Caribbean Coastal Pollution Project (CCPP)

Quantitative Biomonitoring of Persistent Organic Pollutants (POPs) in Caribbean Coastal Zones Using Oysters

Report on Research Project
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Introduction:

Popularized by large-scale biomonitoring programs such as Mussel Watch (O'Connor 1999), classical biomonitoring methods involve collecting native mussels at study sites to compare spatial patterns of chemical contamination in biological tissues. Oysters and various species of filter feeding mussels are widely used as biomonitors of hydrophobic organic chemical and heavy metal contamination (O'Connor 1999, Sures et al 1999; Gewurz et al 2003). Sessile filter feeders possess a number of desirable qualities as biomonitors including that they are common in different types of environments, tolerate wide variations in habitat types, are sedentary, exhibit slow growth, and exhibit poor capabilities to biotransform many types of organic contaminants (Gewurtz et al 2002). Bioaccumulated residues in filter feeding oysters and mussels provide a time-integrated measure of bioavailable chemical contamination that is likely to be more representative of the time scales over which exposures and bioaccumulation is experienced by other large invertebrates and small fish occupying the same system. This study was performed as part of the Caribbean Coastal Pollution Project to provide baseline monitoring data on persistent organic pollutants (POPs) in the Caribbean region with emphasis towards Stockholm Convention compounds. The first phase of this project involved implementation of a qualitative biomonitoring survey using oysters collected in selected study locations from Jamaica, Trinidad and Mexico. Subsequent planned phases of the study include transplant and quantitative biomonitoring data.

Methods

Mangrove oysters, *Crassostrea rizophorae* were collected from 3 major locations in Mexico, four sites in Trinidad and one site in Jamaica. Oysters species *Isognomon alatus* and *Perna viridis* were also collected from 3 sites in Jamaica. Table 1 lists the sampling locations provided and GPS coordinates where available. Figure 1 provides satellite image maps of sample site locations.

Table 1. Sample locations and species of oysters collected

Country	Site	Coordinates	Species
Mexico	Isla de Contoy		
	Station 1	N21°28' 04.5" W86°47'23.70"	*Crassostrea risophorae*
	Station 2	N21°29' 34.5" W86°47'59.50"	*Crassostrea risophorae*
	Station 3	N21°21' 28.2" W86°47'22.53"	*Crassostrea risophorae*
	Sian Ka'an		
	Station 1	N19°47' 12. 2" W87°28'52.4"	*Crassostrea risophorae*
	Station 2	N19°48' 11. 4" W87°33'08.9"	*Crassostrea risophorae*
	Station 3	N19°46' 19. 0" W87°35.10.1"	*Crassostrea risophorae*
	Xcalak		
	Station 1	N18°16' 37.0" W87°50'15.0"	*Crassostrea risophorae*
	Station 2	N18°16' 42.7" W87°50'12.4"	*Crassostrea risophorae*
	Station 3	N18°16' 40.8" W86°47'23.7"	*Crassostrea risophorae*
Trinidad	Blue River	N10°36"21.8" W61°28'25.86"	*Crassostrea risophorae*
	Entrance Canal	N10°36"18.7" W61°26'31.50"	*Crassostrea risophorae*
	L. Lagoon	N10°35"49.6" W61°27'5.10"	*Crassostrea risophorae*
	Espagnol River	N10 °32"35.0" W61°27'41.40"	*Crassostrea risophorae*
Jamaica	Port Royal		*Crassostrea risophorae* *Isognomon alatus* *Perna viridis*
	Old Harbour		*Isognomon alatus* *Perna viridis*
	Bowden, St. Thomas		*Isognomon alatus* *Perna viridis*

Chemical Analysis.

Several individual oysters of the smaller mangrove species, *Crassostrea risophorae*, were pooled into 1 g samples (approximately 5 shucked individuals per sample). Both the number of oysters and relative weight of individual oysters contributed to each pool was recorded. *Isognomon* and *Perna spp.* were analysed as individuals owing to the larger size of these organisms.

Oysters collected from Trinidad and Jamaica were extracted for selected POPs compounds using a micro-extraction method (Daley et al. 2009) followed by florisil cleanup (Lazar et al. 1992). Oysters collected from Mexico are to be extracted by a solvent/sample sonication procedure followed by florisil clean-up. Each sample was spiked with 7 ng PCB 30 for use as an internal recovery standard prior to extraction. For each batch of 6 samples, a blank and reference tissue homogenate was extracted. For Jamaica and Trinidad oysters, an in-house (Aroclor spiked goat liver homogenate) reference tissue was used. Extractions of Trinidad and Jamaica oysters were performed at the University of Windsor by Ms. Ann-Tenneil O'Connor as part of her analytical training and following completion of sample proficiency testing. Extractions and chemical analysis of Mexico oysters are being performed by the CINVESTAV laboratory, Mexico. Instrumental analysis was performed by gas chromatography electron capture detection (GC-ECD) as described in Lazar et al. (1992). Both laboratories used the same certified standards,

Quebec Ministry of Environment PCB Congener Mix (Chromatographic Specialties, Brockville, ON, Canada, Cat # C-QME-01) and Pesticide/Congener Mix 1 (Chromatographic Specialties, Brockville, ON, Canada, Cat # AE-00010) for quantitation purposes.

Organochlorine pesticide analytes included the following compounds: cis-chlordane, trans-chlordane, oxy-chloradne, o,p'-DDD, p,p'-DDD, o,p'-DDE, p,p'-DDE, o,p'-DDT, p,p'-DDT, dieldrin, α-endosulfane, β-endosulfane, α-HCH, β-HCH, У-HCH, heptachlor, cis-heptachlorepoxide, trans-heptachlorepoxide, hexachlorobenzene and mirex. Polychlorinated biphenyls were analysed as the sum of 41 individual and co-eluting congeners present in the certified standard mixture. All analytes were identified by retention time and according to expected elution profiles in florisil fractions.

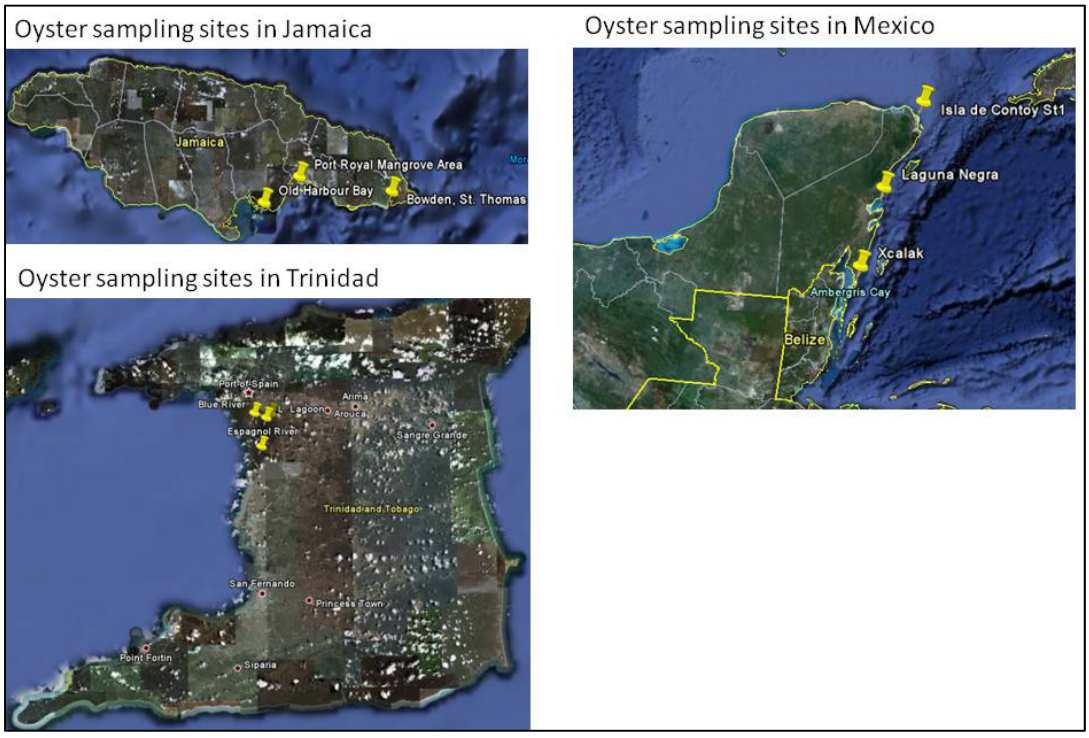

Figure 1. Oyster sample locations by country.

Results.

At the time of writing, data from Mexico were not yet available owing to delays in instrument procurement and installation on site. Partial data sets were available from Jamaica and Trinidad. For Jamaica, the sampling design allowed a comparison of bioaccumulation of POPs among three different oyster species at the same site. However, this analysis was not yet completed in time for this report. A total of 30 oysters/oyster pools were extracted and analyzed including 19 from Port Royal, Jamaica, 6 from Old Harbour, Jamaica, 1 from St. Thomas, Jamaica and 4 pools oysters from Trinidad (1 pool per site). Figure 2 summarizes results for mean OC pesticide concentrations (ng/g wet weight) in oysters analysed to date. Figure 3 presents total PCBs across sites as well as common congener profiles observed in oyster tissues.

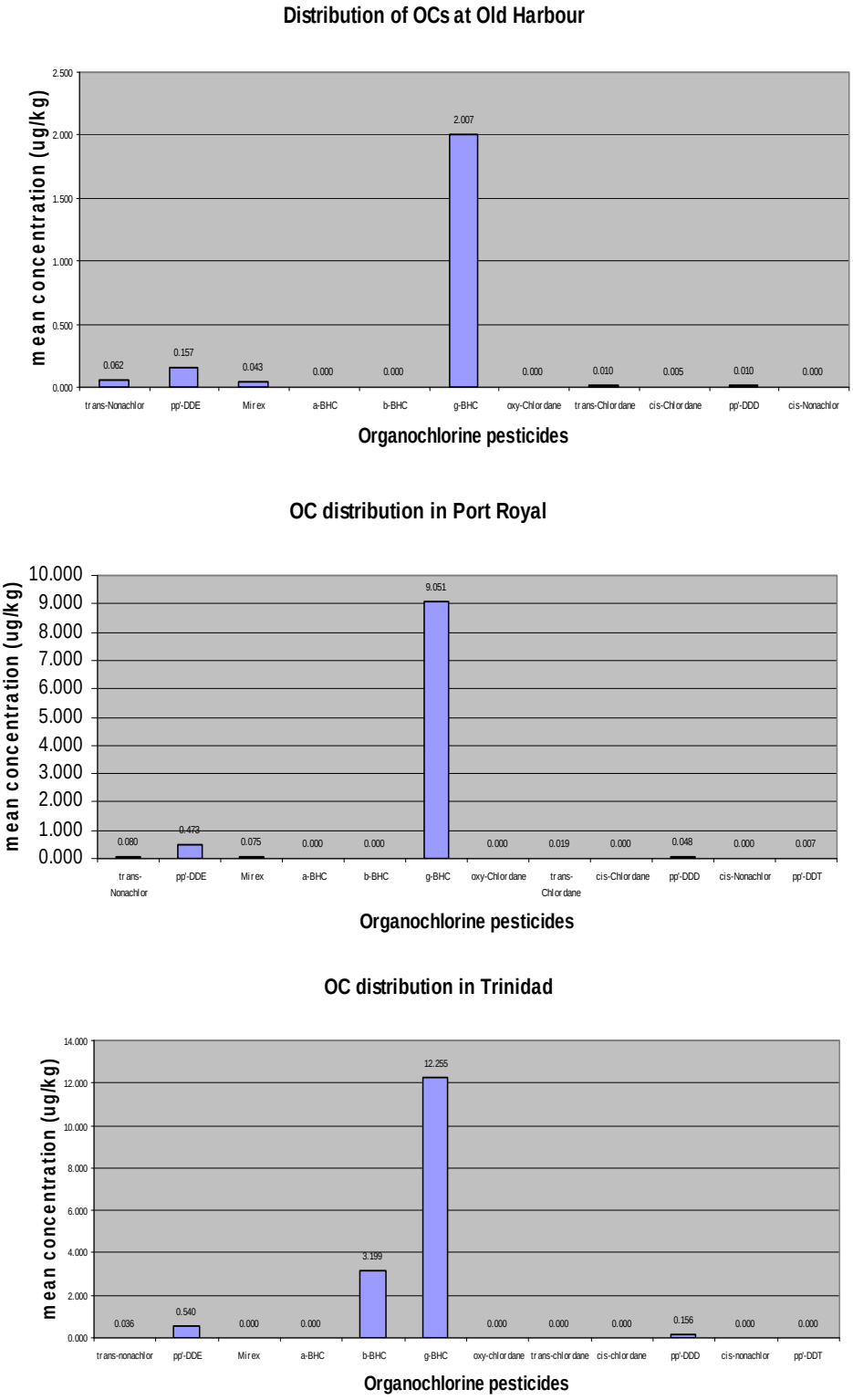

Figure 2. Organochlorine pesticide concentrations in oyster samples from Jamaica and Trinidad.

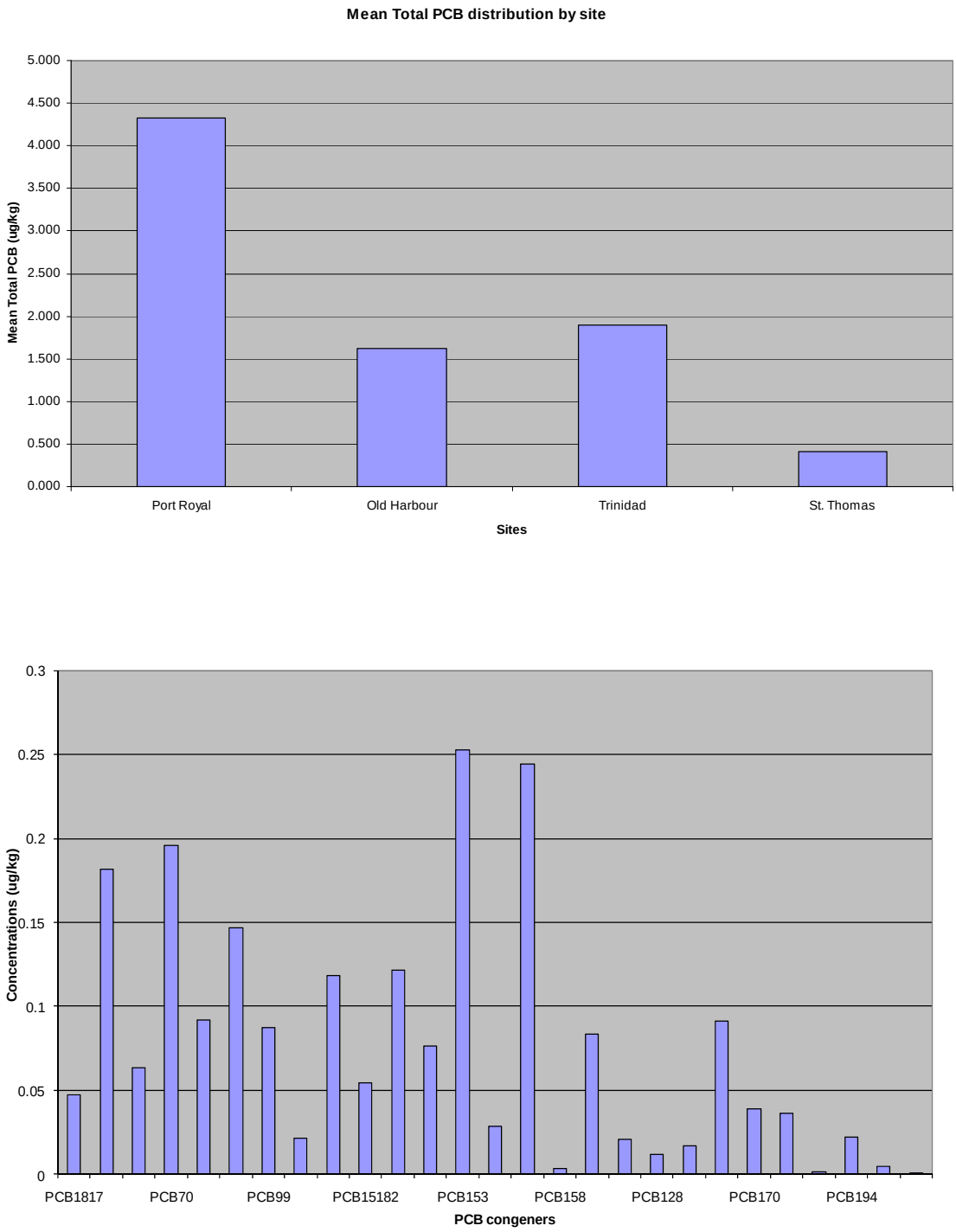

Figure 3. Total PCB concentrations (top graphic) across sites and representative PCB congener composition in Jamaica and Trinidad oyster samples (bottom graphic).

For organochlorine pesticides, lindane (У-HCH) was the highest contaminant measured followed by low concentrations of p,p'-DDE at the different sites of study. Relative rankings of contaminants followed the trend: lindane > total PCBs > p,p-DDE at most sites. In all cases, absolute POPs concentrations measured in oysters were low relative to human health concerns associated with POP exposures due to consumption of contaminated food items. For lindane, the maximum concentrations observed was 3 ng/g wet weight which was two orders of magnitude lower than the most stringent action levels used in the United States (300 ng/g wet weight fish consumption advisory). For PCBs, the highest concentration observed was 4 ng/g wet weight. This value was an order of magnitude lower than the most stringent action level in the United States (50 ng/g wet weight restricted fish consumption threshold). The pesticide metabolite p,p'-DDE was less than 1 ng/g at all locations and 5000 times lower than the action level (5000 ng/g wet weight) used in the United States to assess the requirement of fish consumption restrictions.

Conclusions

Overall, the oyster biomonitor survey confirmed the presence of Stockholm Convention Compounds in waters of Jamaica and Trinidad. However, the concentrations of POPs measured in oyster tissues were generally low relative to threshold levels used to address human health concerns associated with contaminated seafood. Concentrations of lindane and PCBs measured in oyster tissues were consistent with the magnitude of concentrations determined in white grunt skinless fillet samples collected from the same countries. Of these two chemicals, total PCBs is most likely to undergo food web biomagnification. Since both oysters and white grunt occupy low to mid-trophic levels in the marine food web, there may be a risk of higher PCB concentrations being achieved in top trophic level piscivorous fish and fish eating sea birds.

References

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