Distribution and behavior of hazardous chemical substances in rivers adjacent to coral reefs in Okinawa Island, Japan

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Hazardous chemical substances such as nonylphenol (NP), bisphenol A (BPA), diuron, Irgarol 1051, chlorpyrifos in natural samples were analyzed by solid-phase extraction (SPE) followed by high-performance liquid chromatography with tandem mass spectrometry (LC-MS-MS). These hazardous chemical substances were detected in water and sediments collected from rivers adjacent to coral reefs in Okinawa, Japan. Northern Okinawa is characterized by rural area with low population density. In middle and southern Okinawa, which areas are urbanized with high population density.

In order to understand the behavior of endocrine disrupting chemicals (EDCs) in the environment, degradation experiments were conducted in laboratory. The degradation of NP, nonylphenol monoethoxylate (NP1EO) and BPA was examined in native river sediments as a function of aerobic/anaerobic condition, temperature, and sediment type. All target compounds degraded in sediments under aerobic condition. Aerobic degradation rates of NP and BPA increased with temperature and decreased with total organic carbon (TOC) content. The results suggest that NP, NP1EO and BPA will easily disappear from the environment under aerobic condition. On the other hand, the target compounds did not degrade at 28 ? under anaerobic condition even after 49 days of experiment. NP was not produced from NP1EO degradation even under anaerobic condition.

Hazardous chemical substances were distributed in the environment according to their chemical characteristics and application. High NP and BPA contents in sediments were associated with urban areas, while low contents in sediments are associated with rural areas.

The BPA concentration in river water at Site K-1, which is a residential area in Naha City, was similar to that in domestic wastewater. BPA is leached from polycarbonate (PC) and polyvinyl chloride (PVC) plastics used as daily life materials. The main route of BPA leached from plastics into the rivers was domestic wastewater. The variation of BPA contents tended to be high in July and low in February. BPA plastics-to-water migration rate increases with increase temperature. Therefore, BPA contents in the environment were controlled by temperature. These results suggested that the variation of BPA contents depended on the amount of BPA released into rivers.

Diuron and chlorpyrifos were detected both in rural areas and in urban areas such as Naha City. The diuron contents in urban areas were higher than that in rural area. Diuron was used in non-crop areas and household. The results suggested that urban applications of diuron were larger than agricultural ones. Chlorpyrifos was used as termiticide in residential areas until three years ago. The results showed that chlorpyrifos had remained in houses and continued to be released into the rivers even after three years of ban on termiticide application. Irgarol 1051 was detected at downstream of the rivers, where port and/or fishing port are located at river mouth. Irgarol 1051 was used in antifouling paints. Irgarol 1051 has low affinity to sediments and is remobilized in seawater. In seawater, Irgarol 1051 was persistent and its half-life was 200-350 days. Therefore, a tidal current could transport Irgarol 1051 to the downstream of rivers.

Most of the sampling sites for this study are located within a distance of 1 km from the coral reefs, which are under the influence of river-waters to a variable extent. The hazardous chemical contents in sediments were especially high. The sediments are delivered in large quantity through runoff into coral reefs during a typhoon and heavy rainfall. The highly hazardous chemicals were carried into coral reefs onto sediments. Therefore, influence of hazardous chemical substance may have begun on the coral reefs.