Single acritarch cell carbon isotope analyses: implications for geobiology.

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Acritarchs, or close-walled organic microfossils, are abundant in many siliciclastic strata in the Proterozoic and Paleozoic. However, their taxonomic affinities and paleoecology remains enigmatic. Their presence and relative abundance have been used to make inferences about environments of deposition and have been correlated a range of geochemical proxies from their host sediments. Studies that employ direct analysis of acritarch organic matter have been limited, but this approach can provide an addition dimension of data against which hypotheses about their affinities and paleoecology can be tested. Here we present a simple method for the analysis of single acritarch cells for their carbon isotopic composition and discuss the implications for our initial data. The coupling of elemental analysis-isotope ratio mass spectrometry with cryo-trapping and capillary focussing (NanoEA) provides a relatively simple method that is available in many stable isotope laboratories.

We analyzed several hundred leiospherid and acanthomorphic (ornamented) acritarchs and kerogens from the Late Devonian of the Appalachian Basin. The $\delta^{13}C$ of kerogen grains were isotopically similar between grains and to bulk $\delta^{13}C_{org}$. The $\delta^{13}C$ of individual microfossils varied between individuals and was significantly different from co-occcuring kerogens. For example, the $\delta^{13}C$ of individual leiospherids from the Lower Kellwasser black shale range from -23.8 to -25.4‰ compared to -30.4‰ for kerogens. The $\delta^{13}C$ of leiospherid organic matter is consistent with an algal origin. We speculate that the isotopic difference between kerogen and the leiospherids is the result of a surface water ecology where the DIC is ^{13}C-enriched because of a strong biological pump. Alternatively, these organisms may have had a high rate of growth under eutrophic conditions that depressed ε_p, or employed and alternative means of carbon fixation that resulted in the observed ^{13}C-enrichment. The $\delta^{13}C$ range between individual leiospherids likely represents environmental variability captured by a relatively short duation of life compared to time range of a single sample.