Centr. eur. J. publ. Hlth 2, 1994, Supplement, p. 65-69.

CONTAMINANT EFFECTS IN THE ENVIRONMENT: THEIR USE IN WASTE SITE ASSESSMENT

M. J. Hooper, T. W. La Point
Department of Environmental Toxicology and Institute of Wildlife and Environmental Toxicology, Clemson University, Pendleton, SC, USA

INTRODUCTION

Chemical exposure and effects assessments, when performed on wildlife species, incorporate many factors similar to those performed on humans. Exposure evaluation endpoints include population demographics, chemical form and environmental distribution, potential exposure routes and duration of potential exposure. Once exposure data are compiled, pathological symptoms in the population are evaluated for dose-response relationships, assessments of biological plausibility and temporal relationships between exposure and effect to further tie effects to exposure data (1). Human studies, though complex in nature, represent a single species approach to contaminant exposure and effects assessments. Ecological effects studies, by their very nature, incorporate a variety of individual species as well as population-, community- and ecosystem-level evaluations. Though the scope of these assessments seems vast, directed studies of selected species using appropriate endpoints will result in data useful in site management decision-making.

ASSESSMENT TECHNIQUES

Early field investigations focussed primarily on mortality incidents associated with agricultural chemical application (2). Laboratory studies evaluated the lethal potential of chemicals in wildlife species and predicted their ability to accumulate in tissues. The occurrence of and concern over health effects grew when DDT was discovered to cause eggshell thinning at sublethal doses to the birds which consumed it. Since that time, the role of health effects has grown in importance in ecological evaluations.

Chemical contaminants affect wildlife health at a variety of levels, in a manner similar to that seen in humans. Tissue-specific pathologies are well characterized for major organs such as liver, kidney, lung and central and peripheral nervous systems. More generalized effects, typified by disruption of endocrine or immune function, though less well studied, have recently gained attention due to their ability to impart major changes in an animal's ability to respond to its external environment (3, 4).

The assessment of chemically-induced health effects has benefited greatly from basic research on the mechanism of action of different chemical classes. These studies identify specific molecular, biochemical and physiological targets of chemical action and thus provide measurable endpoints of contaminant exposure. Mechanistically pertinent responses to chemical exposure and effects have become increasingly useful in ecological risk assessments which attempt to quantify contaminant risk in the environment (5). Biomarkers, as these responses have come to be known, are now a powerful tool in nearly every aspect of contaminated site evaluations.

BIOMARKER CHARACTERIZATION AND APPLICATION

Biomarkers are biochemical, physiological, histopathological and behavioral endpoints indicative of chemical interactions with living organisms. Their occurrence can be indicative of chemical exposure as well as chemical effects. In some cases, they can be used to predict susceptibility of an individual or population to chemically induced effects. Ideally, biomarkers follow a number of criteria. The measurement should be relevant to chemicals under study and should be sensitive to the chemical's influence at environmentally relevant concentrations. The biomarker should be indicative of important processes in the species under study. Perhaps most importantly when using biomarkers, they should be characterized such that responses can be quantitatively evaluated. What follows are brief descriptions of a number of biomarker approaches used in wildlife studies performed primarily, though not exclusively, in the authors' research programs. The reader is encouraged to refer to any of several excellent texts which have recently emerged on this subject (5–8).

The cytochrome P450s (CYPs) are a family of heme-containing metabolic enzymes whose activity can increase following exposure to certain chemicals. The particular CYP form which increases and the degree of increase (or induction) which occurs depends on the chemical and species of animal. CYPs 1A1 and 2B are particularly useful as they respond to a wide variety of co-planar (e.g. 2,3,7,8-tetrachlorodibenzo-*p*-dioxin or "TCDD-like") and non-coplanar halogenated aromatic hydrocarbons (HAHs), respectively. Their activities can be measured as EROD (7-ethoxyresorufin-O-dealkylase) and PROD (7-pentoxyresorufin-O-dealkylase) activities, respectively. These enzyme activities have been characterized in many species of animals and their responsiveness and consistency in response are currently topics of active study. An example is their assessment in next box-dwelling European starling *(Sturnus vulgaris)* nestlings where temporal patterns from hatch to fledge have been characterized for both activity and responsiveness to classical inducers (Hofius, J. L., Masters Theis, Clemson University, Clemson, SC, 1992). Another is the H4IIE rat hepatoma cell line whose CYP1A1 activity can be induced by chemicals in environmental extracts. This cell line is used as an in vitro screening tool for CYP inducing chemicals in analytical extracts from soils and food web components (9). It has been used in implicating specific PCB residue profiles in egg mortality in colonial water birds of the Great Lakes (10).

Immune suppression can be measured using a variety of assays including the Jerne plaque forming cell assay, B and T cell blastogenesis and hemagglutination assays (11). These techniques have been particularly successful with starlings (12, 13) and deer mice (*Peromyscus maniculatis*; 14). In contrast to most biomarkers, many immune function assays incorporate whole cell function or cooperativity as their