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Investigating insecticides in water and sediment of Chile: do they sink or swim?

Authors: Luke G. Allmon2, Jonathan M. Ali1, Daniel D. Snow2, Nicolas Gouin4,5, Angeline Bertín4,5 and Alan S. Kolok1

1Department of Environmental, Agricultural and Occupational Health, University of Nebraska-Medical Center, 986805 Nebraska Medical Center, Omaha, NE, United States.
2Department of Biology, University of Nebraska at Omaha, 6001 Dodge Street, Omaha, NE, United States.
3 School of Natural Resources, University of Nebraska-Lincoln, Lincoln, NE 68583-0844, United States
4Departamento de Biología, Facultad de Ciencias, Universidad de La Serena, Casilla 554, LaSerena, Chile
5Centro de Estudios Avanzados en Zonas Áridas, La Serena, Chile

Abstract

In central Chile the climate is Mediterranean and suffers from challenging problems with ecotoxicology. In Chile, the rivers that are present travel short distances from the Andes Mountains to the Pacific Ocean while being surrounded by desert. Although these areas are remote in the Andes these river systems are subject to intense agricultural activities to increase crop production. In this region we have found that a native organism, *Trichomycterus areolatus* or known as a pencil catfish, suffers from genetic alteration downstream from areas that are agriculturally dominated. Since we found that the *T. areolatus* was being affected from agricultural runoff we sought out to determine whether insecticides used in Chile are predominately found in surface waters or sediment in an agriculturally-dominated river system. We took water and sediment samples from 3 different sites on the Choapa River to analyze them back in the United States. To analyze the samples, we would use a solid phase extraction technique to extract the chemicals from the water and sediment samples. After extracting all the chemicals from the water and sediment samples, we sent our extracts to the Water Science Lab (WSL) at University ofNebraska Lincoln where they will quantify our extracts using gas chromatography–mass spectrometry (GC-MS). We found that the insecticides found in Chile were not predominately found in the water samples but rather the sediment samples. Thus, this supports the idea that agricultural runoff affects the river system causing harm to native species found in the river.

Introduction

In 1999, Chile introduced the Agricultural and Livestock Service with a mission to evaluate the effects of pesticides in the environment [1]. This introduction was important, given Chile's role as a primary fruit producer among nations participating in the Organization for Economic Co-Operation and Development (OECD) [2]. The agricultural activities in Chile are focused around river systems to increase crop production. In these areas the use of insecticides on fruits and vegetables is heavy [3].

Insecticides can be transported into Chilean rivers following rainstorms. Chemicals that enter rivers in this manner can either be hydrophilic, and stay in the water, or may be hydrophobic and interact with sediments [4,5]. Hydrophobic insecticides are most likely to partition into the sediment rather than staying in the water that will carry them downstream [5]. The interaction between sediment and pesticides raises concerns of magnitude and persistence of sediment bed contamination.

Streams in Chile are only present temporarily throughout the year due to the arid environment. It is unknown if the persistence of insecticides in the sediment in a temporary river system is the same as that of a continuous river system. When the dry season comes, the insecticides that are trapped in the river bed cannot be released due to the absence of water [6]. When pesticides can't be washed away with river water this would prolong the persistence of these insecticides in sediment. Therefor, there is a need to evaluate the presence of insecticides in the water and sediment in a temporary river system to determine where insecticides predominately reside.

The objective of this project is to compare the Choapa and Limari river to determine the concentration of pesticides in the water and soil of these river systems in Chile.

Figure 1 (Above). The upperstream location on the Choapa river (B) and the downstream location on the Choapa River (A) in Coquimbo, Chile

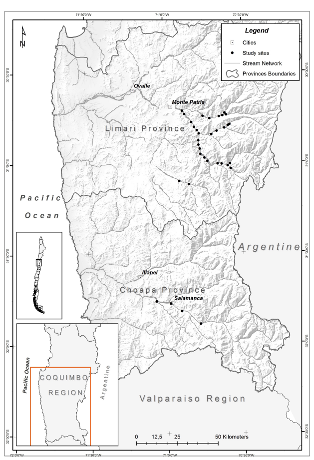

Figure 2 (Right). Map of Limari and Choapa Province with the location of sample collection sites.

Methods

Sediment and water samples were collected in specific locations along the rivers of interest. Both samples were stored in amber glass bottles for transportation. The water samples collect underwent solid phase extraction technique to extract the chemicals from the water samples [7].

The sediment underwent a solvent wash to extract the chemicals from the samples for subsequent solid phase extraction to isolate the chemicals for quantification [7,8]. Extracts were sent to the Water Science Lab (WSL) at the University of Nebraska Lincoln where they quantified our extracts using gas chromatography–mass spectrometry (GC-MS). Data obtained from WSL expressed the concentration of insecticides in sediment and water as g/g and g/L, respectively, which will then be compared between the water and sediment.

Table 1. Samples collected tested for chemicals listed below

Acetochlor	Atrazine	Bifentrin	Boscalid	Butachlor	Carbofuran
Chlorpyrifos	Cyhalothrin λ	Cyprodinil	DEA	Deltamethrin	DIA
Diazinon	Fludioxonil	Malathion	Methidathion	Methomyl	Metolachlor
Metribuzin	Parathion ethyl	Parathion methyl	Pendimethalin	Permethrin	Propazine
Pyrimethanil	Quinoxyfen	Tebuconazole	Tefluthrin	Tertbuthylazine	Triadimefon

Table 2. Percent recovery of extracted samples

	Water Specs.	Sediment Specs.
Choapa River	% Terbutylazine: 101.1 ± 6.1 % Butachlor: 86.0 ± 6.0	% Terbutylazine: 106.7 ± 11.2 % Butachlor: 99.0 ± 6.4
Limari River	% Terbutylazine: 93.3 ± 2.1 % Butachlor: 85.8 ± 4.3	% Terbutylazine: 102.7 ± 8.4 % Butachlor: 82.4 ± 5.6

Figure 3. Collection of water samples in the Choapa River.

Figure 4. Water samples undergoing solid phase extraction (SPE) to extract any pesticides that could be found in the water.

Choapa River

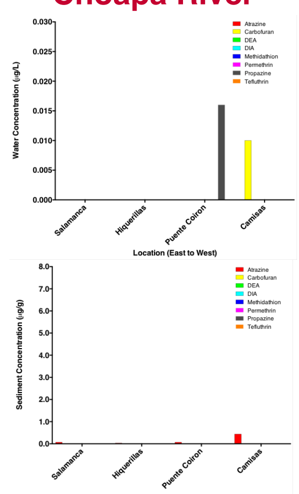

Figure 5. The concentration of pesticides in the water (µg/L) and sediment (µg/g) on the Choapa River Basin collected in October. The sites from left to right are the order of the site from east to west.

Limari River

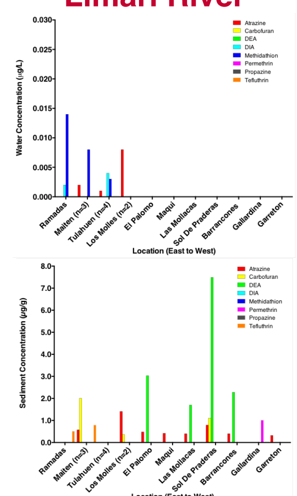

Figure 6. The concentration of pesticides in the water (µg/L) and sediment (µg/g) on the Limari River Basin collected in October. The sites from left to right are the order of sites from east to west. (Note: Sites Maiten, Tulahuen, and Los Molles were the average of multiple concentrations in the same area.)

Major Findings

I. In an arid environment, such as Chile, pesticides predominately partition into sediment rather than water.

II. Pesticide concentrations in water and sediment differ when the terrain of the rivers are different.

III. The concentration of pesticides are greater downstream rather than upstream.

Future Directions

- A native species of fish must be found to test whether these chemicals, when present in their environment, affect them
- The water and sediment must be tested during different seasons to see if pesticides are still present.
- There should be further research on contamination in the Choapa River than just the four sites we were limited to.

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