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THE USE OF STABLE AND RADIOCARBON ISOTOPES AS A METHOD FOR DELINEATING SOURCES OF ORGANIC MATERIAL IN ANCHIALINE SYSTEMS

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A duel isotope (stable and radiocarbon) investigation of anchialine cave systems in the Yucatan Peninsula compares the food web of a coastal and an inland cenote. Isotopic data demonstrates distinct photosynthetic and chemoautotrophic trophic levels, as well as the ability of fauna within the cave to be selective feeders even within these nutrient poor environments.

Key words: anchialine, cenote, stable isotopes, radiocarbon, trophic web

INTRODUCTION

Submerged caves, locally referred to as cenotes, can be found throughout the Yucatan Peninsula of Mexico. These nutrient poor, aphotic »subterranean estuaries« lack photosynthetic primary productivity, but are often found underlying high primary productivity areas such as mangroves and tropical jungles. Adjacent ecosystems contribute organic carbon to the cave systems via percolation and tidal exchange, where it is then utilized by the obligate, cave-dwelling fish and crustaceans (POHLMAN *et al.*, 1997; GRAENING & BROWN, 2003). Recent investigations have identified chemosynthesis as an additional pathway through which organic carbon can enter the cave food web. Chemoautotrophic sulfur-oxidizing or nitrifying bacteria have been found in the hydrogen sulfide layer or in the sediments of some anchialine caves throughout the Bahamas and Yucatan (HUMPHREYS, 1999; SEYMOUR *et al.*, 2007).

METHODS AND HYPOTHESIZED RESULTS

This study utilized $^{13}C/^{12}C$ and $^{15}N/^{14}N$ stable isotopes as well as ^{14}C radiocarbon dating to delineate trophic structure, comparing organic matter pathways of a coastal anchialine cave (Cenote Aak Kimin) to those of a cave more distant from the coast (Cenote Maya Blue). It was hypothesized that the food web of the coastal cave, with greater tidal influence, would be enriched with marine organic matter, while the inland cave would be dependent on detrital material from the overlying jungle. Chemoautotrophic contributions to each system were also hypothesized, but undetermined in extent. In situ measurements of water column salinity, temperature, pH, and dissolved oxygen were also collected.

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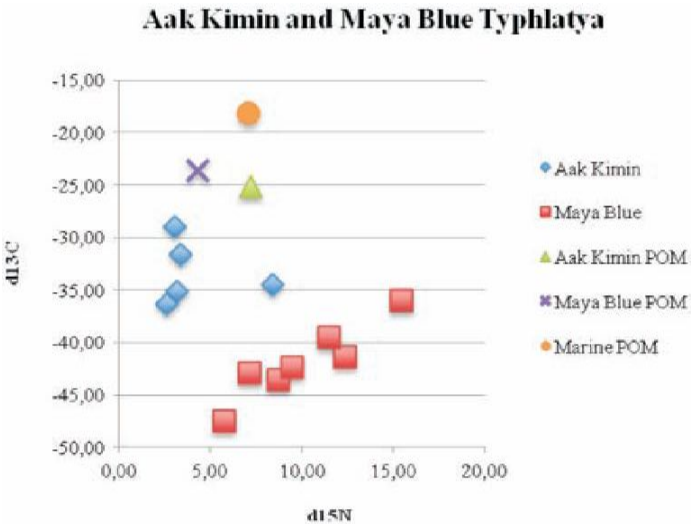
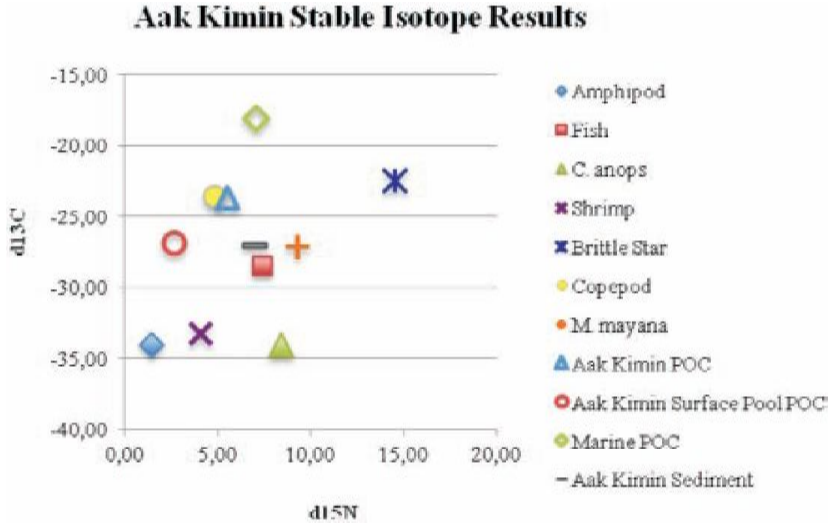


Fig. 1. Stable Isotope Results from *Typhlatya* sp.



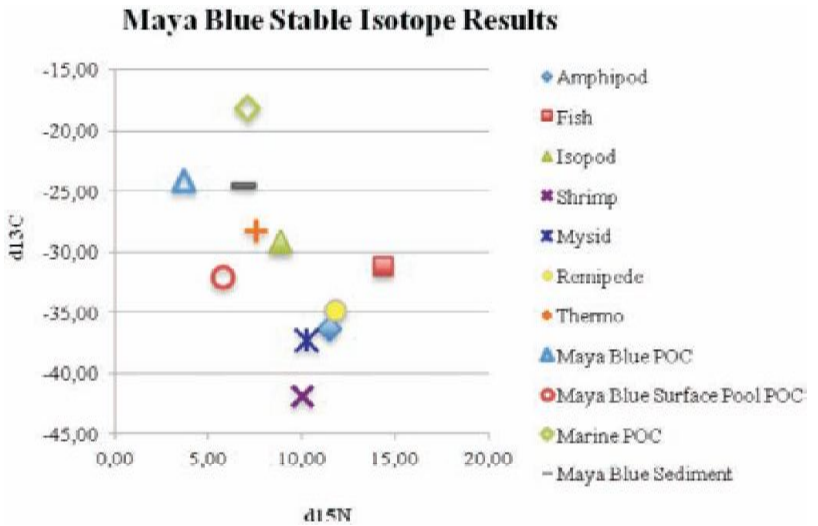


Fig. 2. Cenote Aak Kimin and Cenote Maya Blue Stable Isotope Results

INITIAL RESULTS

Initial isotopic data suggests that chemosynthetically derived organic carbon contributes substantially to the diet of some crustaceans, such as the stygobitic shrimp *Typhlatya* (Fig. 1), while other species remain dependent on detrital inputs. A comparison of isotopic values between Cenote Aak Kimin and Cenote Maya Blue suggests that the trophic web of the coastal cave incorporates more modern carbon than the inland cave. Within both systems, however, distinct photosynthetic and chemoautotrophic levels were identified (Fig. 2). Water quality parameters, especially dissolved oxygen and pH, support the hypothesis of chemoautotrophy at the halocline.

JUSTIFICATION

Stable isotopes have long been employed in tropic investigations. This study, however, will be the first to utilize radiocarbon isotopes in anchialine caves. The use of both stable and radiocarbon isotopes as source indicators provides greater discrimination in systems that contain numerous carbon sources or indistinct trophic levels, particularly to distinguish between chemoautotropic versus photosynthetically derived carbon.

While conservation of all marine environments is certainly important, Yucatan's anchialine cave systems are unique in many ways. The porous nature of the limestone ensures that the cave passages contain all of the areas freshwater, as meteoric waters flow through the underlying cave systems, connecting the interior of the peninsula to the adjacent mangroves, coral reefs, and ocean. Because of this, all ecosystems within the area are highly dependent on the cenotes, and in turn, the cenotes rely on other ecosystems as a potential source of nutrients. This interconnectivity magnifies even small or distal anthropogenic disturbances. Additionally, these cave systems contain a unique array of endemic organisms that are found nowhere else on earth. Many of these species evolved many millions of years ago, making them a vital link to understanding invertebrate evolution. This research demonstrates the delicate tropic structure of the anchialine caves, the connectivity between the many ecosystems of the Yucatan Peninsula, and the need for increased awareness for the conservation of all environments.

REFERENCES

GRAENING, G. O. & BROWN, A. V., 2003: Ecosystem dynamics and pollution effects in an Ozark cave stream. Journal of the American Water Resources Association **39**, 1497–1507.

HUMPHREYS, W. F., 1999: Physico-chemical profile and energy fixation in Bundera Sinkhole, an anchialine remiped habitat in north-western Australia. Journal of the Royal Society of Western Australia **82**, 89–98.

POHLMAN, J. W., ILIFFE, T. M., & CIFUENTES, L. A., 1997: A stable isotope study of organic cycling and the ecology of an anchialine cave ecosystem. Marine Ecology Progress Series **155**, 17–27.

SEYMOUR, J. R., HUMPHREYS, W. F., & MITCHELL, J. G., 2007: Stratification of the microbial community inhabiting and anchialine sinkhole. Aquatic Microbial Ecology **50**, 11–24.