4. Oxygen Isotope Analysis of the Shells of *Nautilus pompilius* from Tañon Strait, the Philippines

by

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Abstract

Oxygen isotope analysis was made for the shells of two *Nautilus pompilius* (Mollusca, Cephalopoda) captured alive from Tañon Strait, the Philippines. Both specimens show a remarkable change in $\delta^{18}O$ from light values in the first six or seven septa to heavier ones in the succeeding septa, and this is probably due to the hatching. Water temperatures estimated from $\delta^{18}O$ values of the septa do not coincide with the actual temperatures in the *Nautilus* habitat. This fact suggests a possibility of the oxygen isotopic disequilibrium among the septa, cameral fluid and surrounding seawater.

Introduction

Oxygen isotope analysis is one of the effective approaches for estimating early life history and absolute growth of benthic animals living in deep waters. For this purpose, shells of the chambered *Nautilus* have previously analyzed radiometrically by EICHLER and RISTEDT (1966) and COCHRAN *et al.* (1981). These authors, however, did not show the relations of the oxygen isotopic composition of the shell, cameral fluid and seawater near the habitat. In this respect, testing an isotopic equilibrium among these interrelated materials is needed to use $\delta^{18}O$ values of the *Nautilus* shells as indices of water temperature.

In this paper, we discuss the above problem on the basis of two *N. pompilius* specimens whose habitat conditions are well determined.

Material and Method

Two specimens of *N. pompilius* examined were captured alive from waters about 1.5 km off Bindoy, southwestern margin of Tañon Strait in the environs of Cebu and Negros Islands, the Philippines by Mr. W. VAILOCES and his family in September, 1981. One specimen (B-5) with 32 septa is a full-grown male, which was trapped at point LTR 3 (148 m in depth). The other one (B-52) with 34 septa is an immature

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male, which was sampled at point LTR 29 (312 m in depth). The detailed locations and habitat conditions are summarized in HAYASAKA *et al.* (1982, figs. 1-9, tables 1-3).

For oxygen isotope analysis very small amounts (about 0.1-0.3 mg $CaCO_3$) of powdered sample were taken from the adoral surface of each septum of the two specimens using a dental drill. Samples without any pre-treatment were reacted in a vacuum with 100% H_3PO_4 in a thermostatic bath at 60°C and thereafter they were analyzed on a Micro-mass spectrometer 903 at Yamagata University.

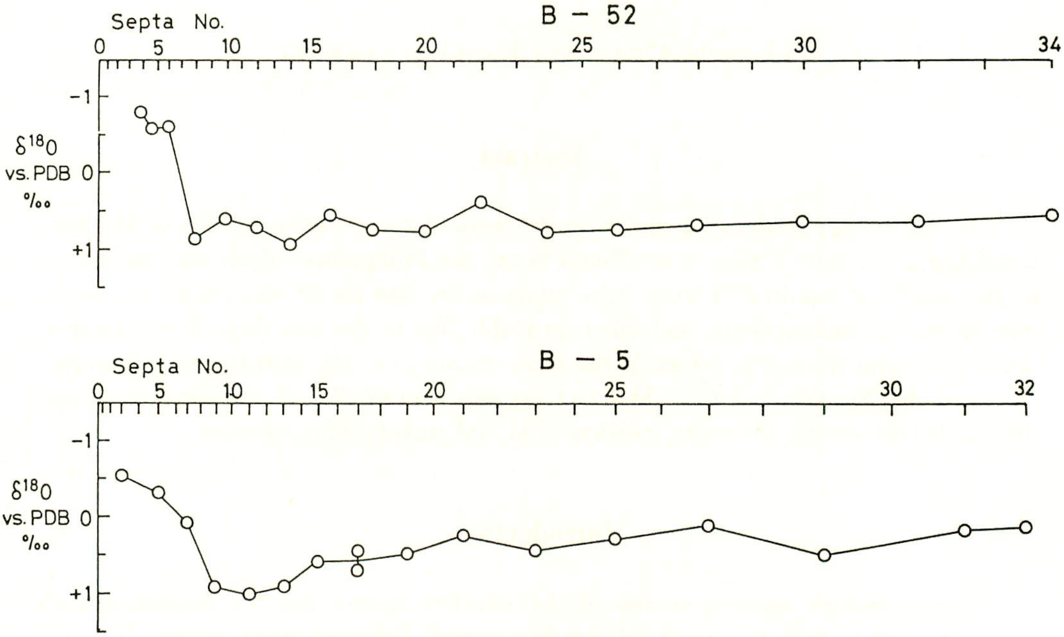

Fig. 1. Oxygen isotopic composition of the septa in two specimens of *Nautilus pompilius* (B-5 & B-52) from Tañon Strait, the Philippines.

Result and Discussion

$\delta^{18}O$ values of the septa in these two specimens range from −0.8‰ to +1.0‰ vs. PDB (Fig. 1). Both specimens show a remarkable change in $\delta^{18}O$ from light values (−0.3 to −0.8‰) characteristic of the first six or seven septa to heavier values (+0.8 to +1.0‰) in the remaining septa. In both specimens the change in $\delta^{18}O$ coincides with a marked decrease in septal spacing and chamber volume observed from the fifth or sixth septum. As the early ontogeny of living *Nautilus* is believed to spend within an egg capsule of about 25 mm in maximum size before hatching (WILLEY, 1897), the change in $\delta^{18}O$ between the sixth or seventh and seventh or eighth septa is probably attributed to the hatching of *Nautilus*. The light $\delta^{18}O$ values for the first six or seven septa may not reflect the temperature of the surrounding water, but possibly derived from the light oxygen isotopic composition of the cameral fluid. A similar abrupt change in $\delta^{18}O$ between the seventh and eighth septa has already been noticed by EICHLER and RISTEDT (1966) and COCHRAN *et al.* (1981). They interpreted this phenomenon to be due to the migration to deeper habitat (EICHLER and RISTEDT, 1966) or to the hatching (COCHRAN *et al.*, 1981).

The $\delta^{18}O$ patterns for the septa 9-32 in specimen B-5 and the septa 8-34 in specimen B-52 show a trend toward slightly lighter values in more recently formed septa. The heaviest values of $\delta^{18}O$ are observed at the eleventh septum in specimen B-5 and at the fourteenth one in specimen B-52. They are different from that of the last septum by 0.87‰ and 0.39‰, respectively. If these differences in $\delta^{18}O$ are resulted from the changes in water temperature, the corresponding temperature changes are about 4°C for specimen B-5 and 1.8°C for specimen B-52. These two Nautilus were captured from the bottom of Tañon Strait at the depth of 148 m and 312 m, where the water temperatures are about 20°C and 18°C, respectively (Fig. 2). As the lowest temperature of the bottom water in the strait is about 17.5°C (Fig. 2), the decrease of water temperature of 4°C from 20°C in specimen B-5 and 1.8°C from 18°C in specimen B-52 seems unlikely in this region. Furthermore, the habitat of *Nautilus pompilius* in Tañon Strait is represented by the stagnant water mass below 100 m, whose northern and southern ends are closed by the warm water mass shallower than 100 m (HAYASAKA *et al.*, 1982, figs. 1 and 8). It is strongly suggested that the population of *N. pompilius* in Tañon Strait is distinctly or nearly isolated from those in Bohol Strait and Visayan Sea.

These lines of evidence, therefore, may offer us a possibility that the oxygen isotopic composition of cameral fluid in the septum 11 or 14 was much heavier than that of the last septum, if the septa were deposited in an isotopic equilibrium. This problem will be clarified by measuring the differences of oxygen isotopic composition between the cameral fluid and surrounding sea water.

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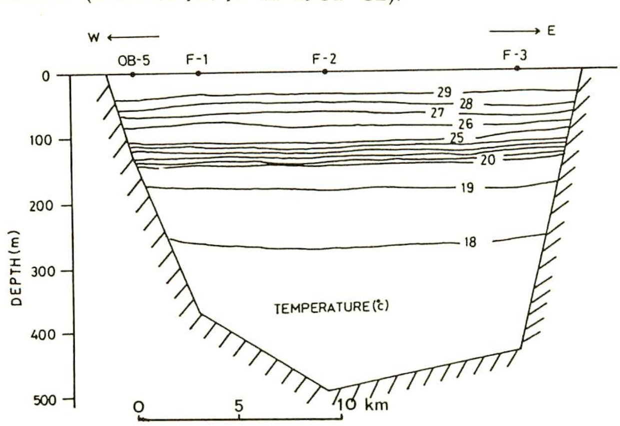

Fig. 2. Vertical profile of the water temperature in the transverse section of Tañon Strait (adapted from HAYASAKA *et al.*, 1982, fig. 8a).

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