Occurrence patterns and ontogenetic intervals of fishes in the inner Tokyo Bay

［課程博士・論文博士共通］

博士学位論文内容要旨
Abstract

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Most of fishes occurring in the inner Tokyo Bay utilize the areas of shoreline especially tidal flats during their early life stages. However, the tidal-flat areas have been declined during the last five decades due to the reclamation in all over the inner Tokyo Bay. Thus, it is necessary to clarify how the tidal flats are important for fishes in the inner Tokyo Bay.

The occurrence patterns and ontogenetic development of some fish species in the inner Tokyo Bay were observed in this study. Occurrence patterns of the following five species were examined in this study: *Konosirus punctatus* (*n*= 6,105; 3.0 – 34.1 mm BL; collected from April 1996 to March 1999); *Nuchequula nuchalis* (*n*= 256; 3.8 – 28.4 mm BL; collected from August 2009 to September 2013); *Sillago japonica* (*n*= 262; 2.0 – 49.3 mm BL; collected from January 2006 to September 2009); *Eutaeniichthys gilli* (*n*= 1,336; 2.5 – 40.6 mm BL; collected from May to December 2005, March and April 2006, July 2009 to June 2010, and from October 2006 to August 2012; and *Chaenogobius gulosus* (*n*= 1,938; 3.8 – 107.1 mm BL; collected from February 2010 to April 2011, January 2015 to August 2018, and from January to December 2016). Their osteological development was observed on the specimens deposited in the Laboratory of Ichthyology (*K. punctatus*, *n*=129, 3.6 – 25.1 mm BL; *N. nuchalis*, *n*= 49, 3.8 – 20.1 mm BL; and *S. japonica*, *n*=111, 2.0 – 21.1 mm BL; *E. gilli*, *n*= 100, 3.5 – 39.1 mm BL; and *C. gulosus*, *n*= 94, 3.9 – 25.5 mm BL), and the developmental phases were determined. The information regarding their occurring months or seasons and sizes were also examined. Based on these two approaches, the ontogenetic habitat shifts of each species were recognized in relation to developmental phases. Information of the following six species was gathered and compared with other species in this study: *Plecoglossus altivelis altivelis* (mainly cited from Uehara, 2015), *Lateolabrax japonicus* (Tamura *et al*., 2013), *Acanthogobius flavimanus* (Kanou, 1999), *Gymnogobius breunigii* (Shinjo, 2019), *Gymnogobius heptacanthus* (Oguma, 2020), and *Gymnogobius macrognathos* (Hirano, 2017).

Based on the development of swimming- and feeding-related elements, the eleven species were divided into four and two groups, respectively. Four groups based on swimming-related elements were as follows: fishes beating the caudal fin to produce the propulsion force first then shifting to whole-body propulsion (Group A composed of *K. punctatus*, *P. altivelis altivelis*, *L. japonicus*, *S. japonica* and *E. gilli*); those swimming with caudal propulsion first then shifting to maneuverability-increased phase (Group B of *A. flavimanus*, *G. breunigii* and *G. heptacanthus*); those possessing caudal+whole-body propulsion first then shifting to maneuverability-increased phase (Group C of *C. gulosus* and *G. macrognathos*); and those possessing enough ability to swim with caudal fin and whole-body since after being hatched and then shifting to maneuverability-increased phase (Group D of *N. nuchalis*). Two groups based on feeding-related elements were species possessing a primordial/initial sucking after being hatched and developing their sucking ability thereafter (Group A of *K. punctatus*, *P. altivelis altivelis*, *L. japonicus*, *S. japonica* and *C. gulosus*) and those possessing the sucking phase equipped with dentary-related elements (Group B of *N. nuchalis*, *A. flavimanus*, *E. gilli*, *G. breunigii*, *G. heptacanthus* and *G. macrognathos*).

Furthermore, based on the swimming and feeding behavior, the eleven species were divided into respective two groups. The first group divided by the swimming behavior was free-swimming species (Group I of *K.*

punctatus, *P. altivelis altivelis*, *L. japonicus*, *N. nuchalis* and *S. japonica*), and the second group was bottom-dweller species, which was divided into two subgroups as follows: fishes staying on the bottom after settlement (Group II-1 of *A. flavimanus*, *C. gulosus*, *E. gilli* and *G. macrognathos*); and those swimming occasionally in the lower and middle layers of water column after the settlement (Group II-2 of *G. breunigii* and *G. heptacanthus*). Meanwhile, the following two feeding modes were recognized: fishes swimming through the water with mouth open to feed (Group I of *K. punctatus*, *P. altivelis altivelis*, *L. japonicus* and *S. japonica*); and those sucking in individual food items with the surrounding water (Group II of *N. nuchalis*, *A. flavimanus*, *C. gulosus*, *E. gilli*, *G. breunigii*, *G. heptacanthus* and *G. macrognathos*).

Based on the occurrence patterns of these eleven species, the tidal flats were used by these species as a spawning ground, a nursery and growing area and/or only as a transit area by depending on the species. Although the fishes utilize the tidal flats in different seasons and size ranges, the tidal-flat areas in the inner Tokyo Bay are so important for the eleven species especially during their early life stages and thus are necessary to be conserved or mitigated and/or restored when the areas were developed.