

## **PCB Residues in Mullet, *Mugil cephalus*, fed to Captive Eastern Australian Water Rats, *Hydromys chrysogaster***

Penny Woollard and H. Settle\*

*Division of Wildlife Research, CSIRO, P.O. Box 84, Lyneham, A.C.T. 2602, Australia*

*\*Australian Government Analytical Laboratories, Regional Laboratory (S.A.),  
344 Tapleys Hill Road, Seaton, S.A. 5023, Australia*

During an investigation into levels of organochlorine pesticides in water rats, *Hydromys chrysogaster*, from an irrigation area in New South Wales (in preparation), captive-raised water rats were found to contain polychlorinated biphenyl (PCB) residues. The most likely source of these residues was found to be mullet, *Mugil cephalus*, the major item of diet, obtained through a wholesaler from the Sydney fish markets.

The following is a report of the detection of significant levels of PCB's in the captive water rats and in mullet caught in waters adjacent to Sydney (Australia).

### **METHODS**

#### **I. Water Rat Material**

The water rats analysed were born and raised in captivity on a basic diet of fish (mainly mullet) and dog food pellets (K9 Ken'l Mix). They were killed with an overdose of Nembutal. Livers and kidneys were removed from six rats, mammary glands from two, preserved in 10% formalin and stored in glass jars.

In preparation for analysis organs were drained and air dried, cut into small pieces, mixed with sodium sulphate and extracted in a Soxhlet thimble for four hours using hexane. Further extraction showed no increase in residue levels. The hexane layer was dried by passing through anhydrous sodium sulphate and concentrated to 5 mls. This concentrated extract was mixed with 20 g of 2% deactivated florisil and added to a 20 g column of 2% deactivated florisil (SMYTH 1972). The combined column was eluted with 400 ml of 20% methylene chloride/hexane. The eluate was concentrated to 1 ml and examined by injection into a Varian 2700 G.L.C., fitted with a 0.2% DC 200/0.8% QF1 on Varaport 30 column, and a tritium electron capture detector.

#### **II. Extraneous Material**

Samples of items which may have contributed to exposure of the water rats to PCB's were analysed using the same technique. They included dog food pellets and their packaging, water and

cement from water tanks, fibro sheeting from pen walls, straw-bedding, wood and marineply from nest boxes, a fish container from a fishing boat and plastic and cardboard packaging from the fish.

### III. Mullet

Initially two mullet of unknown origin, purchased as food for the water rats, were analysed and the presence of PCB in one of them led to examination of further mullet from known areas. Mullet from three commercial fishing areas in New South Wales - Clarence River, Wallis Lake and waterways around metropolitan Sydney (Figure 1) - were purchased from the Sydney fish markets. Additional specimens, from thirteen localities in waters adjacent to Sydney, were supplied by NSW State Fisheries and caught by commercial fishermen using mesh or hauling nets. All specimens were approximately 33 cm long, and were gutted and frozen for storage.

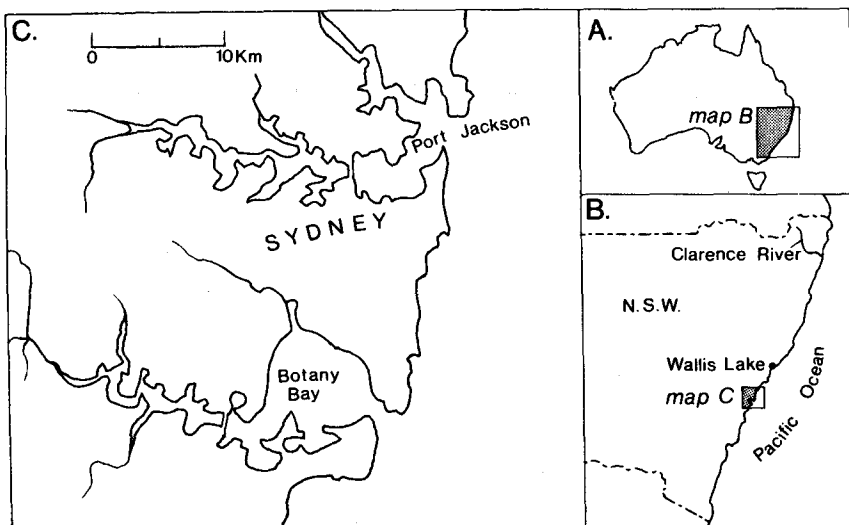


Figure 1. Areas referred to in text.

Prior to analysis, heads and tails were removed from the mullet and one half of the remainder minced in a blender. A 20 g subsample was then extracted by refluxing with 2% KOH in ethanol for 30 minutes (YOUNG *et al.* 1973). PCB's and organochlorines

were extracted into hexane, which was dried by passing through sodium sulphate. After concentration, the extract was partitioned with acetonitrile and passed through a 10 cm florosil column, eluting with 200 ml of 20% methylene chloride/hexane. The eluate was concentrated and injected into a Tracor 550 G.L.C. fitted with an OV1 column (3% on Varaport 30) and a Ni<sub>63</sub> detector.

Blanks were run at frequent intervals. PCB's were confirmed using thin layer chromatography (sandwich chamber and reverse phase). Recovery rates on a concentration of 1.0 ppm were 80% for Aroclor 1242 and 78.4% for Aroclor 1254.

## RESULTS

PCB residues, similar to Aroclor 1254, were detected in all six livers, three of six kidneys and both mammary glands (Table 1). Twenty-four water rats trapped in an irrigation swamp in rural New South Wales did not contain detectable levels of PCB's.

TABLE I

Residues in water rat livers, kidneys and mammary glands (ppm drained weight)

Water rat No.	PCB (Measured against Aroclor 1254)		
	Liver	Kidney	Mammary Gland
♂ 28/2-5	0.50	0.30	
♂ 1/4-3	4.10	ND	
♂ 8/6-2	NQ	ND	
♀ 2/2-1	0.35	0.20	
♀ 10/6-2	NQ	ND	
♀ 25/2-1	NQ	0.20	2.2
♀ 2/4-2	NA	NA	5.2

ND Not detected or less than 0.01 ppm

NQ Present, not quantified

NA Not analysed

Those items, found to contain PCB's, which may have contributed to contamination of the water rats are listed in Table II. No PCB's were detected in the other possible sources of contamination analysed. One of the two specimens of mullet, examined initially, contained PCB measured as Aroclor 1254. This suggested that mullet was the source of PCB's in the water rats, some of the components being selectively retained in the rats (HUTZINGER et al. 1974).

TABLE II

PCB residues found in one of two mullet and possible sources of contamination of the mullet (ppm wet weight)

Item	Use	PCB
Mullet (one specimen)	Food	1.0 (1254) in one specimen only
Cardboard )	Fish purchased and stored in these	9.6 (1242)
)		
Plastic Bag Type A )		1.7 (1242)
)		
Plastic Bag Type B )		1.4 (1242)
Plastic bucket	To carry fish	0.6 (1248)

In the subsequent analysis of mullet from three widely separated commercial fishing areas, PCB was found in three of ten mullet from Sydney waters (0.02, 0.24, 1.0 ppm, measured as Aroclor 1254) and was not detected in three mullet from the Clarence River and one from Wallis Lake.

Of the thirteen specimens of mullet from localities in waters adjacent to Sydney (Botany Bay and Port Jackson, Figure 1c), ten were found to contain PCB. Ten mullet contained PCB measured as Aroclor 1254, six of these also contained PCB measured as Aroclor 1242 (Table III). Organochlorines were detected but not quantified. PCB's were present in some of the wrappings around the mullet, however levels were not high enough to significantly influence residues in the fish.

TABLE III

Residues in single mullet, and wrapping in which mullet were stored, from Botany Bay and Port Jackson (ppm wet weight)

Locality	Aroclor 1254	Aroclor 1242	Wrapping	Aroclor 1242 wrapping
Port Jackson				
Hen and Chicken Bay	0.25	ND	Daily Telegraph - newspaper	NA
Leichardt Bay	1.1	4.1	Sydney Morning Herald - newspaper	ND
Burns Bay, Lane Cove River	0.23	ND	Envelope - brown business	NA
Snapper Is, Paramatta River	ND	ND	Daily Telegraph - newspaper	NA
Clifton Gardens, Chowder Bay	0.46	1.9	Sun - newspaper	0.41
Middle Harbour	0.57	ND	Sydney Morning Herald - newspaper	NA
Vaucluse Bay	ND	ND	Daily Mirror (inside) Sun (outside) - newspaper	NA
Botany Bay				
Oatley Bay	0.74	1.0	Plastic Bag (plain)	0.86
Kogarah Bay	1.6	ND	Plastic Bag (party ice)	NA
Georges River, Taren Pt. Bridge	0.75	5.3	Plastic Bag (plain)	NA
Woolooware Bay	0.77	5.0	Plastic Bag (plain)	NA
Towra Point	ND	ND	Plastic Bag (party ice)	NA
Brighton Beach, near Baths	1.1	3.1	Plastic Bag (plain)	NA

ND = not detected; NA = not analysed; \* = PCB's measured against Aroclors 1254 and 1242.

## DISCUSSION

Although PCB's have been found to be ubiquitous in the environment, there have been few reports of environmental contamination in the Southern Hemisphere (PEAKALL 1975) and no published studies in Australia.

Because of their low water solubility and high specific gravity PCB's are thought to rest as sludges or adsorbed in the sediment of water bodies near their point of discharge (NISBET and SAROFIM 1972). Mullet, because of their habit of feeding on the bottom, picking up detritus and diatoms (THOMSON 1954), could be exposed to PCB's in the sediment by ingestion and also via the gills.

PCB levels found in mullet from Sydney were of the same order of magnitude as those reported in studies on Northern Hemisphere fish (eg. PEAKALL 1975, HAMMOND *et al.* 1972). These authors draw attention to possible environmental effects of PCB's due to their high fat solubility and persistence. The U.S. Environmental Protection Agency recommends that residues of PCB's in the general body tissues of aquatic organisms should be less than 0.5 mg/kg (E.P.A. 1973). Eight of thirteen mullet in this study contained PCB residues higher than this level.

HAMMOND *et al.* (1972) considered that most exposure of the general (U.S.) human population to PCB's appears to be by ingestion of fish in the diet. Mullet is one of the most common fish sold on Eastern Australian markets (ANON a. 1977). The finding that three of thirteen mullet, from areas used for commercial fishing, had levels of PCB's above the 5 ppm (wet weight) recommended by the U.S. Food and Drug Administration for human consumption and that five of thirteen were above the F.D.A's proposed new level of 2 ppm (ANON b. 1977), suggests the need for a comprehensive study to assess the extent, severity and source of this pollution.

## ACKNOWLEDGEMENTS

The authors wish to thank the staff of the pesticide group, Australian Government Analytical Laboratories (S.A.) for preparation and analysis of samples. We are also grateful to Dr H.J. Frith (Chief, Division of Wildlife Research), Dr D. Francois (Director, NSW State Fisheries) and Mr B.L. Bates (Director, A.G.A.L. (S.A.)) for their support of the study and to Mr R.J. Williams, Dr B. Green, Mr D. Mowbray, Dr H. Tyndale-Biscoe and Mr B.V. Fennessy for their helpful criticism of the manuscript.

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