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Changings of Polycyclic Aromatic Hydrocarbons in Aquatic Organisms and Sediment at Guimaras after Oil Spill

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Key words: Oil spill, polycyclic aromatic hydrocarbons, shellfish

Abstract

Following the oil spill accident of the Solar I tanker in 2006 off the coast of Guimaras Island in the Philippines, polycyclic aromatic hydrocarbons (PAHs) in shellfish was investigated at Luzaran in Guimaras Islands, which was heavily polluted with spilled oil, from September 2006 (1 month after the accident) to June 2008. Although concentrations of total PAHs extremely decreased during 3 months after oil spill, those slowly changed in the following period. The relative high molecular weight PAHs such as benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)-anthracene, indeno(1,2,3-cd)pyrene, and benzo(g,h,i)perylene also tended to be residue in shellfish.

On August 11, 2006, the Solar I tanker was hit by hard rainstorm and sank off the coast of Guimaras Island in the Philippines. About 350,000 tons of heavy fuel oil was spilled from the tanker polluting about 200 km of shoreline around Guimaras. Over 450 ha of huge protected mangrove areas with complex topography at Guimaras was also contaminated[1)].

In general, spilled oil degrades with several factors such as evaporation, diffusion, photooxidation, and biodegradation[1-5)]. In tropical areas, because of strong sunshine, high temperature, and frequent storms, spilled oil is expected to degrade faster than in the temperate and boreal areas although it is still poorly studied. Since polycyclic aromatic hydrocarbons (PAHs) are persistent in the environment[5-7)], their toxicities to aquatic organisms have been examined[8-11)]. The acute toxicity of PAHs to fish generally induces narcosis, which is a reversible anesthetic effect[12)]. In addition, acute exposures with early life stages PAHs resulted in developmental abnormalities[13)]. When an oil spill occurs in a water system, the concentrations of PAHs are significantly high in water and could have significant threats and several negative impacts on the surrounding aquatic organisms.

Uno et al. reported the initial impacts of the Solar I, and especially the accumulations of PAHs were examined in some species of fish, shellfish, and crabs immediately after the spill and 1 month later[1)]. In the present study, the changing of PAH concentrations in shellfish, was caught at the southern tip of Guimaras Island, were investigated for about 1 year immediately after oil spill.

Materials and Methods

Collection of organisms

The five investigations were conducted at Luzaran the southern tip of Guimaras Island, from 2006 to 2008 (September and November 2006, March and September 2007, and June 2008). Luzaran has the huge mangrove forests, and has many species of aquatic organisms. Fig. 1 shows the location of Luzaran on the map. Four species of shellfish, *Modiolus* sp., *Pinctada* sp., *Clyupeomorus* sp., and oyster (its taxon has not been identified), were collected in each investigation. After the collections, all samples were stored at -20℃ until anal-

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ysis.

Analysis of PAHs in shellfish

The analysis of PAHs was conducted according to the previous method procedures[1]. The target PAHs were as following: naphthalene, acenaphthylene, acenaphthene, fluorene, dibenzothiophene, phenanthrene, anthracene, fluoranthene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k) fluoranthene, benzo(a)pyrene, perylene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and benzo(g,h,i)perylene. The index total PAHs were calculated as the sum of the quantity of all these compounds.

Results and Discussion

Concentrations of mean total PAHs extremely decreased from September to November 2006, but those slowly changed in the following period (Fig. 2). Especially, shellfish collected at September 2006 could accumulate PAHs directly from water, because it had been just one month after oil spill, and much oil components were suspended in sea water yet. On the other hand, the slow change of PAHs from November 2006 to June 2008 suggested that the pollutions of PAHs had continued around Luzaran since oil spill. In general, when oil spill happens on the sea, the oil components burrow into sediments and are residue with little degradation in sediments for long period[14]. The PAHs in shellfish at Luzaran from November 2006 to June 2008 could be derived the oil components, which were eluted gradually from sediment.

Figure 3 shows the example of the changes for individual PAH concentrations in shellfish (*Clyupeomorus* sp.) at individual investigations. Concentration of chrysene was the highest among PAHs in *Clyupeomorus* sp. for about six months after spill. However, that was rapidly lowered after September 2007. In addition, concentrations of relatively high molecular weight PAHs such as benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and benzo(g,h,i)perylene, changed little in *Clyupeomorus* sp. Those PAHs could be residue in sediments with little degradation, and/or be more slowly metabolized by shellfish than low molecular weight PAHs. Joint FAO/WHO Expert Committee on Food Additives (JECFA) indicated that those high molecular weight PAHs are mutagenic or carcinogenic compounds[15]. The continuous investigation should be conducted at Guimaras Island until the residues of high molecular weight PAHs with mutagenicity and carcinogenicity will be low in shellfish.

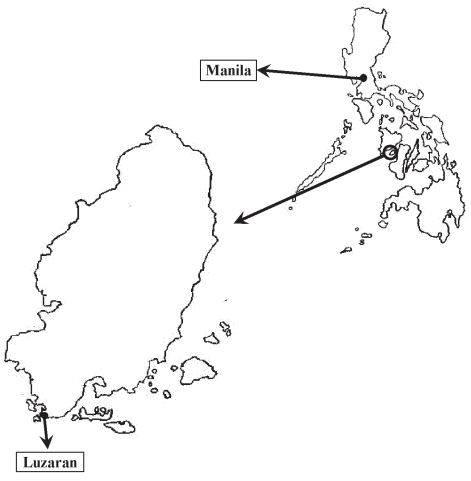

Fig. 1. Locations of the sampling site, Luzaran, where shellfish was collected.

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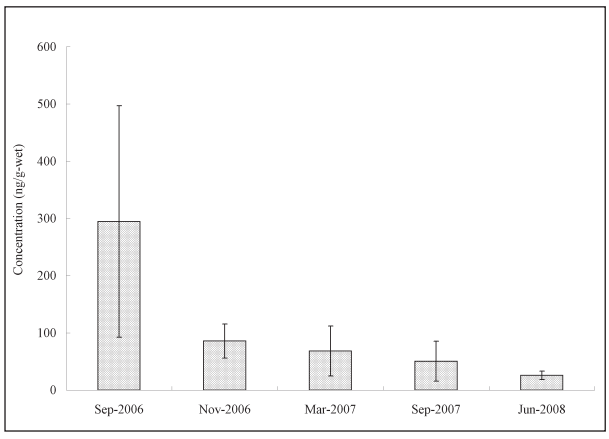

Fig. 2. Changings of total PAHs in 4 species of shellfish from September 2006 to June 2008. A bar indicates mean concentration of PAHs in shellfish.

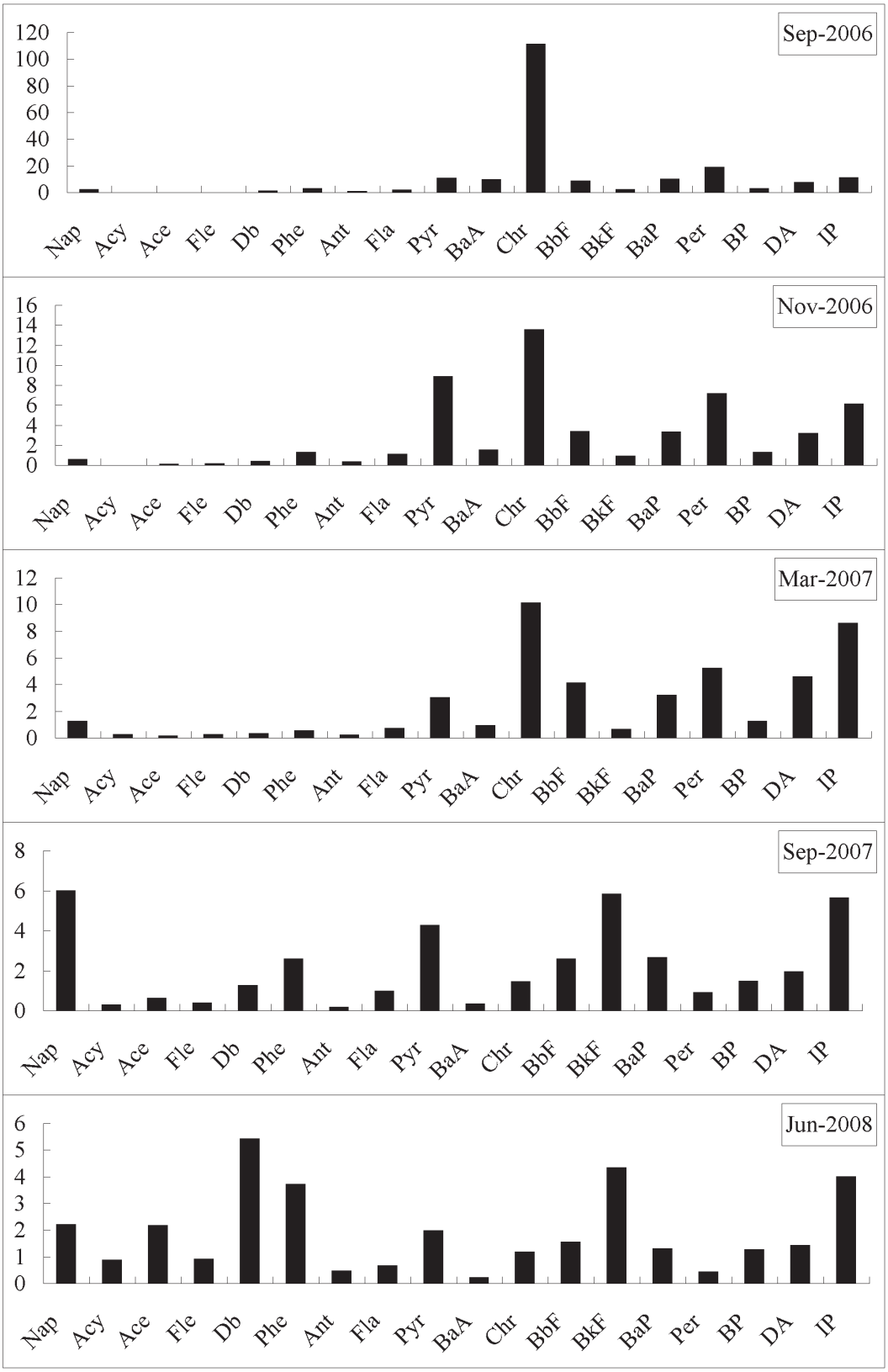

Fig. 3. Concentrations of individual PAHs in *Clyupeomorus* sp. at September and November 2006, March and September 2007, and June 2008 (ng/g-wet weight). The abbreviations are as follows: Nap, naphthalene; Acy, acenaphthylene; Ace, acenaphthene; Fle, fluorine; Db, dibenzothiophene; Phe, phenanthrene; Ant, anthracene; Fla, fluoranthene; Pyr, pyrene; BaA, benzo(a)anthracene; Chr, chrysene; BbF, benzo(b)fluoranthene; BkF, benzo(k)fluoranthene; BaP, benzo(a)pyrene; Per, perylene; BP, benzo(g,h,i)perylene DA, dibenz(a,h)anthracene; and IP, indeno(1,2,3-cd)pyrene.

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