

論文名 アオリイカ生態研究への安定同位体比技術の応用

Ecological applications of stable isotopic technique on bigfin reef squid *Sepioteuthis lessoniana*

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Stable isotopic analytical technique has been applied on ecology of varied marine organisms but with few cases on cephalopods. *Sepioteuthis lessoniana* is a neritic squid species distributed in the Indo-Pacific Ocean. Fisheries management of the species is difficult due to inadequate ecological information, e.g. habitat use, movement pattern, metabolism and dietary shift of each life history stage. Therefore, the aim of this study is to apply stable isotopic technique for ecological studies on *S. lessoniana* in Taiwan waters as a pioneer example.

This study first evaluated the efficacy of enriched stable isotopic mass-marking technique on hatchlings for further larval dispersal tracking purpose and the potential mass-marking effects on hatchling size and statolith chemistry of *S. lessoniana*. *S. lessoniana* egg capsules were collected from northern Taiwan and assigned randomly to ^{137}Ba -spiking experimental groups at 0.2, 0.5 and 1 ppm and three immersion durations (1, 3 and 7 days). Immersion duration >3 days produced significantly lower $^{138}\text{Ba} : ^{137}\text{Ba}$ ratios, with 100% marking success, indicating that it is a reliable marking technique. The ^{137}Ba mass marking had a positive effect on size at hatch and was likely to affect statolith trace element incorporation, including Cu, Zn and Pb. These findings highlight that it is necessary to consider the species-specific effects on hatchling size and physiological responses when using stable isotopes mass-marking techniques.

Subsequently, the daily growth and $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ values from the core to the edge of statoliths on *S. lessoniana* collected in northern Taiwan and the Penghu Islands were analyzed to predict the ontogenetic temperature and metabolic rate changes. The probability of occurrence in a given area at each life stage in three seasonal groups was determined using salinity values, deduced and measured temperatures, and the known ecology of *S. lessoniana*. The results showed that ontogenetic variation in the statolith $\delta^{18}\text{O}$ values in *S. lessoniana* reflected the seasonal temperature fluctuation observed in Taiwanese waters, which indicated the reliability of the prediction method.

Highly diverted dispersal and movement patterns were observed. The results indicated the importance of the waters near the coast of northeastern Taiwan and the Penghu Islands as spawning grounds. Based on a model prediction, the distribution of *S. lessoniana* is likely associated with water temperature and upwelling, which supports high primary production and sustains the prey of the squid in the waters. The geographical overlap and a potential migration route between northeastern Taiwan and the Penghu Islands suggests the possibility of population connectivity in *S. lessoniana* between the two sites.

Finally, the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in muscles of *S. lessoniana* in northern Taiwan were analyzed to investigate the diet composition shifting resulting from habitat change as growth. The $\delta^{13}\text{C}$ values in muscles and statoliths are further used to assess the proportion of metabolically derived carbon (M value), evaluating the metabolic change along the ontogeny. The results showed an increasing pattern of $\delta^{15}\text{N}$ and relatively consistent $\delta^{13}\text{C}$ in squid muscles with the ontogenetic change, suggesting that they consume consistent species composition of prey in the same latitude region, whereas the prey size increases within ontogenetic change. A high level of metabolic rate, regarding high M value, found in adult individuals suggested obvious mobility for overwintering, and a high feeding rate and energy consumption during the reproductive period.

This study evaluated the potential of stable isotopic mass-marking approach to track hatchling dispersal of *S. lessoniana*, and provided information on the spatial-temporal movement and dietary shift of bigfin reef squid at various ontogenetic stages, which is essential for resource management and conservation of the species. These findings extend the limited knowledge about the life history of *S. lessoniana* in Taiwan. Future developments can reduce the uncertainty associated with this approach and provide more accurate species-specific interpretations of the variations of stable isotopic signatures within individuals and stocks of free-moving cephalopods.