Feeding Habit Analysis of Early Life Fishes in the East China Sea, based on Ultra-sensitive Stable Isotopes Analyses

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The East China Sea (ECS) is an important spawning and nursery grounds for both epipelagic and mesopelagic fish species. The feeding habits of some early life fishes distributed in this area are still unclear. The small size and empty stomach/gut contents limit the feeding habit analysis by using traditional stomach/gut contents analysis, even molecular biology analysis.

In this thesis, Chapter 1 provides a general background information from the literature review on fish resources and situation of fish larvae and juveniles in the ECS, and on different feeding habit analysis methods, and later on factors affecting stable isotope (SI) ratios of fish larvae or juveniles, and finally to the rationale of the study.

Chapter 2 provides an ultra-sensitive elemental analyzer/isotope ratio mass spectrometer (EA/IRMS) system for stable isotope analysis (SIA) for feeding habits analysis of very small-size fishes, with selection on capsule to contain powder sample for SIA to minimizing contamination. A correction of the effect of preservation methods on SI ratios is also carried out.

Chapter 3 discusses the feeding habits of six taxa of mesopelagic fish larvae, and their patterns of shift in stable carbon and nitrogen isotopes (δ^{13}C and δ^{15}N), based on the field samples collected in February 2009 and 2010. The δ^{13}C and δ^{15}N of larval fishes showed large variation during early period of the larval stage. It suggested maternal effects from parents (i.e. some SI characters of parent fishes are transferred into larval individuals), and non-selective feeding on a variety of plankton species due to poor swimming ability. The similarity between stable isotope (SI) ratios measured in larval tissues and those estimated for eggs of an “income breeder” in the spawning area support an “income breeder” strategy in *Diaphus* slender type and *Vinciguerria nimbaria,* while *Lipolagus ochotensis* seemed to show “capital breeder”-like characteristics. SI ratios of the fish larvae studied became relatively constant at species-specific body dry-weights (0.5–1.0 mg), probably due to the commencement of selective feeding, meaning SI ratios during late larval periods could be

used for trophic position analysis. There was great overlap (44.6–76.5%) in trophic niche among the larval fishes within the same taxonomic family of Myctophidae. Even if principal diet components cannot be identified with gut contents analysis for some fish species, diet information from other fish species occupying a similar isotopic niche can thus improve our understanding of the diets of larval fishes, by using ultra-sensitive stable isotope analysis method.

Chapter 4 deals with the factors controlling the spatial and interannual shifts in δ^{13}C and δ^{15}N values of Japanese jack mackerel *Trachurus japonicus* larvae and juveniles sampled in the shelf break region of the ECS in April during six consecutive surveys (2005–2010). The δ^{13}C values of fishes were similar between northern and southern ECS. Spatial distribution showed that the δ^{15}N of fishes were higher in the southern ECS, probably because of the lower nitrogen fixation and the presence of larger body size of fishes occupying a higher trophic level. Interannual variations in δ^{15}N of *T. japonicus* juveniles might be mainly contributed by the extent of Changjiang discharge and variation in the abundance of the main diet such as *Paracalanus* and *Corycaeus*. The isotopic overlaps between epipelagic *T. japonicus* larvae and other dominant mesopelagic fish larvae were negligible, suggesting lesser competition for food sources. Knowledge regarding spatiotemporal variation of SI ratios of *T. japonicus* can be applied to understand the feeding habits and migrations of fishes in the ECS.

Chapter 5 discusses applicability and limitations of breeder type analysis in the view of stable isotopes, and the effect of sample selection (i.e. individual or mixed sample) on SIA.

I suggest that it is critical for us to consider the various factors which potentially influence SI ratios, when SI ratios of fish larvae and juveniles are compared with those cited from other literature. I also suggest that the relationship between the maternal effect of stable isotopes and breeder type should be further study based on rearing and field experiments of various early life fish species.