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Organochlorine pesticides and polychlorinated biphenyls in the Bering flounder (*Hippoglossoides robustus*) from the Sea of Okhotsk

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ABSTRACT

The purpose of this study is to establish the presence of POPs in the Bering flounder (*Hippoglossoides robustus*) from the Sea of Okhotsk (North-West Pacific). Concentration of OCPs (α-HCH, β-HCH, γ-HCH, *o,p′*-DDT, *p,p′*-DDT, *o,p′*-DDD, *p,p′*-DDD, *o,p′*-DDE and *p,p′*-DDE) and PCBs (28, 52, 155, 101, 118, 143, 153, 138, 180, 207) in samples were measured by GC–MS and GC–ECD. The mean OCP concentrations in flounder from East and South areas of the Sea of Okhotsk were 99.8 ± 125.4 and 53.6 ± 40.5 ng/g lipid, respectively; PCB congeners – 112 ± 94.2 and 88.8 ± 50.8 ng/g lipid, respectively. POPs in fish tissue decreased in the order: PCBs > HCHs > DDTs. Our results indicate that consumers will have no health risk due to fish consumption from Sea of Okhotsk. OCP and PCB levels in the Sea of Okhotsk may be considered as background level for the North Pacific.

1. Introduction

Organochlorine pollutants are mainly anthropogenic and, being highly persistent and lipophilic, are strongly bioaccumulative in food chains. Moreover, they exhibit harmful and toxic effects. These compounds include organochlorines such as chlorinated pesticides (OCPs) and some of the congeners of polychlorinated biphenyls (PCBs). Organohalogens input to the environment as a result of intentional and unintentional releases from human activities. The toxic effects of POPs may first appear in the next generation due to their bioaccumulation and persistence. DDT and HCH originate from the leaching of soils following their application as insecticides on fields and in forests. The use of DDT has been banned in many countries since the 1970s, when the use of PCBs was also restricted. During the 1960s and 1970s, PCBs were extensively used in capacitors, transformers and paints, from which they leached into the environment either directly or after waste disposal (Jensen, 1972). The production of PCBs was prohibited under the Stockholm Convention on Persistent Organic Pollutants in 2001 (UNEP, 2005).

The occurrence of persistent organic pollutants (POPs) in the environment can affect organisms inhabiting aquatic systems. The final "depot" of organochlorines often becomes marine ecosystems. Once release into environment, these pollutants enter marine ecosystems via the hydrological cycle and result in adverse impacts to fish, shellfish and other marine organisms. Concentration of pesticides in fish, used as an important item in the human diet, is especially hazardous (AMAP, 1998; UNEP, 2005; Tanabe, 2007; Rigét et al., 2010). POPs concentrations in fish from the various regions of the World Ocean were studied actively in last years (Smalling et al., 2013; Reindl et al., 2013; de Boer et al., 2001; Webster et al., 2009; Sakurai et al., 2009; Tanabe, 2007; Vuorinen et al., 2017). POPs accumulation was found in organs of marine mammals and seabirds (Tsygankov et al., 2014, 2015, 2016a, 2017, 2018) and Pacific salmon in Russian part of North Western Pacific (Lukyanova et al., 2014, 2015, 2016; Tsygankov et al., 2016b, 2017). The Sea of Okhotsk is an important fishing area, the stocks of fish and commercial invertebrates are of great importance for the national economy. This area is remote from the main industrial regions; however, active navigation can affect the entry of dangerous compounds to marine environment. Flounder in the Sea of Okhotsk are target species of commercial fisheries and have significance for nutrition of local population. Moreover, fish are highly important for the ecosystem as predator species. The purpose of this study is to establish the presence of persistent organic pollutants (PCBs and OCPs) in the bottom fish – Bering flounder (*Hippoglossoides robustus*) – from the Sea of Okhotsk.

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Table 1
Characteristics of flounder samples.

Sample ID	Study area	Weight, g	Lipids, %	Sample ID	Study area	Weight, g	Lipids, %
KO-1	East area of the Sea of Okhotsk	174	0,34	KO-11	South area of the Sea of Okhotsk	311	0,11
KO-2		245	0,24	KO-12		316	0,64
KO-3		415	0,47	KO-13		274	0,82
KO-4		324	0,22	KO-14		281	2,07
KO-5		189	0,14	KO-15		308	1,02
KO-6		174	0,22	KO-16		402	0,11
KO-7		240	0,19	KO-17		335	1,14
KO-8		165	0,06	KO-18		245	0,19
KO-9		212	0,07	KO-19		252	1,07
KO-10		160	0,06	KO-20		219	0,03

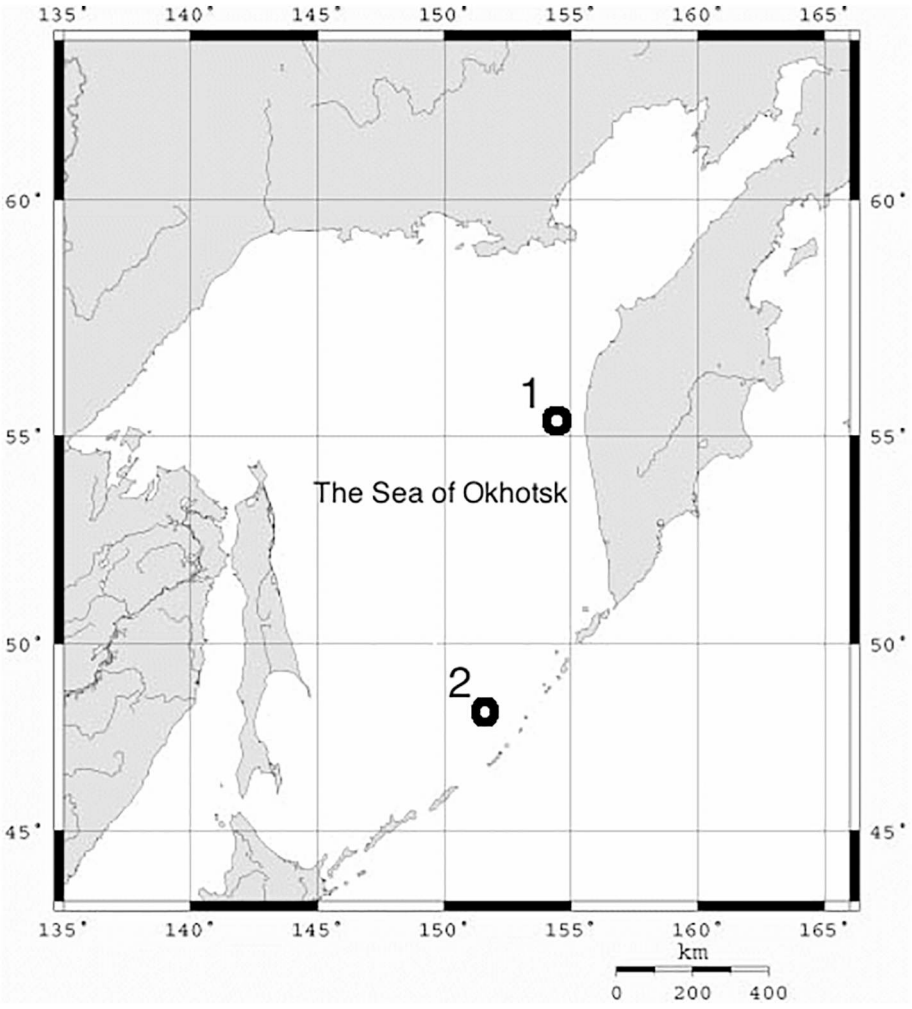

Fig. 1. Map of sampling: 1 – East area; 2 – South area.

2. Materials and methods

2.1. Study sites and sample

Bering flounder (Table 1) were collected in various areas – East (1) and South (2) – of the Sea of Okhotsk over the summer of 2016 (Fig. 1). Muscles (fillet) of flounder were analyzed. Frozen samples (−20 °C) were transported to laboratory. Before chemical analysis, separate tissues were homogenized.

2.2. Chemical analysis

Lipids were extracted from homogenate (10–20 g) using *n*-hexane, with subsequent disintegration of the fat components by concentrated sulphuric acid (Tsygankov and Boyarova, 2015). Concentrations of organochlorine pesticides (OCPs) (α-HCH, β-HCH, γ-HCH, *o,p′*-DDT, *p,p′*-DDT, *o,p′*-DDD, *p,p′*-DDD, *o,p′*-DDE and *p,p′*-DDE) and polychlorinated biphenyls (PCBs) (28, 52, 155, 101, 118, 143, 153, 138, 180, 207) in samples were measured by gas chromatography–mass spectrometry (GC–MS), and gas-chromatography with electron capture detector (GC–ECD) for validation of results. A gas Shimadzu chromatograph GC-2010 Plus with an ECD equipped with an auto-sampler AOC-20i. A DB-5 capillary column was used with mixture of helium and nitrogen as carried gas at a constant flow of 1.0 mL/min. Temperatures at the column, injector and detector were 210 °C, 250 °C and 280 °C, respectively.