DIATOM LIFE-CYCLE AND DEMOGRAPHY: MATHEMATICAL MODELS AND A PALEOLIMNOLOGICAL RECORD

Virginia M. Card[1] and Rikki Wagstrom[1]
[1]Metropolitan State University, St. Paul, Minnesota 55106 USA

In the MacDonald-Pfitzer model of the diatom life-cycle, each cell division produces two offspring cells, one that is the same size as the parent and one that is smaller by a fixed increment. This classic model explains some important features of diatom size-class dynamics, such as the decrease over time of mean and model cell size in a population, but does not explain other features observed in natural populations, including persistently narrow size variance, asymmetrical distribution of valve abundance about the mode, and small size and slow change of mean and modal valve size. In addressing these challenges, Jewson and others proposed a variation to the classic model in which the increment of size reduction for diatom offspring decreases as a linear function of parental cell size. The objectives of this project were to investigate for the first time the mathematical consequences of this model for the distribution of cell sizes in diatom populations, and to test those results against a detailed paleolimnological record. The model was developed in Mathematica and the results compared to a 70-year annual-resolution paleolimnological record of a planktonic freshwater diatom, *Cyclotella bodanica*, from the varved sediments of Foy Lake, Montana, USA. The closed form solution to the recurrence equation describing the relationship between parental cell size and size of the smaller offspring cell using parameters of minimum cell length, maximum cell length and initial increment of decrease was found, the inverse function to which describes the relationship between cell size-class number and measurable cell size. This function successfully reproduces the characteristics of natural populations described above. Three hundred vegetative diatom valves from each year were measured on annual slides, 21,000 valves total, diameter 14 to 44 micrometers, modal diameter 21 and mean diameter 22.15; five hundred initial valves were also measured. For most years, the data were best described by single Gaussian distributions following transformation, rather than log-normal or multiple normal distributions, and the life-cycle length and frequency of significant sexual reproduction agreed with the predictions of the model. These results demonstrate that a model incorporating linear decrease in size increment, as proposed by Jewson, is capable of producing the size-class distributions that are observed in nature; other variations on the classic MacDonald-Pfitzer model, such as systematic variation of generation time or mortality rates may also be important and remain to be investigated.