CONFIDENCE INTERVALS ON STRATIGRAPHIC RANGES BASED ON DISCRETE SAMPLING, AND THE CENOMANIAN/TURONIAN BOUNDARY EXTINCTIONS IN THE WESTERN INTERIOR SEAWAY, U.S.A.

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The standard method for calculating confidence intervals on the ends of stratigraphic ranges (developed by Strauss and Sadler) is based on the assumption that stratigraphic sections are sampled continuously (the position of each fossil, or fossil bed, is reported as it is found as one moves up or down section). However, many studies that report detailed stratigraphic distributions of fossils are based on discrete (binned) sampling regimes; chunks of section, or core, are sampled at some standard interval. Furthermore, the exact positions of the fossils within each sampling interval is usually not recorded.

We show that standard confidence intervals calculated for stratigraphic ranges based on discrete sampling regimes are usually much too large. A correction method for adjusting the biases introduced by discrete sampling is presented, along with the results of computer simulations and analytic techniques that show under what conditions the corrections should be used.

This new method of calculating confidence intervals is then used to test the proposed pattern of stepwise mass extinctions associated with the Cenomanian/ Turonian boundary in the Western Interior Seaway of the United States. These data were selected because: 1) The rich fossil record from this interval is well studied; 2) The data were collected using a discrete sampling technique; 3) These sections have been important in the development of the concept of stepwise mass extinctions; 4) These sections have been important to debates over the synchronicity of geochemical signatures and paleobiological changes; and, 5) A well-developed stratigraphic framework has been developed independently of the macro-fossil record (based on prominent bentonite and limestone marker beds).

Data from six exquisitely sampled sections along a roughly east-west transect are analyzed. The analysis consists of four steps: 1) Determination of whether the distributions of gaps in the observed stratigraphic ranges are consistent with random fossilization. 2) For each proposed stepwise extinction event, use of confidence intervals to determine which taxa are likely victims of that event. 3) Application of 50% confidence intervals to the stratigraphic ranges of taxa identified in (2) to determine whether their fossil records are consistent with a sudden extinction/ emigration event. If they are, the position of the extinction/emigration horizon is estimated. 4) If the data are consistent with a sudden extinction/emigration event, confidence intervals and computer simulations are used to determine the range of gradual extinction/emigration scenarios that are also consistent with the observed fossil record.

Finally, the hypothesis that there was, in fact, a simple graded mass extinction through the Cenomanian and Turonian in the Western Interior Seaway, and that the observed step-wise extinctions are just the result of chance co-occurrences of some of the observed stratigraphic endpoints, is tested using computer simulations and analytic techniques.