Research on Fish Meat—The Gap between Basic and Applied Research

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The powerful earthquake that struck off the coast of Japan's northeastern district sparked a massive tsunami, which caused a complete failure of Tokyo Electric Power Company's #1 Fukushima Nuclear Power Plant, emitting radioactive contamination over a wide area of the district. This Great East Japan Earthquake caused immense damage to Japan's fisheries industry, about which I am engaged in teaching and research. In the wake of the disaster, I wondered if there was something that I could do through research to help mitigate the damage. Seeking the cooperation of Fukushima Prefecture's Marine Experiment Station, I was able to obtain samples of radiation-contaminated fish. Using a leaching process, I found that amount of cesium accumulated in the fish could be reduced to about 5% of the original value. Processing the leached fish meat, I made a heated fishsurimi-based product including *kamaboko*. This process eliminated the undesirable fish meat pigment and odor, while giving the *kamaboko* a white gloss and strong elasticity. The fishsurimi-based product made through this process from the contaminated fish fell within the government's radiation safety guidelines. Nevertheless, I'm afraid consumers may be hesitant to eat this *kamaboko*. At least, I would be happy if the results of this study were to be some good news to people in the fisheries industry.

I have been conducting research on fish protein since my days as a graduate student at the University of Tokyo. One outlet of this research has been technological innovation in fish surimi-based products. The texture of *kamaboko* is called *ashi* (foot). It is the special elasticity that determines the quality of *kamaboko*. Nevertheless, its molecular mechanism has yet to be elucidated. There is a tendency to think that because *kamaboko* is a traditional food its manufacture technology has already been perfected. However, even using the same process, weak *ashi* may sometimes be produced. This is one of many problems that remain unsolved. At the same time, we do not have a good knowledge of the molecular mechanism forming *ashi*, making it difficult to find true solutions to problems when they occur. Of course, much research has shown that the source of *ashi* formation is mainly found in the properties of the major protein, myosin; nevertheless, to understand changes in the higher order structure of myosin in *ashi* requires first elucidating its primary structure.

My research in fisheries science came under agricultural science within the Grants-in-Aid program, so my applications needed to be for research useful to the fisheries and related industries. I felt it would be difficult to get selected for research that takes a different approach. But, if I were to do research that mainly concentrated on application, my response to problems that arise in it implementation could be haphazard, not yielding genuine solutions.

Amidst that dilemma, I embarked on genetic cloning research aimed at advancing primary-structure analysis of myosin heavy chain. Gauging the protein levels of various myosin heavy chains, I found differences in them when species' temperature adaptation was taken into account. At that time, I would have liked to call myself an "oldbie" researcher. If I were to stretch the truth a little, I'd say that I made this discovery as an offshoot on my research results on the habitat temperature of various fish species being the cause of different progresses in their rigor mortis. Truthfully, my findings were based on the work of the English researcher Prof. Ian Johnston, who has become my very good friend. He had published research results on biochemical changes in myofibrillar ATPase activity effected by fishes' temperature adaptation and on how such changes are based in changes in the regulatory protein, troponin, within their myofibrils. So as a still "newbie" researcher at that time, I applied and was selected for a Grant-in-Aid under the category "Encouraging of Young Scientists" to initiate research on myosin, secretly feeling that troponin was not a main player in myofibrillar changes. While thinking about this work, I had to wait for about ten years to start it. Subsequently, I was chosen in good succession for various Grants-in-Aid. Considered new in this realm of research, the projects were characterized by such terms as "temperature adaptation," "rigor mortis," and "myosin." However, I can vividly remember feeling despondent when occasionally not selected for a grant. I can also recall waiting in a cold sweet for good news on my new applications. Not being selected could put my research in limbo for a year.

Later, I transferred from the university's fisheries chemistry lab to its hydrospheric biotechnology lab, where I grappled with that field of research utilizing molecular biological techniques. Using a Grant-in-Aid, I succeeded in cloning the genes of myosin heavy chains. The results yielded an ability to deduct its primary structure, exerting a significant impact on fish protein research. Nevertheless, my research had still not come close to elucidating the molecular mechanisms involved in *ashi* formation. To do so would require an acute change in the direction of my research. So, I shifted it to an emphasis on muscle development and growth, as my work already had relativity with them via its trajectory on myosin heavy chains. Research in this direction tended to be centered on an analysis of transcription factors, and even now it is fair to say that there are virtually no researchers using expression changes in myosin heavy chains as an index in their work. However, the rate of muscle growth is an important factor in raising farmed fish.

These circumstances won me further Grants-in-Aid on this theme. I carried out intensive research on the tiger pufferfish (*torafugu*), its complete genome having been the second reported among vertebrates after human's. Now, my previous students, who have matured into fine researchers, are continuing to advance this work.

After that, I returned to the fisheries chemistry lab, where for five years I carried out research on a different subject until my compulsory retirement age. Returning to food chemistry, I concentrated on the molecular mechanism of lipid accumulation in muscles. Though I didn't myself apply for a Grant-in-Aid, I benefited from the grants acquired by my previous students and collaborators.

This year, I moved from the national university to a private university, where I have taken up two research topics using new Grants-in-Aid. They are related to temperature adaptation in various fish species and to salinity adaptation and food quality in blackish water clam (*yamatoshijimi*). I am pursuing these topics with the help of my colleagues at the present university.

In the realm of applied research, it is often said that research themes ought to be picked up from the field. To the extent feasible, I also believe this to be the case. In fact, a plethora of research themes are rolling about in the field. Needless to say, there is no problem in pursuing research on already decided themes, not extracted from the field. Though, I believe it necessary to determine whether such themes have genuine applied components. This is needed so as not to lose the identity of applied research as a research domain.