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**MOSS BAGS AS MONITORS OF
ORGANIC CONTAMINATION IN THE ATMOSPHERE**

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Executive Summary

Moss bags and lichen have been examined as monitoring aids for atmospheric deposition of organic contaminants. Remote locations (Caribou Island and Agawa on Lake Superior and Kouchibouguac in New Brunswick, Canada) were used and alpha-BHC, lindane, PCBs and HCB were found at all locations. Dieldrin, the DDT residues and methoxychlor were found less frequently and endrin, heptachlor epoxide, chlordane and toxaphene were not observed at significant levels. Levels of observed substances were generally in the order: moss sheltered from the rain > exposed moss > native lichen; levels from Kouchibouguac were generally higher than those from Lake Superior.

UTILISATION D'ECHANTILLONNEURS A MOUSSE POUR SURVEILLER LA
CONTAMINATION ORGANIQUE DE L'ATMOSPHERE

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Résumé - Gestion

On a étudié la possibilité d'utiliser des échantillonneurs à mousse et des lichens pour la surveillance du dépôt atmosphérique de contaminants organiques. Des endroits éloignés (îles Caribou et Agawa, lac Supérieur, et Kouchibougouac, Nouveau-Brunswick, Canada) ont été utilisés et on a constaté la présence d'alpha-BHC, de lindane, de PCB et de HCB à tous ces endroits. La présence de dieldrine, de résidus de DDT et de méthoxychlore étaient moins fréquente alors que les cas d'observation d'endrine, d'époxyde d'heptachlore, de chlordane et de toxaphène ne correspondaient pas à des concentrations significatives. Les concentrations des substances observées étaient habituellement dans l'ordre décroissant suivant : mousse abritée de la pluie, mousse exposée, lichen autochtone; les teneurs observées à Kouchibougouac étaient généralement supérieures à celles du lac Supérieur.

UTILISATION D'ECHANTILLONNEURS À MOUSSE POUR SURVEILLER LA
CONCENTRATION DE COMPOSÉS ORGANIQUES DANS L'ATMOSPHERE

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On a décelé la présence de composés organiques à l'état de traces dans plusieurs régions éloignées de notre écosystème global, y compris l'atmosphère (Bidleman et Olney, 1974; Eisenreich et al., 1981), où des dispositifs d'échantillonnage perfectionnés ne sont habituellement pas disponibles. On a utilisé des échantillonneurs à mousse pour échantillonner plusieurs types de contaminants atmosphériques, y compris les métaux lourds (Ratcliffe, 1975; Cameron et Nickless, 1977), et on a également suggéré leur utilisation comme matrice d'échantillonnage pour les composés organiques (Thomas, 1979). Utilisés en 1984 au cours d'un programme d'échantillonnage des eaux de pluie de l'Institut national de recherche sur les eaux, les échantillonneurs à mousse étaient suspendus avec des collecteurs de précipitations de matières organiques (Strachan, 1985) afin de permettre l'évaluation de leur utilité pour la cueillette de polluants organiques atmosphériques.

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

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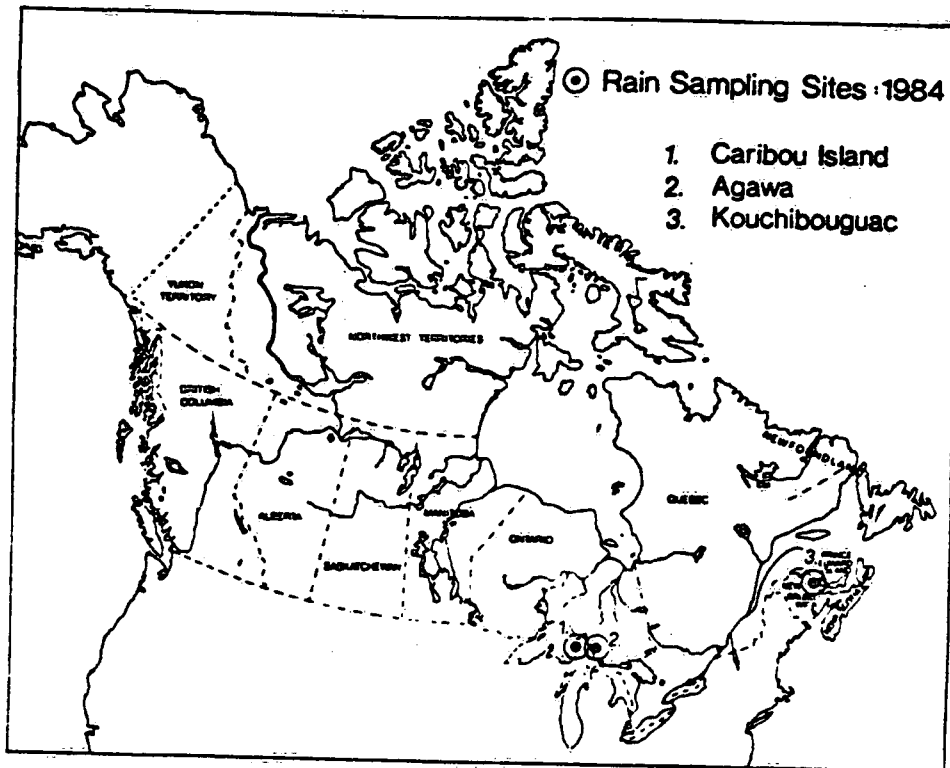


Table: Concentrations of PCBs and Organochlorine Pesticides in Moss Samples

	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)	0.64	1.6(27)#	1.3(17)	0.88(20)#	0.16
Lindane	0.83(24)	0.15	0.65(58)#	0.22(19)	0.18(44)	nd
Dieldrin	0.60(2)#	nd@	nd	nd	nd	0.16
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	0.22(19)	nd	0.16
M'ychlor	nd	nd	nd	0.24(15)#	nd	0.16
PCB's	3.(22)	1.9	39.(35)	-----	-----	*
HCB	2.1(34)	1.4	0.60(9)#	0.24(15)#	nd	0.16

- 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 (0.2), endrin (0.05), p,p'-DDD (0.1), a- and g-chlordane (0.2 ea.) and toxaphene (10.).

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.

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