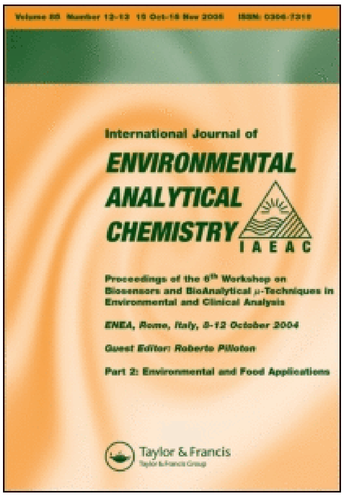

International Journal of Environmental Analytical Chemistry
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713640455

Cadmium in New Zealand Dredge Oysters: Geographic Distribution

Stephen A. Nielsen[a]
[a] Fisheries Research Division, Ministry of Agriculture and Fisheries, Wellington, New Zealand

To cite this Article Nielsen, Stephen A.(1975) 'Cadmium in New Zealand Dredge Oysters: Geographic Distribution', International Journal of Environmental Analytical Chemistry, 4: 1, 1 — 7
To link to this Article: DOI: 10.1080/03067317508071096
URL: http://dx.doi.org/10.1080/03067317508071096

Intern. J. Environ. Anal. Chem., 1975, Vol. 4, pp. 1–7

Printed in Great Britain

Cadmium in New Zealand Dredge Oysters: Geographic Distribution

STEPHEN A. NIELSEN

Fisheries Research Division, Ministry of Agriculture and Fisheries, Wellington, New Zealand

(*Received September 15, 1973*)

High Cd levels of up to 9 ppm wet wt. have been found in the dredge oyster, *Ostrea lutaria* (Hutton), from Foveaux Strait, New Zealand. Average Cd levels in the oysters were determined at 24 stations in order to obtain a pattern of the geographic distribution of Cd. These data, in combination with a consideration of the prevailing currents, indicate that the source of the Cd must lie to the west of Foveaux Strait, possibly in Fiordland. These high Cd levels are naturally occurring since there is no industrial pollution in the area. Compared with other oyster species, *O. lutaria* may have a predilection for accumulating Cd.

KEY WORDS: Cadmium, oysters, geographic distribution, trace metals.

INTRODUCTION

Brooks and Rumsby[1] found unusually high cadmium levels in dredge oysters (*Ostrea lutaria* Hutton) from Tasman Bay, New Zealand. The average Cd content was 35 ppm dry weight (which is approximately equal to 6 ppm wet weight). Such high levels are not normally found in oyster species from other parts of the world, (Table 1) nor are they representative for *O. lutaria* from other parts of New Zealand. The high Cd levels in *O. lutaria* from Tasman Bay may result from high Cd levels in the waters of Tasman Bay, due to the large amount of river run-off associated with an area of high mineral content.

Recent analyses of *O. lutaria* from Foveaux Strait (Figure 1) have shown high Cd levels similar to those in Tasman Bay. Individual oysters with over 9 ppm (wet wt.) were found, and the average value for all samples was 5.75 ppm (wet wt.). *O. lutaria* is common in the southern region of the South Island of New Zealand, and in Foveaux Strait dense populations support a dredge fishery.[6] Water masses from two different regions impinge on Foveaux

TABLE I
Cd content of various oyster species

Country and species		Locality[a]	ppm Cd wet weight[b]
New Zealand			
	Ostrea lutaria	Wellington (2)	0.12 (8)
		Marlborough Sounds (2)	1.3 (12)
		Golden Bay (2)	1.42 (12)
		Tasman Bay (1)	approx. 6 (6)
		Foveaux Strait (this study)	5.75 (360)
	Crassostrea glomerata	Bay of Islands (2)	0.65 (40)
		Auckland (2)	0.75 (118)
		Bay of Plenty (2)	0.55 (60)
United Kingdom			
	Ostrea edulis	England and Wales (3)	1.2 (49)
United States			
	Crassostrea virginica	East coast (4)	2.40 (30)
		Florida (5)	0.2 (3)

[a] Literature reference indicated in parentheses.
[b] Number of samples indicated in parentheses.

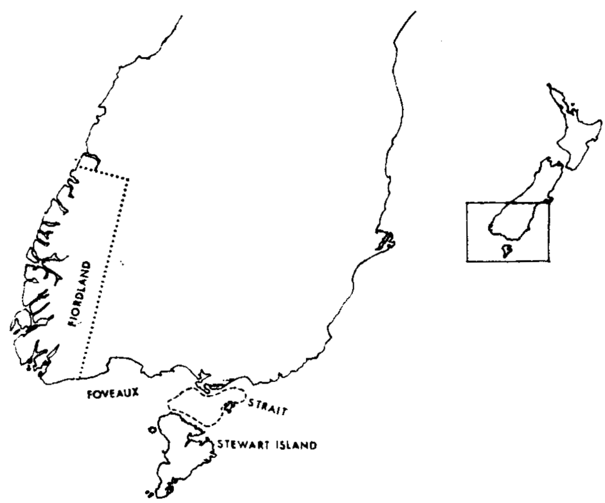

FIGURE 1 Location map. The dashed line in Foveaux Strait indicates the approximate limits of occurrence of *Ostrea lutaria* in the Strait, and the dotted line indicates the Fiordland area.

Strait making it an ideal area to study the geographic distribution of Cd levels in oysters. In particular it was hoped that concentration gradients existed within the oyster population which would make it possible to identify the source of the Cd.

The toxic effects of Cd have been reviewed by Flick[7] and will not be discussed here.

METHODS

Samples of *Ostrea lutaria* were dredged at 15 stations in Foveaux Strait, and were collected by diving at 9 stations around Stewart Island (Figure 1). The size range of oysters used for Cd analysis was 7–12 cm (measured as height) which is approximately equal to a body weight of 8 g or more. From each station 14–20 oysters were pooled and homogenized together. 10 g of the homogenate was dried at 105°C for 24 hours, then ashed for 12 hours at 450°C in a muffle furnace. Cd in the ash was dissolved in 20% HNO_3 and analysed by atomic absorption spectrophotometry. Recovery of added Cd was 100%.

RESULTS AND DISCUSSION

Cd content in Ostrea Lutaria

Fifteen *O. lutaria* of widely varying size were analysed individually to determine whether Cd content varies with body weight. The Cd content was found to be proportional to body weight up to a body weight of about 8–10 g, while in larger oysters the Cd content was independent of body weight (Figure 2).

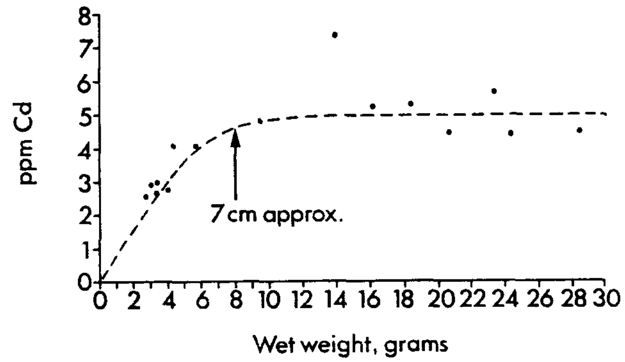

FIGURE 2 Concentration of Cd Vs. body weight for *Ostrea lutaria*.

In these larger oysters, a dynamic equilibrium is probably established whereby the rate of Cd excretion equals the rate of Cd intake. Since the rate of Cd intake is proportional to the Cd levels in the adjacent waters,[4] the Cd content of these larger oysters should be proportional to the Cd concentration in the surrounding seawater. So that analyses from the various stations would be reproduceable and representative of the Cd levels at equilibrium in the oysters, only oysters of 8 g body weight or greater were used for analysis.

Cd concentrations in 14 oysters from one station were determined individually. The average Cd content of the individuals was 4.49 ppm (wet weight), and the standard deviation was 0.21 ppm. This confirms the data of Brooks and Rumsby[1,8] which showed that individual *O. lutaria* from the same locality contain remarkably uniform concentrations of trace elements, with individual variation of Cd concentrations of only $\pm 10\%$. These authors also showed that there is little seasonal variation in Cd content of these oysters.

Geographic distribution of Cd in oysters

The concentrations of Cd in *O. lutaria* from Foveaux Strait and Stewart Island are presented in Table 2. These data (as ppm wet weight only) are presented diagrammatically in Figure 3. The Cd levels increase to the west of Foveaux Strait with the westernmost stations (1–6) averaging 7.16 ppm (wet weight), while lower values occur in the center and southeast of Foveaux Strait. The values in Stewart Island inlets are generally lower.

Currents and possible sources of Cd

Industrial pollution in Foveaux Strait is relatively little, particularly with respect to heavy metal pollution. Therefore it seems logical to suppose that the Cd source is of natural origin. Topographic deflection and concentration of winds around the main mountain mass of the South Island through Foveaux Strait coincides with the topographically restricted channel available for oceanic surface water movements and combines to produce a marked surface flow, the Southland Current (Figure 4), from the lower west coast of the South Island and the western approaches to Foveaux Strait through the Strait and out through the northeast.[9] This water is considerably affected by run-off from the adjacent coastal regions, due to the particularly high rainfall which occurs. The Fiordland area (Figure 1) is known to contain deposits of several minerals[10] including zinc, which often is associated with cadmium. This suggests that the source of the Cd may be in the vicinity of the Fiordland area, but unfortunately no oysters could be found closer to this area than those shown in Figure 3.

TABLE II

Cadmium in *Ostrea lutaria* from Foveaux Strait and Stewart Island

Station	Location	ppm Cd wet weight	ppm Cd dry weight
1	46° 31.4′ S, 167° 55.2′ E	6.43	35.7
2	46° 34.0′ S, 167° 54.0′ E	7.54	49.6
3	46° 37.4′ S, 167° 49.4′ E	7.10	44.0
4	46° 38.5′ S, 167° 54.0′ E	7.90	48.2
5	46° 34.5′ S, 168° 05.6′ E	6.82	39.0
6	46° 38.0′ S, 168° 03.2′ E	7.15	34.0
7	46° 42.0′ S, 167° 59.4′ E	4.30	27.4
8	46° 47.0′ S, 168° 04.8′ E	4.33	25.2
9	46° 40.0′ S, 168° 09.3′ E	4.49	29.2
10	46° 44.1′ S, 168° 12.1′ E	3.42	22.4
11	46° 48.0′ S, 168° 11.7′ E	5.24	32.4
12	46° 38.7′ S, 168° 16.6′ E	2.99	17.4
13	46° 41.8′ S, 168° 25.4′ E	3.65	19.4
14	46° 44.4′ S, 168° 23.8′ E	4.04	21.1
15	46° 41.9′ S, 168° 31.3′ E	4.40	27.6
16	Kaipipi Bay, Paterson Inlet	1.72	9.2
17	South West Bay, Paterson Inlet	5.15	31.4
18	White Beach, Port Adventure	2.79	14.9
19	Oyster Cove, Port Adventure	1.76	8.7
20	North Arm, Port Adventure	1.40	14.0
21	Lord's River	2.20	12.8
22	Shipbuilder's Cove, Port Pegasus	3.68	22.8
23	North Arm, Port Pegasus	1.68	10.7
24	Islet Cove, Port Pegasus	2.17	12.2

During the tidal stream oscillations, the water in the middle of Foveaux Strait becomes mixed with oceanic water which enters from the southeast. This oceanic water is presumed to be lower in Cd than the relatively enriched coastal waters entering from the west, and the resulting dilution would account for the eastward decrease in Cd levels in the oysters.

Two other possible sources of Cd were considered. The first was that a submarine mineral deposit could contribute Cd to the overlying waters. No such deposit has yet been found and the possibility seems unlikely since the floor of Foveaux Strait consists of an almost featureless sedimentary plain.[11] The second possibility was that Cd could be contributed via run-off from Stewart Island. This now seems unlikely since oysters from Stewart Island were generally lower in Cd content that those from Foveaux Strait. Samples from bays and inlets at nine locations on Stewart Island had an average of 2.5 ppm Cd (wet weight), and only two of the nine samples had over 3 ppm Cd.

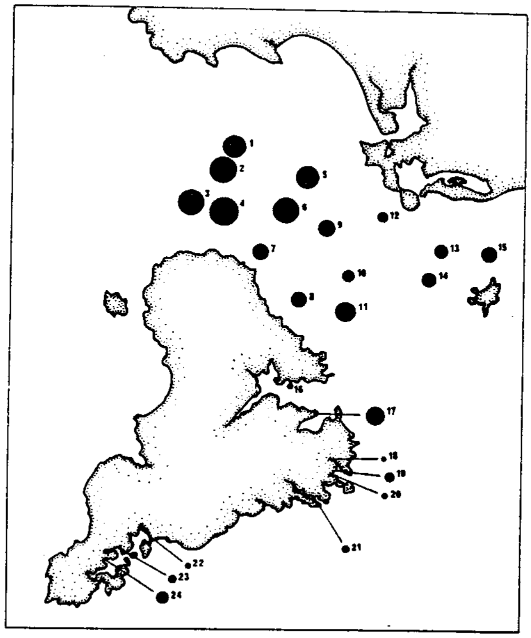

FIGURE 3 Diagrammatic representation of Cd content in *Ostrea lutaria* samples. The diameters of the circles are proportional to the wet weight concentrations of Cd.

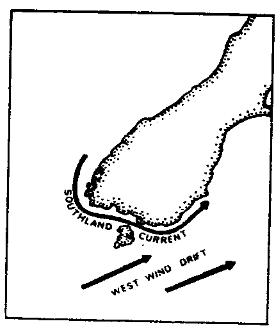

FIGURE 4 Currents affecting Foveaux Strait (modified from Brodie[9]).

One question which remains is whether *O. lutaria* have a greater predilection for Cd than other oyster species. This is quite possible, since *Crassostrea glomerata* (Gould), which live in the northern half of the North Island, New Zealand, generally have Cd levels almost an order of magnitude lower than *O. lutaria* from Foveaux Strait.[2] However, the question cannot be completely answered until either controlled laboratory growth experiments are done, or *O. lutaria* are found growing adjacent to other species in the natural environment. The latter possibility occurs only rarely (P. Dinamani, personal communication) since *C. glomerata* occurs only in intertidal areas, while *O. lutaria* is a deep water species.

The author wishes to thank the New Zealand National Research Advisory Council and the Fisheries Research Division of the Ministry of Agriculture and Fisheries for their support, and Ms. Jan Henriques for preparing the figures.

References

1. R. R. Brooks and M. G. Rumsby, *Limnol. Oceanog.* **10**, 521 (1965).
2. S. A. Nielsen, (in prep.)
3. J. E. Portman and J. D. Yardley, *Inter. Council for the Explor. of the Sea.* C.M. 1972/K:12 (1972).
4. C. N. Shuster and B. H. Pringle, *Proc. Nat. Shellfish. Assoc.* **69**, 91 (1969).
5. S. A. Nielsen, unpublished data.
6. D. H. Stead, *Fisheries Technical Report No. 59: New Zealand Marine Department* (1971).
7. D. F. Flick, *et al., Environ. Res.* **4**, 71 (1971).
8. R. R. Brooks and M. G. Rumsby, *Aust. J. Mar. Freshwat. Res.* **18**, 53 (1967).
9. J. W. Brodie, *N.Z. J. Geol. Geophys.* **3**, 235 (1960).
10. New Zealand Geological Survey. Minerals of New Zealand (Part A: Metallics). *N.Z. Geological Society, Report No. 38A* (1970).
11. D. J. Cullen, *N.Z. Ocean. Inst. Memoir No. 33*, (1967).