

Original article

The transition of chemical substances from marine sediments in Onagawa Bay after Great East Japan Earthquake

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Introduction

The Great East Japan Earthquake that occurred on March 11, 2011, measured 9.0 on the Richter scale. The earthquake damage expanded due accompanying tsunami [1], which caused catastrophic damage to the fishery industry, the core industry of Onagawa Town. Not only did the tsunami destroy land and marine facilities, it also had a tremendous effect on the marine environment.

In this research, the aim was aimed to analyze the chemical substances contained in the Onagawa Bay sediment after the earthquake and clarify some of the changes that occurred in the aquaculture environment. It is concluded that the influence of the tsunami still remains.

Materials and methods

The sampling sites in Onagawa Bay are shown in Fig.1. Station 1 is an inner part of the Bay close to the Onagawa River estuary. Stations 11, 12, 16 and 17 are aquaculture dominated areas where coho salmon, oyster, scallop and ascidians are farmed. At each station, sediments were collected from the surface to depth of 5 cm. Deeper samples were collected at St.1, 6 and 11 and sediment was analyzed every 2 cm to clarify vertical profiles. The samples were taken during April of 2012 and December of 2016.

Samples were freeze dried before extraction with normal hexane (n-hex) using a Speed Extractor (E-914 BÜCHI Labortechnik AG). The sediment PAHs concentrations were analyzed according to method US EPA 8270. PAH concentration was analyzed by Gas Chromatography-Mass Spectrometry (GC/MS PAH Analyzer, Agilent Technologies) after extraction with n-hex/acetone (1:1, v/v). Five internal standards were used for identification and quantification: d8-naphthalene, d10-acenaphthene, d10-phenanthrene, d12-chrysene, and d12-perylene (PAH Analyzer

Calibration Sample Kit, Agilent Technologies) [2].

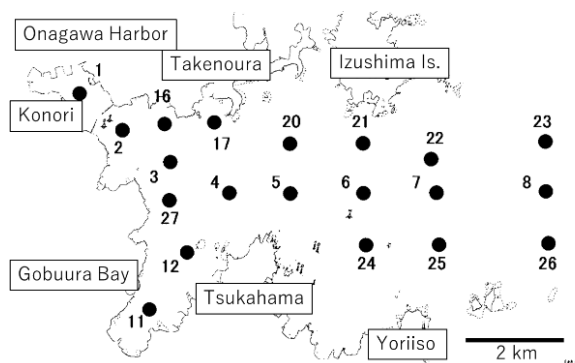


Fig. 1. Sediment sampling sites in Onagawa Bay.

Comet assays were performed according to Singh et al with the KMST-6 human cell line derived from embryonic fibroblasts [3].

Radioactivity in sediments was detected with a Germanium Semiconductor Detector (Ortec).

Results

The amount of n-hex extract was more than the standard value at some points in Onagawa Bay, but tended to decrease with time (Fig. 2). The extract was detected at high concentration at station 1, 3, 6 and 12. The extract was not uniformly distributed in the bay. The amount of n-hex extract was abundant among fine particles (less than 0.075 mm). Although PAHs were also non-uniformly distributed, their distribution pattern was different from those of n-hex extracts. The highest concentration of PAHs was detected at St.11.

The Benzo[a]pyrene (BaP) and PAH₄ contents in Mussels taken from St. 11 and St. 17 are shown in Fig. 3.

Most of the PAHs detected in Onagawa Bay were derived from combustion according to the isomer ratio of PAHs [4].

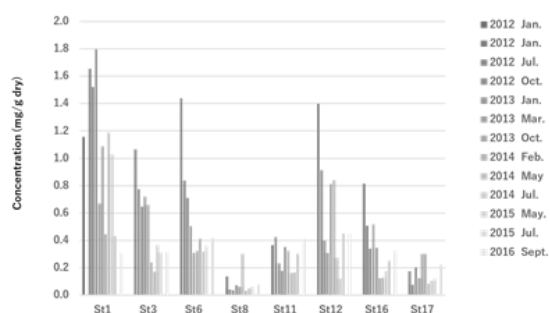


Fig. 2. Concentration of n-hexane extracts in Onagawa Bay sediments from 2012 to 2016 (mg/kg dry matter) collected at St. 1, 3, 6, 8, 11, 12, 16 and 17.

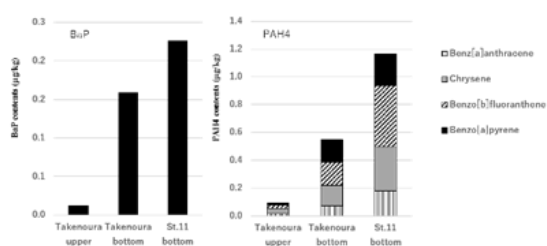


Fig. 3. BaP and PAH₄ contents of *Mytilus galloprovincialis* collected from aquaculture ropes at Takenoura (St. 17) and St. 11.

No genotoxicity was observed for KMST-5 human normal cell.

From the vertical profiles of PAHs concentration and radioactivity of the sediments, the PAHs concentration was low in the 10-cm layer from the sediment surface and the radioactivity was not detected below 10 cm from the sediment surface at St. 1.

Discussion

The sediment of Onagawa Bay was greatly affected by the disturbance and the inflow of soil from the land caused when the tsunami retreated. Analysis of the organic chemical substances contained in the sediment revealed a part of the influence. As a result of redistribution of the sediment after the tsunami, there was a point where PAHs were detected at a high concentration, but the detection value did not exceed the reference value from organisms produced there [5].

It is important to verify the safety of the environment and the product by continued monitoring.

Acknowledgements

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