SELECTIVE DISTRIBUTION OF ASSIMILATED PCB CONGENERS TO DIFFERENT ORGANS OF A MOLLUSC

B. Jahan-Parwar, L.W. Wood, and B. Bush

SUNY School of Public Health and
Wadsworth Center for Laboratories and Research
New York State Department of Health
Empire State Plaza
Albany, N.Y., U.S.A., 12201

ABSTRACT

Snails, *Aplysia californica*, were contaminated with PCBs via the diet at 11,700 μg/kg levels. Similarity analysis of PCB congeners showed differences between 9 tissues and assimilation. Both exposure concentration and organ affinities were revealed. Preference analysis showed congeners to have affinities for specific tissues.

INTRODUCTION

To determine if assimilated xenobiotics, represented by specific PCB congeners, redistribute to tissues within an organism, *Aplysia californica*, a marine snail, was fed *Rhodymenia palmata*, a seaweed, contaminated with Aroclors 1221, 1016, 1254 and 1260. The data analysis employed ecological models to measure affinities of specific congeners for different tissues as well as similarities and differences amongst the tissues for the congeners. Additionally, an analysis to group the congeners as to chemical structure and affinity was done to try and determine characteristics of the different chemical species included in the experiment.

EXPERIMENTAL PART

Contamination of the food was achieved to the 11,700 μg/kg level though application of a hexane solution containing 10 ppm of the Aroclors (1:1:1:1) in a revolving glass drum. The hexane solvent was removed by a continuous flow of air. After 3 weeks of feeding 1 g dry food per day, the 120 -150 gm animals were dissected for their organs.

These distinct organ samples as well as those of the seaweed and feces were freeze dried, crushed with a glass rod and extracted with hexane and homogenization for contained PCBs. The samples were passed through a sodium sulfate, Florisil column prior to concentration for glass-capillary chromatography. Water samples were thrice extracted with 5 ml hexane each, the combined extracts being placed over sodium sulfate.

Analysis of the PCBs utilized a Hewlett-Packard instrument with a 5880 splitless glass capillary inlet, a 40 m Apiezon coated glass column, a ^{63}Ni electron capture detector and an ASCII interface board through which calibrated results were transmitted to a computer. Both congener structure and amounts were on the computer output as well as blanks and quality control results at intervals of every 4 samples (1).

Similarity of congener content and amounts employed an ordination analysis. The analysis yields a measure of uniformity between congener abundance and distribution in the various organs as well as assimilation. A theoretical 0 indicates no similarity while 1 indicates identity (2).

Cluster analysis employed the weighted variable-group method using correlations (r) after transformation to Fisher's Z (3). Both negative and positive relations between organs and congeners were ascertainable through this analysis system.

Preference analysis related relative assimilation concentration to the relative concentration of the specific congeners in the tissues. Because the animals were fed daily, the no depletion model

4) was used.

RESULTS AND DISCUSSION

Concentrations of PCBs assimilated were slightly variable depending upon specific chlorination patterns. Whereas the majority had assimilation values of 90% or more, two, 25/3 and 2345/26 were noticeably lower. A tendency for lower assimilation as chlorine content increased was also apparent (5).

The high concentrations in the hepatopancreas (3904 ng/g) reflected the anatomical as well as functional relationship of this organ to the site of food assimilation (10083 ng/g). The very close relationships between the two samples was reflected to in the 82.4 % similarity of congener concentration and presence in the two data sets (Table 1). Low total PCB concentrations in the other tissues forced a relevance of the congener concentrations in them to their respective totals.

Table 1. Similarities of PCB congener distributions and amounts between the different organs of *Aplysia* fed contaminated sea weed for a period of 3 weeks.

Organ	Assim	Brain	Hepat	Blood	Parap	Skin	Heart	Gizzd	Stom	Musc	ng/g
Assim	X	52.75	82.47	24.89	72.17	60.11	15.31	72.85	58.31	30.71	10083
Brain	52.75	X	58.66	53.66	40.07	35.78	8.72	45.55	29.22	22.39	59
Hepat	82.47	58.66	X	28.34	65.26	54.72	14.68	67.74	50.66	36.17	3904
Blood	24.89	53.46	28.34	X	24.48	22.19	5.82	18.36	21.90	13.89	24
Parap	72.17	40.07	65.26	24.48	X	64.77	21.15	66.57	60.10	37.31	398
Skin	60.11	35.78	54.72	22.19	64.77	X	22.95	62.34	51.93	40.11	113
Heart	15.31	8.72	14.68	5.82	21.15	22.95	X	25.36	21.10	20.57	121
Gizzd	72.85	45.55	67.74	18.36	66.57	62.34	25.36	X	60.47	43.35	108
Stom	58.31	29.22	50.66	21.90	60.10	51.93	21.10	60.47	X	48.06	582
Muscl	39.71	22.39	36.17	13.17	37.31	40.11	20.57	43.35	48.06	X	202

Comparison of the similarities showed that differences were present as to relative concentrations and presence in the tissues. Cluster analysis revealed both an affinity component for muscles, hearts, brains (nervous systems), and skins in contrast to an exposure component for the digestive system tissues and parapodia.

Preference analysis allowed for a determination of which congeners exhibited an affinity for which tissues. The analysis showed that different congeners exhibited different affinities or dissaffinities depending upon the molecular structure being considered for the tissues included in this experiment (Figure 1). Even low contamination levels (5 ng/g) showed affinities for the same specific congeners present in the control diet in keeping with those in the more contaminated diet.

Clustering of the congeners was done to try to provide some insight as to the nature of the chemical species in their observed affinities and disaffinities for the various tissues of the snail. An overall result was the degree of chlorination as an important factor. Since virtually all congeners considered had ortho substitutions, the isolation of 33'44' in a group separate from those with lower chlorine content could signify a distributional isolation of those forms able to assume a coplanar orientation.

The results indicated an affinity of muscles for the more highly chlorinated congeners which may explain a portion of the observation of Oliver and Niimi (6) of a tendency for more highly chlorinated congeners to be passed up the food web. The presence of selectivity of different tissues for different congeners points to a lack of ability to use biological specimens as accurate monitors of the presence of PCBs at the Aroclor level in the environment. Such selective distributions may result in distinct adverse actions of the specific congeners on the physiological and biochemical activities within the target organs.

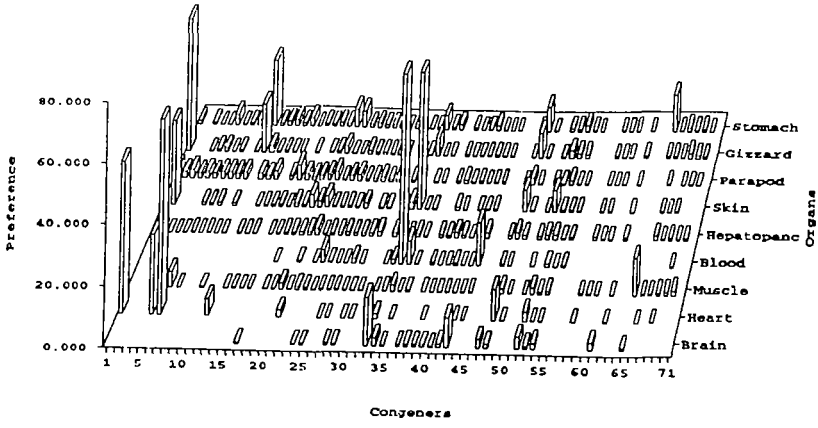

Figure 1. Preferences [= $(T_i/E_i) / \{\Sigma(T_j/E_j)\}$ for different congeners in the different tissues of *Aplysia californica*. T represents the tissue concentration of the congener and E the assimilated concentration, with the subscrips referring to the congener in question (i) and all other congeners except i (j). Congener numbers are as follows:

1 - 2	25 - 22'356'+244'5	49 - 22'344'5'
2 - 4	26 - 23'4'5	50 - 22'34566'
3 - 22'+26	27 - 23'44'	51 - 22'33'45
4 - 24+25	28 - 2344'	52 - 22'33'55'6
5 - 23'	29 - 22'455'	53 - 22'34'55'6+22'344'56'
6 - 24'+23	30 - 22'44'5	54 - 22'344'5'6
7 - 22'	31 - 22'344'	55 - 22'33'44'+23'44'55'
8 - 44'	32 - 22'345'+22'3'45	56 - 22'3455'6
9 - 22'4	33 - 22'33'66'	57 - 22'33'456'
10 - 23'6	34 - 33'44'	58 - 22'33'4'56
11 - 23'5	35 - 22'33'4	59 - 22'33'44'6+233'44'5
12 - 23'4	36 - 22'355'6	60 - 22'33'45'66'
13 - 24'5	37 - 22'345'6	61 - 22'33'455'
14 - 244'	38 - 22'34'56	62 - 22'344'55'
15 - 2'34	39 - 22'34'5'6	63 - 233'4'55'6
16 - 234'	40 - 23'44'5	64 - 233'44'5'6
17 - 22'36	41 - 22'33'56	65 - 22'33'4566'
18 - 22'55'	42 - 22'34'566'	66 - 22'33'44'5+233'44'56
19 - 22'45'	43 - 22'44'55'+22'33'46'	67 - 22'33'455'6'
20 - 22'44'	44 - 233'44'	68 - 22'344'55'6+22'33'44'56'
21 - 22'35'	45 - 22'3455'	69 - 22'33'44'56+22'33'456
22 - 233'6+22'34'	46 - 22'33'566'	70 - 22'33'44'55'
23 - 22'35'	47 - 22'33'45'	71 - 22'33'44'55'6
24 - 22'33'	48 - 22'33'466'+233'4'56	

Acknowlegement. This research was supported in npart by a grant from the Great Lakes Research Consortium, a Superfund grant #1 P42 ES04913-01, Project 3, from the National Institute of Environmental Health Sciences, and funds from the New York State Department of Health to BJP.

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