Bull. Environ. Contam. Toxicol. (1988) 40:447–450

Environmental Contamination and Toxicology

Moss Bags as Monitors of Organic Contamination in the Atmosphere

W. M. J. Strachan and W. A. Glooschenko

National Water Research Institute, Canada Centre for Inland Waters, Burlington, Ontario, Canada, L7R 4A6

Trace organic chemicals have been detected in many remote parts of our global ecosystem, including the atmosphere (Bidleman and Olney, 1974; Eisenreich et al., 1981) where facilities for sophisticated sampling are not usually available. Moss "bags" have been employed for sampling several types of atmospheric contamination including heavy metals (Ratcliffe, 1975; Cameron and Nickless, 1977) and have also been suggested as a sampling matrix for the organics (Thomas, 1979). Associated with a 1984 rain sampling program of the National Water Research Institute, moss sample bags were hung with the organic rain samplers (Strachan, 1985) in order to explore their utility as scavengers of atmospheric organic pollutants.

MATERIALS AND METHODS

Commercially available, Sphagnum peat was washed (distilled water, methanol, distilled water) dried, sieved and 15-20 g placed in polypropylene mesh (1.5x2.0 mm) bags. Triplicates bags were placed at Caribou Island and Agawa Bay on Lake Superior, Ontario and at Kouchibouguac Park, New Brunswick, Canada (see figure). They were suspended beneath the rain samplers to prevent washout from the rain; in addition, one set of three bags was suspended in the open at the Agawa site with no protection from washout. A sample of native Cladonia lichen was collected from Kouchibouguac and Agawa near the end of the season (circa October); none could be obtained from Caribou Island which is a very small island and moss-free.

All samples were homogenized, extracted with dichloromethane and analysed by gas chromatography (Strachan, 1985). Results are shown in the table. Although the Spagnum peat samples are expressed as wet weight, they were "dry" and powdery; they have been

Send reprint requests to W. M. J. Strachan

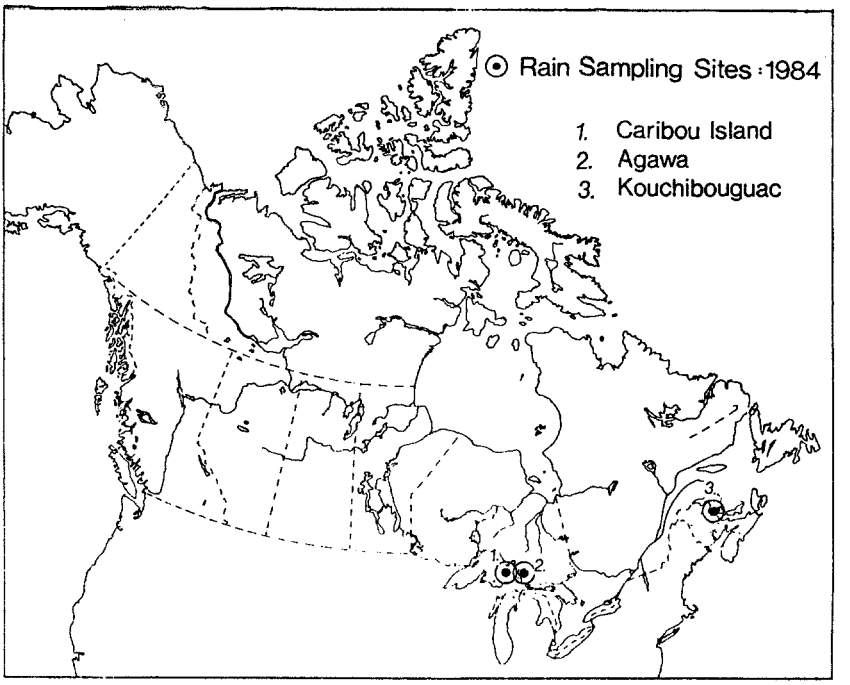

Table 1. Concentrations of PCBs and organochlorine pesticides in moss samples

	Kouch'ac Park		Caribou Is.	Agawa Bay		
	Shelter Moss	Native Lichen	Shelter Moss	Shelter Moss	Exposed Moss	Native Lichen
	ng/g(% rel.std.dev)					
a-BHC	3.2(14)	Ø.64	1.6(27)#	1.3(17)	Ø.88(2Ø)#	Ø.16
Lindane	Ø.83(24)	Ø.15	Ø.65(58)#	Ø.22(19)	Ø.18(44)	nd
Dieldrin	Ø.6Ø(2)#	nd@	nd	nd	nd	Ø.16
pp'-DDE	4.4(48)	4.3	nd	nd	nd	nd
op'-DDT	1.5(37)	1.3	nd	nd	nd	nd
pp'-DDT	46.(3)#	16.	nd	Ø.22(19)	nd	Ø.16
M'ychlor	nd	nd	nd	Ø.24(15)#	nd	Ø.16
PCB's	3.(22)	1.9	39.(35)	- - - - - - - - - - - - - *		
HCB	2.1(34)	1.4	Ø.6Ø(9)#	Ø.24(15)#	nd	Ø.16

#- results for duplicate samples @ - not detected
* - very poor reproducibility but apparently high levels

corrected for blanks. The native lichen results are expressed as dry weight. In addition to the compounds reported in the table, others were investigated but not found at significant levels. These included (with approximate detection limits in ng/g): heptachlor epoxide (Ø.2), endrin (Ø.Ø5), p,p'-DDD (Ø.1), a- and g-chlordane (Ø.2 ea.) and toxaphene (1Ø.).

RESULTS AND DISCUSSION

The Sphagnum peat was extremely dry and considerable (50-75 %) material was lost due to loss of finer material from wind action on the mesh bags. The reported results are therefore not quantitative measures of exposure during the season. An examination of these semi-quantitative determinations indicates that the compounds found are the same as those found in rain samples from the Lake Superior area (Strachan, 1985) and that the levels were generally higher at Kouchibouguac than elsewhere. PCBs were an exception being highest at Caribou Island (Agawa might have been higher but lack of reproducibility prevents this conclusion).

Levels of contaminants at Caribou are somewhat higher than at Agawa which is approximately 100 km "downwind" entirely over water. This observation is in keeping with similar observations for levels in rain from Caribou Island and Isle Royale (200 km "upwind") during 1983 (Strachan, 1985) and in rain for the same locations in 1984 (Strachan, in preparation). This probably reflects atmospheric washout or dry deposition as the air mass moves over the water.

In the two cases where comparisons were possible, the sheltered peat samples had considerably higher a-HCH/lindane levels than the exposed peat or native lichen. This was probably due to the lack of exposure to rain for the sheltered peat and a correspondingly decreased likelihood of extraction of any sorbed contaminants. The results are suggestive of adsorption of the contaminants during the dry periods. HCB and PCBs, which also appear at apparently significant levels, partition more strongly to organic particulate matter and hence show less effect of exposure. Similar statements cannot generally be made for the other contaminants since their levels were closer for the two sample types and were also closer to detection.

It would seem that there is little feasibility for using moss bags as monitors of atmospheric levels of persistent organic contaminants. The situation may change when more quantitative efforts are undertaken, in particular the provision of air permeable, finer mesh bags and more intensive efforts to determine the extent of sorption and analytical recoveries. Even then, however, the samplers are only passive which makes them poor indicators of the quantity of air sampled. They may be used qualitatively to compare locations and to provide an inexpensive early warning indicator of the need for further quantitative sampling and analysis.

REFERENCES

Bidleman TF, Olney CE (1974). Chlorinated hydrocarbons in the Sargasso Sea atmosphere and surface water. Science 183: 516-518.

Cameron AJ, Nickless G (1977). Use of mosses as collectors of airborne heavy metals near a smelting complex. Water, Air & Soil Pollution 7: 117-125.

Eisenreich SJ, Looney BB, Thornton JD (1981). Airborne organic contaminants in the Great Lakes ecosystem. Envir. Science & Technol. 15: 30-38.

Ratcliffe JM (1975). An evaluation of the use of biological indicators in an atmospheric lead survey. Atmospheric Environment 9: 623-629.

Strachan WMJ (1985). Organic substances in the rainfall of Lake Superior: 1983. Envir. Toxic. & Chem. 4: 677-683.

Thomas W (1979). Monitoring organic and inorganic trace substances by epiphytic mosses -- a regional pattern of air pollution. Trace Subst. Envir. Health 13: 285-289.

Received June 15, 1987; accepted October 31, 1987.