

DRINKING WATER POLLUTION BY POLYCHLORINATED BIPHENYLS

Chevreuil M. and Granier L.

Institut d'Hydrologie et de Climatologie, 4, place Jussieu, 75252 Paris, France.

Abstract. PCBs were analysed in supply water in the Paris area. The quality of drinking water originating from aquifers or surface waters was not satisfactory, with an average concentration of 105 ng.l⁻¹. The 100 ng.l⁻¹ EEC standard was exceeded in 40% of the cases.

INTRODUCTION

A few studies deal with PCBs in drinking water. Most are related to extraction efficiency using solid adsorbents (Musty and Nickless, 1974; Lebel and Williams, 1980). PCBs being little soluble in water and not very mobile in soils (Lee et al., 1979) migration from contaminated soils to aquifers seemed unlikely. Similarly, as PCBs were meant to be carried in rivers mainly adsorbed on suspended solids, one could think they would be completely removed by the water treatment. Yet PCBs are found predominantly in the aqueous phase (73%) in the surface waters of the Paris area (Chevreuil et al., 1988). Furthermore, many studies show that the pollution of the Seine River basin by PCBs remains high since 1979 (Abarnou et al., 1987; Chevreuil et al., 1987; Marchand, 1989). It seemed therefore interesting to assess the contamination level of supply waters produced from surface waters and aquifers, as the Seine river and its two tributaries the Oise and the Marne supply 75% of the urban area of Paris (3 million m³ per day).

MATERIALS AND METHODS

The quality of drinking water was evaluated by sampling four representative points of the water distributed in the Paris area, originating from surface or groundwater (fig 1). Monthly samples were taken from the tap during 18 months. The origins and treatments of the sampled waters are showed table 1.

Table 1 : Origin and treatment of sampled tap water from december 1985 to june 1986.

Sampling point	Origine	Treatment
Melun (Seine et Marne)	Groundwater (Champigny limestone)	Sterilization
Paris (5 th district)	Groundwater + occasional river water	
Fontenay (Val de Marne)	River water (Marne)	Clarification and
Clichy (Hauts de Seine)	River water (Seine)	sterilization

The behaviour of PCBs in a filtration plant was also studied at the Orly plant from May 1985 to December 1987. We will only mention the main results, which have been developed elsewhere (Chevreuil et al., 1990). Bottled waters becoming an always more important part of human consumption, we have also analysed a few spring waters (Fig. 1). Samples of 1 or 2 l were extracted with three times 300 ml of hexane. The extracts were concentrated and, after florisil cleanup when necessary, they were analysed by capillary column gas chromatography (SCBS, l. 30 m; i.d. 0.25 mm). The quantification was done by comparison to a mixture of Aroclor 1242, 1254, and 1268, ranging from tri to nonachlorinated biphenyls.

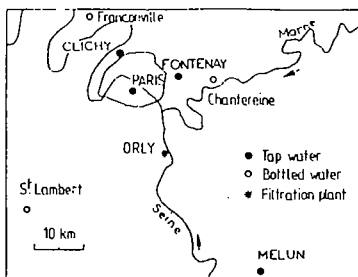


Figure 1 :
Situation of
sampling points

RESULTS AND DISCUSSION

Results of the four supply waters are reported on figure 2 and table 2.

Table 2: PCB concentrations (ng.l^{-1}) of tap water and at the orly plant.

	Melun	Fontenay	Paris 5 th	Clichy	Orly
Average	115	108	114	110	79
Standard deviation	72	127	75	85	49
Range	20-220	24-250	5-320	17-300	25-220
% exceeding 100 ng.l^{-1}	44	44	33	44	33

Whatever the area and presumed origin of the waters were, the concentrations remained high. 40% of the samples showed concentrations higher than the 100 ng.l^{-1} EEC standard, sometimes by a two to five fold. The average concentration was 110 ng.l^{-1} . Surprisingly these values reached 200 ng.l^{-1} in the groundwater originating samples, notably in Melun. The contamination level of the Champigny aquifer may be explained by the karstification of the water bearing bed. There are many dumps in the overlying formations, one of them could have received Pyralene wastes. Such pollution may lead to cease the exploitation during many years, as happened to an aquifer in the south of Montreal (Poulin et al., 1985). The impact of a dump on the aquifer (fluvio-glacial formation) of the Dronse delta (french bank of the Geneva lake) was established. While the concentrations in the river did not exceed 30 ng.l^{-1} , they varied in the alluvial aquifer from 50 to 370 ng.l^{-1} , depending on the dump proximity and the water table level.

The quality of waters sampled at Paris remained satisfactory during the first 12 months of the study. The maximal concentration measured in March 1986 (320 ng.l^{-1}) corresponded to that of Clichy, supplied by Seine water, and was probably due to a mixture in the distributed water (Seine water contribution or penetration of runoff water in the aqueducts coming from distant catchings).

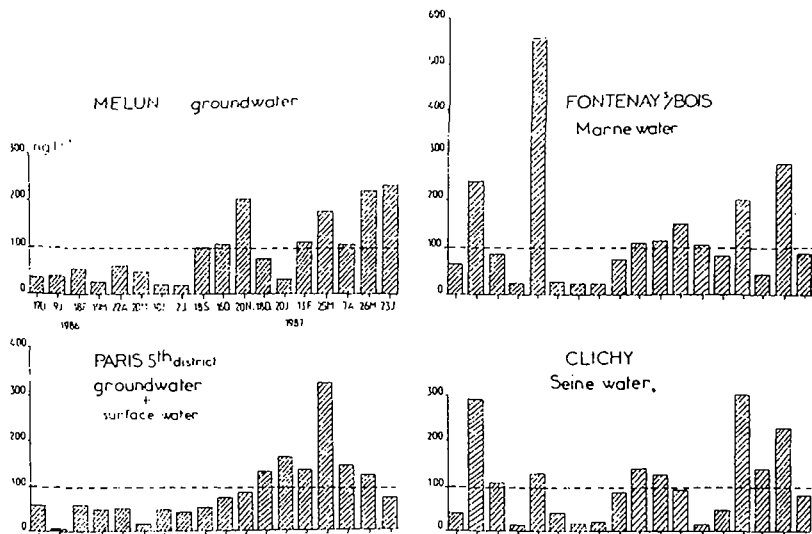


Figure 2 : Evolution of PCB concentrations in tap water from december 1986 to june 1987.

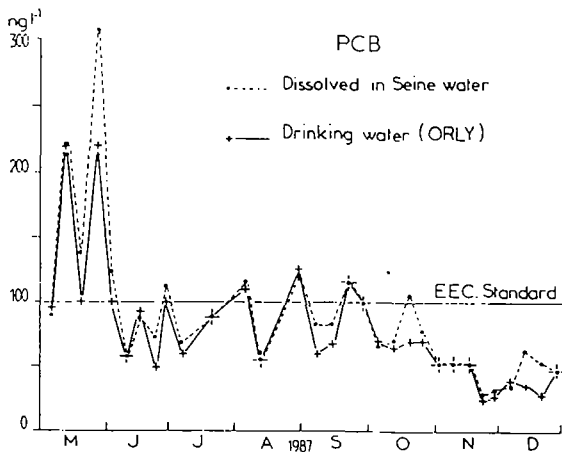


Figure 3 : Concentration of PCBs in Seine River aqueous phase and in drinking water from Orly plant.

Concentrations in bottled waters (Table 3) are near the value of 10 ng.l⁻¹ measured by Alencastro and Tarradellas (1988) in Swiss groundwater.

Table 3: Concentrations of some PCB components and of total PCBs in bottled waters.

	28	52	60	101	153	138	180	Total PCBs
Chantereine	0,26	0,74	0,31	1,2	0,87	1,2	0,92	21
Franconville	0,39	0,90	0,31	1,1	0,66	0,79	0,69	14
St Lambert	0,51	0,65	0,17	0,88	0,63	0,63	0,49	11

The concentration of PCBs in drinking water produced at the Orly plant were studied in relation with concentrations in raw Seine water, and partition between aqueous and adsorbed phase. The concentration in drinking water and in the aqueous phase of the river were very similar (fig.3). The treatment process only removed PCBs which were adsorbed on suspended solids. Under these conditions, 65% of the PCBs in the river were not removed in the plant.

The PCBs measured in the majority of the supply water samples were moderately chlorinated (pentachlorinated biphenyls), but in some samples, more chlorinated congeners (octa and nonachlorinated biphenyls) ranged up to 54% of total PCBs.

CONCLUSION

The PCB concentrations in waters produced from groundwater was as high (115 +/-75 ng.l⁻¹) as in waters originating from surface waters. Some aquifers seem to be polluted, probably by percolation through dumps.

80% of the PCBs dissolved in the Seine waters (74%) went through the treatment plant, leading to mean concentrations of 80 to 110 ng.l⁻¹, depending on the plant or the ressource.

ACKNOWLEDGEMENTS

We are grateful to the Société Anonyme de Gestion des Eaux de Paris for allowing us to take samples at the water treatment plant of Orly.

REFERENCES

- Abarnou A., Avoine J., Dupont J.-P., Lafitte R. and Simon S., 1987, Continental Shelf Res., 7 : 1345-1350.
- de Alencastro L.F. and Tarradellas J., 1988, Gaz, Eaux, Eaux usées, 68 : 120-130.
- Chevreuil M., Chesterikoff A. and Létolle R., 1987, Water Res., 21 : 427-434.
- Chevreuil M., Chesterikoff A. and Létolle R., 1988, Rev. Sci. de l'Eau, 1 : 321-337.
- Chevreuil M., Granier L., Chesterikoff A. and Létolle R., 1990, Water Res., to be published.
- Lebel G.L. and Williams D.T., 1980, Bull. Environ. Contam. Toxicol., 24 : 397-403.
- Lee M.C., Griffin R.A., Miller M.L. and Chian E.S.K., 1979, J. Environ. Sci. Health, A 14 : 415-442.
- Marchand M., 1989, Rev. Sci de l'Eau, 2 : 373-404.
- Musty P.R. and Nickless G., 1974, J. of Chromatography, 89 : 185-190.
- Poulin M., Simard G. and Sylvestre, 1985, Hydrogéologie, 2 : 125-131.