

Polychlorinated Biphenyls in Adult Mayflies (*Hexagenia bilineata*) from the Upper Mississippi River

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The Upper Mississippi River is an important producer of sport and commercial fisheries. In 1971, commercial fishermen harvested 31.5 million pounds of fish worth \$3.1 million (U.S. NATIONAL MARINE FISHERIES SERVICE 1975). Recent pesticide monitoring data, however, have shown excessive levels of polychlorinated biphenyls (PCB's) in fish collected from certain segments of the Upper Mississippi River (DEGURSE and RUHLAND 1972; DEGURSE and DUTER 1975; INTERAGENCY TASK FORCE ON PCB'S 1975).

A few years ago, the U.S. Food and Drug Administration (FDA) set several tolerances for PCB's in food, ranging from 0.2 ppm in baby food to 5.0 ppm in fish. Recently, the FDA banned the interstate sale of carp (*Cyprinus carpio*) caught in Lake Pepin because PCB residues exceeded the 5-ppm level. Lake Pepin is on the Mississippi River, about 60 river miles south of Twin Cities, Minnesota.

The burrowing mayfly (*Hexagenia bilineata*) is an important natural fish food in the Upper Mississippi River, and the food chain of which it is a part -- detritus-mayfly-fish -- is short and efficient (FREM-LING 1975). This mayfly is one of the most abundant aquatic insects in navigation pools of the Upper Mississippi River and should be an excellent organism for monitoring pollution trends. PCB's are now considered the dominant pollutant in freshwater food chains in the United States (PEAKALL 1972).

This study was initiated to determine the residue background of the PCB, Aroclor 1254, in the adult mayflies collected from the Upper Mississippi River. The mayfly was selected because of its great abundance in the river and its significance in the food web.

MATERIALS AND METHODS

A total of 14 river towns, along both sides of the Mississippi River from Lynxville to Prescott, Wisconsin (160 river miles), were selected as sample sites for the collection of adult mayflies. A small poly-

AROCLOR 1254 RESIDUES

4

3

2

1

L Y N X V I L L E W I →

Lake
Pepin

P R E S C O T T W I →

RIVER MILES

650

700

750

800

Fig. 1. Aroclor 1254 residues ($\mu\text{g/g}$, whole body weight) in adult burrowing mayflies (*Heuragenia bilineata*) collected along the Upper Mississippi River.

ethylene bag with a data card attached was distributed to one to three cooperators in each town with instructions to collect live mayflies whenever they encountered a mass emergence. The cooperators were asked to record on the data card the location, time, and date of collection, and to immediately place the samples in a freezer until they could be retrieved for chemical analysis.

All mayflies were of the same life stage (imagos), collected within 24 hours after emergence. Individual samples for residue determination were a composite of 10 to 100 mayflies.

The frozen mayfly samples were weighed, ground with sodium sulfate, and extracted with petroleum ether:diethyl ether (94:6). The ether was then evaporated to a small volume, and a measured quantity was transferred to a Florisil column. Samples were eluted with petroleum ether:diethyl ether (94:6) from the Florisil column and were evaporated again (JOHNSON et al. 1974). A measured volume was injected into a gas chromatograph containing a column (180 cm long, 4 mm i.d.) packed with 3% OV-7 on Chromosorb W-HP at a column temperature of 205°C.

RESULTS AND DISCUSSION

Mayflies from all of the 14 stations contained significant residues of Aroclor 1254 (Fig. 1). Concentrations were highest in mayflies collected from Lake Pepin and immediately above Lake Pepin. The source of PCB pollution is assumed to be above Lake Pepin. Concentrations of residues in fish (DEGURSE and DUTER 1975) collected from river locations corresponding to those at which mayflies were collected showed similar trends but were much higher. Generally, PCB residues in carp were 4 to 5 times greater than those in mayflies. DEGURSE and DUTER (1975) found residues as high as 31 µg/g (ppm) in fish collected from Lake Pepin. Probably mayflies, by way of the food chain, contribute to the high PCB residues in the fish.

Mayfly naiads may be exposed to significant levels of PCB's even though they live in burrows. HAQUE and SCHMEDDING (1975) reported very low water solubilities for highly chlorinated PCB's, and most of the residues in streams are associated with suspended sediment and bottom material (CRUMP-WIESNER et al. 1974). Consequently, PCB (Aroclor 1254) concentrations may be expected to vary directly with the concentration of suspended sediments in a stream or river. Lake Pepin is a natural lake spanning nearly 20 miles in the Mississippi River. The sediments are carried by the river,

and much of the suspended material settles to the bottom when the current velocity is reduced as the river flows into the lake. The lake thus becomes a large settling basin for PCB's as well, and aquatic fauna in the lake may accumulate significant concentrations of the residues.

CARLANDER et al. (1967) reported that the early June population of *Hexagenia* spp. in Pool 18 of the Upper Mississippi River at Keokuk, Iowa, exceeded 3.5 billion in 1959. Consequently, the adult mayfly may be a very useful indicator of chemical residue trends in the Upper Mississippi River, both because it is abundant, and because it can be easily collected around lights.

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