



# Polychlorinated biphenyls in apple snails from an abandoned e-waste recycling site, 2010–2016: A temporal snapshot after the regulatory efforts and the bioaccumulation characteristics

Jiang-Ping Wu <sup>a,b,\*</sup>, Xiao-Yun Chen <sup>a,b</sup>, Si-Kang Wu <sup>a,b</sup>, Lin Tao <sup>c</sup>, Ya-Zhe She <sup>c</sup>, Xiao-Jun Luo <sup>c</sup>, Bi-Xian Mai <sup>c,\*\*</sup>

<sup>a</sup> Anhui Provincial Engineering Laboratory of Water and Soil Pollution Control and Remediation, Anhui Normal University, Wuhu 241003, China

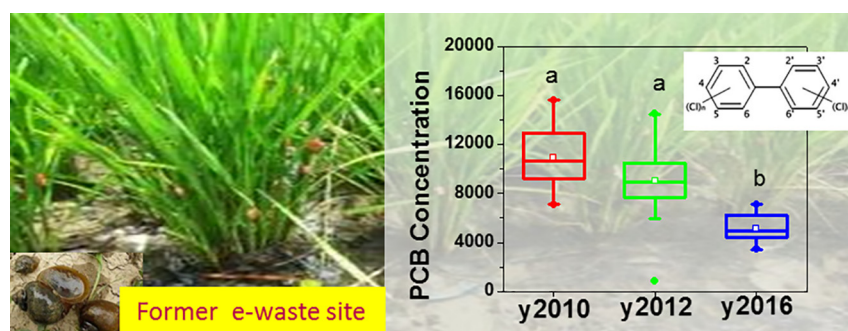
<sup>b</sup> College of Environmental Science and Engineering, Anhui Normal University, Wuhu 241003, China

<sup>c</sup> State Key Laboratory of Organic Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China

## HIGHLIGHTS

- PCBs in apple snails from the abandoned e-waste site decreased during 2010–2016.
- The contribution of lighter PCB congeners increased over the years.
- Theoretical BSAFs could predict the bioaccumulation of PCBs in apple snails.
- Apple snail is a suitable bioindicator for PCBs in paddy field soils.

## GRAPHICAL ABSTRACT



## ARTICLE INFO

### Article history:

Received 13 July 2018

Received in revised form 24 August 2018

Accepted 6 September 2018

Available online 07 September 2018

Editor: Kevin V. Thomas

### Keywords:

PCBs  
E-waste  
Temporal trend  
Bioindicator  
Apple snail

## ABSTRACT

The rudimentary recycling of electronic waste (e-waste) has been banned in China since the late 2000s, leaving many abandoned e-waste sites. However, knowledge is limited on the concentrations and fates of the e-waste derived contaminants such as polychlorinated biphenyls (PCBs) in these abandoned sites. In this work, we assessed the temporal trend of PCB concentrations in the year 2010, 2012, and 2016 at an abandoned e-waste site in South China, using apple snail as a bioindicator. The mean  $\sum$ PCBs concentrations in apple snails sampled in 2016 (53.2 ng/g dry weight) was approximately 11-fold higher than that (4.68 ng/g dry weight) in apple snails from a reference site. The result suggested that the abandoned e-waste recycling site was still heavily polluted by PCBs, despite of the fact that crude e-waste recycling processes have been prohibited for nearly 10 years. The concentrations of  $\sum$ PCBs were significantly decreased in 2016 compared to those in 2010 (mean: 115 ng/g dry weight) and 2012 (mean: 92.3 ng/g dry weight), but there were no significant differences in the concentrations between 2010 and 2012. Regarding the congener profiles, the contributions of lower chlorinated congeners (tri- and tetra-PCBs) in the snails tended to be higher over the years. The  $\sum$ PCBs in snails were significantly correlated with those in soils. Additionally, PCB profiles in snails resembled those in soils. These results suggested that apple snails can be used as an ideal bioindicator for PCBs in the paddy soils. Field determined biota-soil accumulation factors (BSAFs) for PCBs ranged from 0.31 to 1.9, with most of the values being 1–2; indicating that theoretical BSAFs can be used to predict the bioaccumulation of PCBs in the snails with a reasonable degree of certainty.

© 2018 Elsevier B.V. All rights reserved.

\* Correspondence to: J.-P. Wu, Anhui Provincial Engineering Laboratory of Water and Soil Pollution Control and Remediation, Anhui Normal University, Wuhu 241003, China.

\*\* Corresponding author.

E-mail addresses: [jpwu@ahnu.edu.cn](mailto:jpwu@ahnu.edu.cn) (J.-P. Wu), [nancymai@gig.ac.cn](mailto:nancymai@gig.ac.cn) (B.-X. Mai).

## 1. Introduction

Polychlorinated biphenyls (PCBs) are a class of chlorinated aromatic compounds in which one to ten chlorine atoms are attached to a biphenyl skeleton. Since the initial production of commercial PCBs in 1929, they had been extensively used for industrial purposes due to their highly chemical and thermal stability (Erickson, 2001). They were widely utilized as dielectric fluids in transformers, capacitor and voltage regulators, and as plasticizers, lubricants, inks and surface coatings in carbonless copy paper (Erickson, 2001). These chemicals can be released to the environment during their production and the disposal of PCB-containing products. Because of their persistence, bioaccumulation potential and highly toxic effects, commercial PCB production ended in the USA, Western Europe and China during the 1970s (Erickson, 2001; Zhao et al., 2017), and worldwide formulation and application of PCBs was prohibited after the Stockholm Convention on persistent organic pollutants (POPs) in 2001 (UNEP, 2001). Despite the ban on the production and usages of PCBs, they continue to be of great concern because they can be emitted from fundamental sources such as old electrical and electronic products, and re-emitted from environmental reservoirs including soils, sediments, and other contaminated compartments (Breivik et al., 2007, 2016; Zhao et al., 2017; Bogdal et al., 2014; Shanahan et al., 2015; Yadav et al., 2017; Li et al., 2018).

The primitive electronic waste (e-waste) recycling activities have caused heavy pollution of PCBs and other contaminants in developing countries such as China, India and Pakistan and some African countries (Wong et al., 2007; Chen et al., 2014; Iqbal et al., 2015). To deal with the worsening environmental problems in e-waste recycling sites, the Chinese local government has banned some crude processes of e-waste recycling such as open burning and acid washing since the late 2000s, leaving many abandoned e-waste sites in fields (Fu et al., 2012; Zhang et al., 2014; Wu et al., 2015; Wang et al., 2016). The local government also took some measures, e.g., covering the burning sites with uncontaminated soil, to control the re-emission of the pollutants (Wang et al., 2016). Despite of these efforts, extremely high levels of e-waste related contaminants were detected in the environment of the abandoned sites without further e-waste disposal and can still pose ecological risks (Zhang et al., 2014; Wu et al., 2015; Wang et al., 2016, 2017; Huang et al., 2018).

Apple snails (*Pomacea canaliculata*) are freshwater snails that naturally occur throughout the tropics and subtropics. They inhabit a wide range of ecosystems including natural streams, ponds, paddy fields and other waterways. Apple snails have a broad diet, preferring plant materials and decomposing organic matter (Kwong et al., 2010). Paddy fields constitute a more favorable habitat for apple snails than other ecosystems because of similarities in the environmental conditions (e.g., temperature, salinity, pH and flow velocity of paddy water) necessary for both rice production and for snail survival and development (Horgan, 2018). The ecology and biology of apple snail fit in with most of the essential characteristics of an ideal bioindicator, that is, bioaccumulation potential, wide distribution, narrow range of movement, short life-span, and ease in collection (Tanabe and Subramanian, 2006). These advantages make apple snail inhabited paddy field a suitable bioindicator for PCBs and other organic chemicals (Fu et al., 2011; She et al., 2013; Yuan et al., 2017).

Biomonitoring of PCB concentrations in abandoned e-waste recycling sites could provide information on PCB trends now that crude e-waste recycling activities have been banned. In this work, we present data from an abandoned e-waste recycling site in South China, using apple snail as a bioindicator. We collected the samples in 2010, 2012 and 2016 to evaluate whether PCB levels have continued to decrease following the stricter environmental regulations. Furthermore, we examined PCB levels in paddy soils and estimated the biota-soil accumulation factors (BSAFs) for these chemicals, to assess the bioaccumulation characteristics of PCBs in apple snails from the abandoned e-waste recycling site.

## 2. Materials and methods

### 2.1. Sampling strategy

Apple snails (*Pomacea canaliculata*) were collected from 15, 16 and 11 adjacent paddy fields of an abandoned e-waste recycling site in South China (latitude 23°34' N and longitude 113°01' E), in April of 2010, 2012 and 2016, respectively. Apple snails collected from one paddy field were mixed as a pool sample which was composed of at least 20 individuals. The apple snails sampled for each year possess similar body length ( $3.0 \pm 0.2$  cm; mean  $\pm$  SE). In the 2016 sampling, paddy soils ( $n = 11$ ) were also collected around the location where the apple snails sampled. Moreover, we collected apple snails from 16 adjacent paddy fields located at approximately 25 km north away from the abandoned e-waste recycling site where no known e-waste recycling activities were conducted, serving as reference samples. The collected samples were placed in polyethylene bags (PCB free) and subsequently transported to the laboratory.

### 2.2. PCB analysis

In the laboratory, after rinsed by running water and deionized water, the apple snails were dissected and soft tissue of the apple snails was taken. All the samples were stored at  $-20$  °C until chemical analysis.

The apple snail or soil samples were freeze-dried for 48 h. Approximately 1 g of the samples was spiked with surrogate standards (PCBs 30, 65 and 204) and ground in a glass mortar with anhydrous sodium sulfate. The mixture was Soxhlet extracted with a hexane/acetone mixture (1/1, v/v) for 48 h. Activated granular copper was added to the soil extract system to remove sulfur precipitates. For apple snail samples, an aliquot of the extract was used for lipid determination using a gravimetric method. The remainder of the extracts used for chemical analysis were concentrated and subjected to gel permeation chromatography (GPC) through a glass column (50 cm  $\times$  2.5 cm i.d.) packed with 40 g of SX-2 Bio-Beads media (Bio-Rad Laboratories, Hercules, CA, USA), to remove bulk lipids and other interfering compounds. Both the apple snail and soil extracts were finally cleaned up by passing through a multilayer silica gel column (1.0 cm i.d., from the bottom up packed with 8 cm neutral silica, 8 cm sulfuric acid silica and 2 cm anhydrous sodium sulfate). Analytes were eluted with 80 mL of dichloromethane/hexane mixture (1/1, v/v). The eluate was then concentrated, solvent exchanged to hexane, and finally concentrated to near dryness under a gentle stream of purified nitrogen gas. The final extract was then reconstituted in 200  $\mu$ L of *n*-hexane. Known amounts of internal standards (PCBs 24, 82 and 198) were spiked to the final extract prior to instrumental analysis.

Instrumental analysis of PCBs was according to a previously published method (Wu et al., 2008), with minor modification. Briefly, PCBs were determined using an Agilent 7890A gas chromatograph (GC) coupled with a 5975C Series mass selective detector (MSD) using an electron impact (EI) ion source. GC separation was performed using a DB-5 MS column (60 m  $\times$  250  $\mu$ m i.d.  $\times$  0.25  $\mu$ m film thickness). The column oven was programmed from an initial temperature of 120 °C to 180 °C at a rate of 6 °C/min, then ramped to 240 °C at a rate of 1 °C/min, and finally increased to 290 °C at a rate of 6 °C/min, hold for 17 min. PCB congeners were monitored at the two most intense ions of the molecular ion cluster.

### 2.3. Quality assurance and quality control

Quality control and assurance for the quantitative analysis included procedural blanks, spiked samples and surrogate spiking. Procedural blanks were processed in parallel with each batch of 12 samples. CBs 28, 118, 138 and 153 were detected in the procedural blanks, but were at relatively low levels (<10% of the lowest concentration in each batch of the samples). The recoveries of surrogate standards PCBs 30,

Download English Version:

<https://daneshyari.com/en/article/10149566>

Download Persian Version:

<https://daneshyari.com/article/10149566>

[Daneshyari.com](https://daneshyari.com)