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ORGANOCHLORINE CONTAMINANT LEVELS IN TISSUES OF A SHORT-BEAKED COMMON DOLPHIN, *DELPHINUS DELPHIS*, FROM THE NORTHERN ADRIATIC SEA

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Lazar, B., Holcer, D., Mackelworth, P., Klinčić, D. & Herceg Romanić, S.: Organochlorine contaminant levels in tissues of a short-beaked common dolphin, *Delphinus delphis*, from northern Adriatic Sea. Nat. Croat., Vol. 21, No. 2., 391–401, 2012, Zagreb.

We analyzed 17 polychlorinated biphenyls (PCBs) and 7 organochlorine pesticides (OCPs) in blubber, liver, muscle, lung, heart and kidney of an adult male short-beaked common dolphin (*Delphinus delphis*) found dead stranded on the island of Cres (Croatia) in 2004. The PCB profile was dominated by hexachlorobiphenyls (39.4 – 63.2% of ΣPCB), with PCB-153 exhibiting the highest concentrations across all tissues. The pattern of PCB tissue distribution (ΣPCB) showed the highest burdens in blubber >> liver > kidney > heart > muscle > lung, which were positively correlated with tissue lipid content ($r_s = 0.986$, $p < 0.01$). Among OCPs, HCB and ΣDDT exhibited the same distribution between tissues, correlated with the tissue lipids ($r_s = 0.985$ and 0.986, respectively, $p < 0.01$). Total HCHs showed highest levels in muscle > blubber > liver > kidney > lung > heart, with no correlation to tissue lipid content ($p > 0.05$). Total DDTs were lower than total PCB levels for all tissues, with ΣPCB/ΣDDTs ratios ranging from 1.3 in blubber to 5.9 in muscles. Blubber OC burdens recorded in our specimen were among the highest found in a dolphin in the Mediterranean after the year 2000. This result and the presence of mono-*ortho* substituted PCBs with dioxin-like toxicity in all our samples may present an additional factor of concern for the conservation of regional dolphin populations.

Key words: cetaceans, common dolphin, PCB congeners, organochlorine pesticides, Adriatic Sea, Mediterranean Sea

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Lazar, B., Holcer, D., Mackelworth, P., Klinčić, D. & Herceg Romanić, S.: Razine organoklorovih spojeva u tkivima kratkokljunog običnog dupina, *Delphinus delphis*, iz sjevernog Jadranskog mora. Nat. Croat., Vol. 21, No. 2., 391–401, 2012, Zagreb.

Analizirali smo 17 poliklorbifenila (PCB) i sedam organoklorovih pesticida (OCP) u potkožnom masnom tkivu, jetri, mišiću, plućima, srcu i bubregu odraslog mužjaka kratkokljunog običnog dupina (*Delphinus delphis*) koj je nađen nasukan na otoku Cresu (Hrvatska) 2004. godine. PCB profilom dominirali su heksaklorobifenili (39.4 – 63.2% ΣPCB), s PCB-153 utvrđenim s najvišim koncentracijama u svim tkivima. Raspodjela PCB-a u tkivima slijedi redoslijed: potkožno masno tkivo >> jetra > bubreg > srce > mišić > pluća te pozitivno korelira sa sadržajem masti u pojedinom tkivu ($r_s = 0.986$, $p < 0.01$). HCB i ΣDDT slijede jednaku distribuciju u tkivima koja također korelira sa sadržajem masti ($r_s = 0.985$, odnosno 0.986, $p < 0.01$), dok ΣHCH slijedi redoslijed: mišić > potkožno masno tkivo > jetra > bubreg > pluća > srce te ne pokazuje korelaciju sa sadržajem masti ($p > 0.05$). U svim su tkivima razine ukupnih DDT-a bile niže od razina ukupnih PCB-a, a omjeri ΣPCB/ΣDDTs u rasponu su od 1.3 u potkožnom masnom tkivu do 5.9 u mišiću. Razine organoklorovih spojeva u analiziranom uzorku potkožnog masnog tkiva među najvišim su nađenim razinama u dupinima u Sredozemnom moru nakon 2000. godine. Taj podatak te prisutnost mono-*ortho* supstituiranih PCB-a koji pokazuju toksičnost sličnu dioksinima u svim našim uzorcima mogu predstavljati dodatan razlog ugroženosti regionalne populacije dupina.

Ključne riječi: kitovi, obični dupin, PCB kongeneri, organoklorovi pesticidi, Jadransko more, Mediteransko more

INTRODUCTION

Marine mammals, together with other large marine vertebrates such as sharks, rays and sea turtles, face numerous human-induced threats in the Adriatic Sea. These range from intentional and incidental catch, prey depletion, habitat deterioration by fisheries, physical and noise disturbance, to chemical pollution (LAZAR & TVRTKOVIĆ, 1995, 2006; BEARZI *et al.*, 2004; CASALE *et al.*, 2004, 2010; LIPEJ *et al.*, 2004; HOLCER, 2006a,b; FORTUNA *et al.*, 2010; LAZAR & GRAČAN, 2011; LAZAR *et al.*, 2011; HOLCER *et al.*, 2012; RAKO *et al.*, 2012). The synergistic effects of these threats have already resulted in documented reductions in populations of large elasmobranches in the Adriatic (JUKIĆ-PELADIĆ *et al.*, 2001) and the disappearance of the historically abundant short-beaked common dolphin (*Delphinus delphis* Linnaeus, 1758) (hereafter referred to as the »common dolphin«) from the northern Adriatic (BEARZI *et al.*, 2003, 2004).

Until the early 1970s the northern Adriatic Sea was generally considered a relatively healthy uncontaminated ecosystem. The situation deteriorated in the subsequent three decades mostly due to anthropogenic activities. Commercial fishing, mainly bottom trawling, coupled with land-sourced pollution and possibly climate change, has resulted in repeated episodes of bottom anoxia, benthic mortality, marine snow development and the collapse of native benthic filter-feeding communities (STACHOWITSCH, 1991; DEGOBBIS *et al.*, 1995; KOLLMANN & STACHOWITSCH, 2001). Strong riverine inflow, coming mainly from the Po River, and wastewater inputs from other densely populated coastal regions have resulted in high organic loads recorded in the northern Adriatic water column, marine sediments and wildlife (review by PICER, 2000). Thus concentrations of organochlorine contaminants (OCs), such as polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs), are generally higher throughout taxa from Adriatic Sea than from any other Mediterranean region (STORELLI *et al.*, 2003; GARRITANO *et al.*, 2006; LAZAR *et al.*, 2011).

Both PCBs and OCPs are stable, man-made lipophilic chemicals that have been used extensively in industry, agriculture and public health. OCPs bioaccumulate in tissues and biomagnify through food webs, so their impact on long lived animals at higher trophic levels is a matter of particular concern. Marine mammals as apex predators occupy the highest position in marine food webs and are hence highly vulnerable to the long-term effects of biomagnifying contaminants. Chronic exposure to OCs, even at low concentrations, may have a negative influence on reproduction, physical development, the immune system and endocrine processes in these animals, affecting both individual fitness and the viability of the population (O'SHEA & TANABE, 2003; REIJNDERS, 2003; MURPHY *et al.*, 2010). OC levels have been reported in the tissues of several marine mammal species from the Adriatic (CORSOLINI *et al.*, 1995; STORELLI & MARCOTRIGIANO, 2000, 2003; STORELLI *et al.*, 2007), but as yet no information exists for the common dolphin. This small cetacean has faced a steep decline in abundance and distribution across the whole Mediterranean in recent decades, and is regionally listed as Endangered (EN) by the International Union for Conservation of Nature (IUCN; BEARZI, 2003). Today it occurs in geographically disparate populations (CAÑADAS & HAMMOND, 2008), including a relict group in the eastern Ionian Sea (BEARZI *et al.*, 2003). In Croatia, common dolphin is currently classified as Data Deficient (DD; HOLCER, 2006b). In this study we provide the first report on OC levels in a common dolphin from the Adriatic Sea and compare its OC burdens with other dolphin species from the region.

MATERIALS AND METHODS

We sampled blubber, liver, muscle, lung, heart and kidney from a dead stranded male adult common dolphin of 220 cm in body length, for analysis. The specimen was found in Martinščica Bay on the island of Cres, Croatia (Fig. 1) in an advanced state of decomposition on August 7th 2004. All samples were stored in aluminum foil

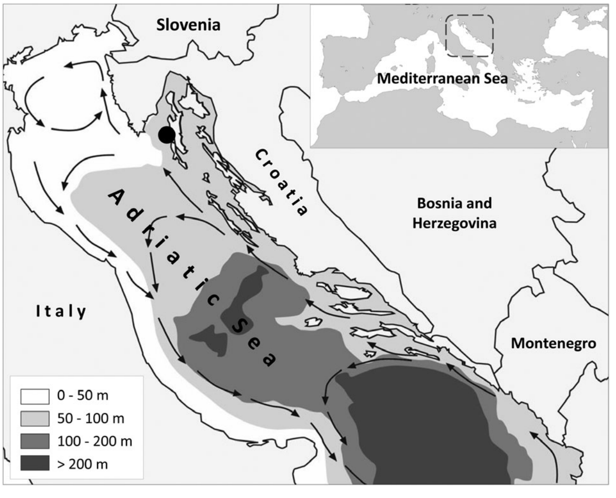

Fig. 1. The Adriatic Sea with bathymetry, direction of main surface currents (arrows) and locality of finding of a short-beaked common dolphin, *Delphinus delphis* (circle).

at –20 °C until analysis. We analyzed 17 PCB congeners (PCB-28, PCB-52, PCB-101, PCB-138, PCB-153, PCB-180, PCB-105, PCB-114, PCB-118, PCB-123, PCB-156, PCB-157, PCB-167, PCB-170, PCB-189, PCB-60, PCB-74; numbered according to the International Union of Pure and Applied Chemistry – IUPAC) and 7 OCP compounds: hexachlorobenzene (HCB), α-HCH, β-HCH, γ-HCH (α-, β-, γ-hexachlorocyclohexanes), 1,1-dichloro-2,2-di(4-chlorophenyl)ethylene (DDE), 1,1-dichloro-2,2-di(4-chlorophenyl)ethane (DDD), and 1,1,1-trichloro-2,2-di(4-chlorophenyl)ethane (DDT).

Samples (approximately 1 g) were extracted with *n*-hexane and cleaned up with sulphuric acid (for detailed protocol see Herceg Romanić *et al.*, 2012). The prepared extracts were analysed on an »ATI Unicam« 610 Series gas chromatograph equipped with electron capture detector (HRGC-ECD). Compounds were separated simultaneously on two capillary columns (»Supelco«, Bellefonte, USA): 1) 60 m × 0.25 mm, SPB-5 film thickness 0.25 μm, temperature program 100 °C, then 4 °C min^{-1} to 240 °C, 50 min isothermally; and 2) 30 m × 0.25 mm, SPB-1701 film thickness 0.25 μm, temperature program 110 °C, then 4 °C min^{-1} to 240 °C, 50 min isothermally. The carrier gas was nitrogen. The injector and detector temperature were 250 °C and 270 °C, respectively, and the volume of injected sample was 5 μL. Only compounds identified on both columns were evaluated. Qualitative and quantitative analyses were done by comparison with an external standard. In the external standard method, quantification is accomplished by comparing the peak responses in chromatogram of the sample extract with those occuring at the same retention times in the analysis of solutions containing the reference standards known concentrations. Identification was carried out by comparing the peak relative retention times in both sample and standard solution. Each compound appeared as a single peak. Recoveries for the PCBs ranged from 79% to 91%, with relative standard deviation from 9% to 15%, and for OCPs they ranged from 73% to 86%, with relative standard deviation from 13% to 19%. The limits of detection (LOD) for the PCBs and OCPs were 0.3 ng g^{-1} and 0.1 ng g^{-1} wet mass (w.m.), respectively, and were calculated as the average of all determinations based on signal-to-noise ratio and recovery of compounds.

Total PCBs (ΣPCB) were considered as the sum of all 17 PCB congeners analysed. Likewise, total HCHs (ΣHCH) was the sum of α-, β-, and γ-HCH, while total DDTs (ΣDDT) included the sum of concentrations of DDE, DDD and DDT. The relation between tissue lipid content and OC levels was tested by Spearman correlation, with tests performed on the wet-mass basis (ng OC g^{-1} tissue w.m.). Due to the decomposed state of the animal and expected low levels of tissue lipid content we also used w.m. concentrations to analyse distribution patterns of OCs within and between tissues. However, as is many studies of OCs in cetaceans concentrations are expressed as »lipid weights«, we also present our results in the lipid-normalised form (lipid-normalised mass, l.m.) to allow comparison.

RESULTS AND DISCUSSION

All 17 PCB congeners and 7 OCP compounds analysed in this study were detected in all tissues with levels >LOD and with wide concentration ranges (Tab. 1). The PCB burden was dominated by hexachlorobiphenyls (39.4 – 63.2% of ΣPCB; Fig. 2). In terms of wet masses, PCB-153 exhibited the highest concentrations across all tissues, followed by PCB-170 and/or PCB-138, while PCB-28 and/or PCB-101

Tab. 1. Organochlorine contaminant levels in tissues of a short-beaked common dolphin (*Delphinus delphis*) from the northern Adriatic Sea [w.m. – wet mass (ng g^{-1}); l.m. – lipid-normalised mass (mg kg^{-1})].

Compound	Blubber		Muscle		Liver		Heart		Lung		Kidney	
	w.m.	l.m.	w.m.	l.m.	w.m.	l.m.	w.m.	l.m.	w.m.	l.m.	w.m.	l.m.
Polychlorinated biphenyls												
PCB-28	27.9	0.2	6.3	12.6	15.4	0.3	10.3	6.1	5.9	6.5	6.0	0.6
PCB-52	197.8	1.4	28.6	57.2	21.7	0.4	7.2	4.2	5.4	6.0	6.0	0.7
PCB-138	1893.1	13.6	15.9	31.8	414.6	8.0	32.6	19.1	14.9	16.6	39.6	4.3
PCB-153	8974.5	64.3	29.7	59.4	922.2	17.9	75.2	44.2	34.9	38.8	98.7	10.6
PCB-180	574.3	4.1	4.5	9.0	100.1	1.9	13.6	8.0	5.9	6.6	12.4	1.3
PCB-118	648.1	4.6	8.1	16.2	133.9	2.6	6.6	3.9	5.5	6.1	9.5	1.0
PCB-60	283.7	2.0	8.2	16.4	154.1	3.0	8.9	5.2	6.2	6.9	7.8	0.8
PCB-74	130.8	0.9	8.1	16.2	18.4	0.4	7.2	4.3	6.1	6.8	4.9	0.5
PCB-101	230.0	1.6	3.5	7.1	79.5	1.5	4.7	2.8	4.0	4.5	3.9	0.4
PCB-105	474.6	3.4	11.5	23.0	71.2	1.4	8.1	4.7	11.3	12.6	10.1	1.1
PCB-114	256.7	1.8	5.6	11.1	17.6	0.3	5.6	3.3	5.6	6.2	8.7	0.9
PCB-123	1310.7	9.4	13.7	27.3	135.6	2.6	12.0	7.1	7.8	8.7	16.0	1.7
PCB-156	481.3	3.5	9.5	19.0	42.2	0.8	5.8	3.4	5.6	6.2	7.9	0.8
PCB-157	188.9	1.4	20.0	40.0	28.0	0.5	10.4	6.1	10.3	11.4	12.6	1.4
PCB-167	635.5	4.6	11.7	23.3	84.2	1.6	13.6	8.0	8.1	9.0	12.0	1.3
PCB-170	2838.5	20.3	17.5	35.1	131.4	2.5	21.2	12.5	13.8	15.3	22.2	2.4
PCB-189	124.0	0.9	17.8	35.6	27.8	0.5	15.7	9.3	12.0	13.3	17.4	1.9
ΣPCB	19270.2	138.1	220.1	440.2	2397.9	46.5	258.6	152.1	163.3	181.5	295.7	31.8
Organochlorine pesticides												
HCB	59.7	0.4	1.1	2.3	15.2	0.3	1.2	0.7	0.9	1.0	1.4	0.2
α-HCH	24.4	0.2	1.6	3.1	6.2	0.1	1.7	1.0	2.2	2.4	2.0	0.2
β-HCH	77.4	0.6	268.7	537.4	65.3	1.3	16.5	9.7	24.4	27.1	23.7	2.6
β-HCH	18.3	0.1	8.2	16.3	7.2	0.1	5.6	3.3	6.0	6.6	11.2	1.2
ΣHCH	120.0	0.9	278.4	556.8	78.7	1.5	23.8	14.0	32.5	36.1	36.9	4.0
DDE	9729.1	69.7	19.5	39.0	627.3	12.2	38.1	22.4	20.4	22.7	49.5	5.3
DDD	1325.6	9.5	6.4	12.9	115.1	2.2	7.1	4.2	5.7	6.3	9.4	1.0
DDT	3722.6	26.7	11.3	22.6	197.4	3.8	10.5	6.2	7.1	7.9	32.1	3.4
ΣDDT	14777.3	105.9	37.2	74.5	939.8	18.2	55.6	32.7	33.3	37.0	90.9	9.8
% Lipid	14.0		0.1		5.2		0.2		0.1		0.9	

were detected at the lowest levels. The pattern of PCB tissue distribution (ΣPCB) showed the highest burdens in blubber >> liver > kidney > heart > muscle > lung (Tab. 1), which were positively correlated with tissue lipid contents (r_s = 0.986, $p < 0.01$). Among OCPs, HCB and ΣDDT exhibited the same distribution between tissues, correlated with the tissue lipids (r_s = 0.985 and 0.986, respectively, both $p < 0.01$). Total HCHs (ΣHCH) showed highest levels in muscle > blubber > liver > kidney > lung > heart, with no correlation to tissue lipids ($p > 0.05$). Total DDTs (ΣDDT) were lower than total PCB (ΣPCB) levels for all tissues, with ΣPCB/ΣDDTs ratios ranging from 1.3 in blubber to 5.9 in muscles. Calculated DDE/ΣDDT ratios were between 0.5 in kidney and muscle, and 0.7 in blubber, liver and heart, indicating a lack of new sources of DDT entering the ecosystem (AGUILAR, 1984).

As lipophilic compounds, OCs primarily accumulate in fat tissue. In marine mammals the highest concentration is found in the blubber which has a lipid content of 60 – 90% (COLBORN & SMOLEN, 1996; O'SHEA & TANABE, 2003). However, due to the advanced state of decomposition of the animal in our study the blubber had extremely low lipid content (14%, Tab. 1). BORRELL & AGUILAR (1990) sampled blubber from a dead stranded dolphin carcass over a period of 65 days which revealed a progressive decline in levels of ΣDDT and ΣPCB to about 40% of initial values. This suggests that our results likely underestimate real OC burdens.

Most ecotoxicological studies on marine mammals in the Mediterranean have used only blubber. This make the data on OC distribution and burdens in other tissues limited (MARSILI & FOCARDI, 1997; WAFO *et al.*, 2005; STORELLI *et al.*, 2007; SHOHAM-FRIDER *et al.*, 2009). For the common dolphin this information is completely absent. As expected, the pattern of OCs distribution among the tissues from our study is similar to the pattern found in the common bottlenose dolphin (*Tursiops truncatus*), with the highest loads detected in the blubber followed by liver and kidney, and with significantly lower concentrations in the muscle tissue and lung (STORELLI *et al.*, 2007; SHOHAM-FRIDER *et al.*, 2009). In stripped dolphins (*Stenella coeruleoalba*) blubber was also found to contain the highest levels of PCBs followed by the liver, muscle/heart, kidney and lung (MARSILI & FOCARDI, 1997; WAFO *et al.*, 2005).

Several studies have addressed OC levels in marine mammals from the Adriatic Sea (CORSOLLINI *et al.*, 1995; MARSILI & FOCARDI, 1997; STORELLI & MARCOTRIGIANO,

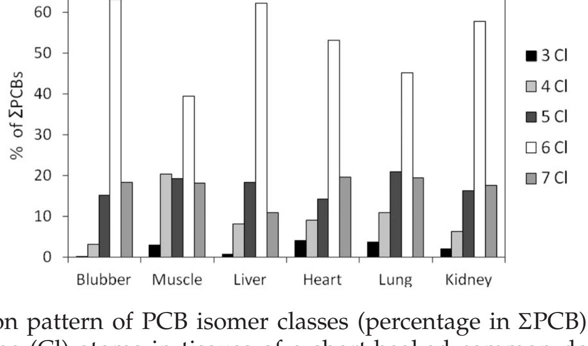

Fig. 2. Distribution pattern of PCB isomer classes (percentage in ΣPCB) based upon the number of chlorine (Cl) atoms in tissues of a short-beaked common dolphin (*Delphinus delphis*) from the northern Adriatic.

Tab. 2. Lipid-normalised organochlorine contaminant levels in blubber of dolphins from the Mediterranean Sea (NA – not available).

Species / Locality	Sampling period	N	Lipid content (%)	PCB 153 (mg kg^{-1})	ΣPCB (mg kg^{-1})	ΣDDT (mg kg^{-1})	References
Delphinus delphis							
Adriatic Sea	2004	1	14	64.3	138.1	105.9	This study
Alboran Sea	1992–1994	27	65.1 ± 15.2	6.43 ± 5.81	32.65 ± 28.62	33.40 ± 38.64	BORRELL *et al.*, 2001
	1992–1994	26	66 ± 15	6.1 ± 5.8	30 ± 28	31 ± 39	BORRELL & AGUILAR, 2005
	2001–2003	31*	59.1 ± 8.3	NA	24.64 ± 16.11	6.27 ± 3.80	TORNERO *et al.*, 2006
Ionian Sea	1992–1998	3	NA	NA	12.35**	9.75**	FOSSI *et al.*, 2000
	1994–1998	13	NA	NA	3.8	7.0	FOSSI *et al.*, 2003
Stenella coeruleoalba							
Italy	1987–1992	64	74 ± 20	NA	98.72**	65.37**	MARSILI & FOCARDI, 1997
	Adriatic Sea only:	7	NA	NA	67.38**	60.31**	
Alboran Sea	1992–1993	27	67 ± 12	13.8 ± 7.5	68 ± 39	79 ± 47	BORRELL & AGUILAR, 2005
Western Mediterranean	1987	31	55.9 ± 8.8	NA	342.12 ± 194.34	198.42 ± 182.66	AGUILAR & BORRELL, 2005
	1988	46	60.8 ± 7.9	NA	308.89 ± 108.64	145.51 ± 76.53	
	1989	10	58.7 ± 11.3	NA	236.70 ± 60.57	115.23 ± 39.32	
	1991	17	59.7 ± 10.4	33.70 ± 11.05	172.13 ± 51.76	137.53 ± 56.44	
	1992	6	38.5 ± 12.6	21.76 ± 2.44	152.29 ± 15.36	69.15 ± 6.61	
	1993	34	58.4 ± 7.7	20.87 ± 14.14	103.68 ± 44.45	79.04 ± 41.94	
	2000	6	27.6 ± 15.1	20.08 ± 7.80	90.40 ± 29.38	56.22 ± 24.12	
	2001	31	58.5 ± 17.8	11.13 ± 4.59	51.42 ± 21.85	38.11 ± 23.46	
	2002	5	57.0 ± 8.7	16.41 ± 4.09	75.90 ± 16.80	55.09 ± 15.28	
France	2000–2003	3	87.2	10.91	69.98 ± 35,46	4.04 ± 2,19	WAFO *et al.*, 2005
Tursiops truncatus							
Italy	1987–1992	8	80 ± 7	NA	21.66**	6.03**	MARSILI & FOCARDI, 1997
Italy (Adriatic Sea)	1999–2000	9	45.9 ± 7.0	NA	32.71 ± 16.95	NA	STORELLI & MARCOTRIGIANO, 2003
Western Mediterranean	1978–1989	9	66.3 ± 17.8	NA	578.6 ± 362.5	246.9 ± 153.2	BORRELL & AGUILAR, 2007
	1990–1999	18	64.5 ± 18.0	NA	209.0 ± 170.9	91.0 ± 100.9	
	2000–2002	9	42.1 ± 18.3	NA	149.8 ± 76.8	67.8 ± 54.8	
Israel	2004–2006	5	NA	1.89 ± 0.41**	6.30 ± 2.26**	34.82 ± 59.53**	SHOHAM-FRIDER *et al.*, 2009

* Values for adult males.
** Concentrations expressed as wet mass (mg kg^{-1}); factor of 35% average moisture content in blubber (MARSILI & FOCARDI, 1997) was applied for conversion where necessary.

2000, 2003; STORELLI *et al.* 2007), but as yet no published information exists for common dolphin. In fact, data for the common dolphin are generally scarce at the Mediterranean level, with information only available from the Alboran Sea (BORRELL *et al.*, 2001, BORRELL & AGUILAR, 2005; TORNERO *et al.*, 2006) and the Ionian Sea, where analyses were done on a relatively small number of samples (FOSSI *et al.*, 2000, 2003; N = 3 and 13, respectively). In terms of lipid-normalised concentrations, ΣPCB and ΣDDT in the blubber of the individual from our study were an order of magnitude higher than in the blubber of common dolphins from other parts of the Mediterranean (Tab. 2 and references therein). BORRELL & AGUILAR (2007) showed that ΣDDTs in bottlenose dolphins from the western Mediterranean decreased by a factor of 23.7 during a 25-year period (1987 – 2002), while PCBs decreased by a factor of 6.1 Similarly, the mean blubber concentration of OCs in stripped dolphin from the same region exhibited temporal decrease for a factor of 3.6 (ΣDDT) and 4.5 (ΣPCB) in 16 years (1987 – 2002; AGUILAR & BORRELL, 2005). Declining trends in DDT and PCB concentrations in the environment and across most of taxa over the last two decades have also been recorded in the Adriatic Sea (review by PICER, 2000). Taking in account the temporal decrease in OC levels in the Mediterranean marine environment and the effect of the decomposition on ΣDDT and ΣPCB levels in blubber (BORRELL & AGUILAR, 1990), the OC burdens in our specimen is the highest found in a dolphin throughout the Mediterranean after the year 2000, with only the exception of ΣPCB in bottlenose dolphins from western part of the Basin (BORRELL & AGUILAR, 2007; Tab. 2). Additionally PCB-153, a relatively non-toxic and highly resistant PCB conger to metabolic breakdown, which is commonly used for the comparison of OC burdens between species and populations, exhibited the highest blubber concentration (64.3 mg kg^{-1} l.m.) among all other dolphin populations and species in the Mediterranean Sea (Tab. 2).

Many factors determine the OC burden in marine mammal populations. Age, sex, physiological condition, diet, toxicological dynamics and metabolism of the compounds, and differences in the levels of OC contamination in the environment result in wide concentration ranges found in different species and populations (AGUILAR *et al.*, 2002; O'SHEA & TANABE, 2003). Common dolphins may also travel long distances (GENOV *et al.*, 2012), hence it is not possible to correlate individual animal to specific foraging habitats. The bottlenose dolphin remains the only cetacean regularly found in the northern Adriatic (BEARZI *et al.*, 2004). The high OC levels found in this study, coupled with high burdens of OCs found in another long lived large marine vertebrate resident in the Adriatic Sea, the loggerhead sea turtle (*Caretta caretta*; LAZAR *et al.*, 2011), and the presence of mono-*ortho* substituted PCBs with dioxin-like toxicity in all our samples, present an additional factor of concern for the conservation of regional dolphin populations. In the light of increasing reports on diseases and epizootics in marine mammals globally during 1980s and 1990s and the possible role of toxic contaminant in these events (AGUILAR & BORRELL, 1994; TANABE, 2002; O'SHEA & TANABE, 2003), the monitoring of OC trends in marine mammals as apex predators in Adriatic ecosystem is recommended.

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