Occurrence of organophosphorus flame retardants and plasticizers in edible and wild insects from China

Giulia Poma[1*], Yu Liu[2], Matthias Cuykx[1], Bin Tang[1,2], Xiao-Jun Luo[2], Adrian Covaci[1]

1-Toxicological Center, University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium
2-State Key Laboratory of Organic Geochemistry and Guangdong Key Laboratory of Environmental Resources Utilization and Protection, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, PR China

*giulia.poma@uantwerpen.be

DioXin 2018
& 10th International PCB Workshop
26 – 31 August 2018, Kraków, Poland

INTRODUCTION and OBJECTIVES

- ✓ Organophosphorus flame retardants (PFRs) have been implemented as the foremost substitutes of brominated flame retardants (BFRs) after their phase out due to toxicity concerns and environmental persistence[1].
- ✓ Data on occurrence of PFRs in biota are still scarce[2].
- ✓ Insects are a dominant component of biodiversity in both aquatic and terrestrial ecosystems, playing a key role in the transportation and bioaccumulation of organic pollutants in the environment[3].
- ✓ The occurrence of 12 PFRs was investigated in Chinese edible and wild insects species (Table 1 and 2).

Table 1. Edible insects

Sample name
Mealworm larva
Silkworm pupa
Cicade larva
Cricket adult
Grasshopper adult
Dragonfly nymph

Table 2. Wild insects

(Order) Sample name	Species	Location
(Odonata)		
Dragonfly ny	-	pond
Dragonfly ad	-	pond
Dragonfly ny_2	-	paddy field
(Orthoptera)		
Grasshopper ny	*Oxya chinensis*	paddy field
Grasshopper ad	*Oxya chinensis*	paddy field
Cricket ad	*Gryllus chinensis*	paddy field
Mole-cricket ad	*Gryllotalpa orientalis*	paddy field
(Hemiptera)		
Aquatic stinkbug ad	*Diplonychus esakii*	farmland water
Terrestrial stinkbug ad	*Tessaratoma papillosa*	farmland
(Coleoptera)		
Terrestrial beetle ad	*Anomala corpulenta*	farmland
Aquatic beetle ad	*Sternolophus inconspicuus*	farmland water
(Lepidoptera)		
Moth lar	-	guava tree - pond
Moth ad	-	guava tree - pond

MATERIALS and METHODS

- ✓ Six edible insect species were bought from an online store in the Shandong province (East China) in 2017.
- ✓ Nine wild insect species belonging to five orders (*Odonata*, *Orthoptera*, *Hemiptera*, *Coleoptera* and *Lepidoptera*) were collected around a pond, heavily polluted by chemicals associated with e-waste (Fig. 1), in the Guangdong province (South China) between 2015 and 2016.
- ✓ Quantification of target analytes was achieved by GC–MS/MS in electron ionization (EI) mode[1].

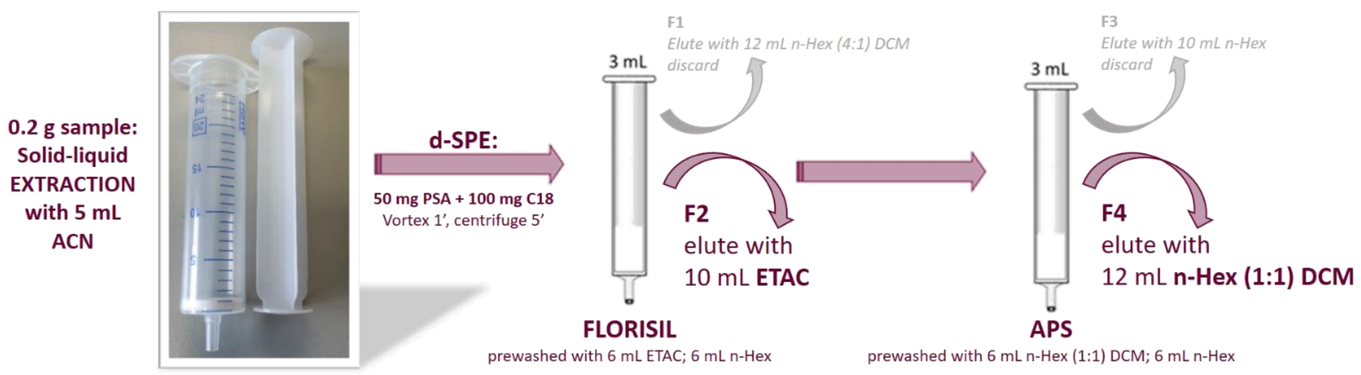

Fig. 1 Insect sampling site and e-waste dumping area in Guangdong province, South China

RESULTS and DISCUSSION

- ✓ Six out of twelve PFRs (tris(2-chloroethyl) phosphate (TCEP), tris(1-chloro-2-propyl) phosphate (TCPP), triphenyl phosphate (TPHP), ethylhexyldiphenyl phosphate (EHDPP), tris(2-ethylhexyl) phosphate (TEHP) and tricresyl phosphate, (TCP)) were detected at concentrations above quantification limits.
- ✓ TEHP was the most abundant compound in edible (54 %) and wild (50 %) insects, followed by TCEP (38 % in edible insects), TPHP and TCIPP (22 and 19 %, in wild insects respectively) (Fig. 2).
- ✓ Dragonfly nymphs were the most contaminated samples, in both edible and wild insects, with total PFR concentrations of 142 and 68 ng/g ww, respectively, followed by moth adult insects (26 ng/g ww) and terrestrial stinkbug (17 ng/g ww) (Fig. 3). The other analyzed insect species contributed each less than 10 % to the total PFR contamination.

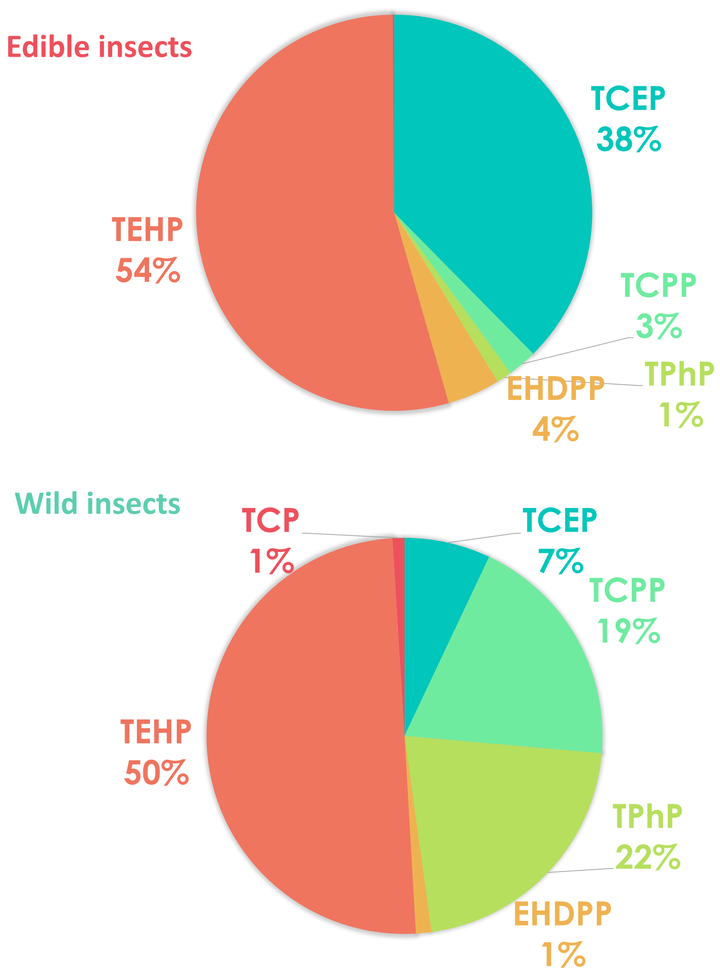

Fig. 2 PFR contamination pattern in edible (upper) and wild (lower) insect samples

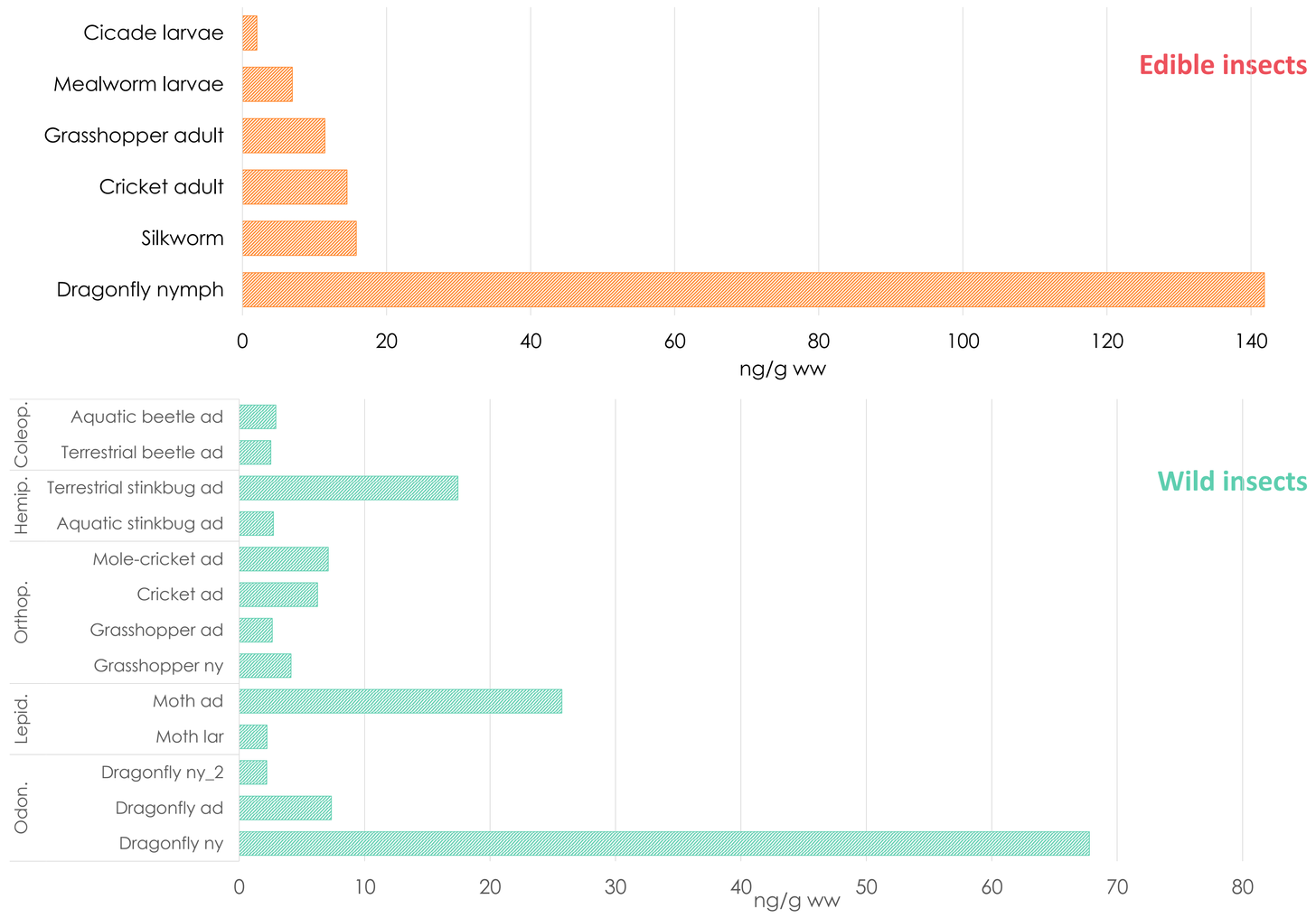

Fig. 3 Concentrations of measured PFRs in edible (upper) and wild (lower) insect samples

CONCLUSIONS

- ✓ Like other animals, insects are capable to accumulate PFRs, but the extent and pattern of contamination may differ among insect species. These variations could be due to their different habitats and feeding habits.
- ✓ Dragonflies have higher PFR concentrations when compared to other insects. As larvae, dragonflies live in aquatic environments, and they are predators at both larval and adult stage, while the other investigated species are terrestrial phytophagous.
- ✓ The PFR concentration pattern among the five insect orders was *Odonata* > *Lepidoptera* > *Orthoptera* > *Hemiptera* > *Coleoptera.*

ACKNOWLEDGEMENTS

Giulia Poma acknowledges a post-doctoral fellowship from the University of Antwerp, while Matthias Cuykx acknowledges the Research Foundation – Flanders (FWO, project 11Z3318N) for his PhD scholarship. The secondments of Giulia Poma and Matthias Cuykx to GIG were funded by the EU H2020 INTERWASTE project (grant agreement 734522). Bin Tang acknowledges a research scholarship (201704910738) funded by the China Scholarship Council for his research stay at the University of Antwerp

REFERENCES

(1) Poma G, Sales C, Bruyland B. et al. (2018); Environ. Sci. Technol. 52 (4): 2331–2338.
(2) van der Veen I, de Boer J. (2012); Chemosphere 88 (10): 1119–1153.
(3) Liu Y, Luo XJ, Huang L, et al. (2018); Environ. Sci. Technol. 52: 5145-5153.