

Strontium to calcium (Sr/Ca) ratio in otolith as a tool for stock discrimination of oilsardine and mackerel

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Otoliths are found in the membranous labyrinth of the inner ear of teleost fish and serve mainly in balancing the organism. They are composed of calcium carbonate and are deposited rhythmically as aragonite crystals within a protein matrix. They have long been used in fish aging studies. Recently, changes in the strontium (Sr): calcium (Ca) ratios in otoliths have received increasing attention, as these provide a method of reconstructing environmental history of the fish. Strontium is a calcium analogue sharing a similar crystal ionic radius and can substitute for Ca in the aragonite lattice of otoliths. The Sr concentration in seawater is approximately 100 fold greater than that in freshwater (Campana, 1999), and a good relationship exists between otolith Sr:Ca ratios and ambient salinities (Secor *et al.*, 1995, Tzeng, 1996). Thus Sr:Ca ratios in otoliths have widely been applied for studying habitat use and migratory behaviour of fish (Chang *et al.*, 2004) and in stock discrimination (Volpedo and Cerelli, 2006).

As a part of the in-house project on the “Impact and yield study of environmental changes on the distribution shifts in small pelagics along the Indian coast”, otolith chemistry with special reference to Sr/Ca ratio in otolith collected from different zones of the Indian coast were worked out for oilsardine (*Sardinella longiceps*) and mackerel (*Rastrelliger kanagurta*). Database on Sr/Ca ratio of otolith of oilsardine and mackerel were developed in the Fishery Environment Management Division (FEMD) of Central Marine Fisheries Research Institute (CMFRI), Kochi. The locations of otolith collection were : Veraval (Gujarat), Mumbai (Maharashtra), Karwar and Mangalore (Karnataka), Mandapam, Tuticorin and Chennai (Tamil Nadu), Visakhapatnam (Andhra Pradesh) and Cochin (Kearala) covering the Indian coast from different regional/research centres and headquarter of CMFRI. Cochin. The salient findings from the analysis carried out on this database is presented here.

From the otolith samples of oilsardine and mackerel collected at different centres of CMFRI, intact pairs were selected, processed and chemically digested in the Environment Laboratory of CMFRI, Kochi. Further analysis using Inductively Coupled Plasma Spectroscopy for Ca and Sr were outsourced at Cochin University of Science and Technology. The data were subjected to statistical analysis on Pearson Correlation and Analysis of Variance using SPSS 16.

Correlation analysis was done with Sr/Ca ratio of otolith vs ambient salinity in the location and significant positive correlation was observed in the case of otoliths of both oilsardine and mackerel.

Otolith chemistry (Sr/Ca ratio) from different zones of the Indian Coast

The results on variation in Sr/Ca ratio in otolith pairs of oilsardine collected at different centres of CMFRI are plotted in figures 1 and 2.

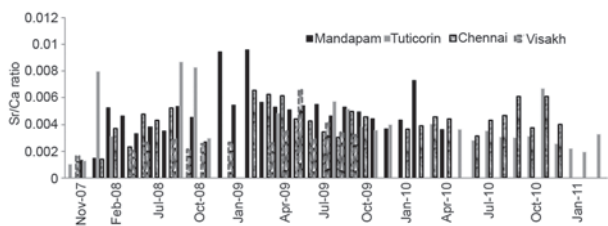


Fig. 1. Sr/Ca ratio of oilsardine otolith collected from selected centres along the Indian coast

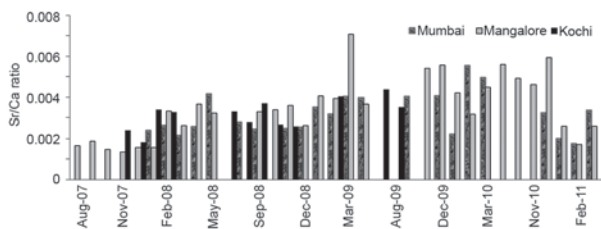


Fig. 2. Sr/Ca ratio of oilsardine otolith collected from selected centres of the Indian coast

Statistical analysis (ANOVA) showed significant difference between the Sr/Ca ratio of oilsardine otolith of the east coast and west coast ($p < 0.01$). Significant difference was seen among the different locations of the east and west coast together ($p < 0.05$). No significant difference was seen among the monthly variability of the Sr/Ca ratio of the oilsardine otolith of the east and west coast together.

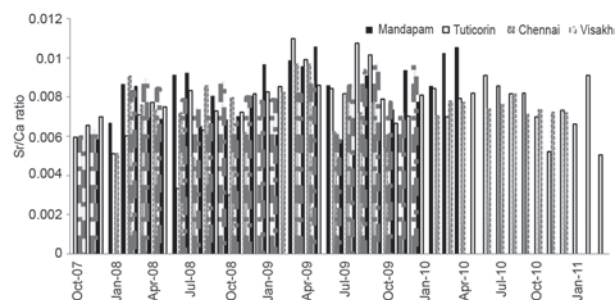


Fig. 3. Sr/Ca ratio of mackerel otolith collected from selected centres along the east coast of India

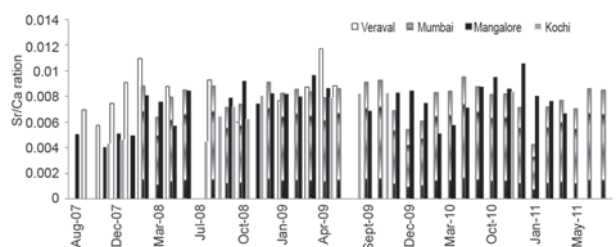


Fig. 4. Sr/Ca ratio of mackerel otolith collected from selected centres along the west coast, India

The results on variation in Sr/Ca ratio in otolith pairs of mackerel collected from different centres of CMFRI are depicted in figures 3 and 4.

No significant difference was observed between the Sr/Ca ratio of mackerel otolith of the east coast and west coast. No significant difference was seen among the different locations of the east and west coast together. But significant difference was seen among the monthly variability of the Sr/Ca ratio of the mackerel otolith of the east and west coast together ($p < 0.05$).

The database on Sr/Ca ratio of otolith from different regions of the Indian coast does show significant spatial variability in the case of oilsardine. In mackerel otolith, temporal variability in the Sr/Ca ratio was reflected from this analysis. The data can be further subjected to Discriminant Analysis, making use of the data on size variability of the corresponding fishes from which the pair of otoliths have been collected, resulting in classification of discrimination in the stock of oilsardine and mackerel which are fishes found to be spreading towards other parts of the Indian coast, other than their natural historic distribution. The stock discrimination analysis can further be confirmed with DNA stock identification technique.