

D-2.3.2 Biological Effects of Pollutants for Dolphins and Seals, and Bioaccumulation Process of Pollutants

Contact Person Tadasu K. Yamada
Senior Curator
Dept. of Zoology, National Science Museum
3-23-1 Hyakunin-cho, Shinjuku-ku, Tokyo 169, Japan
Phone +81-3-5332-7168, Fax +81-3-3364-7104
E-mail tkymda@tansei.cc.u-tokyo.ac.jp

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Abstract During the course of study on marine mammal morphology and ecology, we have realized that their tissues have been more and more contaminated by man-made toxic pollutants like organochlorines and heavy metals. Our project has been concentrated on revealing how and to which degree the marine mammals are contaminated and how contaminants are concentrated within their body. Our results show serious pollutions in seas close to the highly industrialized countries but even in Arctic and Antarctic area where little influence of these toxic contaminants are expected. We convened an international symposium to provide scientists from 16 countries to present and discuss the actual situations found in their field area. We also tried to reveal pathogenic influences of these contaminants and genes.

Key Words Dolphin, Seal, Marine Pollution, Organochlorine Compound, Heavy Metal

1. Introduction

During the course of study on marine mammal morphology and ecology, we have realized that their tissues have been more and more contaminated by man-made toxic pollutants like organochlorines and heavy metals. Our project has been concentrated on revealing how and to which degree the marine mammals are contaminated and how contaminants are concentrated within their body. Our results show serious pollutions in seas close to the highly industrialized countries but even in Arctic and Antarctic area where little influence of these toxic contaminants are expected. We convened an international symposium to provide scientists from 16 countries to present and discuss the actual situations found in their field area. We also tried to reveal pathogenic influences of these contaminants and genes.

2. Research Objective

(1) Actual influence of marine pollution to the marine mammals

This project was to find out man-made toxic contaminants in samples collected from cetaceans and phocid pinnipeds. We concentrated on detecting organochlorines such as , DDTs, PCBs, HCHs and so on, and heavy metals, such as Hg, Pb, Zn, Cd and so on.

(2) The process of concentration of contaminants within marine mammal body

The distribution patterns of the contaminants mentioned above among organs, species and habitats were to be made clear. Attitudes of the contaminants within the animal body and the modes of elimination were the purpose of this study.

(3) Pathogenic influences of contaminants

It was also aimed at that how these contaminants induce pathological influences to the individuals.

(4) Other objectives

It would be necessary to provide occasions where scientists of various countries exchange their findings and opinions. We convened an international symposium on marine pollution and marine mammals in 1993. The necessity for the international specimen bank has become more and more serious because there would be more chance to re-examine the specimens or introduction of new techniques would be possible. It is necessary to scheme out well organized data base with biological, pathological and toxicological data of the specimens. In order to produce much more comprehensive results from the analyses we need more detailed

exact informations on marine mammals.

3. Research Methods

Tissue samples obtained from various species of cetaceans and phocid pinnipeds were collected. The species examined were : Common dolphin, Striped dolphin, Spinner dolphin, Pacific white-sided dolphin, Bottlenose dolphin, Lisso's dolphin, Fraser's dolphin, Common porpoise, Dall's porpoise, Cuvier's beaked whale, Stejneger's beaked whale, Pigmy sperm whale, Steller sea lion, Weddell seal, Spotted seal, Baikal seal, Caspian seal and Ringed seal. Total number of the specimens were 387.

Samples collected from these were subjected to chemical analyses to detect organochlorines such as DDTs, PCBs, HCHs, etc and heavy metals such as Hg, Cd, Cu, Zn, Se, Su, etc. Mitochondrial DNA were also detected and analysed to reveal pod structure of these animals. Gross and microscopic observations on these animals were also obtained to estimate the influences of contaminants.

4. Results

Accumulation of heavy metals were various according to organs, ages and habitats. In Striped dolphin (*Stenella coeruleoalba*) collected off the Pacific coast of Japan, concentrations of Fe, Mn, Cu and Hg were highest in liver, whereas those of Zn and Ni, Pb and Cd were highest in blubber, bone, and kidney, respectively (Honda, et al., 1982). Fe, Mn, Zn, Cu, Pb and Ni were transferred through maternal placenta to foetuses, but Hg and Cd were not. According to Honda, et al. (1983), in Striped dolphin muscular Fe, Pb, Ni, Cd, and Hg levels, hepatic Pb, Ni, Cd and Hg levels, and renal Hg level increase according to the age whereas hepatic Mn, Zn and Cu and renal Mn and Cu levels decrease. There could be differences of heavy metal accumulation according to the habitat. Hg concentration in Striped dolphin and sea birds were around 10^6 , while those of Weddell seal and Adélie penguin were at the level of 10^4 .

These differences could be attributed to the complexity of food web between these areas. That in the western North Pacific the food web is much more complex than in the Antarctic.

Butyltin compounds are highly toxic and utilized for antifouling paints for boats and aquaculture nets to prevent inconveniences. These substances have been detected in lower animals. Iwata, et al. (1994) were successful in detecting butyltin compound residues in marine mammals, namely Dall's porpoise and Common dolphin from northern North Pacific, Stejneger's beaked whale from the Sea of Japan, Spinner dolphin from the Bay of Bengal and Minke whale from the Antarctic. The concentration of the substance is extremely higher in the seas around Japan and industrialized countries. Animals from tropic seas adjacent to developing countries were less contaminated but they have certain levels of residues in their body. The result of analysis on Finless porpoise from the Seto inland sea showed that Butyltin compounds are highly accumulated in liver and to some extent in brain and kidney.

The study on western North Pacific biota revealed extremely high accumulation of DDTs and PCBs in Striped dolphin blubber at the power of six to seven times compared with concentration in the surface water. HCHs are at the level of power of five to six. These results could be attributed to lipophilic nature of those organochlorine compounds and the rich fatty tissue composing the blubber. Organochlorine residue found in Striped dolphin blubber were higher in adult males and in the young than in adult females. It is understood that in the males the contaminants are simply accumulated according to their age but in females certain portions of the accumulated contaminants are transferred to their foetus through placenta and to their young through milk.

Tanabe, et al. (1988) indicated cetaceans have very high variety of PCB isomers than other mammals including pinnipeds. This could be because of the lack of enzymatic activity of degrading PCBs.

Pathological examinations were carried out on Common dolphin, Striped dolphin, White sided dolphin, Bottlenose dolphin and Pigmy sperm whale. In some cases abnormal FE and Cu in hepatocytes which usually are not detected in terrestrial mammals.

Food habit of marine mammals is important for the contaminant analyses. In our project

we found stomach contents in three strands Stejneger's beaked whale, and beakes of Gonatid squids were identified. This means the feed at the depth of deeper than 200 m below surface. This may lead to some new aspect in pollution analyses related to depth difference.

In analyzing these results of ours we have to go back to published data. However, sometimes because of the difference of the techniques or difference of the quality of the results, significant comparison is impossible. What if we have good specimen bank for marine pollution analyses? It is very important for the long-term monitoring of the marine pollution, to preserve the specimens collected with sufficient biological, pathological data. We have deposited the skeletal part of the specimens we collected for this project at National Science Museum, Tokyo and the tissue samples at Ehime University. We also built a database of the specimens we used for this study.

We also built a database of stranding record of marine mammals in the Sea of Japan to provide fundamental information on cetacean bio-data of the Sea of Japan where we have very little knowledge. Both these data bases will become accessible through the internet when KAHAKU LAN will be completed soon.

We convened an international symposium in Kamogawa, Chiba, Feb. 6-8 1993. There, scientists from 16 countries had the opportunity to discuss their information and problems. The proceeding was published as a special issue of the periodical "The Science of the Total Environment" published by Elsevier, Netherlands, after critical referee reading by the editorial board of the journal.

We visited Argentina, Russia, Turkey, Thailand, Singapore, Indonesia, New Zealand, and Australia for collecting samples and for discussion with the counterparts.

5. Discussion

This project revealed a series of serious results of toxic contaminants in marine environment in global scale. Marine mammals are polluted as high as 10^7 times than that of surface water in the case of DDTs in Striped dolphin. Cetaceans are more exposed to high accumulation rate of organochlorine compounds. What is important here for us is to estimate what kind of actual influence or disasters will be brought forth by this pollution to our physical condition. In this case we include human beings and other species of mammals and could be all the organisms if we are to maintain biodiversity on this planet.

We need more precise evaluation of the mode of contamination and the direct pathological and immunological influences. For this purpose we need more basic informations.

6. Publications resulting from this project

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