Lead in Hair of Urban and Rural Small Mammals

by RICHARD B. RAYMOND
and
RICHARD B. FORBES
Department of Biology
Portland State University
Portland, Ore. 97207

Since 1940 there has been a rapid increase in the amount of lead dispersed in the environment (JENKINS 1972, JAWOROWSKI 1968). This increase has been attributed largely to lead aerosols that result from the burning of alkyl lead compounds in gasoline (CHOW and EARL 1970, Airborne Lead in Perspective, 1972). Concentrations of lead in city air and in precipitation are correlated with the amount of automotive traffic (BOVE and SIEBENBERG 1970, LAZRUS et al 1970). Rapid fallout of lead along heavily traveled roads results in high exposure of the nearby plants and soil to lead; exposure to lead diminishes rapidly as distance from the road increases (PATTERSON 1965, LAGERWERFF and SPECHT 1970). CHOW (1970) and MOTTO et al (1970), found that plants growing close to heavily traveled roads show elevated levels of lead, and that these levels are dependent on promixity to the road. SMITH (1972) found also that the amount of lead in plant tissues is related to proximity to highways, and to traffic volume.

In order to investigate the effects of increased risk of exposure to high lead levels for roadside organisms, we measured the amounts of lead in hair of small mammals (Sorex sp., Peromyscus maniculatus, Eutamias towsendii, and Microtus sp.) from urban and rural populations. Hair has been shown to be a useful indicator of body burden of lead (HAMMER et al 1971, KOPITO et al 1967). It is easy to obtain, and since it is exposed to the air it can also give an indication of total exposure. We found that members of roadside small mammal populations had significantly higher levels of lead in their hair than did members of either urban parkland or wilderness populations. In contrast to a study by WEISS et al (1972) on human hair, we found no significant difference between lead content of the hair of mammals trapped in 1972 and those trapped in similar habitats 60 years ago.

Animals were trapped in three locations: "roadside" specimens beside U. S. Highway 26, a heavily traveled road (66,500 vehicles per day) one-half mile west of downtown Portland, Oregon; "parkland" specimens in Forest Park, an urban wildlife preserve about one-half mile from the nearest traveled road (18,000 vehicles per day) in Portland, Oregon; and "wilderness" specimens in the Mt. Hood National Forest (T. 4 S., R. 8 E., Clackamas County, Oregon) two miles from the nearest road access and five miles from U. S. Highway 26, the nearest major road. Locations were selected to be as similar in plant cover and topography as possible. Antique hair was obtained from study skins of small mammals trapped in northwestern Oregon between 1913 and 1915.

The analytical method used was that of HARRISON et al (1969). Each hair sample was divided into two parts. One part was washed

Bulletin of Environmental Contamination & Toxicology,
Vol. 13, No. 5 © 1975 by Springer-Verlag New York Inc.

by agitation in a solution of 1% nonionic detergent (Acationix, Scientific Products, Evanston, Ill.) for 30 minutes, then rinsed in a polyethylene filter funnel with a liter of deionized-distilled water. All samples were dried at 110 C to constant weight, weighed to the nearest 0.1 mg., and digested in nitric and perchloric acid (5:1). The digests were evaporated to dryness, and diluted to 10 ml in volumetric flasks with deionized-distilled water. Analysis for lead was done with a Perkin-Elmer 303 atomic absorption spectrophotometer. Duplicate samples were analyzed, as were reagent blanks and standards. The primary lead standard was a 10,000 ug/ml stock solution from Instrumentation Laboratory Inc.

The data in Table I show the amounts of lead found in hair of the mammals examined. When the samples were compared between groups with a *t* test, both washed and unwashed samples of hair from roadside specimens contained significantly higher ($P < .001$) amounts of lead than the hair of the other three groups. The amounts of lead found in unwashed parkland samples were also higher ($P < .05$) than in unwashed wilderness samples. The unwashed hair samples from the roadside and antique groups had significantly higher lead content ($P < .01$) than the washed samples from the same animals. The difference between washed and unwashed samples for park animals was not significant ($P > .20$), and no difference could be detected for animals trapped in the wilderness.

TABLE I

Lead content of hair of three populations of small mammals (mean ± standard error).

		Lead content (ug/g dry weight)	
Population	N	Washed	Unwashed
Roadside	43	133.08 ± 21.31	235.63 ± 36.80
Parkland	34	11.16 ± 3.22	25.05 ± 6.69
Wilderness	28	0	6.02 ± 2.27
Antique	16	17.72 ± 4.30	29.89 ± 8.62

Tentative signs of lead poisoning may be observed in humans having amounts of lead as low as 30 ug/g in their hair (KOPITO 1967). Table II shows the percent of animals in each group whose hair showed lead amounts greater than 30 ug/g.

TABLE II

Percent of specimens with more than 30.00 ug/g lead in hair.

		Percent	
Population	N	Washed	Unwashed
Roadside	43	65.85	92.68
Parkland	34	0	21.43
Wilderness	28	0	0
Antique	16	11.76	41.18

Our results indicate that the high exposure to lead for small mammals living near a heavily traveled road results in a significantly increased amount of lead in the hair. There apparently is less exposure to lead at an urban site removed from the roads, but even this is markedly higher than the exposure to lead of animals relatively isolated from contact with automobile exhausts. Despite higher exposure of contemporary wild small mammals to lead aerosols, there seems to be no greater amount of lead present in their hair than in that of such mammals trapped before the introduction of lead antiknock compounds into gasoline. This is in contrast to data from studies on Swedish moss (Airborne Lead in Perspective 1972) that showed a chronological increase in lead content presumably related to use of alkyl lead compounds in gasoline, and to studies on human hair (WEISS et al. 1972) and bones (JAWOROWSKI 1968) which showed a decrease in lead content from 1871 to the present, possibly related to decreased exposure from paint and household utensils.

SCHROEDER et al. (1964, 1965) has shown that lifelong exposure to lead, resulting in lead levels similar to those found in humans has an adverse effect on survival of mice and rats of any age, and that lead seems to be continuously toxic, increasing susceptibility of rats to spontaneous infection. Our results indicate that near heavily traveled roads the levels of lead to which small mammals are exposed may be great enough to affect detrimentally their health and longevity.

Airborne Lead in Perspective: Nat. Acad. Sci. Nat. Res. Counc. Publ. No. 1941 (1972).
BOVE, J. L. and S. SIEBENBERG: Science 167, 986 (1970).
CHOW, T. J.: Nature 222, 295 (1970).
CHOW, T. J. and J. L. EARL: Science 169, 577 (1970).
HAMMER, D. I., J. F. FINKLEA, R. H. HENDRICKS, C. M. SHY and R. J. M. HORTON: Amer. J. Epidemiol. 93, 84 (1971).
HARRISON, W. W., J. P. YURACHEK and C. A. BENSON: Clin. Chem. Acta 23, 83 (1969).
JAWOROWSKI, Z.: Nature 217, 152 (1968).
JENKINS, D. W.: Smithsonian 3, 62 (1972).
KOPITO, L., R. K. BYERS and H. SHWACHMAN: New Eng. J. Med. 276, 946 (1967).
LAGERWERFF, J. V. and A. W. SPECHT: Env. Sci. Tech. 4, 583 (1970).
LAZRUS, A. L., E. LORANGE and J. P. LODGE, JR.: Env. Sci. Tech 4, 56 (1970).
MOTTO, H. L., R. H. DAINES, D. M. CHILKO and C. K. MOTTO: Env. Sci. Tech 4, 231 (1970).
PATTERSON, C. C.: Arch. Environ. Health, 11, 344 (1965).
SCHROEDER, H. A., J. J. BALASSA and W. H. VINTON, JR.: J. Nutr. 83, 239 (1964).
SCHROEDER, H. A., J. J. BALASSA and W. H. VINTON, JR.: J. Nutr. 86, 51 (1965).
SMITH, W. H.: Science 176, 1237 (1972).
WEISS, D., B. WHITTEN and D. LEDDY: Science 178, 69 (1972).