CONTAMINATION AND DISTRIBUTION OF ORGANOCHLORINE AND BUTYLTIN COMPOUNDS IN DEEP-SEA ORGANISMS COLLECTED FROM JAPANESE COASTAL AND OFFSHORE WATERS

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Introduction

During the last few decades, pollution by persistent man-made chemicals such as organochlorines (OCs) has spread all over the world as evidenced by their detection in various environmental components and biota including those from remote areas. In this regard, it has been emphasized that deep-sea sediments play a role as a sink and final reservoir for persistent contaminants[1]. During the 1970s and the 1980s, several monitoring studies have reported the accumulation of OCs in deep-sea organisms collected from the Atlantic Ocean and around the US coasts[2-5]. Despite this, only few studies have reported contamination by OCs in deep-sea environment so far[6-8]. In particular, scarce data are available in the western North Pacific region.

Based on such background, we have investigated contamination by man-made contaminants, such as OCs including polychlorinated biphenyls (PCBs) and organochlorine pesticides and butyltin compounds (BTs) including an antifouling agent, tributyltin (TBT), in deep-sea organisms collected around Japanese coastal and offshore waters since 1994. In this study, the results of our recent studies in Suruga[9, 10] and Tosa Bays[11] and in the western North Pacific, off Tohoku[12, 13] have been reviewed and discussed to elucidate present status of contamination in the deep-sea ecosystems and horizontal and vertical distribution of contaminants.

Materials and Methods

Various deep-sea and shallow-water organisms were collected from Japanese coastal and offshore waters, during 1994 to 1998. Sampling locations are shown in Fig 1. Details of samples were described in our previous papers[9-13]. Total 49, 37 and 52 species of organisms were collected from the western North Pacific, off Tohoku, Suruga Bay and Tosa Bay, respectively. In addition, 6 species of mesopelagic myctophid fishes were collected from the western North Pacific, off-Tohoku. OCs including PCBs and organochlorine pesticides such as DDT and its metabolites (DDTs), chlordane compounds (CHLs), hexachlorocyclhexane isomers (HCHs) and hexachlorobenzene (HCB) were determine by gas chromatography with an electron capture detector (GC-ECD) following the method described in elsewhere[10]. BTs, such as TBT and its breakdown compounds, mono- (MBT) and dibutyltins (DBT), were determined by gas chromatography with a flame photometric detector (GC-FPD)[9].

Results and Discussion

OCs and BTs were detected almost all the deep-sea and shallow water organisms from Japanese coastal (Suruga and Tosa Bays), and offshore waters (off Tohoku). Among the OCs analyzed, concentrations of PCBs and DDTs were the highest and other OCs were approximately in the order of CHLs > HCHs = HCB. Concentrations of OCs such as PCBs and DDTs in deep-sea organisms from Japanese coastal and offshore waters appeared to be lower than those from the Atlantic Ocean and around the US coasts which were reported in 1970~80s. Among sampling locations, the highest concentrations of PCBs, CHLs, and BTs were observed in Suruga Bay.

Lower concentrations of HCHs and HCB were found in shallow-water organisms from Suruga Bay and Tosa Bay than in those from off-Tohoku. Among the fish species analyzed, snubnosed eel showed extremely high concentrations of OCs, which may be due to its feeding habit. Patterns of vertical distributions of OCs were different between off-Tohoku along cold current 'Oyashio', and Suruga and Tosa Bays along warm current 'Kuroshio'. Higher concentrations of PCBs, DDTs and CHLs were observed in fishes from deeper waters than those from shallow waters, off-Tohoku, while these

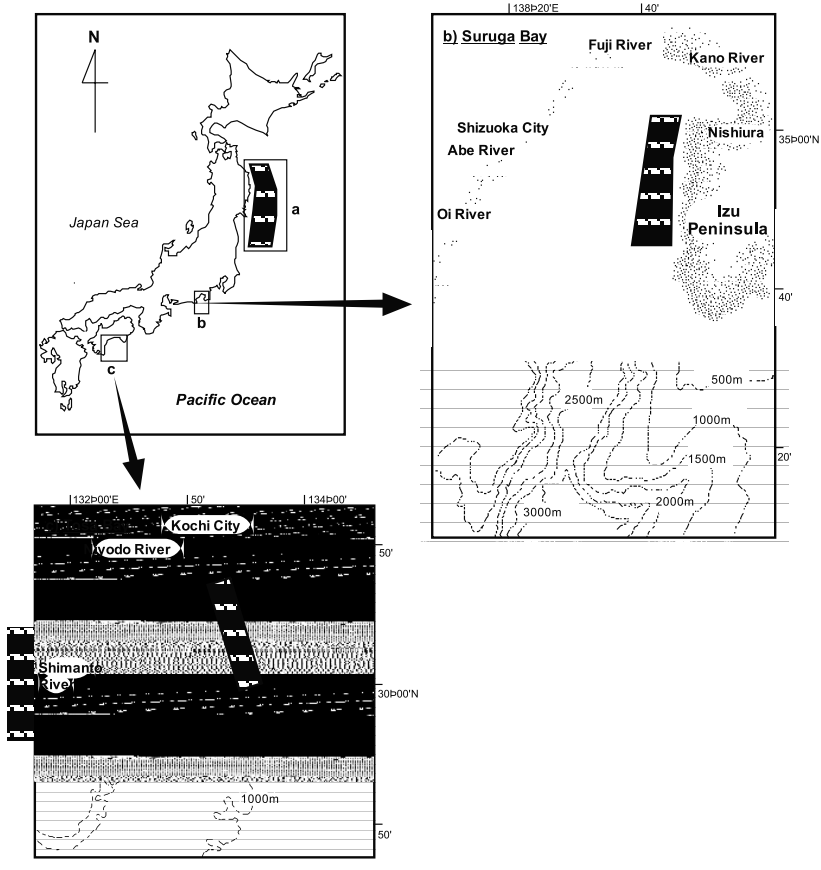

Fig. 1. Map showing sampling locations (shaded portion) in the western North Pacific, off-Tohoku (a), Suruga Bay (b) and Tosa Bay (c).

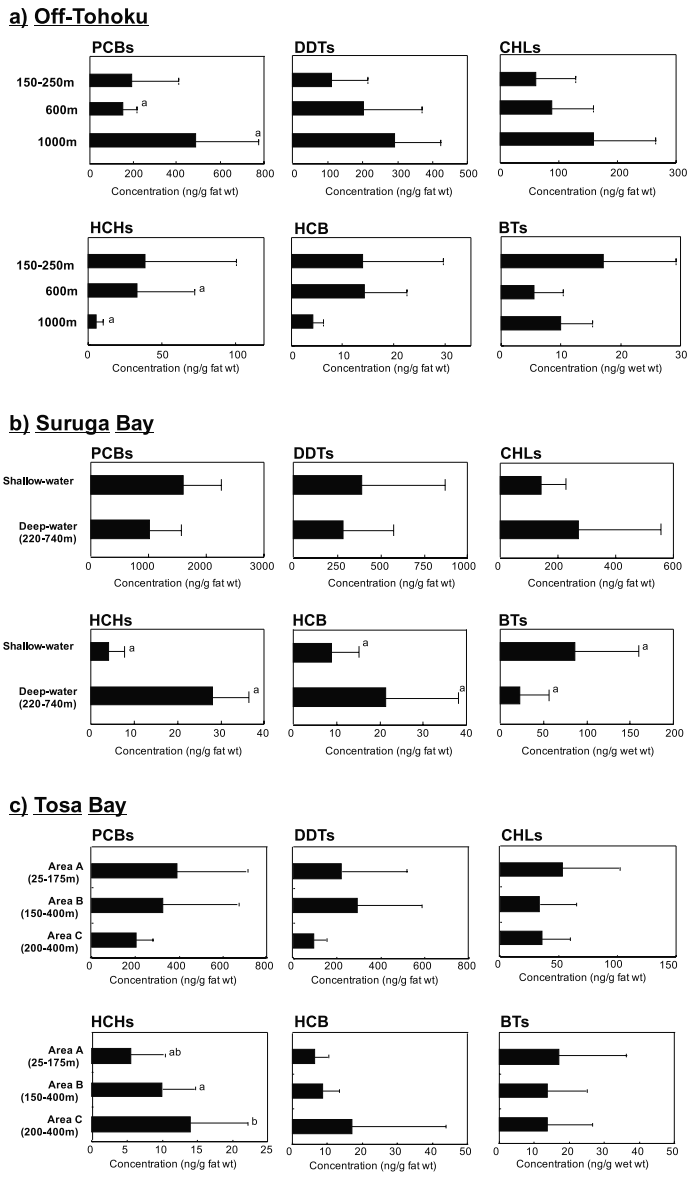

Fig. 2. Mean concentrations of PCBs, DDTs, CHLs, HCHs, HCB and BTs in shallow and deep-water fishes from the western North Pacific, off-Tohoku, Suruga Bay and Tosa Bay, Japan, with different sampling depth. Narrow bars indicate standard deviation of each data. Bars topped with the same superscript show significant difference in Mann-Whitney U-test $p<0.05$).

concentrations were comparable between deep and shallow water fishes from Suruga and Tosa Bays (Fig. 2). This suggests that vertical transport of PCBs, DDTs and CHLs in the area, off-Tohoku, where higher primary and export productions have been observed. In contrast, higher HCH and HCB concentrations were found in fishes from deeper waters in Suruga and Tosa Bays, while, off-Tohoku,

the higher concentrations of these compounds were observed in fishes from shallower waters (Fig. 2). This may imply the evaporation of these contaminants from surface waters along warm current, Kuroshio, but its deposition in the surface waters of higher latitude cold region. On the other hand, higher concentrations of BTs were found in shallow water fishes in all the areas investigated, suggesting continuous and/or recent input of BTs into surface waters that overwhelm the vertical transport of these compounds.

References

1. Woodwell, G. M., Craig, P. P. and Johnson, H. A. (1971) Science. 174, 1101-1107
2. Harvey, G. R. and Steinhauer, W. G. (1976) in: Environmental Biogeochemistry (Nriagu, J. O. ed.), Ann Arbor Science Publishers, pp. 203-231
3. Baird, R. C., Thompson, N. P., Hopkins T. L. and Weiss, W. R. (1975) Bull Mar Sci. 25, 473-481
4. Krämer, W., Buchert, H., Reuter, U., Biscoito, M., Maul, D. G., Le Grand, G.and Ballschmiter, L. (1984) Chemoshere. 13, 1255-1267
5. Melzian, B., Zoffmann, C. and Spies, R. B. (1987) Mar Pollut Bull. 18, 388-393
6. Berg, V., Ugland, K. I., Hareide, N. R., Aspholm, P. E., Polder, A. and Skaare, J. U. (1997) Mar Environ Res. 44, 135-148
7. Looser, R., Froescheis, O., Cailliet, G. M., Jarman W. M. and Ballschmiter, K. (2000) Chemosphere. 40, 661-670
8. Froescheis, O., Looser, R., Cailliet, G. M., Jarman W. M. and Ballschmiter, K. (2000) Chemosphere. 40, 651-660
9. Takahashi, S., Tanabe, S. and Kubodera, T. (1997) Environ Sci Technol. 31, 3103-3109
10. Takahashi, S., Lee, J. S., Tanabe, S. and Kubodera, T. (1998) Sc Total Environ. 214, 49-64
11. Takahashi, S., Hayashi, S., Kasai, R., Tanabe, S. and Kubodera, T. (2001) Natl Sci Museum Monogr No. 20, 363-380.
12. Takahashi, S., Tanabe, S. and Kawaguchi, K. (2000) Environ Sci Technol. 34, 5129-5136
13. de Brito, A. P. X., Takahashi, S., Ueno, D., Iwata, H., Tanabe, S. and Kubodera, T. (2002) Mar Pollut Bull. in press