ENVIRONMENTAL LEVELS II : AN OVERVIEW

Richard J. Wenning[1], Masaru Tanaka [2], and John J. Ryan [3]

[1] The Weinberg Group, One Market, Steuart Tower, Suite 1450, San Francisco, California 94105 USA
[2] Okayama University, 3-1-1 Tsushimanaka, Okayama City, Okayama 700-8530 JAPAN
[3] Health Canada, Chemical Safety, Banting 2203D, Ross Ave, Ottawa, Ontario KIAOL2 CANADA

Throughout the history of the annual international DIOXIN symposium, scientists from around the world have reported on the results of a wide range of environmental studies of polychlorinated dibenzo-p-dioxins and furans (PCDD/Fs), polychlorinated biphenyls (PCBs), and organochlorine (OC) pesticides. PCDD/Fs, in particular, have been measured in nearly every environmental compartment on every continent, including soil, sediment, air particulate, vegetation, the tissues of fish and aquatic mammals, other aquatic and terrestrial wildlife, and human tissues (*see e.g.*, USEPA, 2000). A significant portion of these data can be directly attributed to, or inspired by, the work of Dr. Christopher Rappe and Dr. Matts Tysklind and their colleagues at the University of Umea and other research institutions in Sweden. Their work during the 1980s and 1990s contributed significantly to advancements in two scientific disciplines, environmental chemistry and environmental forensic analysis.

Not content with reporting only on current environmental conditions at the annual international DIOXIN symposia, scientists from Sweden, the United Kingdom, Japan, Canada, the United States and elsewhere also have reported on investigations of our past. The presence of PCDD/Fs has been confirmed in the mummified remains of indigenous peoples from both the northern and southern hemispheres, in centuries-old preserved soil and vegetation from the United Kingdom, and in buried sediment deposits that pre-date the modern manufacture and use of chlorinated chemicals (*see e.g.*, Ligon *et al.*, 1989; Kjeller *et al.*, 1991; Alcock and Jones, 1996; Cleverly, 2000). These studies are widely cited as evidence supporting the hypothesis that natural processes, and not strictly anthropogenic activity alone, have contributed to the formation and occurrence of PCDD/Fs in the environment (*see e.g.*, Asplund and Grimvall, 1991; Green *et al.*, 2000).

Reporting on Environmental Levels at DIOXIN 2001

At this year's international symposium, over 50 papers presented in two Environmental Sessions continue the tradition of reporting on the occurrence of PCDD/Fs and other halogenated organic chemicals in various environmental compartments. But, perhaps reflecting the inevitable maturation of research in this area, the majority of papers at the DIOXIN2001 symposium also incorporate considerations on possible sources to the environment and address the implications of measured concentrations on ecological receptors and human health. As our understanding of environmental fate and global long-range transport processes has developed, scientists are moving from simply reporting on the presence or absence of chemicals in the environment

towards addressing the larger implications and the significance of their occurrence on ecosystems and the health of future generations.

Levels in Sediments & Aquatic Environments

By far the largest number of presentations at DIOXIN2001 in this session address investigations of the occurrence of PCDD/Fs, PCBs, PAHs, and OC pesticides in sediments and in the tissues of aquatic organisms. This may well reflect the rapidly increasing concerns of the scientific community and environmental authorities throughout the world about the accumulation of contaminants in sediments and potential impacts on coastal fisheries and other important aquatic resources. Not surprisingly, source identification and pattern recognition are significant aspects of several of these presentations.

For example, Litten and Fowler report on PCDD/Fs in suspended particulates in water samples collected from New York Harbor USA and their efforts to ascertain sources and loadings to the environment. Tysklind *et al.* report on the use of principal component analyses to identify potential sources of PCDD/Fs to the lower Roanoke River and its tributaries in North Carolina, USA. Jang and Li report on spatial distributions and temporal trends of PCBs, PAHs and other chemicals in Lake Calumet USA sediments; correlations between concentrations and sediment characteristics reported in their study reveal fingerprint patterns that may distinguish urban locations from remote areas in the Great Lakes region. And, reflecting on different source identification methods, Masunaga *et al.* discuss the importance of different degrees of precision in dioxin monitoring and testing.

The latest results of an ongoing environmental forensics mystery in Queensland, Australia are reported by Prange and Muller, where elevated concentrations of PCDDs and a PCDD/F profile in topsoil are unlike any known anthropogenic profiles. As part of their forensic investigations, they report on the use of mass balance studies as one possible tool to determine potentially unidentified sources to the environment.

Among the studies not focused on PCDD/Fs, is a presentation by Kato *et al.* reporting on the occurrence of nonylphenol in sediments and water collected from Harimanada, in the Seto Inland Sea of Japan. Their results correlate the presence of nonylphenol with both highly and less densely populated coastal areas. Moon *et al.* report on the results of an ongoing PAH monitoring program to assess marine sediments and organisms collected from coastal stations throughout Korea. They also report in a second presentation on past and current input fluxes to the region and the depositional history of PAHs in sediment cores.

Also along the Korean peninsula, Jang *et al.* report on PCDD/Fs in water and sediments from coastal areas. Choi *et al.* report on the concentrations and patterns of PCBs in sediments from southeastern coastal areas. The uniformity of PCB profiles in sediment cores suggests that sources of PCBs in the region have not changed much over time. Levels along the Ulsan coast are 1-2 orders of magnitude higher than along the Masan and Pohang coasts, and similar to those found in Tokyo Bay, Japan.

Several studies investigate the relationship between occurrence in sediments and levels in aquatic

tissues. For example, Loganathan *et al.* report on the concentrations of 2,3,7,8-substituted PCDD/Fs and non- and mono- ortho-substituted PCBs in surficial sediments and mussel tissues collected from reservoirs and waterways located in westernmost Kentucky USA. Lee *et al.* report on similar efforts to evaluate the occurrence and distributions of PCBs in sediments from Inchon Bay located near Seoul, Korea.
Another important concern is the use of certain herbicides in rice paddy farming. For example, Kobayashi *et al.* report on investigations of temporal trends in PCDD/F levels and possible sources in rice paddy fields located in a drainage basin subject to frequent, large applications of herbicides. They correlated levels with PCDD/F impurities in two widely used herbicides, pentachlorophenol (PCP) and chloronitrophen (CNP). Similarly, Seike *et al.* report on PCDD/Fs in soils from rice paddy field, as well as in a sediment core collected from the nearby Shigenobu River estuary and adipose tissues from residents in Matsuyama, Japan.

Two presentations describe environmental investigations in Italy. Frignani *et al.* report on the vertical distribution of PCBs in sediment cores from the central Venice Lagoon and nearby industrial areas, and reconstruct possible past and present depositional trends and inputs. And, Fattore *et al.*, report on PCDD/Fs in River Po sediments, where they observe that the predominance of OCDD in sediment and in the homologue profile of local sewage sludge suggests that domestic waste water may be an important source of inputs to the River Po.

Levels in Air

Presentations describing the results of ambient air investigations and investigations of likely depositional sources and contributions from municipal solid waste (MSW) incinerators also are well represented in the Environmental Levels sessions at DIOXIN2001. Shibakawa *et al.* report on a new follow-up study in Japan comparing PCDD/F emissions from an old MSW incinerator with emissions collected approximately one year after modernization of the facility. Levels in soil and pine needles were determined to ascertain whether source reduction measures associated with modernization efforts were effective. Ikeda *et al.* report on research to identify and clarify the relationship between PCDD/F concentrations in ambient air and needles of Japanese black pine in the Kyushu and Chugoku regions of western Japan. Ok *et al.* report on their investigation of PCDD/F concentrations, distribution characteristics and environmental fate in ambient air in Korea; and, Cheng *et al.* report on monitoring of PCDD/Fs in ambient air in Taiwan prior to the operation of a MSW incinerator and during the trial test burns.

In Europe, Turrio-Baldassarri *et al.* report on a study of PCDD/Fs in air and soil in the city of Mantua, located in Northern Italy, where an excess of incidence of soft tissue sarcomas have been recorded and the cause attributed to emissions from a nearby industrial waste incinerator. In a second presentation, Turrio-Baldassarri *et al.* report on differences between indoor and outdoor air concentrations of PCDD/Fs, PAHs and PCBs in Rome, Italy, including differences between floors within the same office building and differences in air levels between urban and remote sites. The partition between vapor and particulate phase for PCBs and PAHs also is investigated as an important factor influencing bioavailability.

Moche and Thanner report on the results of their study of ambient air concentrations of PCDD/Fs

and PCBs using continuous sampling methods at an air monitoring station located in the vicinity of two iron ore sinter plants, which may account for more than 25 % of total annual emissions in Austria. Mao and Harrad report on the concentrations of individual PCB congeners and DDT, DDE, DDD, and HCH in air collected during more than one year of sampling at Birmingham University in the United Kingdom. Using a novel forensics approach to source identification, they hypothesize that the lower chlorinated PCB congeners are largely from a specific location, while other congeners are due to general background contamination. Abad *et al.* report on their study to characterize dioxin levels in major industrial sites in the four provinces in Catalonia, Spain with the intent of using the data as a basis for future monitoring and evaluation of temporal trends in ambient air.

In central Europe, Kucherenko reports on PCDD/Fs in snow cover in Krasnoyarsk, Ukraine. Based on the high concentrations of PCDD/Fs measured in snow, the estimated median rate of atmospheric fallout is 26.2 ng/m^2/year, or 8.63 g/year, which is 3-8 fold higher than estimates for other European industrial regions. Pervunina *et al.* report on their assessment of PCDD/F sources in the cities of Chapaevsk, Ufa and Dzerzhinsk in the Russian territory, where few environmental data are available and measurements of industrial emissions are practically non-existent.

According to the draft USEPA dioxin reassessment, uncontrolled burning of household wastes in residential backyards is an important environmental source of dioxins (USEPA, 2000). Wevers *et al.*, who report on the results of a study of PCDD/F emissions from open burning of garden and household wastes, confirm this finding. Using a carbon balance method to calculate emission factors, they concluded that emissions to air could be significant; PCDD/F concentrations in the undiluted smoke, as well as the estimated emission factors, are comparable with those from poorly controlled MSW incinerators.

And, Cleverly *et al.* report on the latest progress of USEPA's National Dioxin Air Monitoring Network (NDAMN), which was developed to determine the temporal and geographical variability of atmospheric PCDD/Fs and coplanar PCBs at rural and nonimpacted locations throughout the USA. Reporting on air monitoring results at 22 stations from June 1998 to December 1999, they report that all seventeen of the 2,3,7,8-substituted congeners were detected in ambient air at the 15 rural stations and at some, but not all, of the national parks included in the NDAMN.

Levels in Soil

Despite fewer presentations on soil investigations than in previous years, soil studies presented at this year's symposium focused on sources and the possible impacts on human health. For example, Pless-Mulloli *et al.* report on new investigations conducted in the United Kingdom of PCDD/Fs and other chemicals on footpaths in garden allotments built using incinerator ash, and the occurrence of contaminants in the eggs of chickens and ducks raised in pens by gardeners in those allotments.

Several presentations summarize studies conducted in Korea. Im *et al.* report on PCDD/Fs in soil from the cities of Masan and Changwon in Korea and efforts to identify point sources. The wide range of PCDDs and higher concentrations of PCDDs compared to PCDFs suggests significant inputs from thermal processes such as uncontrolled incineration of industrial wastes and

combustion engines. M-K Kim *et al.* report on the influence of MSW incinerator emissions on PCDD/F levels in soil. S-J Kim *et al.* report on possible sources of PCDD/Fs in soils from urban and industrial areas throughout Korea. And, D-H Kim *et al.* report on efforts to understand PAH concentrations and distributions in soil and, specifically, their use as possible indicators of the occurrence of other persistent organic pollutants in Seoul, Korea.

Recognizing that accurate information about PCDD/Fs in soil is needed to assess the potential risks of exposure, Eom *et al.* report on soil conditions in the vicinity of an MSW incinerator in Seoul, and efforts to understand the major factors responsible for soil contamination. Ono and Ikeguchi report on the results of PCDD/F measurements in 70 soil samples representing different land uses throughout a suburb of Tokyo, Japan as part of an effort to correlate environmental levels with land use and possible sources.

The relationship between levels in soil and vegetation and emissions from municipal solid waste (MSW) incinerators is an important area of research, particularly in Japan. For example, Ikeda *et al.* reports on the use Japanese black pine needles as effective biomonitors for ambient air. Sieke *et al.* report on their investigations of the environmental fate of PCDD/Fs originating from MSW incinerators, as well as the fate of PCDD/F residues from applications of certain herbicides in rice paddy fields in Matsuyama, Japan.

~~Levels in Water Supplies & Waste Treatment Systems~~

Finally, several presentations address the occurrence of PCDD/Fs and PCBs in treated drinking water systems and in waste treatment systems. For example, H-K Kim *et al.* report on PCDD/Fs and co-planar PCBs in source water and the removal efficiencies of different water treatment systems. Fox *et al.* report on a study of PCDD/Fs and PCBs in sewage sludge samples collected from publicly owned treatment works (POTWs) throughout the USA. They could find little statistical correlation between levels in sewage sludge and different treatment processes such as aerobic digestion / anaerobic digestion, dewatering techniques such as heat treatment and vacuum filter press, and the addition of precipitating agents such as polymers.

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