POLYCYCLIC MUSKS INDOORS AND OUTDOORS

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Introduction

Polycyclic musks (PCMs) are a class of synthetic fragrance compounds that are widely used in many personal care products, such as soaps, detergents and deodorants. Since their first detection in the environment in 1994[1] they have been found almost ubiquitously in the environment including in biota[2], air[3], surface waters[4], oceanic waters[5] sediments[6] and human tissues[7]. Recent research has shown that the level of these compounds in the North. American environment have been increasing dramatically over the past 10 years[6]**.** Currently it is estimated that over 4500 t per year of PCMs, are produced in the United States alone[7], the vast majority of which, due to their use in personnel care products, will enter the environment.

Although the toxicity of PCMs is believed to be low there is a growing weight of evidence that they may cause a range of sub-lethal effects[7]**.** Despite this there is still a relative dearth of knowledge regarding the fate and effects of these chemicals within the urban environment.

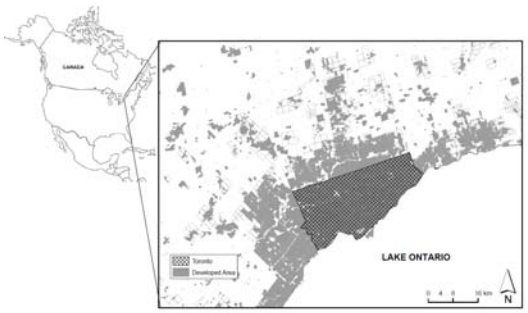

Figure 1: Toronto, with a population of 2.6 million, is Canada's largest city, and sits on the north shore of Lake Ontario

This paper reports the concentrations and trends of five of these chemicals, Galaxolide (HHCB) Tonalide (AHTN), Traseolide (ATII), Celestolide (ADBI), and Phantolide (AHMI) in indoor and outdoor air in the city of Toronto, Canada, with a view to estimating human exposure and loadings to the environment.

Methods and Materials

Indoor air samples were collected from 10 homes and 10 offices in 2006. Outdoor air samples were collected from 14 sites across the city in 2008. Both types of air samples were collected using "dome" type polyurethane foam passive samplers. Indoor air samplers were deployed for 1month and outdoor samples for three months.

Samples were extracted via pressurised fluid extraction (PFE) using a Dionex ASE 350, using DCM as the extraction solvent. Samples were split into two fractions, one for PAH and PCM analysis and one for PCB and PBDE analysis. PAH/PCM samples were cleaned up using 1 g silica SPE columns (Varian, Canada). Following this they were reduced in volume to 100 µl prior to GC/MS analysis. GC/MS analysis was carried out using an Agilent 6890N GC coupled to a 5975 MSD fitted with a 60m (0.25 mm I.D. x 0.25µm film thickness) DB-5MS column. 1µl of sample was injected in splitless mode. One field blank was taken for every 10 samples. All samples were blank corrected.

Results and Discussions

Indoor air concentrations ranged from 0.4 to 46 ng/m^3 with an average of 10.5 ng/m^3. Galaxolide was the most abundant PCM detected in indoor air, comprising on average 65% of the total amount of PCMs detected, with Tonalide second, comprising on average 30% of the total (Figure 2). In outdoor air total PCM concentrations ranged from 0.9 to 3.5 ng/m^3, comprising 77 and 20% of the total respectively (Figure 3). A clear trend was seen of increasing concentration with indicators of urbanisation, such as population density.

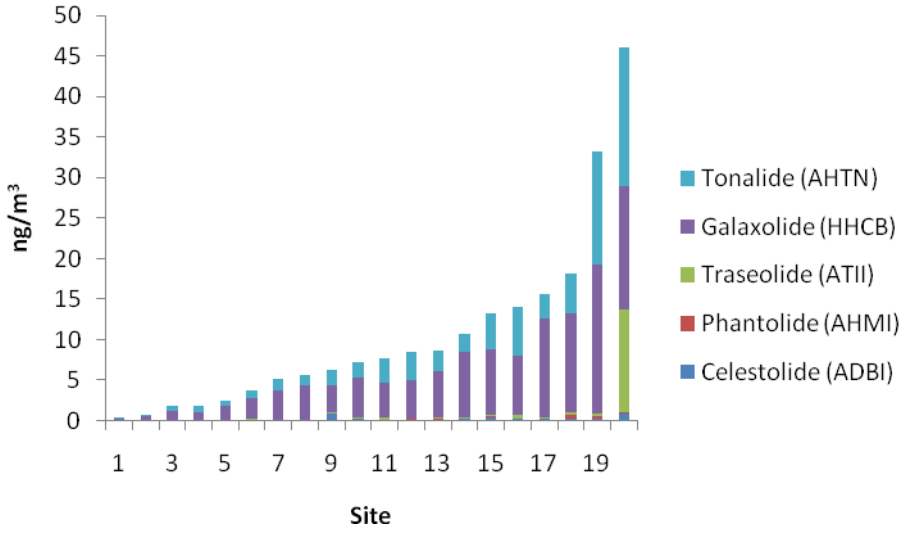

Figure 2: Concentration and composition of polycyclic musks in indoor air

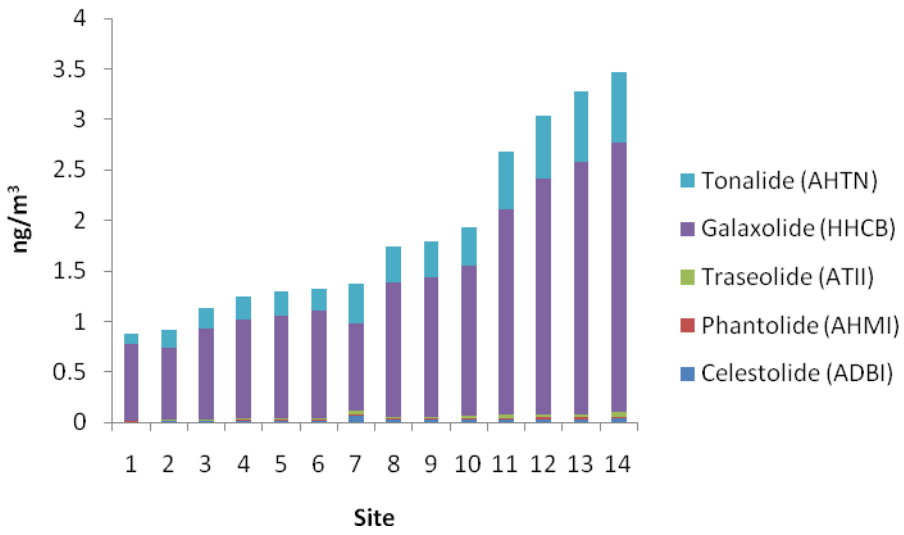

Figure 3: Concentrations and composition of polycyclic musks in outdoor air

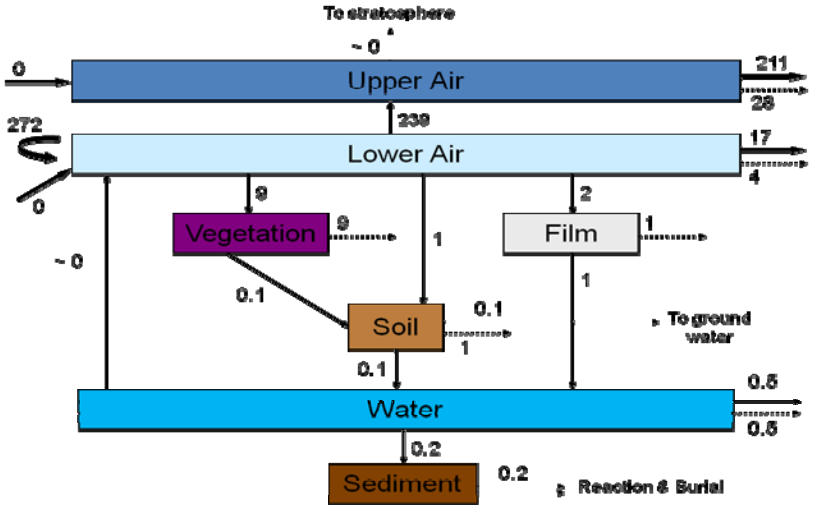

Figure 4: Modelled environmental fate of Galaxolide (HHCB) in the urban atmosphere with 272 g/h (1 mol/h) emission to the lower air compartment. Rates are expressed in g/h.

To elucidate the environmental fate of these chemicals, we used the Multimedia Urban Model (MUM) parameterized for Toronto, Canada, with an illustrative emission of 272 g/h (1 mol/h) emission of Galaxolide to the lower air compartment (0-50 m height, Figure 4). The model results suggested that >95% of emissions are lost via atmospheric transport downwind from the city, which is consistent with this compound's relatively high vapour pressure.

We next calculated adult human exposure to these compounds via inhalation. We assumed 95% of time spent indoors and 5% outdoors and with an inhalation rate off 20 m^3 per hour[10]. The inhalation estimates ranged from 600 ng/day for the 5th percentile to 19000 ng/day for the 95th percentile, with an average adult exposure due to inhalation of 7000 ng/day (Table 1). In all cases inhalation was dominated by Galaxolide and Tonalide. In comparison, Roosens et al.[11] estimated dermal exposure of Galaxolide and Tonalide of 5825 and 1533 µg/day, respectively (medium exposure). Although inhalation exposures are ~10^3 less than dermal exposure[11], it could be important for those people taking active measures to avoid these compounds.

Table 1: Adult human exposure of selected polycyclic musks due to inhalation (ng/day) of indoor and outdoor air.

	5th percentile	Average	Median	95th percentile
Celestolide (ADBI)	13	150	100	370
Phantolide (AHMI)	3	45	23	160
Traseolide (ATII)	12	500	52	2450
Galaxolide (HHCB)	450	4100	2630	9760
Tonalide (AHTN)	130	2250	1400	6320
Total PCM	600	7050	4200	19060

Acknowledgements

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