

Current Situation on Research Core in Marine Bio-production

Makoto Osada and Nobuhiko Taniguchi

Graduate School of Agricultural Science, Tohoku University, Japan

Introduction

The productions of domestic animal, crop and forest have been performed in the limited and controlled area of the land during a long history of agriculture. Domestic animals are reared at the fenced area and a feed is given to them. Crops are cultured at the field where is considerably fertilized. At the same time the breed of terrestrial animals, crop and forest have been improved.

On the other hand, the productions of aquatic animal and plant have mostly depended on a capture of wild species for a long time. Since last decades, the production of artificial seed, mariculture and the development of aquaculture facility in the land have been undertaken, and the aquaculture products greatly contribute to fisheries products today. Miscellaneous wild species containing commercial species inhabit and aquaculture organisms are cultured in a various aquatic environment with other natural creatures; eg) fresh water in land, estuary, coastal area, offshore and a various depth in each area. Therefore, fisheries production has a close relation to the aquatic environment and natural bio-resources. Thus the relationship between environment and bio-production in marine is greatly different from that in the land. It seems that a development of production system based on conservation of natural habitat is required in the coming fisheries production. From this point of view our research group has focused on the biological oceanographic, ecological, physiological, genetic and toxicological projects and found a lot of interesting aspect.

Biological oceanography

The food chain relationship in the food web should be probed to considerably know an ecosystem of marine. Phytoplankton (containing nano- and pico-phytoplankton) and detritus play an important role as a primary production in energy flow. These with other microorganisms and organic particles provide most energy from the surface through the

bottom of deep sea (Sasaki et al., 1988, Endo et al., 1999, Taniguchi, 1999).

Ecology

The primary production links to a higher production in the food chain. The complex of higher level of food chain is formed among many kinds of finfishes and benthic animals. It is suggested that the conservation of ecosystem in the food web that is composed of a various species is necessary to sustain fisheries production based on a capture from natural resource (Omori, 1977, Sasaki et al., 2001).

Rocky shore is covered with a lot of kelp where is a good habitat of herbivorous animals; sea urchin and abalone, which are very important commercial animals. "Coralline flat" which macroalgae disappears from rocky shore is a serious problem in coastal fisheries. The mechanism of transition of marine forest and ecological relationship between macroalgae and herbivorous animals via a chemical substance has been demonstrated, resulting in the possibility of remediation of "coralline flat" (Taniguchi et al., 1994, Sano et al., 1998).

Reproductive biology

Bivalve (mollusk) is also one of the commercially important species, especially oyster is a world wide animal in aquaculture. The technology of artificial seed collection of Pacific oyster had been developed in 1940s by our senior members and greatly contributed to bivalve and gastropod aquaculture all over the world. At the same time a local race of the oyster had been characterized by using the breeding technology. Reproductive biology and endocrinology of bivalves has been investigated to achieve artificial control of reproduction for breeding and to estimate reproductive condition, and several important biologically active substances regarding gametogenesis and spawning have been found (Osada et al., 2003, Osada et al., 2004). Bivalves are a sessile animal and exposed to the coastal water containing municipal effluent at all time.

The investigation of relationship between bivalve reproduction and polluted environment at protein and molecular levels is ongoing as a cooperative study on endocrine disruption with colleagues of oversea.

Genetics

Genetic study has been performed to analyze a structure of population and relation between wild population and released population bred within a limited number of parents, and to establish a strain with certain heredity. In several fishes the population structure has been demonstrated by using molecular markers and a necessity of molecular diversity was proposed to sustain the natural population and its production in the future (Takagi et al., 1999, Ikeda et al., 2003). In near future the establishment of strain will be required to improve a breed. Seeking genetic markers was undertaken to detect some genes linked to the DNA markers and new approach to achieve an efficient breeding was proposed (Li et al., 2002).

Toxicology

It is well know that aquatic animals are occasionally contaminated with toxic substances. In our group the structure of maitotoxin and other toxins have been determined and the poisoning mechanism of shellfish with toxins in the field was demonstrated (Satake et al., 1995, Mackenzie et al., 1996, Okumura et al., 1996). This study has greatly contributed to guarantee the safety of seafood.

Marine bio-production closely relates to the surrounding environment, biologically and chemically. Our group will carry forward our project to conserve marine bio-production and natural habitat and environment in our integrated studying field.

References

- Endo, Y., M. Ueda, T. Kaneko and T. Sugimoto, Short term and seasonal change in the lower trophic levels of a warm-core ring 93A. In "Ecosystem Dynamics of the Kuroshio-Oyashio Transition Region." Proceedings of the International Marine Science Symposium held on 25-28 August 1998 at Mutsu City and Hakodate, Japan, pp. 88-93, 1999
- Ikeda, M., M. Nunokawa, and N. Taniguchi, Lack of mitochondrial gene flow between populations of the endangered amphidromous fish *Plecoglossus altivelis ryuukyensis* inhabiting Amami-Oshima Island. Fisheries Science, 69, 1162-1168, 2003
- Li, Q., C. Park and A. Kijima, Isolation and characterization of microsatellite loci in the Pacific abalone, *Haliotis discus Hannai*. J. Shell. Res., 21, 811-815, 2002
- Mackenzie, L., D. White, Y. Oshima, Y., and J. Kapa, The resting cyst and toxicity of *Alexandrium ostenfeldii* (Dinophyceae) in New Zealand. Phycologia, 35, 148-155, 1996.
- Okumura, M., S. Yamada, N. Ishikawa, M. Ishida, N. Kuroda and Y. Oshima, Characteristics of paralytic shellfish poisoning toxins derived from *Alexandrium tamarense* and short necked clams in Mikawa Bay, Aichi, Japan. In Harmful and Toxic Algal Blooms, T. Ysumoto, Y. Oshima and Y. Fukuyo, Eds. ; Intergovernmental Oceanographic Commission of UNESCO, pp. 523-526, 1996
- Omori, M., Demersal Fishes, In Productivity of Biocoenoses in Coastal Regions of Japan. JIBP SYNTHESIS, 14, 203-208, 1977
- Osada, M., T. Takamura, H. Sato and K. Mori, Vitellogenin synthesis in the ovary of scallop, *Patinopecten yessoensis*: Control by estradiol-17 β and central nervous system. J. Exp. Zool., 299A, 172-179, 2003
- Osada, M., M. Harata, M. Kishida and A. Kijima, Molecular cloning and expression analysis of vitellogenin in scallop, *Patinopecten yessoensis* (Bivalvia, Mollusca). Mol. Reprod. Dev., 67, 273-281, 2004
- Sano, M., M. Omori, K. Taniguchi, T. Seki, and R. Sasaki, Distribution of the sea urchin *Strongylocentrotus nudus* in relation to marine algal zonation in the rocky coastal area of the Oshika Peninsula, Northern Japan. Benthos Research, 53, 79-87, 1998.
- Sasaki, H., H. Hattori and S. Nishizawa, Downward flux of particulate organic matter and vertical distribution of calanoid copepods in the Oyashio water in summer. Deep-Sea Res., 33, 505-515, 1988
- Sasaki, K., M. Kudo, T. Tomiyama, K. Ito and M. Omori, Predation pressure on the siphons of the bivalve *Nuttalia olivacea* by the juvenile stone flounder *Platichthys bicoloratus* in the Natori River estuary, northern Japan, Fish. Sci., 68,

- 104–116, 2001
- Satake, M., S. Ishida, T. Yasumoto, M. Murata, H. Utsumi and T. Hinomoto, Structural confirmation of maitotoxin based on complete ^{13}C NMR assignments and the three-dimensional PFG NOESY-HMQC spectrum. *J. Am. Chem. Soc.*, 117, 7019–7020, 1995
- Takagi, M., E. Shoji, and N. Taniguchi, Microsatellite DNA polymorphism to reveal genetic divergence in Ayu, *Plecoglossus altivelis*. *Fisheries Science*, 65, 507–512, 1999
- Taniguchi, A., Differences in the structure of the lower trophic levels of pelagic ecosystems in the eastern and western subarctic Pacific. *Prog. Oceanogr.*, 43, 285–319, 1999
- Taniguchi, K., K. Kurata, T. Maruzoi, and M. Suzuki, Dibromomethane, a chemical inducer of larval settlement and metamorphosis of the sea urchin *Strongylocentrotus nudus*. *Fisheries Sci.*, 60, 795–796, 1994