Harmful Algal Blooms and their Global Expansion

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Two types of harmful algal blooms (HABs) by unicellular microalgae have been known to occur in coastal waters and impact marine environments and development of utilization of coastal area. The first one is noxious algal blooms which kill marine organisms, especially fish in aquaculture cages and shellfish hanged from rafts. The other is contamination of fish and shellfish by toxins produced by microalgae, which can sometimes causes human poisoning.

HAB occurrences and their ill consequences have increased in frequency, intensity and geographic distribution in the last two decades. The cause of the expansion has been suspected due to;

1. Expansion of harmful microalgae;
2. Increase in cell numbers during the blooming of previously hidden flora;
3. Development of fish and shellfish aquaculture, providing more chances of harmful impacts;
4. Increase of information concerning ill consequences of harmful algae; and
5. Advance in methodology, leading to the detection of new harmful events.

The No. 1 cause, invasion to new areas, is brought by natural mechanisms such as water current, but rather quick recent expansions suggest the implication of anthropogenic activities. Transfer of catch and seedling in fisheries may be one of the important mechanisms, as harmful microalgae attach to them. Discharge of ballast water by cargo ships during their voyage and at ports may also enhance invasion. The No. 2 cause, bloom of hidden flora, may be caused by changes of environmental conditions such as nutrient levels by man-made activities or global long-term environmental changes such as El Nino -Southern Oscillation (ENSO).

The main cause of occurrence and recurrence of certain species in certain areas may vary by the topology of the area and the nature of the species. In eastern and southeastern Pacific countries, there are several harmful microalgae occurring widely throughout the area such as *Pyrodinium bahamense*, *Alexandrium* spp. *Gymnodinium catenatum* and *Gambierdiscus toxicus*. International cooperative scientific research has just started with the initiative of Ocean Research Institute (ORI) to address their blooming mechanism and driving environmental factors.

Osmoregulation during Early Life Stages of Fish

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In my presentation, recent advances in the study of osmoregulation in early life stages of fish are reviewed with special reference to extrabranchial chloride cells. Teleost fish maintain ion concentrations and osmolality of the body fluid at levels different from external environments. In adult fish, the gills, kidney and intestine are important osmoregulatory organs, creating ionic and osmotic gradients between the body fluid and external environments. In particular, gill chloride cells function as the salt-secreting site in seawater (SW) fish, and probably as the ion-absorbing site in freshwater (FW) fish. In fish embryos and larvae, however, those osmoregulatory organs in adult fish are not yet developed or not fully functional. Nevertheless, embryos and larvae are also able to maintain ionic and osmotic gradients. In early life stages of fish when the gills are not yet developed, chloride cells are mainly distributed in the yolk-sac membrane, which covers the yolk. As the fish develop, the functional site of chloride cells shifts from the yolk-sac membrane to the gills.

Numerous chloride cells are present in the yolk-sac membrane of Mozambique tilapia embryos and larvae adapted to FW and SW. Chloride cells in SW often form multicellular complexes together with adjacent accessory cells, whereas chloride cells exist individually in FW. The chloride test and X-ray microanalysis have shown that the SW-type, chloride cell complexes have a definitive function of chloride secretion. According to *in vivo* sequential observations of chloride cells in the yolk-sac membrane of tilapia, single FW-type chloride cells are transformed into multicellular SW-type cells in response to SW transfer, suggesting plasticity in the ion-transporting functions of chloride cells. Recently, we have established a unique *in vitro* experimental model named a "yolk-ball" incubation system, in which the yolk sac is separated from the embryonic body and subjected to *in vitro* incubation. In the yolk balls prepared from FW tilapia embryos, chloride