, yet few biostratigraphers routinely attempt to evaluate the effect of such sources of bias in their data.

While the calculation of confidence intervals associated with stratigraphic first and last occurrences has recently been proposed as a general-purpose remedy for such sources of bias, several theoretical and practical problems arise when attempts are made to apply this statistical technique to standard biostratigraphic data in general and to micropaleontological data in particular. A more robust approach to the issue of biostratigraphic reliability analysis is gained by formulating specific hypotheses for various sources of potential bias (e.g., sample size effects, differential preservation effects, paleoecologic effects) and then using quantitative methods to determine whether the null-hypothesis (= no bias present in the observed data) can be rejected at a specified confidence level. Aside from being more flexible, this approach has the added advantage of being able to discriminate between different sources of bias, any (or none) of which may have operated within a particular fossiliferous succession.

In order to illustrate this approach to biostratigraphic reliability estimation the Cretaceous-Tertiary (K-T) planktic foraminiferal records from El Kef (Tunisia), Brazos River (Texas), Nye Kløv (Denmark), Agost (Spain), and ODP Site 739 (Kerguelen Plateau) were tested for sample size, preservation, and paleoecological bias using a variety of methodological strategies (e.g., Koch and Morgan sample size analysis, occurrence frequency analysis, multidimensional scaling). Results suggest that the Agost data may included statistically significant Signor-Lipps bias due to differential preservation and sample size fluctuations whereas the Site 738 data may be biased by sample size variations, No systematic biases consistent with any of these factors were discovered in the El Kef, Brazos Core, and Nye Kløv data. Graphic correlation was then used to summarize the biostratigraphic data present in the unbiased successions and construct a synthetic pattern of planktic foraminiferal faunal turnover across the K-T boundary. This pattern suggests that, in the absence of significant hiatus effects and Signor-Lipps bias, the high resolution biostratigraphic record of planktic foraminifera across the K-T boundary horizon exhibits a pattern of progressive extinction and replacement within an extended interval of ecologic time (10^5–10^6 yr.). Quantitative methods such as these can be successfully integrated with standard micropaleontological biostratigraphic data to dramatically increase the time control available to geologists in a cost-effective and time-effective manner.

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