Reproducing migration history of Japanese sardine using otolith d18O and a data assimilation model

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A new method to reproduce migration histories of Japanese sardine (*Sardinops melanostictus*) was developed by using the combination of otolith oxygen stable isotope ratio ($\delta^{18}O$) and a data assimilation model. Firstly, rearing experiments for three different temperatures were conducted for a month and otolith $\delta^{18}O$ were analyzed. A linear relationship between otolith $\delta^{18}O$ and temperature was determined for the first time for Japanese sardine as follows: $\delta_{otolith} = \delta_{water}$-0.181*Temperature+2.690, r^2=0.91 (1). Secondly, seawater $\delta^{18}O$ and salinity in the western North Pacific were revealed to be strongly correlated from *in situ* samplings: δ_{water}=0.5951*Salinity-20.347, r^2=0.89 (2). Micro-volume $\delta^{18}O$ analysis and our original micro-sampling technique enabled us to extract otolith $\delta^{18}O$ profile in a temporal resolution of 10-15 days through whole life of juveniles approximately 200 days post hatch. For the dates corresponding to each value of the profile, surface temperature and salinity in the range of 30-55N, 130-180E were extracted from a data assimilation ocean model FRA-ROMS which reproduces ocean environment realistically. Temperature and salinity in each grid were converted into otolith $\delta^{18}O$ value using Eq. (1) and (2). Grid points in which the calculated otolith $\delta^{18}O$ value was equivalent to actually analyzed one were considered to be the location of the individual on the date. Movements of the juveniles reproduced by this method clearly showed the northward migration from the Kuroshio-Oyashio transition zone to the Oyashio region and the estimated location on the sampling week approached to the actual sampling point, which indicated the high accuracy of the method.

Keywords: Sardine, Otolith, Oxygen isotope

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