

Research Articles: Butyltin Compounds

Butyltin Compounds in Sediment and Fish from the Polish Coast of the Baltic Sea

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Abstract. Concentrations of mono- (MBT), di- (DBT), and tri- (TBT) butyltin compounds were measured in eggs, liver, and muscle of nine species of fish from four regions of the Baltic Sea – the Firth of Vistula, the Gulf of Gdańsk, Puck Bay, and the mouth of the Vistula River. The overall concentration ranges among all the fish sampled from the four sites were: <7 to 79 ng/g for MBT, 6 to 1100 ng/g for DBT, 7 to 3600 ng/g for TBT, and 16 to 4800 ng/g for total BTs, on a wet wt basis. The highest concentration of total BTs was found in herring liver from the Firth of Vistula (4800 ng/g, wet wt) and in roach muscle from Puck Bay (3300 ng/g, wet wt), while the least concentration was found in burbot eggs and liver from the Vistula River (39 and 32 ng/g, wet wt, respectively). TBT was the major form of BTs present in most samples analyzed. Sediment samples collected from shipyards in the Gulf of Gdańsk contained butyltin concentrations ranging from 1.2 to 46 µg/g (dry wt) for MBT, 2.0 to 42 µg/g for DBT, and 2.6 to 40 µg/g for TBT. As with the fish, the majority of the BTs in sediment were present as TBT, which suggested recent exposure of the aquatic environment of the region to TBT.

Keywords: Aquatic contamination; Baltic Sea; Butyltin; dibutyltin; fish; Helsinki Commission; monobutyltin; organotin; Poland; sediment; TBT; tributyltin

1 Introduction

The first commercially registered organotin compound was marketed in 1936 as a stabilizer for synthetic polymers. In the 1950's, the pesticidal properties of the tri-alkylated organotins were recognized. Tributyltin (TBT) is a biocidal organotin that has been used extensively in Europe, North America, and Japan for almost 30 years as a component of antifouling paints on pleasure boats, large ships, and docks. In the late 1970's, it was recognized that TBT leaching from antifouling paints was contaminating boat harbors and coastal areas and causing adverse effects on aquatic organisms.

TBT is toxic to aquatic organisms. It has been implicated in the increased occurrence of 'imposex' (the superposition of male sex characteristics in females) in gastropods (BRYAN et al., 1986), shell chambering in oysters (ALZIEU et al., 1989), and growth retardation of susceptible algae and zooplankton (BEAUMONT and NEWMAN, 1986; BUSHONG et al., 1988). TBT also exhibits various toxic effects on fish, particularly during the early life stages (FENT, 1992). TBT possesses both lipophilic and ionic properties; thus, it can be accumulated in lipids and/or bind to macromolecules like glutathione (KANNAN et al., 1996). As a result, TBT accumulates in the liver and kidneys. These characteristics allow TBT to be transmitted through the food chain (KANNAN et al., 1997a,b; 1998, 1999).

In the late 1980s, most developed nations placed restrictions on the use of TBT as a component of antifouling paints. In 1988, for instance, the Baltic Marine Environment Protection Commission (Helsinki Commission) recommended member countries restrict pollution caused by antifouling paints containing organotin compounds by 1991. Bans on the use of TBT were primarily placed on boats less than 25 meters in length, however. As a result, TBT remains an important pollutant in areas visited by large ships or where hull cleaning of large ships takes place (UHLER et al., 1993; FENT and HUNN, 1995; FENT, 1996; CHAU et al., 1997). In addition, restriction of TBT use in antifouling paints did not limit its use in wood preservatives, which continues unrestricted at present (FENT, 1996). Butyltin monitoring studies are needed to determine whether restrictions placed on TBT use in antifouling paints have been effective. While several studies have been conducted in western European countries (see FENT, 1996 for references), few TBT monitoring studies have been conducted in eastern European waterways. Two studies which focused on the determination of butyltin residues in water, sediment, fish, and other organisms from the Polish Coast of the Baltic Sea (KANNAN And FALANDYSZ, 1997; SZPUNAR et al., 1997) suggested the presence of considerable concentrations of butyltins in the aquatic environment of the southern Baltic region.

The purpose of this study was to further monitor and characterize the extent of recent butyltin contamination along the

Polish Coast of the Baltic Sea. Concentrations of TBT and its degradation products, MBT and DBT, were determined in the eggs, liver, and muscle of nine species of fish and in sediments.

2 Materials and Methods

2.1 Sampling (→ Table 1, Fig. 1)

Fish were collected from various freshwater and marine habitats near Gdańsk, Poland (→ Table 1, Fig. 1), during May and June of 1997. Those from the Gulf of Gdańsk and the Firth of Vistula were collected using gill nets and those from the mouth of the Vistula River were collected using bottom

sacks. Length to the nearest 0.1 cm and weight to the nearest 0.1 g were measured for each fish. Whole fish were covered with clean aluminum foil and stored in polyethylene bags at -20°C. A few hours prior to analysis, samples were thawed at room temperature. Analytically clean forceps were used to remove eggs, muscle, and livers from the fish. Several individuals of the same species (→ Table 1) from the same location were pooled and homogenized using a homogenizer.

Sediments were collected in June 1998 from shipyards in Kaszubski canal located at the Gulf of Gdańsk (→ Fig. 1) using an Eckman-Bridge sampler (0 - 20 cm layer). The sampling locations included shipyard canals in the city of Gdańsk.

Table 1: Details of fish sampled from the Polish coast of the Southern Baltic Sea

Common Name	Species	Site	n	Length (cm) Mean and Range	Weight (g) Mean and Range
Flounder	<i>Platyichthis flesus</i>	Firth of Vistula	5	19.0 (15.0 - 21.5)	94.5 (49.5 - 144.2)
Herring	<i>Clupea harengus</i>	Firth of Vistula	6	21.5 (20.0 - 23.0)	68.7 (53.0 - 93.0)
Perch	<i>Perca fluviatilis</i>	Firth of Vistula	6	14.5 (13.5 - 15.0)	36.8 (31.7 - 44.1)
Roach	<i>Rutilus rutilus</i>	Firth of Vistula	6	17.5 (14.7 - 20.0)	63.3 (36.0 - 91.3)
Ruff	<i>Acerina cernua</i>	Firth of Vistula	6	13.6 (13.3 - 14.0)	34.8 (29.9 - 40.9)
Smelt	<i>Eperlanus eperlanus</i>	Firth of Vistula	6	17.8 (16.0 - 19.2)	27.8 (16.5 - 37.3)
Brown Trout	<i>Salmo trutta</i>	Puck Bay	1	17.0	51.0
Roach	<i>Rutilus rutilus</i>	Puck Bay	1	14.5	39.3
Flounder	<i>Platyichthis flesus</i>	Gulf of Gdańsk	6	22.2 (19.8 - 25.0)	135.8 (99.5 - 162.0)
Turbot	<i>Psetta maxima</i>	Gulf of Gdańsk	6	19.8 (17.5 - 21.5)	152.8 (92.4 - 198.4)
Burbot	<i>Lota lota</i>	Vistula River	3	23.8 (21.5 - 25.0)	137.4 (108.5 - 172.4)
Perch	<i>Perca fluviatilis</i>	Vistula River	7	14.5 (13.5 - 15.5)	40.3 (27.4 - 56.2)
Roach	<i>Rutilus rutilus</i>	Vistula River	4	13.8 (11.5 - 16.0)	40.2 (19.3 - 56.6)

Fish from the Firth of Vistula, Puck Bay, Gulf of Gdańsk and Vistula River were collected on May 22, June 6, 20 and 21, respectively. N = number of samples pooled.

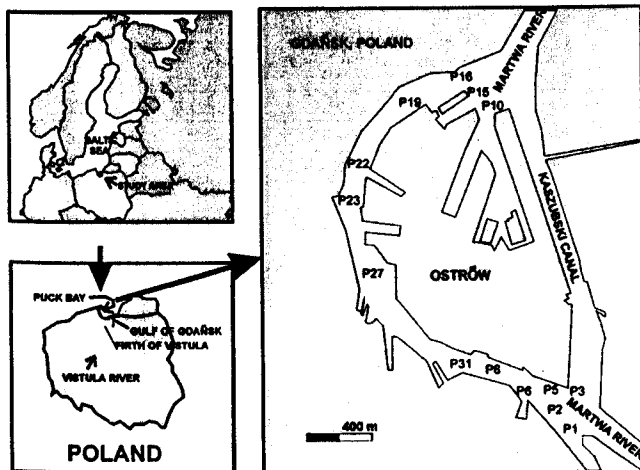


Fig. 1: Map showing the Polish coast of the Baltic Sea, and sampling locations of sediments and fish

2.2 Chemical analysis

The analytical method used for the determination of MBT, DBT, and TBT in fish tissue and sediments has been described elsewhere (KANNAN et al., 1995a,b). Briefly, acidified samples were homogenized with 70 ml of 0.1% tropolone-acetone and the solvent was transferred to 100 ml of 0.1% tropolone-benzene. Moisture in the organic extract was removed using 35 g anhydrous sodium sulfate and the concentrated extract was propylated with *n*-propyl magnesium bromide (ca. 2 mol/L in THF solution, Tokyo Chemical Industries, Portland, OR) as a Grignard reagent. Sulfur was eliminated by using tetrabutyl ammonium hydrogen sulfate reagent. The derivatized extract was passed through a 6 g Florisil packed wet column for clean-up. The eluate from the Florisil column was rotary evaporated to 5 ml and injected into a gas chromatograph.

A capillary gas chromatograph with a flame photometric detector (GC-FPD) was used for the quantification of butyltin

compounds. The flame photometer was operated using a hydrogen-air-nitrogen flame and was equipped with a 610 nm bandpass filter that is selective for tin-containing compounds. One hundred ng each of butyltin trichloride, dibutyltin dichloride, and tributyltin chloride were spiked into the liver of lake trout (*Salvelinus namaycush*), containing butyltins at concentrations less than the limit of detection, passed through the whole analytical procedure and used as an external standard. Only freshly derivatized external standards prepared along with every set of eight samples were used to estimate concentrations. Concentrations were quantified by comparing peak heights of butyltins in samples with those in the external standards. Tributylhexyltin (synthesized by the reaction of *n*-hexyl magnesium bromide with tributyltin chloride) was added to each sample as an internal standard prior to extraction. A procedural blank was analyzed with every set of eight samples to check for interfering compounds and to correct sample values, if necessary. Monobutyltin was found at trace levels in reagent blanks. It may have originated from commercial solvents or reagents that came into contact with polyvinylchloride that contained MBT as a stabilizer. Therefore, the values obtained for MBT in samples were corrected for blank concentrations. Blanks did not contain detectable amounts of TBT. The detection limits of MBT, DBT, and TBT were 7.0, 2.4, and 1.0 ng/g wet wt or dry wt, respectively. The average recovery rates of monobutyltin trichloride, dibutyltin dichloride, and tributyltin chloride dissolved in hexane, spiked into the sample matrix, and passed through the whole analytical procedure were between 90 and 110% for each compound. All concentrations reported in this study refer to butyltin species as the corresponding ion, and they were not corrected for the recovery of the internal standard.

3 Results

3.1 Concentrations in tissues (→ Table 2)

Butyltin compounds were present in fish sampled from all of the sampling locations, including the Firth of Vistula, the Gulf

of Gdańsk, Puck Bay, and the Vistula River (→ Table 2). Total BT concentrations in fish muscle, liver, and eggs ranged from 44 to 3300 ng/g, 32 to 4800 ng/g, and 16 to 370 ng/g, wet wt, respectively (→ Table 2). Among fish species, roach from Puck Bay contained the highest total BT concentration in muscle (3300 ng/g wet wt), while herring from the Firth of Vistula contained the greatest total BT concentration in liver (4800 ng/g, wet wt) and eggs (370 ng/g, wet wt) (→ Table 2).

In a comparison of samples from the Firth of Vistula, where three types of tissues were obtained from each of three species, the highest butyltin concentrations were found in liver. Distribution of butyltin concentrations among the three tissues could be examined from the results. A total of 5248 ng/g, wet wt, BTs was present among the eggs, muscle, and liver of herring. Of these, 91% were present in the liver. Likewise, a total of 1414 ng/g, wet wt, BTs were measured in the three organs of ruff, of which 85% of the BTs was present in the liver. Lastly, smelt exhibited a total concentration of 626 ng/g, wet wt, BTs of which 70% was present in the liver.

3.2 Butyltin composition in fish (→ Fig. 2)

Butyltins were primarily present as TBT in all of the samples, with the exception of muscle tissue from ruff from the Firth of Vistula (→ Fig. 2). Smelt from the Firth of Vistula and roach from Puck Bay exhibited the 87% and 83%, respectively, of butyltins as TBT in muscle tissue (→ Fig. 2). Similarly, eggs of ruff and herring from the Firth of Vistula contained 83% and 81%, respectively, of butyltins as TBT (→ Fig. 2). Liver samples of ruff and herring from the Firth of Vistula contained 78% and 75%, respectively, of total BTs as TBT (→ Fig. 2). The composition of MBT and DBT, were relatively higher in ruff and burbot muscle from the Vistula River, comprising 53% to 61% of the total BT concentrations (→ Fig. 2).

Table 2: Concentrations (ng/g, wet wt) of butyltin compounds in selected tissues of fish collected from the Southern Baltic Sea

Location	Common Name	Species	n	Organ	MBT	DBT	TBT	Total BTs
Firth of Vistula	Herring	<i>Clupea harengus</i>	6	eggs	20	60	290	370
Firth of Vistula	Herring	<i>Clupea harengus</i>	6	liver	76	1100	3600	4800
Firth of Vistula	Herring	<i>Clupea harengus</i>	6	muscle	11	10	57	78
Firth of Vistula	Ruff	<i>Acerina cernua</i>	6	eggs	10	20	150	170
Firth of Vistula	Ruff	<i>Acerina cernua</i>	6	liver	79	190	940	1200
Firth of Vistula	Ruff	<i>Acerina cernua</i>	6	muscle	8.0	19	17	44
Firth of Vistula	Smelt	<i>Eperlanus eperlanus</i>	6	eggs	<7	6.0	7.0	16
Firth of Vistula	Smelt	<i>Eperlanus eperlanus</i>	6	liver	75	100	260	440
Firth of Vistula	Smelt	<i>Eperlanus eperlanus</i>	6	muscle	8.0	14	150	170
Gulf of Gdańsk	Flounder	<i>Platichthis flesus</i>	6	muscle	12	20	51	83
Gulf of Gdańsk	Turbot	<i>Psetta maxima</i>	6	muscle	11	17	73	110
Puck Bay	Brown trout	<i>Salmo trutta</i>	1	muscle	15	8.0	56	78
Puck Bay	Roach	<i>Rutilus rutilus</i>	1	muscle	43	530	2700	3300
Vistula River	Burbot	<i>Lota lota</i>	3	eggs	9.0	7.0	23	39
Vistula River	Burbot	<i>Lota lota</i>	3	liver	7.0	10	15	32
Vistula River	Perch	<i>Perca fluviatilis</i>	7	liver	56	62	290	410
Vistula River	Roach	<i>Rutilus rutilus</i>	4	muscle	14	14	74	100

Total BTs = MBT+DBT+TBT - N = number samples pooled.

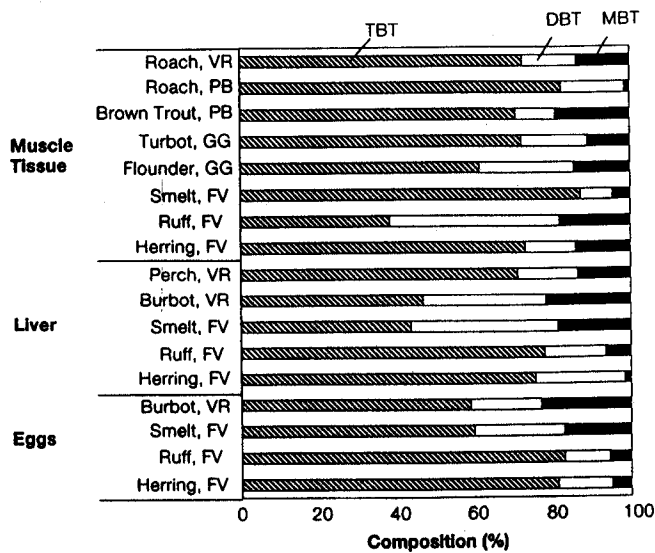


Fig. 2: Percent composition of butyltin compounds in tissues of fish collected from the Polish coast of the Baltic Sea (VR = the Vistula River; PB = Puck Bay; GG = the Gulf of Gdańsk; FV = the Firth of Vistula)

3.3 Sediment butyltin concentrations and compositions (→ Table 3, Fig. 3)

Total butyltin concentrations in sediments from shipyard canals of Gdańsk ranged from 5.8 to 130 µg/g, dry wt (→ Table 3). The highest total BT concentration (130 µg/g dry wt) was observed at location P10 (cf Fig. 1). Other sampling locations with considerable concentrations of total BTs were P15 (94 µg/g dry wt), P5 (82 µg/g dry wt), and P8 (63 µg/g dry wt) (→ Table 3). With the exception of sites P10 and P15, where TBT composed only 31% and 37% of the total BT concentrations, respectively, TBT was the predominant form of butyltins detected in all sediment samples (→ Fig. 3). TBT comprised greater than half of the total BT concentration at sites P16, P31, P22, and P1 (→ Fig. 3).

Table 3: Concentrations (µg/g, dry wt) of butyltins in sediments from the Gulf of Gdańsk, Poland

Sample Location*	MBT	DBT	TBT	Total BTs
P1	11	9.3	22	42
P2	14	12	21	48
P3	9.0	6.5	13	29
P5	23	17	38	82
P6	5.8	7.7	13	27
P8	18	16	29	63
P10	46	42	40	130
P15	22	37	35	94
P16	4.6	8.0	18	30
P19	7.2	8.2	14	30
P22	2.9	2.8	6.3	12
P23	4.1	3.8	7.2	15
P27	1.2	2.0	2.6	5.8
P31	6.2	5.7	14	25

*See Fig. 1 for sampling locations. - Total BTs = MBT+DBT+TBT

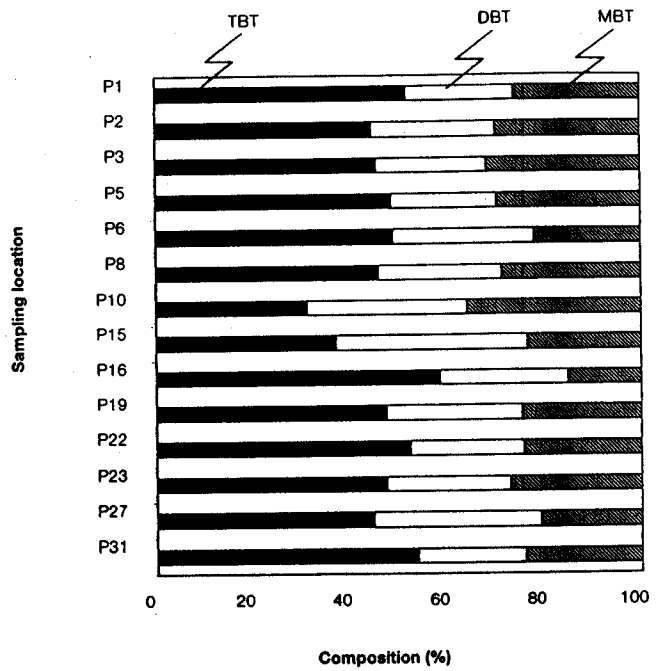


Fig. 3: Percent composition of butyltin compounds (MBT, DBT and TBT) in sediments from shipyard canals in the Gulf of Gdańsk, Poland

4 Discussion

The presence of butyltin compounds in fish and sediment samples collected from the marines and freshwaters around Gdańsk, Poland, suggests that these compounds are widely distributed in the study area and bioaccumulated in fish. In fish, the higher accumulation of butyltins in liver than in muscle or egg tissues may result from binding of TBT to a specific binding protein which is abundant in the liver (KANNAN et al., 1996). The concentrations of total butyltins in fish muscle samples analyzed in this study were generally similar to or greater than concentrations found in other similar studies. Total butyltin concentrations ranging from 19 to 455 ng/g, wet wt, in the southern Baltic region (KANNAN and FALANDYSZ, 1997), ≤ 3 to 190 ng/g, wet wt, in Asian countries (KANNAN et al., 1995a, c) and 16 to 230 ng/g, wet wt, in Italian coastal waters (KANNAN et al., 1996) have been reported earlier.

The presence of detectable concentrations of butyltins in muscle tissue is of concern for humans consuming southern Baltic fish. The average daily fish consumption per capita in Poland is 50 g (FAO, 1991). Based on this average, the estimated daily intake of butyltins was in the range of 2.2 to 164 µg BT/person, with the intake estimates from one species, roach, exceeding the tolerable daily intake (TDI) of 15 µg for TBT per 60 kg person per day (PENNINKS, 1993). Large number of fish need to be analyzed to validate the results. In addition to muscle tissue, livers of cod are also consumed by Poles (FALANDYSZ et al., 1993). Livers of burbot, salmon and brown trout are occasionally consumed by local fishermen. Due to the preferential accumulation of butyltins in liver, consumption of fish liver would increase the exposure rates of butyltin compounds. Similarly, per capita consumption of fish by local fishing populations near the city of

Table 4: Comparison of TBT residues in sediments from various regions

Location	Year	TBT Concentration, ng/g, dry wt	Reference
Poland and Baltic Sea region			
Baltic Sea (open sea)	1994	<1.0-39 ¹	SZPUNAR et al., 1997
Gulf of Gdańsk	1993-1995		
Open area		<1.0 ¹	
Gdynia seaport		1150-7320 ¹	
Puck Bay		24 ¹	
Szczecin Lagoon		15-27 ¹	
Inland freshwater areas	1993-1994		
Dead Vistula River Canal		120 ¹	
Gdańsk, Olszynka, canal		120 ¹	
Mieliński Canal		42 ¹	
Gulf of Gdańsk	1998	5800-130,000	This study
Hong Kong			
Marina Locations	1988-1989	960-1160	
Harbor and Coastal Waters	1989	30-400	
Kowloon Bay	1989	15-150	
Japan			
Ise Bay	1987	ND - 340 ¹	YONEZAWA et al., 1993
The Netherlands			
Lake Westeinder	1993	15-1270 ¹	STAB et al., 1996
Switzerland			
Lake Geneva	1990-1993	1000-2500	BECKER-VAN SLOOTEN AND TARRADELLAS, 1995
Lake Zurich		808-1866	
Lake Bienne		39-83	
Lake Constance		342-616	
United States coastal areas			
East Coast	NA	12-210 ¹	WADE et al., 1990
Gulf Coast		<10-120 ¹	
Maine, U.S.A.			PAGE et al., 1996
S. Portland shipyards and sewage treatment plants	1990	24-520	
Boothbay Harbor	1990	636-3900	
S. Portland Shipyard	1992	385-870	
Boothbay Harbor Shipyard	1992	88-12400	
Thailand			
Coastal mariculture/boat pier areas	1995	4-93	KAN-ATIREKLAP et al., 1997
Fishing boat piers and ports		9-880	
Far seas vessel harbors		4010-6500	
South Korea			
Incheon Harbor	1995	0.8-84	KIM et al., 1998
Canada			
Sea water locations (several sites)	1994	12-6160 ¹	CHAU et al., 1997
Freshwater locations (several sites)		8.8-2380 ¹	
New Zealand			
Auckland coastal areas	1990	<2-1360	DE MORA et al., 1995
Portugal			
Ria of Aveiro	1990	46-800 ¹	CORTEZ et al., 1993
Tejo Estuary	1986-1988	571 ¹	
Sado Estuary	1986-1988	51-29820 ¹	
Ria of Faro	1990	34-78 ¹	

¹ All values originally reported as Sn concentrations are converted here to butyltin ions.

Gdańsk has been reported to be as high as 250 g/day (CHWIR-GOLEBIEWSKA, 1999). Dietary intake rates of total butyltins calculated based on the fish ingestion rate of 250 g/day exceeded the TDI of 15 µg for all the fish species.

Concentrations of total butyltins in fish eggs were 4 to 14% of those in the liver. Concentrations of butyltins in eggs of herring and ruff were higher than those in corresponding muscle samples. The presence of butyltins in fish eggs suggests oviparous transfer of butyltins, which is the passage of TBT and its metabolites from the hepatopancreas/liver into the ovary and oocytes during vitellogenesis. This has been observed in blue crabs (LEE, 1993). During embryogenesis, the fish embryo is susceptible to environmental pollutants. Exposure of fathead minnow larvae to TBT resulted in morphological defects, skeletal deformities, and behavioral aberrations (FENT, 1992).

The higher proportion of TBT than DBT and MBT in fish and sediments suggests recent inputs of TBT in the coastal waters of Poland. Despite regulation of its use in certain countries, TBT continues to occur in the environment due to its use on ships greater than 25 m in length (FENT, 1996; CHAU et al., 1997). Recent input of TBT to Polish coastal areas is further evidenced by the relatively high TBT concentrations in sediments from the shipping canals of Gdańsk.

Due to the metabolism of TBT into DBT by liver microsomal enzymes in fish (LEE, 1985), DBT is expected to be predominant in fish livers. Occurrence of TBT as the predominant compound in fish livers suggests a slow metabolism of TBT, which could be possibly due to the inhibition of microsomal enzymes by TBT at high exposure concentrations (FENT and STEGEMAN, 1993). TBT was not metabolized in minnows at whole body concentrations of 1.48 - 4.5 µg/g (FENT, 1991).

Results of a survey of TBT concentrations in sediments from both saltwater and freshwater regions around the world suggest that the concentration of BTs determined in the sediments in this study are greater than those reported elsewhere (→ Table 4, p. 204). Some of the values reported here are, in fact, among the greatest concentrations reported in the literature so far. This may be due to the fact that sediments were taken from canals in the city of Gdańsk, which are characterized by intensive shipping traffic and ship building activities. It is worth to note that the sediments from the shipyard canals are periodically discharged in the open Baltic Sea, within the Polish Economic Zone, after dredging operations, which could result in widespread contamination in the coastal areas of Poland. Moreover, TBT persists in sediments for several years after the ban and therefore it continues to be of concern (FENT, 1996; CHAU et al., 1997).

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UNEP Corner

News from Persistent Organic Pollutants (POPs)

3rd Session of the Intergovernmental Negotiating Committee (INC-2) for an International Legally Binding Instrument for Implementing International Action on Certain Persistent Organic Pollutants: Geneva, September 6-11, 1999

In the third round of talks on a global treaty, held from 6-11 September 1999 in Geneva, negotiators reached agreement on proposals favoring the elimination of the 10 intentionally produced persistent organic pollutants (POPs) in the mandate for a treaty from the Governing Council of the United Nations Environment Program (UNEP). At the same time, the negotiators recognized the public health need for an exemption for DDT, used in controlling vector-borne diseases, such as malaria.

Their proposals now go to participating countries for consultation, followed by consideration at the fourth round of negotiations, set for 20-25 March 2000 in Bonn. One hundred and fifteen countries participated in the talks in Geneva, working with 17 intergovernmental and 72 non-governmental organizations, bringing the total number of participants to more than 420.

Three of the 12 POPs in the UNEP mandate are slated for elimination with no exemptions: the pesticides aldrin, endrin and toxaphene. Another five POPs are set for elimination, with limited country-specific exemptions: the pesticides chlordane, dieldrin, heptachlor, mirex, and hexachlorobenzene, which is also an industrial compound and a by-product. With the exception of the exemptions, elimination would take place once the treaty enters into force.

While production and use of DDT would be limited to control of vectors, such as mosquitos transmitting malaria, for public health purposes, all other uses, including in agriculture, would be prohibited. Proposals under discussion suggest continuous review, in consultation with WHO, of the need for DDT in vector control; the

availability of safer, effective, and affordable alternative approaches to DDT; and the capacity of countries to pursue such alternative control strategies, with the ultimate goal of elimination.

New use and production of polychlorinated biphenyls (PCBs) would be prohibited, under policy proposals developed by negotiators. Discussion focused on the issue of PCBs already in use, principally in electrical equipment, and the related complexity of identifying existing applications and dealing with replacement costs, particularly in developing countries.

There was agreement on a procedure for adding chemicals to the convention. With the exception of a few remaining issues, the meeting also agreed on scientific criteria and data requirements for screening and evaluation.

The talks moved towards a consensus on the unintentionally produced by-products dioxins and furans. They also laid the groundwork for further consideration of proposals to advance technical and financial assistance, particularly for developing countries and countries with economies in transition, to enable implementation of the treaty.

Further information: Official documents and other information on POPs are available at www.chem.unep.ch/pops and from UNEP Chemicals in Geneva. For additional information or to arrange interviews, contact: Linda Durkee, Policy and Communications Advisor, UNEP Chemicals, at tel: (+41 22) 917 85 11; fax: (+41 22) 797 34 60; e-mail: ldurkee@unepch or Tore J. Brevik, UNEP Spokesman and Director of Information, Communications and Public Information, P.O. Box 30552, Nairobi, Kenya; Tel.: (254-2) 623292, Fax: 623927 email tore.brevik@unep.org