NanoBubble Solutions Limited

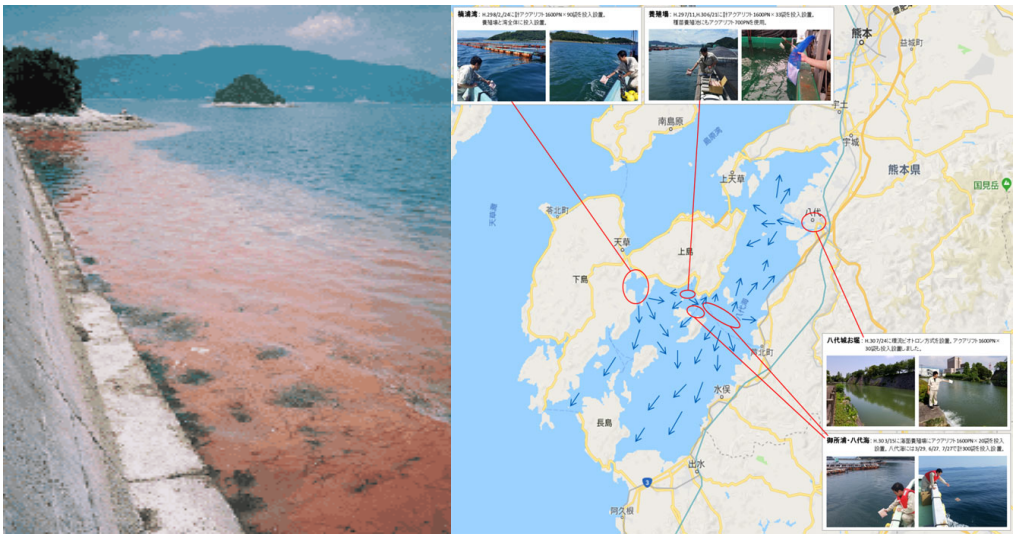
ANZAIKANTETSU CO,LTD mcs section

Red Tide – Seto Inland Sea – Japan

General Overview

Location: Pacific Ocean
Coordinates: 34° 10′ N 133° 20′ E
Type: Sea
Basin countries: Japan
Surface area: 23,203 km2 (9,000 sq mi)
Average depth: 38 m (125 ft)

The Setouchi region is known for its moderate climate, with a stable year-round temperature and relatively low rainfall levels. The sea is also famous for its periodic **red tides (赤潮 akashio) caused by dense groupings of certain phytoplankton** that result in the death of large numbers of fish.

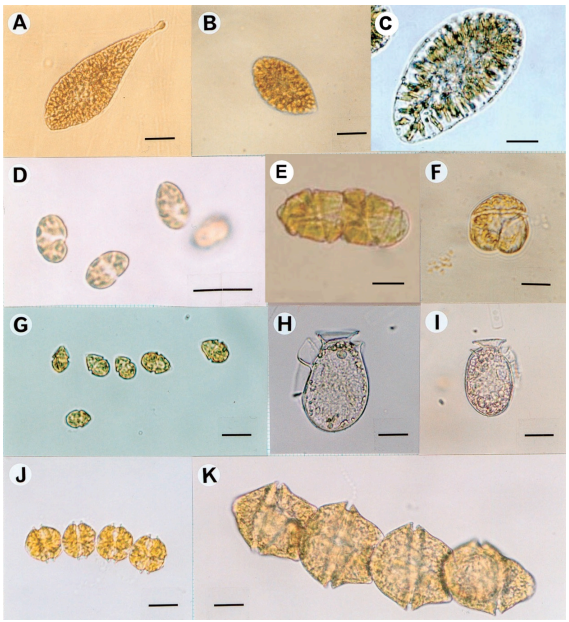


Red Tide

Research on measures to fight Red Tide began in Japan in earnest in the 1960s.

The Seto Inland Sea is the largest coastal water in Japan. Approximately one quarter of the entire Japanese population resides on its coastline and the industries located there in the 1960's contributed greatly to Japan's high economic growth. However, this rapid development caused a large amount of eutrophication substances such as organic matter, Nitrogen, Phosphorus, etc. and large amounts of contaminants such as chemical substances and marine refuse to flow into its waters resulting in a moribund sea.

There are more than 60 species of Red Tide plankton that have been recognized in coastal areas of Japan but the species that has caused the most serious fishery damage among them is Chattonella Antiqua. Fishery damage caused by the Red Tide is said to well exceed the annual average of 1 billion yen (US$10 Million) in the entire Seto Inland Sea.



Typical harmful poisonous plankton in coastal areas of Japan

Above plate:-
Lafid algae Chattonella antiqua (A), Chattonella marina (B), Chattonella ovata (C), Heterosigma akashiwo (D) which kill fish; Cochlodinium polykrikoides (E), Karenia mikimotoi (F) Red Tide dinoflagellates that kill fish and shellfish; Heterocapsa circularisquama (G) to kill clams; Dinophysis fortii (H), dinoflagellates possess diarrheal shellfish poison; Dinophysis acuminata (I), possessing diarrhetic shellfish poison, Dinoflagellate Alexandrium catenella (J), Gymnodinium catenatum (K), hemp causes of paralytic shellfish poison. Photographs scale are all 20 μm.

Nobody has yet mounted any meaningful trials to eradicate the Red Tide in this region, but there have been various studies as a result of the problems which lead to the potential use of Nanobubbles as the most likely solution.

Below are the two most relevant papers:

1. Verification of effectiveness and economy of existing Red Tide Control Agent
By Dr. Yoshio Tahara, Dr. Hiroshi Nishimura and Dr. Akihiko Nakamura,
Kagoshima Fisheries Technology Center, Government of Japan,

and

2. Development of Control Technique by Simple Red Tide Blocking System,
By Dr. Shigeru Kitahara, Dr. Nana Kano and Dr. Keiji Hirano
Nagasaki Institute of Fisheries, Government of Japan

The main points are as follows.

① Red Tide Preventive Measures

Harmful toxic plankton which kills fish, such as Chattonella antiqua, C.marina, C.ovata (Raphidophyceae) - especially Chattonella antiqua, inhabit the sludge in the sea. When DO levels in the sea are low, aerobic bacteria is drastically reduced encouraging the breeding of these harmful plankton. Therefore, it is necessary to keep the sea bed rich in Oxygen to prevent this happening. If not controlled, when there is a rise in sea temperature the seeds are released into the water to create Red Tide. The operation of increasing the DO level with Oxygen Nanobubbles is highly effective, because only Nanobubbles can deliver the Oxygen to the sea bed. When this is done, the presence of the Oxygen readjusts the balance between the species and stimulates the Benthos group of creatures which thrive on more Oxygen and eat the Red Tide seeds, stopping them from being released.

② Countermeasures

Countermeasures after occurrence of Red Tide are typically use of chemicals, Ozone, etc.. In recent years, research on Ozone is progressing in particular. In general, Ozone work temporarily kills micro-organisms, but without killing fish and marine animals, and makes Chattonella antiqua completely harmless. It is necessary to secure a minimum Ozone concentration of 2 ppm. Considering all the various methods, using Nanobubbles offers the

only realistic way of delivering Ozone gas economically, efficiently and without waste of gas to the sea bed.

Chattonella

Chattonella is a genus of marine raphidophytes associated with red tides**.** A technique using monoclonal antibodies can be used to identify the genus, while the RAPD reaction can be used to distinguish between different species within the genus. It includes the species Chattonella antiqua, a bloom forming alga responsible for large scale fish deaths due to the synthesis of toxic compounds related to brevetoxin.