

SHORT NOTE

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An analysis of the fur of river otters in Prince William Sound, Alaska: oil related hydrocarbons 8 years after the *Exxon Valdez* oil spill

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Abstract Approximately 8 years after the *Exxon Valdez* oil spill, river otters (*Lutra canadensis*) were trapped from the shoreline in both oiled (Knight Island) and nonoiled (Jackpot Bay) areas of Prince William Sound, Alaska. Captive river otters were wiped with isopropanol-soaked gauze and the gauze extracts were analyzed by gas chromatography with mass spectrometry detection. Differences in pentacosane (C-25) levels in the fur were observed between the oiled and nonoiled sites, while lower molecular weight aliphatics and aromatics were absent. These data are useful when evaluating the role of fur grooming in the long-term exposure of river otters to hydrocarbons and the expression of P450-1A in Knight Island otters.

Introduction

River otters (*Lutra canadensis*) are widely distributed along the subarctic shores of Alaska (Bowyer et al. 1994; Ben-David et al., in press). As nearshore foragers on marine fishes and invertebrates in intertidal and subtidal zones (Bowyer et al. 1994), they are potentially excellent indicators of pollution (Baker et al. 1981; Clark et al. 1981; Wren 1991), such as that from the *Exxon Valdez* oil spill of March, 1989. In that spill, over 39,000 metric tons of North Slope crude oil spread over > 3,500 km of shoreline in Prince William Sound (Estes 1991). Earlier, we documented (Duffy et al. 1993, 1994a,b) that, 2 years post-spill, river otters from a heavily oiled area had lower body mass, as well as elevated levels of blood haptoglobins and liver enzymes. River otters inhabiting oiled areas could be discriminated from those living in

nonoiled areas using biomarkers, such as fecal profiles of porphyrins (Blajeski et al. 1996). Moreover, there were corresponding ecological effects associated with oil exposure including changes in diet, habitat selection, and sizes of home ranges for river otters (Bowyer et al. 1994, 1995).

In a 1989 survey on dead sea otters that appeared lightly oiled, Ballachey and Kloecker (1997) reported the presence of various compounds present in crude oil on a patch of hair taken from the carcasses of sea otters. More recently, Mazet et al. (1997) reported the development of a field wipe assay to detect the presence of oil on sea otter fur. In their wipe test on sea otter fur, an immunochemical detection system was used. In 1996 Hecker et al. (1997), using that immunochemical detection system, were unable to measure oil in river otter fur at a sensitivity less than 1 ppm. Nonetheless, they reported the presence of C-15 and C-16 aliphatic hydrocarbons using GC-MS. To improve the wipe test to detect the presence of oil on pelage that was not visible, we expanded the analysis to include C-25 and C-26 aliphatics, as well as the aromatics, phenanthrene and chrysene. The long-term objective of this study was to address the question of residual oil exposure to river otters in Prince William Sound (PWS), Alaska.

Materials and methods

River otters were trapped from the shoreline in both oiled (Knight Island; $n = 12$) and nonoiled (Jackpot Bay; $n = 13$) areas of Prince William Sound during the spring and summer of 1996 and 1997. They were captured at latrine sites using either Hancock or no.11 Sleepy Creek double jaw leg-hold traps (Hecker et al. 1997; Blundell et al., in press). Once captured, animals were wiped with gauze (2 by 2 inch swab) that had been presoaked in isopropanol. Areas of pelage, including the ventral aspect of the neck, the abdomen and swaths along each side and the length of back, were wiped for approxi-

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mately 15 s. Swabs were handled with gloved hands only; the gauze was then wrapped in foil and frozen until analysis in the laboratory at the University of Alaska Fairbanks.

The gauze was extracted into isopropanol, and the extract was analyzed by gas chromatography with mass spectrometry detection (GC-MS). The mass spectral data were acquired using selected ions for each of the hydrocarbons (phenanthrene, chrysene, pentacosane and hexacosane). The GC-MS was calibrated by injection of a standard at six concentrations reaching 5 µg/g (ppm). Sample concentrations were calculated from the area for each hydrocarbon.

Results and discussion

Our results confirm the utility of the wipe test previously reported (Mazet et al. 1997) and demonstrate that a wipe test can be a good screening method for hydrocarbon-contaminated fur-bearing mammals, especially if a sensitive detection system is employed. The wipe assays using GC-MS are more sensitive than the immunochemical methods (Hecker et al. 1997). Table 1 summarizes the 1997 results from the GC-MS wipe analysis.

The mean concentration of phenanthrene on fur of river otters from Herring Bay (HB) on Knight Island was similar to phenanthrene concentrations on fur of river otters in Jackpot Bay (JP) (0.001 ppm for HB vs 0.004 ppm for JP). Ballachey and Kloecker (1997) did not report any naphthalene in dead sea otters collected in 1989 from Prince William Sound, but did detect phenanthrene ranging from 3 to 109 ppb. These sea otters had light oiling visible on their pelage and a single patch of hair was sampled from one spot on the body. In contrast, the river otters that were captured live in 1997 had no signs of external oiling and were wiped over a larger area. The levels observed in these PWS river otters ranged from 1 to 18 ppb. Chrysene was also detected in the 1989 dead sea otters (Ballachey and Kloecker 1997). In 1996, chrysene was detected in 3 of 15 river otters from Herring Bay, but was undetected in 19 river otters from Jackpot

Bay (Holland-Bartels 1998). In 1997, chrysene was undetectable in either population of river otters.

In river otters sampled in 1997, pentacosane (C-25) was detected in 5 of 12 animals in Herring Bay and in 4 of 13 animals from Jackpot Bay. The C-25 mean for Jackpot Bay was 0.188 ppm, which was lower than the mean of 0.426 ppm in Herring Bay (Table 1). These pentacosane levels in river otters were higher than those reported by Ballachey and Kloecker (1997) for 1989 dead sea otters. Two river otters in both Herring Bay and Jackpot Bay also had detectable levels of hexacosane. Similar to the sea otters, lower molecular weight aliphatics and aromatics were absent, presumably reflecting that these hydrocarbons are not routinely present in the Prince William Sound environment 8 years after the *Exxon Valdez* oil spill.

In 1996, levels of P450-1A, a biomarker of hydrocarbon exposure, were significantly higher in sea otters captured at Knight Island than in sea otters captured at Montague Island, a non-oiled site (Holland-Bartels 1998). Also, mean values for P450 in river otters from Herring Bay in 1996 were significantly higher than for Jackpot Bay. In 1997, P450 values for Herring Bay were again higher than at Jackpot Bay, but the difference between means was not significant. The presence of chrysene and pentacosane in the Herring Bay population may explain the elevated levels of P450 in the Prince William Sound river otters. Since both of these bays are in frequently visited by marine traffic, we do not believe that the similar level of small boat traffic would be a confounding factor in the observed difference between sites. Although the hydrocarbon levels reported in the river otter fur are very low and not toxic, their ingestion after grooming may be high enough to induce P450 expression.

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Table 1 Analysis of hydrocarbons in fur from two populations of river otters in Prince William Sound, Alaska (1997)

Oil-related compounds ^a (ppm)	P-value ^b	Oiled (n = 12) ^c		Non-oiled (n = 13) ^c	
		\bar{X}	SD	\bar{X}	SD
Phenanthrene	ns	0.0013	0.0031	0.0037	0.0034
Pentacosane	<0.0001	0.4265	0.5836	0.1882	0.3149
Hexacosane	ns	0.2142	0.5002	0.0852	0.2171

^a Chrysene was not detected on otters from oiled or non-oiled areas in 1997

^b *t*-test for unequal variances, ns = not significant ($P > 0.05$) between areas

^c Concentrations in ppm

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