



# Bioaccumulation of persistent organochlorine pesticides (OCPs) by gray whale and Pacific walrus from the western part of the Bering Sea



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## ABSTRACT

The feeding habits of a gray whale (*Eschrichtius robustus*) and a Pacific walrus (*Odobenus rosmarus divergens*), caught from the western Bering Sea in the summers of 2010 and 2011, have been studied, and concentration of persistent organochlorine pesticides (OCPs) in their organs determined. The total OCP concentration ( $\sum\text{HCH} + \sum\text{DDT}$ ) in muscles and liver of the gray whales varies from 297 to 3581 and from 769 to 13,808 ng/g lipids, respectively. The total OCP concentration ( $\sum\text{HCH} + \sum\text{DDT}$ ) in muscles and liver of the Pacific walruses varies from 197 to 5659 and from 4856 to 90,263 ng/g lipids, respectively. The specifics of diet as a source of pesticide accumulation in these two marine mammal species are discussed.

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## 1. Introduction

Persistent organic pollutants (POPs) are toxic xenobiotics that circulate in the biosphere over decades. During the last third of the 20th century, hexachlorocyclohexane (HCHs) and dichlorodiphenyltrichloroethane (DDTs) have been the most actively used among organochlorine pesticides (OCPs).

Researchers, especially those concerned about the issues of global environmental pollution and particularly its influence on the wildlife, have long considered the Arctic as a target region. The Arctic almost does not have its own sources of anthropogenic pollution, but this region is exposed to the continuous effect of some intense sources located at more southerly latitudes. Various pollutants easily reach the Arctic region being transported by air and water currents and by migrating organisms (so-called “biotransport”), rapidly become included in the matter and energy exchange cycles, and exert a negative effect on ecosystems and their inhabitants such as mammals (Wania and Mackay, 1995, 1996; Tanabe and Subramanian, 2006; Ivantsev and Medvedev, 2007; Lukyanova et al., 2014; Tsygankov et al., 2014).

Marine mammals can be considered key species for monitoring of persistent organic pollutants (POPs) in the marine environment all over the world. They can be used as bioindicators of global pollution and also as biomonitors of modern trends in anthropogenic pollution of the biosphere (Tanabe and Subramanian, 2006).

Evaluation of the role that pollutants play in ecosystems and assessment of the character and degree of their influence on wildlife are possible only if we take into account the pathways by which pollutants get into animal organisms. One of the most important pathways is ingestion with food, since food chains are a major mechanism of xenobiotics’ transfer from organisms of one trophic level to another. Biomagnification of harmful substances, i.e. their accumulation to high concentrations, in organisms of higher trophic levels is a manifestation of this process. Upper links of a food chain get pollutants in amounts that can have a toxic effect at the level of cell, tissue, organism, and population. These effects cause reproductive disorders in animals and serious damage to their immune system, as a result of which their organisms become susceptible to various diseases.

The purpose of this study is to determine the concentration of HCH isomers (hexachlorocyclohexane) ( $\alpha$ -,  $\beta$ -,  $\gamma$ -HCH), DDT and its metabolites (DDD (dichlorodiphenyldichloroethane), DDE (dichlorodiphenyldichloroethylene)) in organs of gray whale (*Eschrichtius robustus*) and Pacific walrus (*Odobenus rosmarus divergens*), collected in the coastal waters (Mechigmsky Bay) in the Bering Sea, and to compare the content of pollutants from feeding habits of these two marine mammal species.

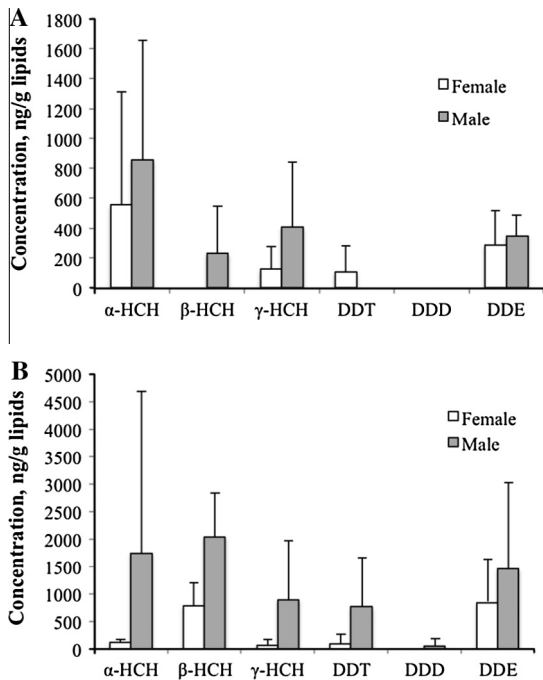
## 2. Materials and methods

### 2.1. Study sites and samples

Concentrations of persistent organochlorine pesticides ( $\alpha$ -,  $\beta$ -, and  $\gamma$ -isomers of HCH, DDT and metabolites (DDD, DDE)) in the

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**Fig. 1.** Concentration of OCPs in muscles (A) and liver (B) of male and female of gray whale.

liver and muscles of gray whales (*E. robustus*; 4 male and 3 female) of different ages, and Pacific walrus (*Odobenus rosmarus divergens*; 5 male and 3 female) caught by the indigenous people in summer 2010–2011 from the coast waters (Mechigmenky Bay) of the Bering Sea were studied.

The International Whaling Commission (IWC) has allowed exclusive harvesting rights for these gray whales to the indigenous peoples of Chukotka and Alaska as a means of supporting their traditional lifestyle.

## 2.2. Chemical and data analyses

Frozen samples ( $-20\text{ }^{\circ}\text{C}$ ) were transported to laboratory. Lipids were extracted from homogenized organs by means of n-hexane extraction, with subsequent disintegration of the fat components by concentration sulfuric acid (Tsygankov and Boyarova, 2015).

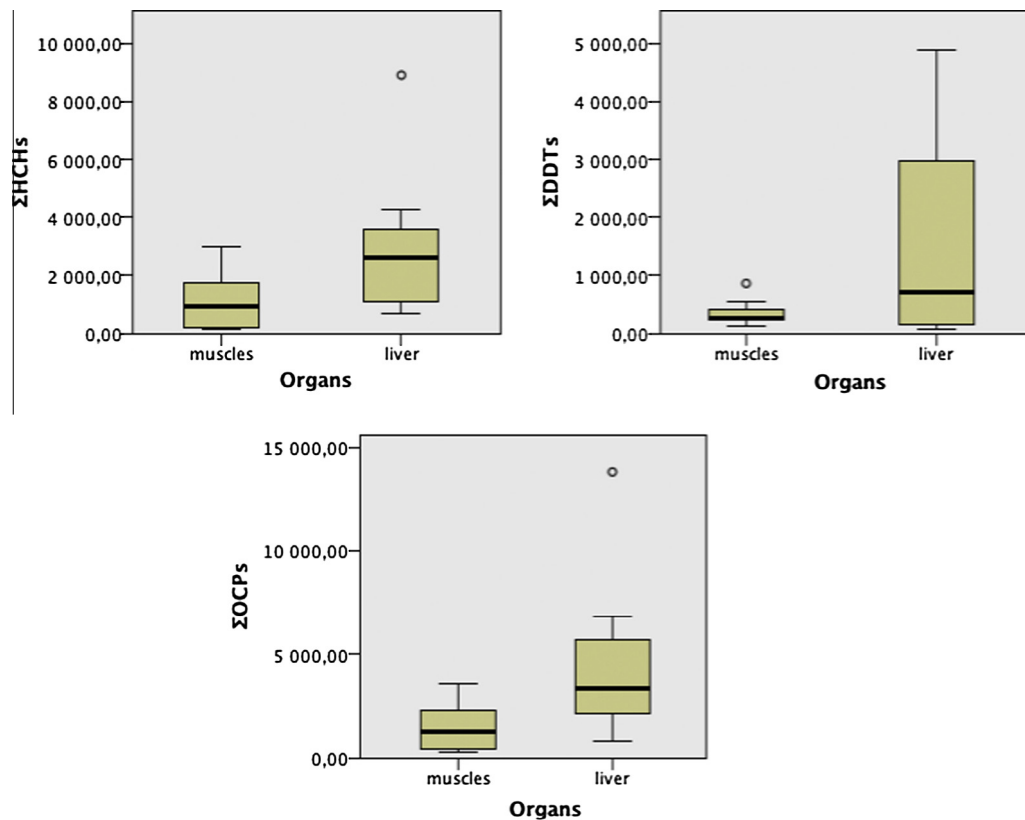
Detection of the concentrations of organochlorine pesticides (HCH isomers ( $\alpha$ -,  $\beta$ -,  $\gamma$ -HCH), DDT and its metabolites (DDD, DDE)) in samples was performed on a gas chromatograph Shimadzu GC-2010 Plus with an ECD (electron capture detector) (capillary column Shimadzu HiCap CBP5). Column temperature –  $210\text{ }^{\circ}\text{C}$ , injector –  $250\text{ }^{\circ}\text{C}$ , and detector –  $280\text{ }^{\circ}\text{C}$ . Carrier gas is argon, inlet pressure:  $2\text{ kg/cm}^2$ , 1:60 flow divider, and flow rate of carrier gas through the column:  $0.5\text{ ml/min}$ . To identify individual substances, standard working solutions of POPs in the concentration range of  $1\text{--}100\text{ mg/ml}$  were applied.

Statistical analyses were performed by the use of SPSS 21 for Mac OS X. Normality was confirmed by the Mann–Whitney test. Kruskal–Wallis one-way analysis of variance was used to test for equality of medians between the muscles and the liver marine mammals.

## 3. Results

### 3.1. OCP concentrations in organs of gray whale

Pesticides were found in all the analyzed specimens of gray whales (Figs. 1 and 2 and Table 1). The total content of pesticides



**Fig. 2.** The total concentration (medians) of HCH isomers, DDT and its metabolites and OCPs ( $\Sigma\text{HCHs} + \Sigma\text{DDTs}$ ) in organs of the gray whale.

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