COLORADO RIVER BASIN TOXICITY REPORT

Final

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Prepared for:

Victor de Vlaming, PhD
Gwen Starrett

State Water Resources Control Board
P.O Box 100
Sacramento, CA 95812-0100

Prepared by:

Carol DiGiorgio, Post Graduate Researcher
Howard C. Bailey, PhD, Assistant Adjunct Professor

David E. Hinton, PhD, Principal Investigator

Department of Medicine & Epidemiology
School of Veterinary Medicine
University of California
Davis, CA 95616

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Introduction

Within the Colorado River Basin Region, there are over 675,000 acres of irrigated cropland and approximately 1700 miles of agricultural drains. In the Imperial Valley, approximately $1 billion in crops is produced annually (Agricultural Crop and Livestock Report, 1990). Water in the Imperial Valley is supplied by the U.S. Bureau of Reclamation from the Colorado River for agriculture and urban use. Six desilting basins remove silt from the Colorado River prior to the water's diversion at the Imperial Dam into the All-American Canal. Since 1942, the Imperial Valley has received its water from the All-American Canal (Imperial Irrigation District, 1992).

Within the valley, irrigation water is distributed through a network of canals and laterals by the Imperial Irrigation District (IID). Growers divert water from the laterals and canals, either for crop irrigation, or for leaching of excess salts in an effort to minimize deleterious effects on wildlife and aquaculture. Some canals, including the All-American Canal, are unlined. Irrigation tailwater and seepage from unlined canals are the major sources of ground water recharge; however, most of the recharge is collected by tile drains before reaching the water table. As of 1990, there were 32,227 miles of tile drains in the Imperial Valley (Imperial Irrigation District, 1992). Water intercepted by tile drains is discharged into a network of approximately 1400 miles of surface drainage ditches or collector drains. Collector drains also intercept tailwater runoff directly from fields. The collector drains discharge into the New and Alamo Rivers which in turn discharge into the southern end of the 35,000 acre Salton Sea National Wildlife Refuge. The Alamo River provides approximately 46% of the freshwater input into the Salton Sea. Approximately 38% is provided by the New River.

There are over 1 million acres within the IID's boundaries. In 1992, 407,053 acres were used

for field crops, 95,638 acres for vegetable crops and 20,027 for permanent crops (Imperial Irrigation District, 1992). In 1988, over 5 million pounds of 152 different pesticides were applied to crops in the Imperial Valley.

Many studies have examined rising salinity problems in the Imperial Valley but, despite the widespread application of pesticides, limited work has been conducted in this region to assess the relationship between agricultural practices and adverse effect(s) on organisms present in receiving waters. In order to better understand the impact of Imperial Valley agricultural drainage on local waters, the State Water Resources Control Board initiated a three-year study with the UC Davis Aquatic Toxicology Laboratory (UCDATL) to:

1) Determine the extent, nature and source of toxicity in agricultural drains and high priority water of the Colorado River Basin.
2) Develop a methodological procedure for assessing toxicity from agricultural runoff.
3) Design a follow-up program to continue monitoring the impact of agricultural drainage water in the Colorado River Basin.

To address these questions, the first year of sampling (1992) was a screening study to help focus and define the following years of research (Colorado River Final Report, 1992). During the second year of sampling, collection efforts were focused on the 50-mile long Alamo River, which drains approximately 600 square miles of irrigated cropland. This river was chosen because the inputs into the river are mainly agricultural. In contrast, the New River receives inputs from sewage and urban runoff from across the border, as well as agriculture.

This report examines toxicity in the Alamo River from March 1993 to February 1994. One

hundred and fifteen water samples were collected during this time period. Ninety-six-hour static renewal bioassays were conducted with two invertebrates, *Ceriodaphnia dubia* and *Neomysis mercedis*. Neomysids were used due to their similar pesticide sensitivities and their ability to tolerate higher salinities than *C. dubia*

Materials and Methods

Ambient Water Samples

In general, samples were collected twice a month from the Alamo River. A total of 11 sampling locations, located upstream of the Harris Street Bridge and 5 sites located at and downstream of the bridge (Table 1, Figure 1) were used. Eleven liters of water (grab samples) were collected from each site in acid-washed amber glass bottles. On the following day, the bottles were shipped overnight on ice to the UCD ATL and were stored at 4°C. Bioassays were initiated the same day the samples were received, generally within 2-8 hrs of sample arrival.

Bioassay Procedures

Ninety-six hour static renewal bioassays were conducted with *Ceriodaphnia dubia* and *Neomysis mercedis*. *C. dubia* neonates (< 24 hr old) were obtained from established cultures at the UCD ATL while juvenile *N. mercedis* were supplied by Brezina and Associates, Dillon Beach, California or from existing in-house cultures. *C. dubia* were cultured in well water diluted with glass distilled water to EPA moderately hard specifications (Dil. EI). Neoysids were acclimated to laboratory waters (19°C and 5000 µmhos conductivity) for at least four days prior to testing. Due to poor organism health, no neomysids were tested with samples collected 11/1/93. Water samples collected on 11/29/93 were tested with laboratory-reared neomysids only.

C. dubia were exposed in 20 ml glass scintillation vials. Ten replicates were used per treatment; each replicate contained one neonate in 18 mls of test solution. The test solutions were renewed daily. During an individual test, *C. dubia* were fed a mixture of trout chow and green algae (*Selenastrum capricornutum*). Test temperature was 25 ± 1°C and *N. mercedis* were exposed in 50 ml glass beakers. Each beaker contained 40 mls of test solution and one neomysid. Twelve replicates were used per treatment, and 50% of the solution was renewed on a daily basis. Only 10 replicates were used for water collected 11/29/93. Neomysids were fed daily approximately 20, less than 24 hr old, *Artemia nauplii*. The test temperature was 19 ± 1°C.

In some cases, the conductivity of the samples exceeded 2500 µmhos. In these instances, the samples were diluted to between 2000 and 2500 µmhos with glass distilled water to minimize osmotic stress to *C. dubia*. The samples were tested without dilution with *N. mercedis*.

Each testing event was accompanied by laboratory controls which incorporated the same procedures as the ambient water samples except that moderately hard well water (Dil. EI) was used. Depending on the conductivity of the ambient samples, the conductivity of this water was adjusted to 2000 - 2500 µmhos, with natural seawater, prior to addition of test organisms.

Chemical Analysis

Toxic samples were sent for chemical analysis between March and August 93 to the Department of Pesticide Regulation (DPR) and Eureka Laboratories. Beginning in September, selected samples were sent to DPR and Agriculture & Priority Pollutant Laboratories (APPL) in Fresno. In most cases, toxic samples were submitted to DPR for analysis from only one of the two sampling periods each month.

Samples for chemical analysis were shipped overnight on ice the day following collection.

Waters were stored at 4°C and analyzed for organophosphate and carbamate pesticides following bioassay results. With the exception of waters analyzed for endosulfans and diazinon, all waters sent to DPR were preserved with concentrated H_2SO_4 to a pH of 2. Water samples sent to Eureka and APPL Laboratories were not acidified. APPL Laboratories used EPA method 8140 and 632 for the analysis of organophosphate and carbamate pesticides, respectively. Eureka Laboratories used EPA methods 614 and 632, respectively. The Department of Pesticide Regulation used methods developed by their laboratory. Pesticides analyzed by each laboratory are listed in Table 2. Beginning in September, laboratory spiked samples were sent to each lab. Laboratory waters were spiked with 1.0 and 0.5 µg/l of carbofuran and chlorpyrifos, respectively.

Toxicity Identification Evaluations (TIEs)

TIEs of 24- or 48-hour duration (EPA, 1992) were conducted with ceriodaphnids based on toxicity and location. Criteria for samples selected for TIEs were bioassay mortality, length of exposure time to achieve mortality, and/or sampling location on the river relative to other toxic sample sites. In general, when an entire stretch of river was toxic, TIEs were conducted on samples collected at the top, the middle and the bottom of the stretch of river sampled. All TIEs were run within 10 days of sample collection. TIE procedures focused primarily on toxicity from non-polar organics; however, metal toxicity was also investigated. Ammonia levels were always below NOEC levels and therefore were not considered a toxicant of interest.

In general, TIE procedures followed EPA guidelines (EPA, 1992). However, based on previous work in this laboratory, procedures associated with pH adjustment were modified slightly. Samples were adjusted to pH 3 or 11 and returned to the initial pH after incubation in the dark at 25°C for 6 hours. Beginning with samples collected 10/18/93, piperonyl butoxide

(PBO) was added to effluents at either 100, 200, or 300 µg/l. Because PBO inhibits the toxicity of metabolically activated organophosphates, reduction of ambient water toxicity following the addition of PBO suggests toxicity from metabolically activated OPs. Because TIE techniques with neomysids have not been developed, only ceriodaphnids were used in these procedures.

Statistics

Mortality in the treatments were compared to the control using Fisher's Exact Test (Sokal and Rohlf, 1981). Differences between the control and sample were declared significant at $p \leq 0.05$.

Quality Control

Ceriodaphnid and neomysid control mortality was < 20% for the entire 1993-94 sampling period.

Results

Spatial and Temporal Patterns of Toxicity

Throughout the 12-month sampling period, waters collected at the All-American Canal (Site 1) exhibited no statistically significant toxicity to either test species. Consequently, this sampling point is not included in any of the following discussions. Unless otherwise noted, results of the 93-94 sampling year are confined to sites 2-11 of the Alamo River.

Ceriodaphnids - Seasonally, there were distinct patterns to ceriodaphnid toxicity. The frequency of toxicity was low during the spring and summer and high throughout the fall and late winter/early spring (Figure 2). Of the 101 samples tested, only 2/51 (4%) were acutely toxic to ceriodaphnids between April and August (Table 3). In contrast, over 70% (39/54) caused toxicity to ceriodaphnids between September and March, with most of the toxicity occurring between