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Mercury Decontamination in a River of Mount Amiata

E. Bacci, C. Leonzio, and A. Renzoni
Chair of Hydrobiology and Fish-culture, University of Siena, Via delle Cerchia 3, 53100 Siena, Italy

Mount Amiata with its concentrated deposits of mercury-bearing minerals, especially cinnabar, has drawn the attention of mineralogists, geologists and geochemists. For more than a century intense mining has gone on with a high production of Hg: 1680 metric tons in 1969, as reported by OCDE (1974).

Following the widespread concern about the Hg pollution of the environment (LÖFROTH 1970, GOLDBERG 1970, WALLACE et al. 1970, GOLDWATER 1971, HARRISS 1971, SAHA 1972 and many others) the Amiata area suggested itself to biologists as a likely area for Hg pollution studies. Such studies have shown the presence of a variable amount of Hg on representative organisms of fauna and flora there (BOMBACE et al. 1973) and the occurrence of high Hg levels in the muscles of fish collected in two rivers (Paglia and Fiora) as opposed to the Hg content (around background levels) in fish from other rivers from the same mountain or from nearby hills (BACCI and RENZONI 1973). The waters of both rivers flow over rich cinnabar ores, and in addition Paglia received the untreated effluent of the plants involved in the final roasting and refining operations.

Since 1970 there has been a drastic reduction in mining activity because of the reduced world demand for mercury. At first the small mines were closed down, leaving only the two largest ones active. Then, in 1973, one of them also closed down entirely and the other installed depuratory equipment, thus reducing the amount of Hg in the water effluent from the previous $\sim$180 $mg.l^{-1}$ to $\sim$0.05 $mg.l^{-1}$ in the 20 cubic meters of water used each day. The waters from the only active factory are eliminated at a discharge point, 5 Km below the source of the Paglia.

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The decrease of mining and mercury refining (down to less than 1000 metric tons in 1974 and still declining) and the installation of the depuratory equipment stimulated us to undertake a long-range study involving annual testing of the natural and the industrial contamination of the river itself and hence of the living organisms within it.

For this analysis, we chose a benthic species (the fresh-water mussel Unio cfr. elongatulus Pfeiffer) collected from a large population in the river sediment, 20 Km south of the effluent discharge. We had previously (RENZONI and BACCI 1976) noticed a size-dependent accumulation of mercury in the abductor muscle of this species collected in the same station and we had studied the rate of Hg discharge from various organs and tissues in the laboratory.

MATERIALS AND METHODS

The animals were collected at the end of the summer in 1973 and at the same period of the year in 1974, 1975 and 1976. After 48 hours in clean water in the laboratory, sufficient time to eliminate the mantle cavity water and the faeces, the animal were killed and deep frozen (-25°C) in sealed plastic bags until the day of the analysis. The Hg content of the abductor muscles was determined by wet digestion followed by a flameless A.A.S. reading according to the method reported elsewhere (RENZONI et al. 1973).

RESULTS AND DISCUSSION

The Hg level in the abductor muscle of the mussels collected in 1973 was about one order of magnitude higher than the levels found in organisms collected in other rivers of Italy (unpublished data). In the years 1974-1975-1976 the Hg concentration in the abductor muscles of specimens collected from the same station was sharply reduced. The relative values for these years are reported in fig.1 (with the specimens subdivided by size). Notwithstanding the large range of results, even within individuals of the same size groups (see the high values

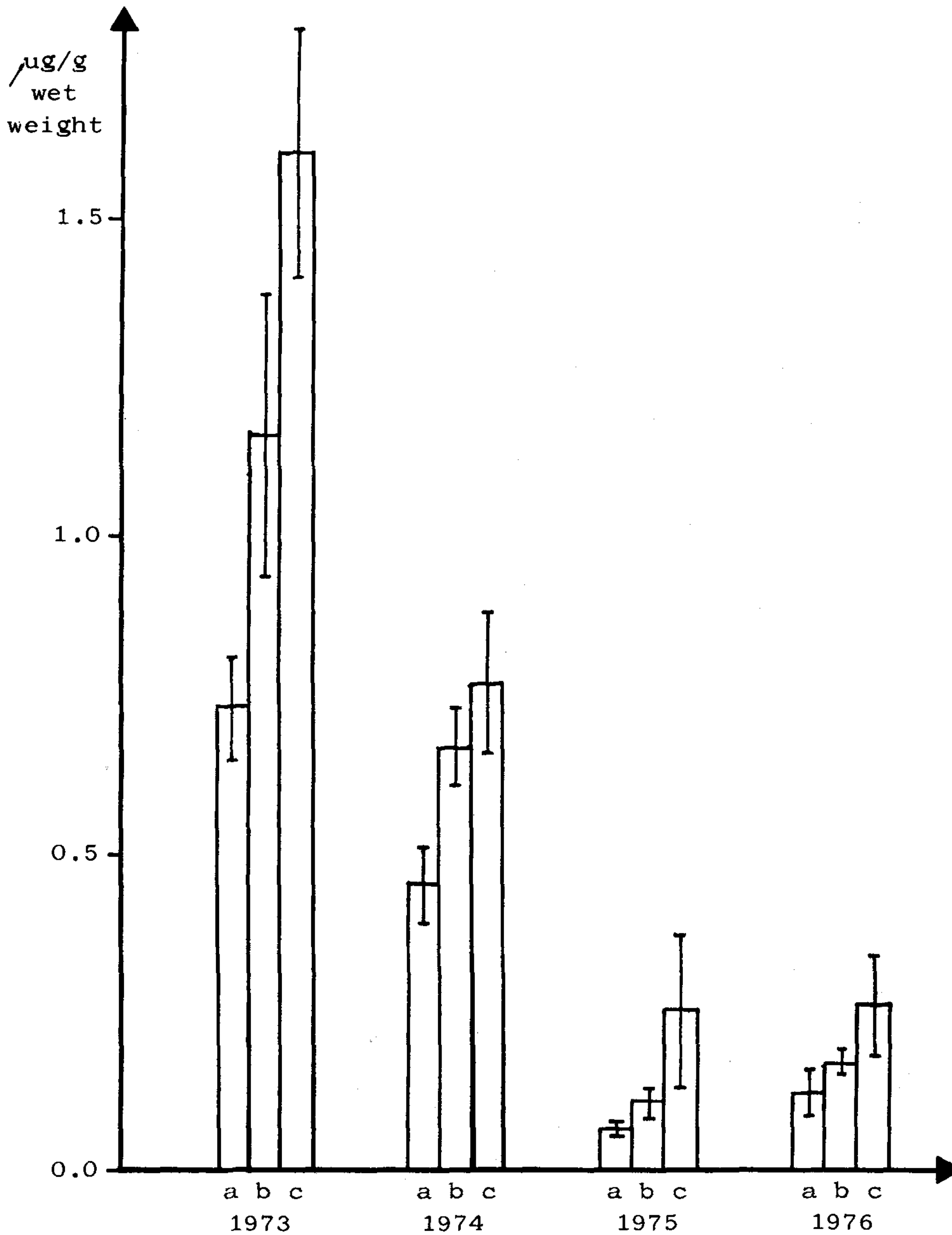

Fig. 1 - Total mercury concentration (mean ± 95% C.L.) in abductor muscles of mussels collected in the Paglia river in 1973,'74,'75,'76. Specimens are divided by length (mm) into three classes:

a = 41 - 60 b = 61 - 80 c = 81 - 100

of the 95% confidence intervals) a reduction of the mercury concentration in their muscles is quite evident after 1973 and particularly in 1974 and 1975. In the 1976 sample there was no decrease with respect to the 1975 values and the mercury concentration is only twice that of the background levels in these animals (0.03-0.07 $\mu g_{Hg} \cdot g^{-1}$, wet weight).

These repeated investigations suggest at least two general conclusions:

1) Depuratory equipment, when efficient, is able to substantially reduce the mercury concentration in the water of the effluent;
2) Whereas previously (BACCI and RENZONI 1973) we had no way of estimating what portion of the Hg in the river sediments and organisms derived from mining, roasting and refining activities and what was the natural contribution of the rocks of this anomalous cinnabar rich area, our present data indicate that most of the pollution was due to the various activities related to mercury production.

One may wonder, why after three years the mercury content of these organisms does not fall to background levels and why the 1976 values are pratically the same of those of 1975. Several explanations are suggested:
a) Mercury mining activities (even though on a reduced scale) have not ended, and the depuration of the effluent wastes of the plant is not perfect (the river still receives a mercury input of about 1 g a day);
b) The contamination of the river water has been going on for more than 100 years and a great quantity of Hg has accumulated in the sediment. This is especially true in the mussel sampling area, wich is rich in organic matter from a sewage outfall of a village with a population of about 5000 people located 3-4 Km upstream;
c) The mercury level in animals living in areas near concentrated deposits of cinnabar and other mercury-bearing minerals could be higher than the usual background one.

REFERENCES

OCDE: Le Mercure et l' Environnement. 2 rue André-Pascal 75775 Paris Cedex 16, France (1974).

LÖFROTH, G.: Methylmercury. Ecol. Res. Comm., Bull. 4, 2nd ed. (1970).

GOLDBERG, E.D.: The chemical invasion of the oceans by man, in 'Global effects of environmental pollution'. S.F. Singer ed., O. Reidel Publ. Comp., Dordrecht, Holland (1970).

WALLACE, R.A., FULKERSON, W., SHULTS, D.W. and W.S. LYON: Mercury in the environment. ORNL NSF-EP-1 (1971)

GOLDWATER, L.J.: Le Scienze 36, 40 (1971).

HARRISS, R.C.: Biol. Cons. 3, 279 (1971).

SAHA, J.G.: Residue Reviews 42, 103 (1972).

BOMBACE, M.A., CIGNA ROSSI,L., CLEMENTE, G.F., ZUCCARO LABELLARTE, G., ALLEGRINI, M., LANZOLA, E. and L. GATTI: Igi. San. Pubbl. 29, 191 (1973).

BACCI, E. and A. RENZONI: Rass. Med. Sper. 20, 60 (1973).

RENZONI A. and E. BACCI: Bull. Environ. Contam. Toxicol. 15, 366 (1976).

RENZONI,A., BACCI, E. and L. FALCIAI: Rev. Intern. Océanog. Méd. 31-32, 17 (1973).