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Trace metal contaminants in algae of Bermuda waters

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Fourteen species of Chlorophyceae, five species of Phaeophyceae, five species of Rhodophyceae and two species of Monocotyledoneae from Bermuda waters were examined for ten prominent bioaccumulated trace metal contaminants. It was found that the level of these trace metals, viz., Cd, Co, Cr, Cu, Fe, Mn, Pb, Zn and Hg, ranged between BDL- 1.12, BDL- 10.52, BDL- 9.47, 0.65-9.69, 1.90-249.76, BDL- 4.79, BDL- 4.79, BDL- 5.01, 0.49-18.84, 2.85-20.87 ppms and BDL respectively. Obviously, this reflects the cleanliness of Bermuda waters from the viewpoint of trace metal contaminants as a tourist resort.

Key Index Words: *Algae*; *Bermuda waters*; *trace metal.*

Bermuda's economy is primarily dependent on its tourist industry and heavy industry is practically nonexistent. Hence, no local source for hydrocarbons, heavy metals, or organic pollution exists. Only one major sewage outfall exists on the island, and its effect on the chemistry of seawater is localized and easily defined.

The islands of Bermuda are located in the Sargasso Sea where they act as a passive "net" collecting any floating matter from a twenty-mile wide area of ocean. Many of the heavily travelled tanker routes cross or coincide with the currents which eventually feed into the Sargasso Sea. Furthermore, the Sargasso Sea located in the midst of the North Atlantic gyre system, tends to accumulate floating material rather than to disperse it (BUTLER *et al.* 1973).

Studies have indicated that long-lived petroleum residues "pelagic tar" released on the surface of the sea by crude oil tankers in the process of tank cleansing and deballasting are highest in concentration in the Sargasso and Mediterranean Seas (MORRIS and BUTLER 1973; MORRIS *et al.* 1975). Since Bermuda is the only land mass in the Sargasso Sea the fate and weathering of considerable quantities of the tar eventually stranded on Bermuda's beaches has been studied by BLUMER *et al.* (1973), ZSOLNAY (1978) and ILIFFE and KNAP (1979). Also there is a study by WADE and QUINN (1975) on the hydrocarbon levels on the surface microlayer in the Sargasso Sea.

From the view point of effective litigation in the light of an oil-spill on the tourist industry of Bermuda a case-study has been reported in 1978 (SLEETER and BUTLER). MORRIS *et al.* (1976) exemplified the transfer mechanisms of petroleum to biogenic hydrocarbons in *Sargassum* communities of the Sargasso Sea. Detailed studies by ZSOLNAY *et al.* (1977) on biogenic hydrocarbons in 84 intertidal algal communities of Bermuda indicated an overall mean level of 33.5 μg/g of wet weight. Similar studies by MAYNARD *et al.* (1977) indicated the possibility of some algal samples containing high levels of petrogenic hydrocarbons from area of heavy tar accumulation.

It is obvious from the foregoing that much of the studies on environmental contamination in Bermuda waters are focussed on oil pollution. Hence, to widen the spectrum the author has endeavoured to investigate the

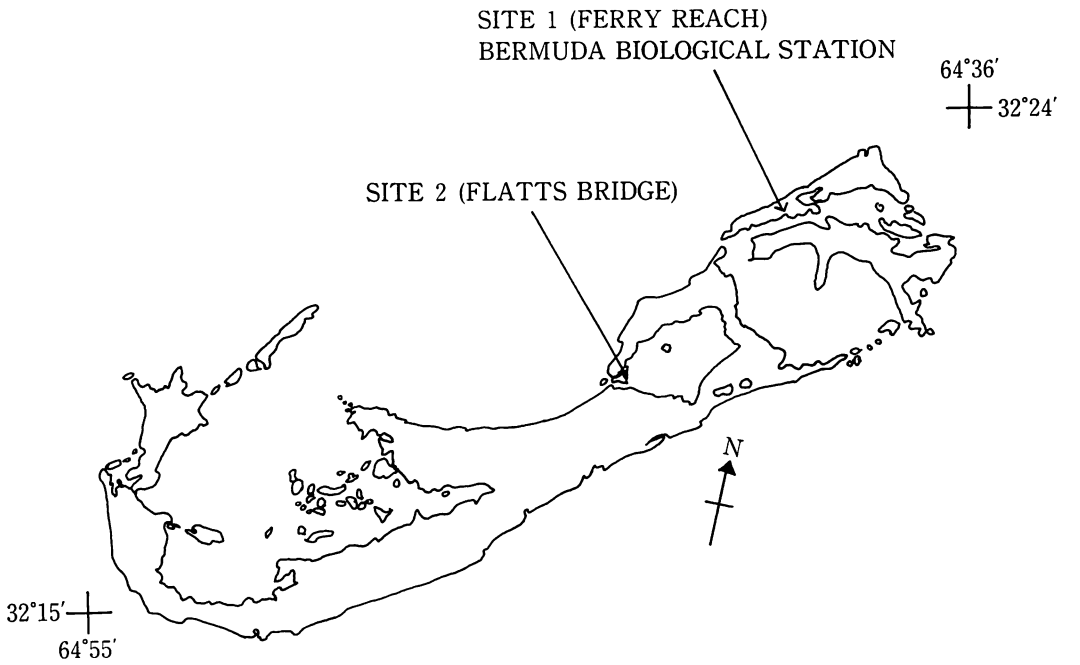

Fig. 1.

trace metal contaminant status of macroalgae found in Bermuda waters in cmparison to those of other regions.

Materials and Methods

Algal samples were collected between 11-26th January 1980 during the "Workshop on the Intercalibration of Sampling Procedures of the IOC/WMO/UNEP Pilot Project on Monitoring Background levels of Selected Pollutants in Open-Waters" at Ferry Reach, where the Bermuda Biological Station is located and Flatts Bridge of Harrington Sound for the *Sargassum* species (Fig. 1). All algal species after careful culling were washed three times with triple glass distilled water and dried completely in an air-oven at 60°C.

For the determination of trace metals other than Hg, 0.5 gm of each dried alga was predigested overnight in 10 m*l* of 25% hypochlorous acid and nitric acid (1 : 2) mixture before being digested in a Kjeldahl flask on an electric heater. The digested solution was filtered, diluted and analyzed using an Atomic Absorption Spectrophotometer. All values were calculated as μg/g dry weight sample.

Total mercury content in the dried thalli was calibrated using a Coleman Mercury Analyzer MAS-50 according to the method by STANLEY *et al.* (1971).

Results and Discussions

Table 1 shows the levels of trace metals detected in the algal species of Bermuda. In general, the levels are low with the overall tendency of higher levels within them found in the Chlorophyceae excepting a few in species of other families. Comparison of these values with those reported (LYONS *et al.* 1983) for Fe, Pb, Cd, Cr, Cu and Zn in sediments from Mills Creek, Hamilton Harbour, Lover's Lake and Hungary Bay, those of only Fe and Cd are higher in some algal species. In relation to available data on algal species from Malaysian waters (SIVALINGAM, 1978 and 1980) the bioaccumulated values of

Table 1. Bioconcentrated trace metals in algae of Bermuda waters

Algal species	Trace metal content (ppm)									
	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Hg
CHLOROPHYCEAE										
Acetabularia crenulata	1.12	1.66	8.96	2.05	129.62	1.00	2.50	18.84	8.86	*BDL
Avrainvillea longicaulis	1.12	BDL	8.98	1.03	46.34	2.01	3.76	10.26	6.37	BDL
Caulerpa brachypus	BDL	5.00	5.97	4.10	249.76	3.00	2.50	7.07	6.00	BDL
Caulerpa racemosa	BDL	3.34	2.29	3.08	240.22	2.00	1.25	11.15	7.43	BDL
Codium spp.	0.55	1.65	2.96	2.03	31.35	0.99	BDL	4.67	4.08	BDL
Cymopolia barbata	0.56	1.67	BDL	2.05	47.52	BDL	1.25	7.08	4.28	BDL
Enteromorpha plumosa	BDL	1.67	2.99	6.14	148.67	3.00	1.25	4.71	6.33	BDL
Halimeda incrassata	0.56	5.01	2.99	2.05	4.75	BDL	2.51	9.44	4.75	BDL
Halimeda monile	1.12	3.34	4.48	2.05	37.94	BDL	5.00	9.42	2.85	BDL
Halimeda tuna	1.12	5.00	4.48	2.05	34.78	BDL	2.50	7.07	2.85	BDL
Lobophora variegata	BDL	BDL	BDL	4.78	53.16	4.67	BDL	13.17	11.08	BDL
Monostroma oxyspermum	0.56	3.34	5.99	4.10	37.89	4.00	1.25	16.49	6.95	BDL
Penicillus capitalus	0.56	3.34	BDL	2.05	11.40	2.01	5.01	8.26	5.07	BDL
Valonia spp.	BDL	5.0	BDL	1.02	158	BDL	2.50	4.71	12.64	BDL
PHAEOPHYCEAE										
Colpomeina sinuosa	BDL	8.39	3.75	5.15	23.84	BDL	3.14	5.92	7.95	BDL
Dictyota spp.	0.56	1.67	2.99	4.10	196.02	BDL	1.25	7.07	8.22	BDL
Padina sanctaecrucis	0.89	5.29	9.47	0.65	29.08	1.59	3.97	2.24	17.55	BDL
Sargassum fluitans	0.56	2.51	BDL	1.03	2.53	1.00	2.51	4.70	3.80	BDL
Sargassum natans	0.56	1.67	BDL	2.05	1.90	BDL	1.26	7.08	4.13	BDL
RHODOPHYCFAE										
Acanthophora spicifera	BDL	BDL	BDL	4.91	75.75	4.79	BDL	11.29	18.18	BDL
Amphiroa fragilissima	1.12	3.34	5.97	4.11	41.14	3.00	2.50	11.79	6.65	BDL
Bostrychia spp.	BDL	10.52	4.71	9.69	99.79	BDL	3.95	11.15	15.47	BDL
Laurencia obtusa	0.56	1.66	5.97	4.09	36.36	3.00	1.75	7.06	20.87	BDL
Spyridia spp.	BDL	BDL	BDL	5.42	83.69	BDL	BDL	2.49	16.74	BDL
MONOCOTYLEDONEAE										
Thalassia testudinum	BDL	BDL	7.23	4.96	53.01	BDL	BDL	5.71	11.49	BDL
Zostera spp.	0.56	3.02	BDL	4.09	12.01	BDL	1.25	0.47	17.07	BDL

* BDL; Below detectable level.

the algal species at Bermuda waters are relatively low and fall within the category of water-type 1 for unpolluted waters as designated by HAGEHALL (1973).

Evidently, it can be concluded from the available information that at least currently the waters of Bermuda are not contaminated with trace elements to cause much concern for the tourist industry.

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P. M. シバリンガム：バーミューダ島で採集した海藻の微量金属量

サルガッソー海のバーミューダ島で採集した緑藻14種，褐藻5種，紅藻5種それに単子葉植物2種について，次の10種類の微量金属の含量を調べた。すなわち，Cd, Co, Co, Cr, Cu, Fe, Mn, Pb, Zn および Hg の含量はそれぞれ，BDL-1.12, BDL-10.52, BDL-9.47, 0.65-9.69, 1.90-249.76, BDL-4.79, BDL-4.79, BDL-5.01, 0.49-18.84, 2.85-20.87 ppm および BDL であった。この微量金属の含量から見るとバーミューダ島近海は清澄であることがわかる (BDL: Below detectable level). (School of Biological Sciences, University of Sciences Malaysia, Minden, Pulau Pinang, Malaysia)