

Wild Mink Exposed to PCBs in the Environment Exhibit Mandibular and Maxillary Hyperproliferation of Squamous Epithelium

K.J. Beckett*¹, S.D. Pastva ², A.L. Blankenship ³, M.J. Zwiernik ¹, J.P. Giesy ¹, S.J. Bursian ¹

¹ Michigan State University, East Lansing, MI;
² U.S. Fish and Wildlife Service, East Lansing, MI;
³ ENTRIX, Inc., Okemos, MI

Abstract:

A jaw lesion identified as hyperproliferation of squamous epithelium, induced by 3,3',4,4',5-pentachlorobiphenyl (PCB 126) previously has been reported in ranch-raised mink (*Mustela vison*). This unique lesion can be detrimental to the survival of exposed mink by causing loose and displaced teeth with eventual loss of teeth, leading to anorexia and finally death. This lesion has recently been detected in a wild population of mink inhabiting the Kalamazoo River basin. The Kalamazoo River is located in southwestern Michigan and approximately 125 km are designated as a Superfund site with polychlorinated biphenyls (PCBs) as the contaminant of concern. Mink are a naturally occurring predator in this area, and also a species of concern due to their known sensitivity to environmental contaminants. Therefore, mink were trapped from two designated areas of the Kalamazoo River, the Kalamazoo River Area of Concern (KRAOC) and the Fort Custer Recreation Area (FCRA), which is an upstream reference area on the same river system. Mink from both KRAOC and FCRA appeared to be in good health based upon weight, lack of pathological abnormalities, and histological analysis of liver tissues. Calculated risk based on site-specific mink tissue residues was minimal, and suggested no expected population-level adverse effects. The calculated 2,3,7,8- TCDD equivalents (TEQs) averaged 300 and 110 pg TEQ/g wet weight in livers of mink from KRAOC and FCRA, respectively. These TEQ concentrations were similar to those that were associated with jaw lesions in ranch-raised mink. Thus, we wanted to determine if these wild mink had the lesion that was previously described as mandibular and maxillary hyperproliferation of squamous epithelium in ranch-raised mink. This lesion was in fact present in the wild mink, the severity of which was related to the hepatic TEQ concentrations. This is the first published report of the lesion type occurring in a wild mink population.

Introduction:

The Kalamazoo River Superfund site is one of 1400 nationally recognized sites listed as national priorities of concern by the U.S. Environmental Protection Agency. Of these 1400 Superfund sites, 69 are located in Michigan. Waste discharged from the recycling and processing of carbonless copy paper has produced an area of high environmental contamination, of which (PCB) contamination is of the most concern. Environmental exposure to PCBs and polychlorinated dibenzo-*p*-dioxins (PCDDs) has become a growing concern for wildlife populations and potential human health risks.

The mink is a semi-aquatic mammal inhabiting the shores of rivers and waterways throughout much of northern North America. Mink have been identified as being among the most sensitive mammals to environmental contaminants (especially PCB toxicity), generally through dietary exposure. Therefore, mink are used as a representative species to study the effects of contaminants on carnivorous mammalian wildlife.

Previous studies from our laboratory have indicated that mink of various ages exposed to PCB 126 or TCDD by way of their diet, developed a lesion of the mandibles and maxilla that consisted of proliferation of squamous epithelium in the gingiva, leading to osteolysis of adjacent alveolar bone, and eventually causing loose and displaced teeth.

Methods:

- 1 Wild mink were trapped throughout the Kalamazoo River Superfund site. Livers were analyzed for PCB concentrations, and stomach contents examined to perform bottom-up and top-down model analyses (see Pastva, in prep).
- 2 Mink were originally frozen, with the heads eventually placed in 10% neutral-buffered formalin as a fixative.
- 3 Heads were decalcified in Surgipath® Decalcifier II (hydrochloric acid), trimmed, and mandibles and maxillae collected.
- 4 Jaws were processed for histological examination, sectioned at 5 microns, stained with hematoxylin and eosin (H & E), and the slides examined using a light microscope.

* We have presented data comparing the Kalamazoo River mink with wild mink from a Canadian region, as well as with ranch-raised mink that were fed diets containing various percentages of fish from two different contaminated rivers in the United States.

Table 2. The incidence of mandibular and maxillary squamous hyperproliferation in mink exposed to environmentally relevant concentrations of PCBs; concentrations listed as µg/kg.

	Dietary Concentrations		Liver Concentrations		% PCB 126 in TEQs		n	% Samples with Lesion
	Total TEQs	Total PCBs	Total TEQs	Total PCBs	Diet	Liver		
Wild Mink Populations:	µg/kg		µg/kg					
Kalamazoo River								
KRAOC	na	na	0.274	2710	--	77	n=9	44 % 4 of 9
FCRA	na	na	0.108	2270	--	69	n=3	0 % no lesions
Canada Regions								
Group 1	na	na	na	1160	--	--	n=8	0 no lesions
Group 2	na	na	na	3780	--	--	n=4	0 no lesions
Feeding Trial Ranch Mink								
Saginaw River								
Group D	0.073	1690	na	na	--	17	n=8	75% 6 of 8
Group C	0.048	1050	na	na	--	11	n=7	57% 4 of 7
Housatonic River								
Group F	0.069	3700	0.197	8561	57	86	n=6	100% 6 of 6
Group E	0.016	1600	0.098	3450	51	87	n=6	33% 2 of 6
Group D	0.009	960	0.040	1696	50	86	n=6	17% 1 of 6

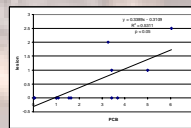
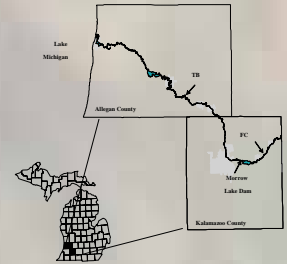


Figure 1. A positive correlation of hepatic PCB concentrations and the expression of the jaw lesion observed in mink from the Kalamazoo River Basin.



Lesion Description:

The lesion is characterized by initial swelling of the upper and lower jaws with nodular proliferation of the gingiva. Extensive infiltration of large islands of squamous epithelial cells develop and form cysts, which may contain centers of exfoliated epithelia and sometimes keratin. The maxilla and mandibles become markedly porous as a result of these epithelial cysts destroying underlying alveolar bone. This leads to gross display of spreading and displacement of the incisor and canine teeth, with concomitant loss of teeth leading to anorexia. The histopathological appearance of this jaw lesion suggests squamous cell carcinoma, a condition characterized by hyper-proliferative activity, invasiveness of atypical cell type and diffuse infiltration, and tissue destruction. This unique jaw lesion is potentially lethal, and may pose a serious threat to wild populations of mink.



A lesion rating of moderate, with diffuse squamous cysts throughout the jaw. The hepatic total PCB concentration was 6.03 mg/kg, and the total TEQ concentration was 1264.0 ng/kg.



A lesion rating of mild-moderate: multi-focal diffuse squamous cell cysts. The hepatic total PCB concentration was 4.99 mg/kg, and the total TEQ concentration was 577.0 ng/kg.



A lesion rating of mild, with one focus and minimal changes around the premolar shown. The hepatic total PCB concentration was 2.91 mg/kg, and the total TEQ concentration was 251.3 ng/kg.



A lesion rating of mild, with focal cysts. The hepatic total PCB concentration was 3.27 mg/kg, and the total TEQ concentration was 207.8 ng/kg.

Conclusions:

- 1 The data presented here indicate that wild mink exposed to environmentally-derived PCBs developed a lesion characterized as squamous epithelial hyperproliferation in the maxillary and mandibular region of mink trapped in the Kalamazoo River area of concern.
- 2 This lesion in wild populations of mink may be, at least in part, responsible for the decline in mink populations in PCB-contaminated areas, such as the Great Lakes region. This unique jaw lesion is potentially lethal, and may pose a serious threat to wild populations of mink.
- 3 No lesions were observed in the Canadian mink, although total PCB concentrations were within the same range as the Kalamazoo mink and ranch mink fed diets containing fish from the Housatonic River that did express the lesion. Total TEQs may be more relevant in determining the probability of the jaw lesion developing in mink, data that were not available for the Canadian mink.