Marine Pollution Bulletin 111 (2016) 493–499

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Baseline

Organotins in fish muscle and liver from the Polish coast of the Baltic Sea: Is the total ban successful?

Anna Filipkowska [a,*], Ilona Złoch [b], Brygida Wawrzyniak-Wydrowska [c], Grażyna Kowalewska [a]

[a] Marine Pollution Laboratory, Institute of Oceanology, Polish Academy of Sciences, ul. Powstańców Warszawy 55, 81-712 Sopot, Poland
[b] Department of Marine Biology and Ecology, Institute of Oceanography, University of Gdańsk, Al. Marszałka Józefa Piłsudskiego 46, 81-378 Gdynia, Poland
[c] Palaeoceanology Unit, Institute of Marine and Coastal Sciences, University of Szczecin, ul. Mickiewicza 16A, 70-383 Szczecin, Poland

ARTICLE INFO

Article history:
Received 24 February 2016
Received in revised form 6 June 2016
Accepted 13 June 2016
Available online 23 June 2016

Keywords:
Tributyltin
Organotins
Fish
Muscle
Liver
Baltic Sea

ABSTRACT

Muscle and liver tissues of nine fish species were analyzed to assess butyltin and phenyltin contamination. The samples were collected from three basins located in the Southern Baltic Sea coastal zone that each represent different potential for organotin pollution. Maximum total concentrations of butyltin compounds (BTs) in the fish muscles and livers were 715 and 1132 ng Sn g^{-1} d.w., respectively, whereas triphenyltin (TPhT) was not detected. In the muscle samples, the predominant compound in the sum of butyltins was tributyltin (TBT), while in the liver samples, tributyltin degradation products were found in the majority. The results demonstrate that 6–7 years after the implementation of the total ban on harmful organotin use in antifouling paints, butyltins remain present in fishes from the Polish coast of the Baltic Sea. According to the HELCOM recommendation, eight samples exceeded the good environmental status boundary for tributyltin in seafood.

The International Convention on the Control of Harmful Anti-fouling Systems on Ships, known as the AFS Convention, came into force on 17 September 2008 (IMO, 2001). However, all European Union (EU) flagged ships and ports had to comply with the Convention requirements starting from July 2003 (EU, 2003). According to the AFS Convention, the last date for the application of organotin paints on ships was 1 January 2003, while the total removal of existing organotin antifouling coatings should have been completed by 1 January 2008. The convention resulted from numerous alarming reports on toxic effects of organotins (OTs) to aquatic life, mostly tributyltin (TBT) and triphenyltin (TPhT). These compounds have been widely used as active ingredients in marine antifouling coatings to prevent the settlement and growth of aquatic organisms on structures such as ship hulls, fish cages, and oil rig supports. TBT and TPhT disrupt the endocrine system of organisms (mostly *Gastropoda* and *Bivalvia*), which may result in sterility and species extinctions as a consequence of reproductive and developmental disorders (Alzieu, 1998; Hoch, 2001). TBT can be harmful to aquatic organisms even at very low concentrations (e.g., <1 ng L^{-1} can cause imposex in marine snails, 1–10 μg L^{-1} affect fish reproduction, 1–1000 μg L^{-1} disturb fish behavior) (Alzieu, 1998). TPhT is less toxic to marine species than TBT but nonetheless poses a hazard to aquatic life (Hoch, 2001).

TBT has a considerable potential for bioaccumulation in aquatic organisms such as plankton, mollusks, and fish, as uptake is rapid whereas clearance and biotransformation are slow (IPCS, 1990). The biomagnification of TBT is still controversial but in general is not considered as significant (Borghi and Porte, 2002; Veltman et al., 2006), although some authors reported high concentrations of TBT in dolphins, porpoises, and marine birds (Ciesielski et al., 2004; Kannan and Falandysz, 1997; Strand and Jacobsen, 2005).

Since the 1960s considerable amounts of TBT and TPhT have entered various ecosystems and HELCOM (Baltic Marine Environment Protection Commission) recognized these as one of the most hazardous substances that have deliberately been released into the marine environment (HELCOM, 2010). Even if vessels are not currently a source of TBT and TPhT for the marine environment, harmful OTs deposited in sediments are still bioavailable and their degradation may last for years (Dowson et al., 1996; Takeuchi et al., 2004). Thus, these compounds should continue to be still monitored in the marine environment (HELCOM, 2010; MSFD, 2015).

The aim of this work was to assess organotin contamination (tributyltin, dibutyltin, monobutyltin, and triphenyltin) in muscle and liver tissues of different fish species collected from three basins of the Southern Baltic coastal zone: the Gulf of Gdańsk (GG), the Vistula (VL) and Szczecin Lagoons (SL). The samples were collected 6–7 years after the implementation of the total ban on organotins in antifouling paints to verify the effectiveness of the regulation in this region. The results of this study are valuable due to the insufficient data on organotin compounds in the Baltic environment as well as provide the basis for assessment of the risk to human health and to the environment.

* Corresponding author.
E-mail address: afilipkowska@iopan.gda.pl (A. Filipkowska).

http://dx.doi.org/10.1016/j.marpolbul.2016.06.052

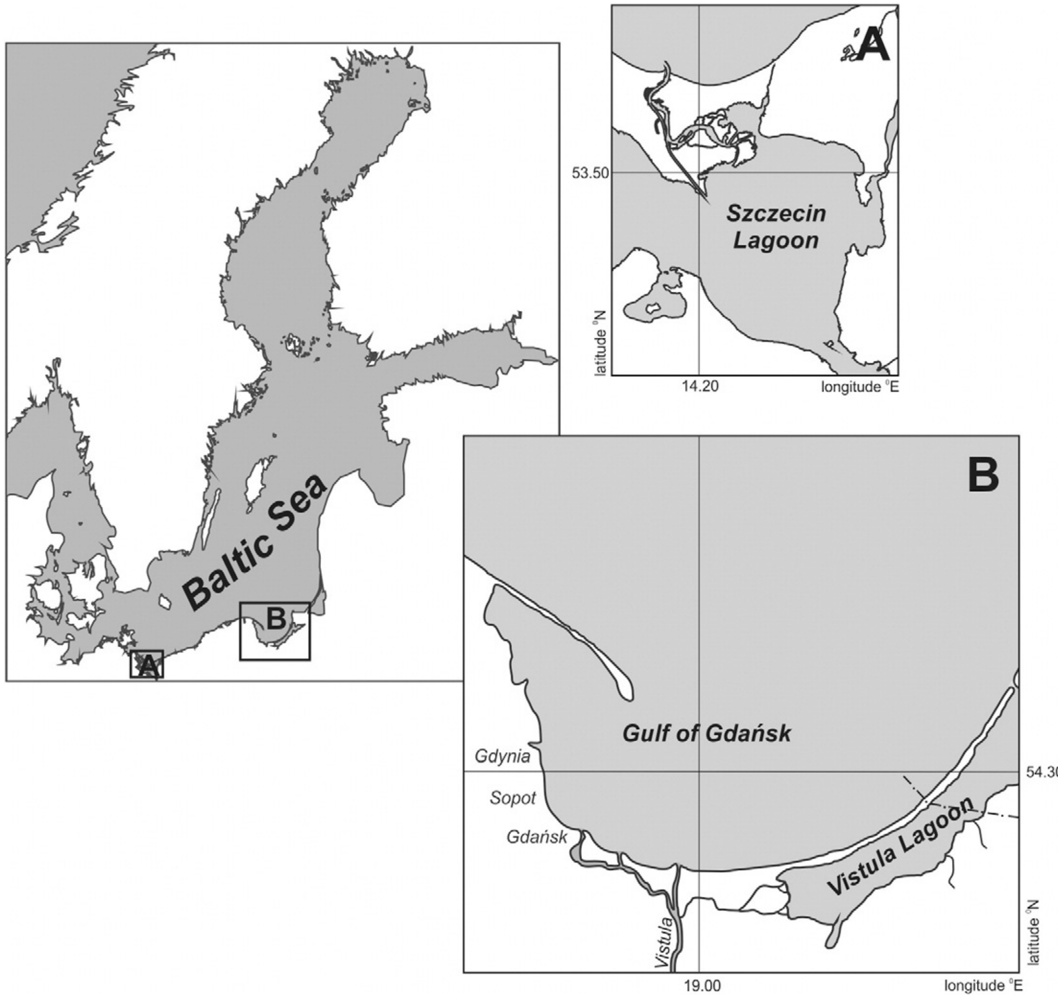

Fig. 1. Sampling area: A—Szczecin Lagoon, B—Gulf of Gdańsk and Vistula Lagoon.

The Gulf of Gdańsk, the Vistula Lagoon, and the Szczecin Lagoon, located along the Polish coast of the Baltic Sea, represent different potentials to organotin pollution. The Gulf of Gdańsk is well known for large international seaports, marine traffic, and large-scale shipyard activity, while the Vistula Lagoon, separated from the Gulf of Gdańsk by the Vistula Spit and dominated by freshwater flora and fauna, abounds in fishing harbors and marinas. The Szczecin Lagoon is the main part of the Odra River estuary and serves as a 'biological filter' both for the river waters and for Szczecin, which is big municipal and industrial area. A shipping route connects the Port of Szczecin with the Port of Świnoujście, which together form a significant port group in the Baltic Sea region.

Muscle and liver tissues of the following nine fish species were analyzed: *Platichthys flesus* (flounder), *Neogobius melanostomus* (round goby), *Clupea harengus* (herring), *Abramis brama* (bream), *Gadus morhua* (cod), *Pelecus cultratus* (ziege), *Gymnocephalus cernua* (ruffe),

Table 1
Sampling site information and physiological data for the fish samples.

Species	Location	Sampling date	Number of fishes	Length [cm] ± SD	Weight [cm] ± SD	Clark's condition factor (CF)	Hepatosomatic index (HSI)
Platichthys flesus (flounder)	Gulf of Gdańsk—1	03.2014	7	24.7 ± 0.8	165.8 ± 12.0	1.02	1.31
	Gulf of Gdańsk—2	04.2014	13	23.3 ± 2.7	144.0 ± 48.3	1.00	1.00
	Gulf of Gdańsk—3	07.2014	14	23.6 ± 2.5	150.7 ± 38.2	1.05	1.03
	Vistula Lagoon	07.2014	7	23.9 ± 3.0	162.8 ± 60.1	1.11	1.29
Neogobius melanostomus (round goby)	Gulf of Gdańsk	04.2014	8	12.6 ± 2.0	35.9 ± 15.0	1.64	2.55
	Vistula Lagoon	11.2014	15	16.5 ± 0.8	72.6 ± 11.3	1.46	4.35
	Szczecin Lagoon	10.2014	14	15.4 ± 1.2	67.5 ± 22.7	1.64	2.49
Clupea harengus (herring)	Gulf of Gdańsk	07.2015	15	23.2 ± 1.2	84.5 ± 11.5	0.59	1.20
	Vistula Lagoon	11.2014	10	22.6 ± 1.1	86.8 ± 15.1	0.61	0.97
Abramis brama (bream)	Vistula Lagoon	07.2014	10	37.7 ± 1.8	610.0 ± 95.6	1.03	1.44
	Szczecin Lagoon	10.2014	10	50.4 ± 4.0	1719.6 ± 423.5	1.15	1.35
Gadus morhua (cod)	Gulf of Gdańsk	08.2015	17	33.0 ± 4.1	309.7 ± 73.9	0.83	3.23
Pelecus cultratus (ziege)	Vistula Lagoon	07.2014	11	32.2 ± 1.5	194.0 ± 29.6	0.53	1.00
Gymnocephalus cernua (ruffe)	Vistula Lagoon	07.2014	6	18.8 ± 1.1	78.9 ± 5.4	0.82	0.64
Perca fluviatilis (perch)	Vistula Lagoon	07.2014	9	27.3 ± 1.1	259.5 ± 31.9	1.16	1.76
Rutilus rutilus (roach)	Vistula Lagoon	07.2014	10	24.8 ± 1.3	175.1 ± 34.8	1.04	1.32