Keynote Speech-4 Research Activities in Aquarium

Looking Back the Research Activities for Technical Improvement on Aquarium Display

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The contents of this presentation consist of two subjects: “Mechanical devices and instruments for aquarium display on the sensory biology of fishes and their environmental factors” and “Circadian rhythms in locomotor activity of the hagfishes”.

The founding director, late Dr. Suyehiro maintained that a composition of aquarium display should be planned not only to collect rare fishes, but also to develop applications of experimental physiology of fish, i.e., sensitive perception of fish. Since the physiology treated rather endogenous phenomena of living fishes, it was hard to develop the systems to be applied for aquarium display. The sensory responses of fish include being on sight, hearing, smell, taste, and electricity. In the initial step, I had to make up the waterproof transducers both for generating ambient stimuli and for recording the reaction of fish in response to the stimuli. Some fundamental experiments were carried out and the effective devices were redesigned and drafted to familiarize my staffs with the use for educational interests. After the experiments had been repeatedly carried out, some successful results were seasonally exhibited to the public with some failed results. Throughout all the experiments, histological slide preparations were made for additional details in reference to aquarium display.

I have had some chances to collaborate my work with anatomists, medical doctors and an electrical engineer where I had learned valuable things. One of them was another subject in this presentation: “Circadian rhythms in locomotor activity of the hagfishes” that had been conducted at Misaki Marine Biological Station (MMBS), University of Tokyo during 1980-1998. This was my own personal study away from the aquarium exhibition. Using two species of hagfish, Eptatretus burgeri, and Paramyxine atami (=Eptatretus atami), a study of a relationship between the external light-dark conditions and locomotor activity of the animals were conducted using various methods and consequently excellent results were obtained. The hagfish showed a clear locomotor activity rhythm in the dark period entraining to the external 12:00 light and 12:00 dark (12L:12D) cycle. In addition, the animal displayed a distinct free-running rhythm in continuous darkness (DD).

The brain of the hagfish was studied to locate its circadian pacemaker. The suprachiasmatic nucleus (SCN) in the hypothalamus and the pineal gland in vertebrates are possible locations of circadian pacemaker. However, in E. burgeri, one of the most primitive vertebrates, neither a pineal gland nor the SCN has been detected in its brain. The characteristic locomotor activity rhythms were lost in the animal lacking the anterior part of the hypothalamus that includes the preoptic nucleus (PON). Incisions in front of the PON did not affect the rhythm, whereas incisions behind the PON caused the animals to lose their rhythms. Destruction of the PON with a high-frequency lesion generator also caused a loss of rhythms. These findings indicated that a candidate location of the circadian pacemaker in the hagfish might lie in the PON.

By looking back on 50-year research work as described above, I was actually aware that modern excessive developments of science and technology would have rapidly estranged the human from wild animals. However, both are “genuine animals” and have coexisted together on the earth. Comparative anatomy and phylogenetic taxonomy tell us that they are all members of vertebrates. The study of the hagfish impressed me that aquariums would be one of the most suitable facilities for a long-term research work especially on ethological activities in captive aquatic animals.