Available online at www.sciencedirect.com
ScienceDirect
Science of the Total Environment 376 (2007) 335–345
Science of the Total Environment
An International Journal for Scientific Research into the Environment and its Relationship with Humankind
www.elsevier.com/locate/scitotenv

Trace metals and organochlorines in the bamboo shark *Chiloscyllium plagiosum* from the southern waters of Hong Kong, China

Andrew S. Cornish [a,b], W.C. Ng [a], Valerie C.M. Ho [a], H.L. Wong [c], James C.W. Lam [c], Paul K.S. Lam [c], Kenneth M.Y. Leung [a,*]

[a] *The Swire Institute of Marine Science, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong, China*
[b] *Present address: WWF Hong Kong, 1 Tramway Path, Central, Hong Kong, China*
[c] *Department of Biology and Chemistry, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, China*

Received 7 August 2006; received in revised form 6 January 2007; accepted 11 January 2007

Abstract

The bamboo shark *Chiloscyllium plagiosum* is an abundant benthic species along the shallow continental shelf of Southeast Asia. It is commonly taken by fishermen in China, India, Taiwan and Thailand for human consumption. This study measured trace metal and organochlorine concentrations in *C. plagiosum* collected from the southern waters of Hong Kong, China. Metals (Ag, Cd, Cr, Cu, Mn, Ni, Pb and Zn) were measured in three different tissues: dorsal muscle, spleen and liver. Polychlorinated biphenyls (PCBs) and chlorinated pesticides in the dorsal muscle were identified and quantified using gas chromatography. Metal concentrations varied among the three different tissues, with liver having higher levels of Ag and Cd, and spleen possessing higher levels of Cu and Mn. Both Ni and Pb in all tissues were below the detection limit. Tissue concentrations of Cr, Cu, Mn and Zn generally decreased with increasing body weight whilst no significant concentration-size relationship was found for other metals. In muscle tissues, total PCBs ranged from 1.056–4.771 ng/g (wet wt.) with a median of 1.801 ng/g, while total DDTs ranged from 0.602–23.55 ng/g with a median of 1.109 ng/g, in which *p,p′*-DDE was the predominant metabolite. Levels of total hexachlorohexanes and cyclodienes were low. The pesticide *p,p′*-DDT was the only compound found to be positively correlated with body weight, indicating temporal bioaccumulation of this compound. Zn concentrations in the muscle of *C. plagiosum* were comparatively higher than recorded in other shark species, however, concentrations of other metals and organochlorines were relatively low. *C. plagiosum* feeds primarily on polychaetes, shrimps and small fishes, and thus is unlikely to contain levels of contaminants of human health concern.

Keywords: Seafood safety; Ecological risk; Marine pollution; *Chiloscyllium plagiosum*

1. Introduction

Trace metals in coastal waters of many Southeast Asian countries pose a potential threat to marine ecosystems, and to coastal inhabitants who rely heavily on seafood as a source of protein (Phillips and Tanabe,

* Corresponding author. Tel.: +852 2299 0607; fax: +852 2517 6082.
E-mail address: kmyleung@hkucc.hku.hk (K.M.Y. Leung).

0048-9697/$ - see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.scitotenv.2007.01.070

1989). Increased concentrations of trace metals in coastal fishes resulting from wastewater discharges via sewage, industrial waste and stormwater have been documented (Chan, 1995). Additionally, coastal fishes are often contaminated with persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs) and chlorinated pesticides, posing a more significant threat because of their high persistence and toxicity (Wu, 1999). Top trophic level animals such as sharks, tunas, dolphins, whales and humans are particularly vulnerable and may undergo elevated bioaccumulation of trace metals and POPs.

Many shark species are top predators and may be particularly susceptible to contamination with trace metals and POPs. For instance, it has been reported that concentrations of mercury in the tissues of several shark species exceeded the safety levels for human consumption in San Francisco (Davis et al., 2002) and southern Australia (Turoczy et al., 2000). Other trace metals are also potentially harmful to shark species (Storelli et al., 2002, 2003), and consequently to humans who consume them (Turoczy et al., 2000). As a result of this vulnerability to accumulate contaminants through the food chain, predatory sharks are likely to be good biomonitors of metals (Vas, 1991; Marcovecchio et al., 1991) and organochlorine compounds (Serrano et al., 1997; Storelli and Marcotrigiano, 2001) in marine ecosystems. However, little such research has been carried out in Southeast Asia.

Hong Kong's marine environment has suffered from metal pollution since the surge of industrialization in the 1970s (Morton, 1989; Phillips and Tanabe, 1989) and contaminant levels have remained high despite the relocation of the source industries (e.g. electroplating factories and chemical plants) to Mainland China in the 1990's. Recent studies have revealed that high levels of trace metals, particularly silver, copper and zinc remain in the sediments of Victoria Harbour, Tolo Harbour, Deep Bay and the northwestern waters of Hong Kong (Blackmore, 1998; Liu et al., 2004). High concentrations of chromium, lead and mercury have been detected in many local fish species that are common food items of the Chinese white dolphin, *Sousa chinensis*, and the finless porpoise, *Neopho-caena phocaenoides* (Chan, 1995; Parsons, 1999a). Correspondingly, mercury concentrations in the livers of these two residential cetaceans have been found to be high enough to constitute a health risk to these mammals (Parsons, 1999b).

The marine environment of Hong Kong is also contaminated with various POPs, which are primarily associated with agricultural and municipal effluent discharges from Hong Kong and China via the Pearl River. High concentrations of organochlorines such as PCBs and hexachlorohexanes (HCHs) have been found in sediment samples from Victoria Harbour, suggesting that the sources of contamination are local, probably from industrial waste and untreated sewage (Connell et al., 1998; Richardson and Zheng, 1999). More recent studies have shown that loadings from the Pearl River are also a significant source of trace metals and organochlorine pollutants, posing a threat to marine organisms in Deep Bay (Chau, 2005; Ip et al., 2005a,b). Such elevations of organochlorines are probably associated with the rapid industrialization of the Pearl River Delta region in combination with the illegal application of organochlorine compounds (Chau, 2005).

Over the last 40 years, the abundance of sharks in Hong Kong waters has declined significantly due to overfishing, habitat loss and pollution. The annual total shark landing figures dropped from ~2200 tonnes in the early 1970's to ~200 tonnes in the mid-1990's (Kreuzer and Ahmed, 1978; Vannuccini, 1999). The sharks are fished mainly for their fins to make shark fin soups, while the flesh is used for making fish balls and other food products, which are commonly consumed by local Chinese people (Parry-Jones, 1996). Recently, the white-spotted bamboo shark, *Chiloscyllium plagiosum*, is the only shark species still abundant in Hong Kong waters (Sadovy and Cornish, 2000). This is a small benthic shark having a maximum total length of about 83 cm. The species is abundant throughout continental Southeast Asia and commonly taken by inshore fisheries in China, India, Taiwan, Thailand and Hong Kong for human consumption (Compagno, 2001). The present study investigated the concentration of selected trace metals, PCBs and chlorinated pesticides in tissues of *C. plagiosum* collected from southern waters of Hong Kong between February 2003 and February 2004. We assessed whether levels found pose a potential risk to local *C. plagiosum*, and whether they have implications on the human consumption of this shark species.

2. Materials and methods

2.1. Collections and sample preparation

Between February 2003–February 2004, *C. plagiosum* were purchased from commercial fishers who had caught them using shrimp trawls, benthic long-lines and monofilament nets within Hong Kong's southern waters (from Lamma Island to southern Hong Kong Island and smaller associated islands, Fig. 1) at depths <30 m. *C. plagiosum* are believed to primarily inhabit sand/mud substrata, as these are the areas fished by shrimp