

Crocodilians as sentinels of current use pesticide contamination in Costa Rica

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Abstract:

Spectacled Caiman (*Caiman crocodilus*) are fish-eating crocodilians that inhabit freshwater and estuarine habitat in tropical regions of the Americas. In Costa Rica, the two crocodilian species present are under considerable pressure from human activities including hunting, habitat destruction, and agricultural impacts. Banana plantations represent 12% of Costa Rica's agricultural lands, but they account for 35% of the county's pesticide use. In order to assess exposure of caiman to pesticides, we obtained whole blood (30cc) samples from 14 live-captured adult males and females. We analyzed the blood samples for 70 legacy and current-use pesticides using newly developed ultra-trace high resolution mass spectrometry (HRMS). Results suggest that high trophic level caiman are exposed to varying pesticide concentrations, reflecting degree of local use and physico-chemical properties of the pesticides.



Fig 1: Map of the study area showing location of samples collected.

Objectives

To use a new analytical procedure to test levels of pesticides in caiman inhabiting rivers in the North Atlantic lowlands of Costa Rica as a means of characterizing:

- 1) the quantity and fate of these contaminants
- 2) the value of caiman as a sentinel species in this environment.



Results:

Fig 2: Occurrence of pesticides in caiman whole blood from the Suerte River basin

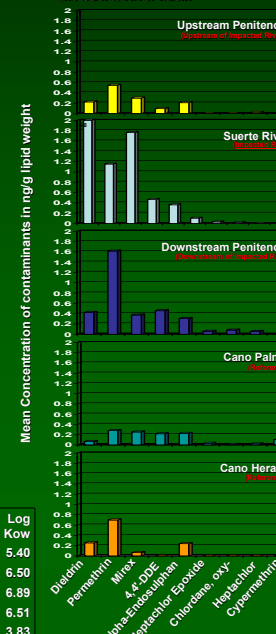


Fig 3: Category of pesticide and Percent of total pesticides residues detected in caiman whole blood from the Suerte River basin

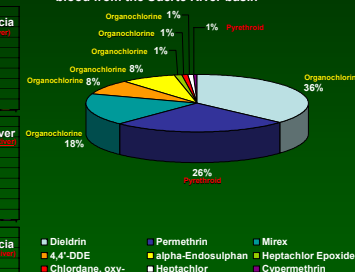


Fig 4: Total concentration of pesticides in caiman whole blood from the Suerte River basin. Suerte River was determined to be significantly higher in pesticide concentration ($p < 0.005$) using a two-way ANOVA, in all sites except Downstream Penitencia, which it flows directly into.

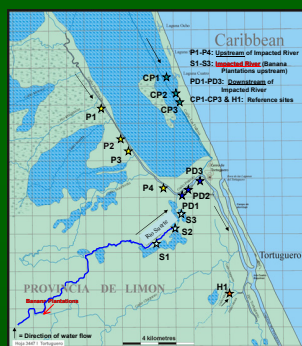
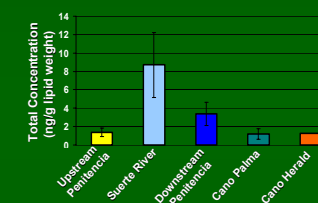
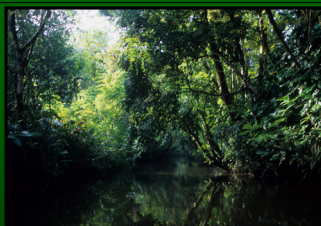


Table 1: Concentration of detected pesticides (ng/g lipid weight) in whole blood of adult caiman (~1.5m) within the Suerte River Basin.

	Upstream Penitencia			Suerte River			Downstream Penitencia			Cano Palma			Cano Herald			Detection Limits	Total	Log Kow
	P1	P2	P3	P4	S1	S2	S3	PD1	PD2	PD3	CP1	CP2	CP3	H1				
Dieldrin	0.169	0.319	0.103	0.302	7.944	2.593	3.873	1.075	0.083	0.120	0.040	0.132	0.033	0.254	0.01	17.040	5.40	
Permethrin	0.402	0.457	0.968	0.345	1.056	0.871	1.527	1.756	0.892	2.193	0.238	0.250	0.353	0.700	0.021-0.059	12.008	6.50	
Mirex	0.129	0.295	0.658	0.120	2.206	2.071	1.009	0.819	0.223	0.070	0.082	0.405	0.273	0.064	0.01-0.036	8.424	6.89	
4,4'-DDE	ND	0.211	0.158	ND	0.889	0.251	0.256	0.514	0.858	ND	ND	0.474	0.178	ND	0.015-0.041	3.789	6.51	
alpha-Endosulphan	0.319	0.149	0.138	0.221	0.258	0.395	0.436	0.374	0.486	0.056	0.241	0.340	0.098	0.236	0.01-0.015	3.748	3.83	
Heptachlor Epoxide	ND	ND	ND	ND	0.209	ND	0.105	0.074	0.096	ND	ND	0.064	0.032	ND	0.01	0.580	5.40	
Chlordane, oxy-	ND	ND	ND	ND	0.088	ND	ND	0.116	0.124	ND	ND	0.000	0.036	ND	0.01-0.018	0.364	6.16	
Heptachlor	ND	0.029	ND	0.039	0.060	ND	ND	0.071	0.091	ND	ND	0.063	ND	ND	0.01	0.353	6.10	
Cypermethrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.310	ND	ND	0.001-0.066	0.310	6.60	
Total	1.02	1.46	2.02	1.03	12.7	6.18	7.21	4.8	2.85	2.44	0.6	1.73	1.31	1.25		46.616		

ND = less than detection limit



Introduction:

The northern Atlantic Zone of Costa Rica is a global hotspot, containing one of the most important wilderness areas, in terms of biodiversity, found in the country. The headwaters of the Suerte River flow through major banana producing and other agricultural areas, draining into this critical habitat, which includes the Tortuguero Conservation Area.

As aquatic ecosystems are complex dynamic systems increased recognition has been given to aquatic organisms as long term biological monitors to investigate exposure and effects caused by contaminants. Adult crocodilians such as the Spectacled Caiman are long lived, high trophic level predators which are territorial, and tend to be fairly localized in areas. Therefore, their potential as long term biological monitors to assess patterns of environmental contaminants is great.

Using a new ultra-trace HRMS analytical procedure, which significantly enhances detection limits over traditional methods, the goal of this study is to shed light on contaminant exposure levels in this protected area and the use of crocodilians as sentinel species.

Methods:

This study was conducted in the Suerte River, which is impacted due to banana plantations upstream; up and downstream of where the Suerte River enters into the Penitencia River and other selected reference rivers, which all drain into the Tortuguero conservation area in the northern Atlantic lowlands of Limon Province, Costa Rica.

Whole blood (30cc) samples were obtained from 14 live-captured adult male and female caiman of a similar size class (~1.5m).

Blood was extracted via the ventral caudal vein using a Vacutainer blood collection system and stored at -25°C in certified pesticide grade glass vials until contaminant analysis.

A newly developed ultra-trace high resolution mass spectrometry (HRMS) analytical procedure was utilized for detection of 70 current and legacy pesticides.

Analysis was carried out by AXYS Analytical Services Ltd, Victoria, Canada.

Conclusions:

- The new ultra-trace high resolution procedure developed by AXYS with lower detection limits, readily detected pesticides in caiman whole blood.
- Top 3 pesticides detected were Dieldrin, Permethrin & Mirex which accounted for 80% of total pesticide residues. Two groups of pesticides detected were legacy Organochlorines (73%) and current use Pyrethroids (26%).
- All pesticide residues detected had high Log Kow values, readily enabling their uptake into biological systems.
- Demonstrated that caiman are a sentinel species which can be used to help evaluate environmental conditions.

References:

- Guillette, L.J. et al. 1999, Arch. Environ Contam Toxicol. 33: 447-455.
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Acknowledgments:

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