

Spatial and temporal variation in organochlorine contaminants in the Antarctic minke whales, *Balaenoptera bonaerensis*

GENTA YASUNAGA*, YOSHIHIRO FUJISE*, RYOKO ZENITANI*, SHINSUKE TANABE*# AND HIDEHIRO KATO*+

* *The Institute of Cetacean Research, 4-18, Toyomi-cho, Chuo-ku, Tokyo 104-0055 Japan.*

*# *Center for Marine Environmental Studies (CMES), Ehime University, 2-5 Bunkyo-cho, Matsuyama, Ehime, 790-8577 JAPAN.*

*+ *Fisheries Research Agency, National Research Institute of Far Seas Fisheries, 5-7-1, Simizu-Orido, Sizuoka 424-8633, Japan.*

ABSTRACT

To evaluate environmental changes in the Antarctic Ocean, concentrations of organochlorines (PCBs, DDTs, HCHs, HCB and CHLs) were determined in the blubber of the mature males of Antarctic minke whales, *Balaenoptera bonaerensis*, (from 21 to 25 years) from the Antarctic Areas IV and V. The ranges of concentrations for each compound were, in ng/g fat wt: PCBs, 7.7-89; DDTs, 29-340; HCHs, 0.20-4.3; HCB, 75-430; CHLs, 10-120. Residue levels of PCBs, and DDTs in blubbers of Antarctic minke whales from the Antarctic Ocean were apparently lower than those levels of the other baleen whales from the middle latitude areas. Regional significant differences between the Areas IV and V were observed in PCBs, HCHs, HCB and CHLs levels in mature male of Antarctic minke whales. And also, their HCHs and HCB levels significantly decreased during 1988/89 and 2002/03 seasons in the Areas IV and V. Yearly changes of PCBs and DDTs were unclear during 1988/89 and 2002/03 seasons.

KEY WORDS: ANTARCTIC MINKE WHALE; ORGANOCHLORINE; MONITORING; TEMPORAL TREND

INTRODUCTION

Whales tend to be in high position in the food chain of the ocean, thus they may be particularly suitable as monitors of pollutant levels and their adverse effects (Tanabe *et al.*, 1986; O'Shea and Brownell, 1994). The third objective of JARPA, 'Elucidation of the effect of environmental change on cetaceans', was added in 1995/96 season (Government of Japan, 1995), in response to two resolutions of the IWC (IWC, 1999). It has been continued to monitor organochlorine levels in blubbers of Antarctic minke whales, *Balaenoptera bonaerensis*.

Aono *et al.* (1996) reported that increasing trend of PCBs residue levels in Antarctic minke whales were noted during 1984/85 and 1992/93 seasons, implying the continuous discharge of PCBs in the Southern Hemisphere. Furthermore, Niimi *et al.* (2000) continually analysed those samples until 1996/97 season, and reported that DDTs levels of Antarctic minke whale had decreased in 1990's and PCBs levels could decrease in late 1990's, while they had increased until middle 1990's.

We analysed organochlorine levels in blubbers of mature male of Antarctic minke whales in the Areas IV and V during 1997/98 and 2002/03 seasons. In this paper, the yearly changes and spatial differences of organochlorine accumulations in Antarctic minke whales in the JARPA surveys are presented.

MATERIALS AND METHODS

In this study, concentrations of PCBs, DDTs, HCHs, HCB and CHLs were determined for blubber samples of 80 Antarctic minke whales (mature males: 21-25 years) taken from the Antarctic Areas IV and V during 1987/88 and 2002/03 seasons (Table 1). In the field, blubber samples were collected for organochlorines analyses, and were stored at -20°C until analysis.

Organochlorine pesticides and PCBs were determined by a GC-ECD (Hewlett Packard 5890 Series) and by GC-MS (JEOL Ltd., JMS-700; JMS-SX102A). Chemical analysis of the Organochlorines was carried out using the standard method described by Environmental Agency of Japan, with some modifications (Japan Environmental Agency, 1998). Concentrations of organochlorines were expressed on a fat weight basis. Accuracy and precision of the methods were confirmed using Organics in cod liver oil (NIST 1588a). Chemical analyses were performed by the Miura Institute of Environmental Science.

The differences of organochlorine concentrations between areas were assessed by Mann-Whitney U test and the temporal trends of organochlorine concentrations were assessed by linear regression analysis (Zar, 1999). These statistical analyses were executed by SPSS ver.11 for windows (SPSS Co. Ltd.).

RESULTS AND DISCUSSION

Tables 2 shows the concentrations of organochlorines in blubbers of Antarctic minke whales taken from the Areas IV and V. Figure 1 shows levels of PCBs and DDTs in blubbers of baleen whales in the world as previously reported for comparison with our data. PCBs, DDTs, HCHs, HCB and CHLs were detected in all the blubber samples of Antarctic minke whales. The ranges of concentrations for each compound were, in ng/g fat wt: PCBs, 7.7-89; DDTs, 29-340; HCHs, 0.20-4.3; HCB, 75-430; CHLs, 10-120. These residue levels were in the order of DDTs>HCB>PCBs>HCHs>CHLs in Antarctic minke whales from both the Areas IV and V. Aono *et al.* (1997) reported these order of HCB>DDTs>CHLs>PCBs>HCHs in male of Antarctic minke whales from Area V in 1990/91 and 1992/93 seasons. This difference could be due to using the CHL isomers between both studies.

PCBs and DDTs levels in blubbers of Antarctic minke and fin whales from the Antarctic were one order of magnitude lower than those of the other whales in the middle and low latitude areas (Fig. 1). PCBs levels in blubbers of Antarctic minke and fin whales from the Antarctic were lower than those of bowhead whales, while DDTs levels were reverse (O'Hara *et al.*, 1999; Krone *et al.*, 1999).

Geographical difference

Concentrations of the organochlorines, except for DDTs, in Antarctic minke whales from the Area IV during 1987/88 and 2001/02 seasons were significantly higher than those from the Area V during 1988/89 and 2002/03 seasons ($p<0.05$). Consequently, examination about temporal trends will be analysed in each area.

Temporal trend

Figures 2 and 3 represent plots of organochlorine concentrations in blubbers of mature of Antarctic minke whales from the Areas IV and V during 1987/88 and 2001/02 seasons. Further, Table 3 shows simple linear correlation coefficients and provability between year and organochlorine contaminant concentrations in blubbers in each area ($p<0.05$). HCHs and HCB levels in Antarctic minke were significantly decreased in both areas, however PCBs and DDTs were significantly decreased in Area-V. These differences could be attributable to differences of the vapor pressure of each compound. However, it should be continued to monitor these levels in Antarctic minke whales carefully, since their variances in each year of all the compound levels are relatively higher.

CONCLUSION

Volatile compounds, such as HCHs and HCB, levels in Antarctic minke whales tend to decrease, while time trends of lower volatile compounds, such as PCBs and DDTs are not clear in JARPA surveys during 1987 and 2003 seasons. These results are consistent with the previous JARPA work, suggesting a fate of organochlorines, such as PCBs and DDTs, which may come near turning point in the Antarctic Ocean.

REFERENCE

- Aono, S., Tanabe, S., Fujise, Y., Kato, H. and Tatsukawa, R. 1996. Persistent organochlorines in minke whale (*Balaenoptera acutorostrata*) and their prey species from the Antarctic and the North Pacific. *Environmental Pollution*. 98: 81-89.

- Fujise, Y. 1997. A brief review of studies related to research on effects of environmental changes on cetaceans in the JARPA survey. Paper SC/M97/5 presented to the IWC Intercessional Working Group to Review Data and Results from Special Permit Research on minke whales in the Antarctic, May 1997 (unpublished). 19pp.
- Gauthier, J.M., Metcalfe, C.D. and Sears, R. 1997. Chlorinated organic contaminants in blubber biopsies from northwestern Atlantic Balaenopterid whales summering in the Gulf of St Lawrence. *Mar. Environ. Res.* 44:201-223.
- Government of Japan. 1995. The 1995/96 research plan of Japanese whale research programme under special permit in the Antarctic. Paper SC/47/SH3 presented to the IWC Scientific Committee, May 1995 (unpublished). 8pp.
- Henry, J. and Best, P.B. 1983. Organochlorine residues in whales landed at Durban, South Africa. *Mar. Pollut. Bull.* 14:223-227.
- Hobbs, K.E., Muir, D.C. and Mitchell, E. 2001. Temporal and biogeographic comparisons of PCBs and persistent organochlorine pollutants in the blubber of fin whales from eastern Canada in 1971-1991. *Environ. Pollut.* 114:243-54.
- International Whaling Commission. 1999. Report of the workshop on chemical pollution and cetaceans. *J. Cetacean Res. Manage.* (special issue) 1:1-42.
- Japan Environmental Agency. 1998. Analytical Manual for endocrine disrupter chemicals. Tokyo, Japan (in Japanese).
- Kang, Y. S., Matsuda, M., Kawano, M., Wakimoto, T. and Min, B. Y. 1997. Organochlorine pesticides, polychlorinated biphenyls, polychlorinated dibenzo-*p*-dioxins and dibenzofurans in human adipose tissue from western Kyungnam, Korea. *Chemosphere*, 35, 2107-2117.
- Kleivane, L. and Skaare, J.U. 1998. Organochlorine contaminants in northeast Atlantic minke whales (*Balaenoptera acutorostrata*). *Environ. Pollut.* 101:231-239.
- Niimi, S., Watanabe, M., Nakata, H., Tanabe, S., Amano, M., Miyazaki, N., Fujise, Y. and Petrov, E.A. 2000. Naibunpi-kakuranbussitsu niyoru kikyakurui oyobi geirui-osen no keinennhenndou (Yearly changes of endocrin disrupting chemical, such as PCBs and organochlorine pesticides). Naibunpikakurankagakubussitsu-gakkai, Yokohama, Dec. 16, 2000.
- O'Hara, T.M., Krhahn, M.M., Boyd, D., Becker, P.R. and Philo, L.M. 1999. Organochlorine contaminant levels in Eskimo harvested bowhead whales of Arctic Alaska. *J. Wildlife Disease.* 35:741-752.
- O'Shea, T.J. and Brounell Jr, R.L. (1994) Organochlorine and metal contaminants in baleen whales: a review and evaluation of conservation implications. *Sci. Total Environ.*, 14: 179-200.
- Tanabe, S., Miura, S. and Tatsukawa, R. (1986) Variations of organochlorine residues with age and sex in Antarctic minke whale. *Mem. Natl. Inst. Polar Res., Spec. Issue*, 44: 174-181.
- Tanabe, S. 1998. Analytical methods of dioxins and PCBs in wildlife. In: An investigating manual of contaminated status of dioxins in wildlife. Center for Natural Environmental Studies, Tokyo, pp 90-100 (in Japanese).
- Tanabe, S., Sung, J.-K., Choi, D.-Y., Baba, N., Kiyota, M., Yoshida, K. and Tatsukawa, R. 1994. Persistent organochlorine residues in northern fur seal from the Pacific coast of Japan since 1971. *Environ. Pollut.*, **85**: 305-314.
- Taruski, A.G., Olney, C.E. and Winn, H.E. 1975. Chlorinated hydrocarbons in cetaceans. *J. Fish. Res. Bd. Can.* 32:2205-9.