STABLE ISOTOPE STUDIES IN MOVILE CAVE

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The natural ratio between the stable isotopes of carbon (^{13}C and ^{12}C) and nitrogen (^{15}N and ^{13}N) was determined in biological samples from Movile Cave (near Mangalia, Romania), from Limanu Cave (a dry, nonsulfide cave located nearby), and from the surface. The conclusions of this study support the hypothesis that the food web in Movile Cave is chemo-autotrophically-based.

INTRODUCTION

An unusual subterranean ecosystem was discovered in 1986 in southern Dobrogea, Romania (Lascu and Sârbu, 1987; Sârbu, 1990; 1991). A shaft dug on the rim of the Movile sinkhole near Mangalia intercepted a natural cave passage at the depth of 20 m under the surface (Lascu, 1989). Movile Cave consists of an upper dry level and a lower level partially flooded by thermal waters (21°C). Specific for this cave is the redox interface between the atmosphere and the thermal waters containing reduced compounds such as HS^-, CH_4, NH_4^- (Sârbu, 1991). A rich microbiota has been found in the airbells in the lower level of the cave (Sârbu et al., 1991). Abundant and diverse invertebrate communities inhabit Movile Cave (Sârbu and Popa, 1992; Lascu et al., 1993). The subterranean ecosystem appears to lack any input of allochthonous photoautotrophically-based food (Sârbu and Kane, 1995).

Stable isotope ratios have proved to be a useful tool in ecological research (Peterson and Fry, 1987). Using the natural abundance of carbon and nitrogen stable isotopes, one can get insight on the food web structure and on the source of food for a particular biological community.

Preliminary work (Sârbu et al., 1994) has shown that samples collected in Movile Cave are considerably lighter with respect to carbon as compared to surface samples. Previous work has suggested that the food base for both the terrestrial and aquatic communities inhabiting Movile Cave is different from the photoautotrophic carbon fixation in surface green plants (Sârbu et al., 1991; Sârbu and Popa, 1992; Lascu et al., 1993; Sârbu et al., 1994) and rather consists of chemoautotrophic carbon fixation in sulfide oxidizing bacteria that take advantage of the redox interface present at the surface of the bodies of water within the cave.

Our working hypothesis is that, while the biological communities of nonsulfide caves rely on food of a photosynthetic origin, the base of the food webs in Movile Cave is represented by autochthonous food produced in situ by chemoautotrophic

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microorganisms, and that there is no significant input of allochthonous photosynthetic food from the surface. Chemoautotrophic microorganisms inhabiting the lower level of Movile Cave use the carbon dioxide present in large amounts in the cave atmosphere (up to 3.5%) to produce organic matter in situ within the subterranean ecosystem.

METHODS

Organic samples (cave fauna, microbial mats, sediments) were collected in Movile Cave, in Limanu Cave, and at the surface. They were dried for several days at 60°C and ground by using an agate mortar and pestle. The ground samples were sent to the Center for Water Resources of the University of Alaska Fairbanks for carbon stable isotope ratio determinations using standard mass spectrometry methods.

Inorganic samples (limestone, methane in gas bubbles ascending from deep wells) were also collected and analyzed by the Geochron Laboratories Inc. in Cambridge, Massachusetts.

The results were expressed as $\delta^{13}C=(R_{sample}-R_{standard})/R_{standard}) \times 1000$, where $R = {}^{13}C/{}^{12}C$. The standard represented belemnite from the Pee Dee formation in South Carolina.

Measurement precision was $0.1^{\circ}/_{00}$ or better for both laboratories.

RESULTS

The $\delta^{13}C$ values for the organic samples collected in Movile Cave range between -47.5 and $-37.5^{0}/_{00}$ (Fig. 1). Surface organic samples exhibit $\delta^{13}C$ values ranging between -30 and $-23^{0}/_{00}$ (Fig. 1). The $\delta^{13}C$ values of organic samples collected in Limanu Cave range between -21 and $-23^{0}/_{00}$. The $\delta^{13}C$ values for methane ascending from deep wells range between -59.5 and $-64^{0}/_{00}$, and the $\delta^{13}C$ values for limestone-bedrock samples collected in Movile Cave and at the surface in Mangalia region range between 0 and $-5^{0}/_{00}$.

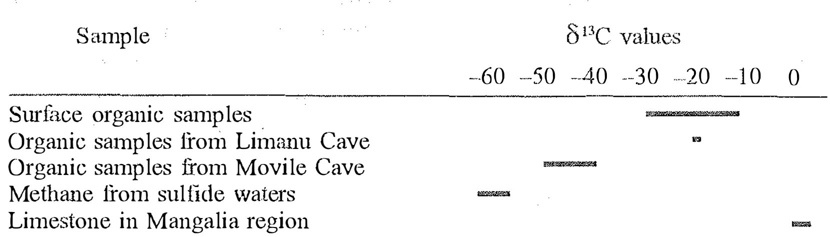

Fig. 1. – Carbon stable isotope composition of organic and inorganic samples collected and analyzed.

DISCUSSION

Surface inorganic and organic samples exhibit isotopic values similar to equivalent samples from other regions of the world. Organic samples collected in Limanu Cave are isotopically heavier with respect to carbon as compared to surface samples (Fig. 1). This is consistent with the hypothesis that carbon source for the terrestrial community inhabiting Limanu Cave is represented by photoautotrophic carbon fixation in surface green plants. Samples collected in Movile Cave are much lighter with respect to carbon as compared to the surface samples. This is consistent with the hypothesis that the aquatic and terrestrial communities inhabiting Movile Cave are independent of the surface photoautotrophic carbon fixation, but rather depend on an alternative source of carbon and energy. Chemoautotrophic microorganisms in Movile Cave use the isotopically light carbon dioxide present in the cave as a source of inorganic carbon to produce isotopically light organic carbon. The fractionation of approximately -23‰ observed in Movile Cave is in accordance with the values previously reported for chemoautotrophs (R a u, 1985).

Research is currently using both carbon and nitrogen stable isotope ratios for a better understanding of the sources of carbon and nitrogen for the subterranean ecosystem and for the deciphering of the trophic web structure in the chemoautotrophically-based ecosystem. Correspondence of the nitrogen and carbon isotopic data will provide soundness to the food web analysis.

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