Marine Biological Research and Possible Application

Kazuhiro Kitazawa

Advisor,
Marine Technology and Engineering Center (MARITEC)
Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

The term, "marine biological resource", is generally used in a very wide meaning. It occasionally applies to aquatic resources, macro- and microbiological resources, and genetic resources. Aquatic resources are discussed in various occasions under the fisheries category. It is reported that enormous numbers of living creatures in the ocean. Marine biological research results and its possible application will be introduced in this presentation taking examples of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) carried out mostly in the deep water area within and/or beyond the EEZ of Japan.

Actual implementation of marine scientific research starts from research vessel operation for sampling and then various analytical works at laboratories follow. Operation of research cruises is very costly and no doubt laborious for scientists onboard. Biological sampling particularly for small creatures is carried out with corers and in some cases with traps. By its nature, it is difficult for scientists to obtain targeted biological sample with one trial. Most cases, interesting samples were obtained by accidental catch: we should understand, in comparison with sampling on land, that no one could get a specified sample with a single trial at sea.

One example is core research for systematic understanding of Life, Ocean and the planet Earth, scientists extract a gene substance from core sediment at a clean laboratory, and then carry out molecular analysis with a high resolution mass spectrometer. Another example is nucleic acid extraction from agarose gel. After screening of agarase-producing microorganisms from sediments obtained from the depth of 2400 m, a reagent for research was successfully introduced.

Scientific findings are, in many cases, led by a curiosity of scientists. Here is an example we met recently. At the first manned deepest dive with a manned submersible: *Trieste* in the Mariana Trench in 1960, Piccard reported that he saw a solelike fish at the bottom of the trench nearly 10,000 meter deep without clear evidence (National Geographic, vol. 118 (1960) p224-239) but its way of living as well as food source left unknown. In 1998, JAMSTEC organized a research cruise with a deep-sea ROV to study biological natures at the Challenger Deep of the Mariana Trench and caught a shrimp shape creature which scientists identified as amphipod and named *Hirondella gigas*. The *H. gigas* thrives at low temperature, under extremely high pressure and very nutrient-poor environment at the bottom of deepest sea. In order to study in detail, they attempted to collect sufficient number of *H. gigas* with a trap using a cut of fish as bait and succeeded to catch in 2009.

Ecology of *H. gigas* was not clear when scientists caught over 100 of them. Thus they thought *H. gigas* might be an ultimate omnivore. However, it is well understood that there are very low population of fish and/or plankton in the deep-sea, and microorganisms are also very rare in the bottom sediment. Then, does digestive enzyme exist in *H. gigas*? Scientists detected four digestive enzymes from mashed *H. gigas,* namely amylase, cellulase, glucomannanase, and maltase, and found that these breakdown plant-source substrates. They also detected glucose, maltose and cellobiose which are products of digestive enzymes in *H. gigas,* and confirmed with TCL analysis that purified cellulase from *H. gigas* produced glucose and cellobiose from carboxymethyl cellulose (CMC). Therefore scientists suspected that *H. gigas* might obtain nutrition from botanical polysaccharides. Scientists then turned their curiosity to another direction: whether or not does this novel enzyme, *H. gigascellulase* (HGcel)*,* react with common carbon materials such as sawdust and plain paper. HGcel demonstrated its reaction with both sawdust and paper.

Based on these scientific facts in a laboratory, one could expand his dream to produce bio-ethanol from sawdust and wastepaper. It would be possible if several conditions become clear. However, reaction speed of cellulase from cellulose to glucose is not known at this stage, and moreover production rate of glucose from cellulose is still unknown. Another big question remains on how much celluloses are needed for industrial application, and how many amount of *H. gigas* we should catch and use for industrial purpose. The biggest difficulty is where and how to collect sufficient number of *H.gigas* in fresh condition. These are common difficulties in front of us when we attempt to transfer laboratory scale scientific results to industrial products.

In conclusion, we should recognize that every useful materials industrialized were initiated by interests or curiosities of scientists and/or engineers. In the next stage, the idea would be developed by research activities starting from very basic level to industrially applicable level, which would take mostly tens of years. During this stage, they should collect enormous amount of research grant including ship operation costs in the case of marine research which are depending upon personal efforts of scientist themselves. Very few of scientific results become considerable candidates to industrialize, and only one or two could reach to produce commercial benefit.

Further information:

http://www.jamstec.go.jp/biogeos/j/xbr/emrt_pressrelease.html

http://www.jamstec.go.jp/biogeos/e/mbrp/mber/