Efectos del mercurio sobre la salud humana

Prof. Jesús Olivero-Verbel. Ph.D.

Doctorado en Toxicología Ambiental
Grupo de Química Ambiental y Computational
Universidad de Cartagena
Cartagena, Colombia

Universidad de Cartagena
Fundada en 1827

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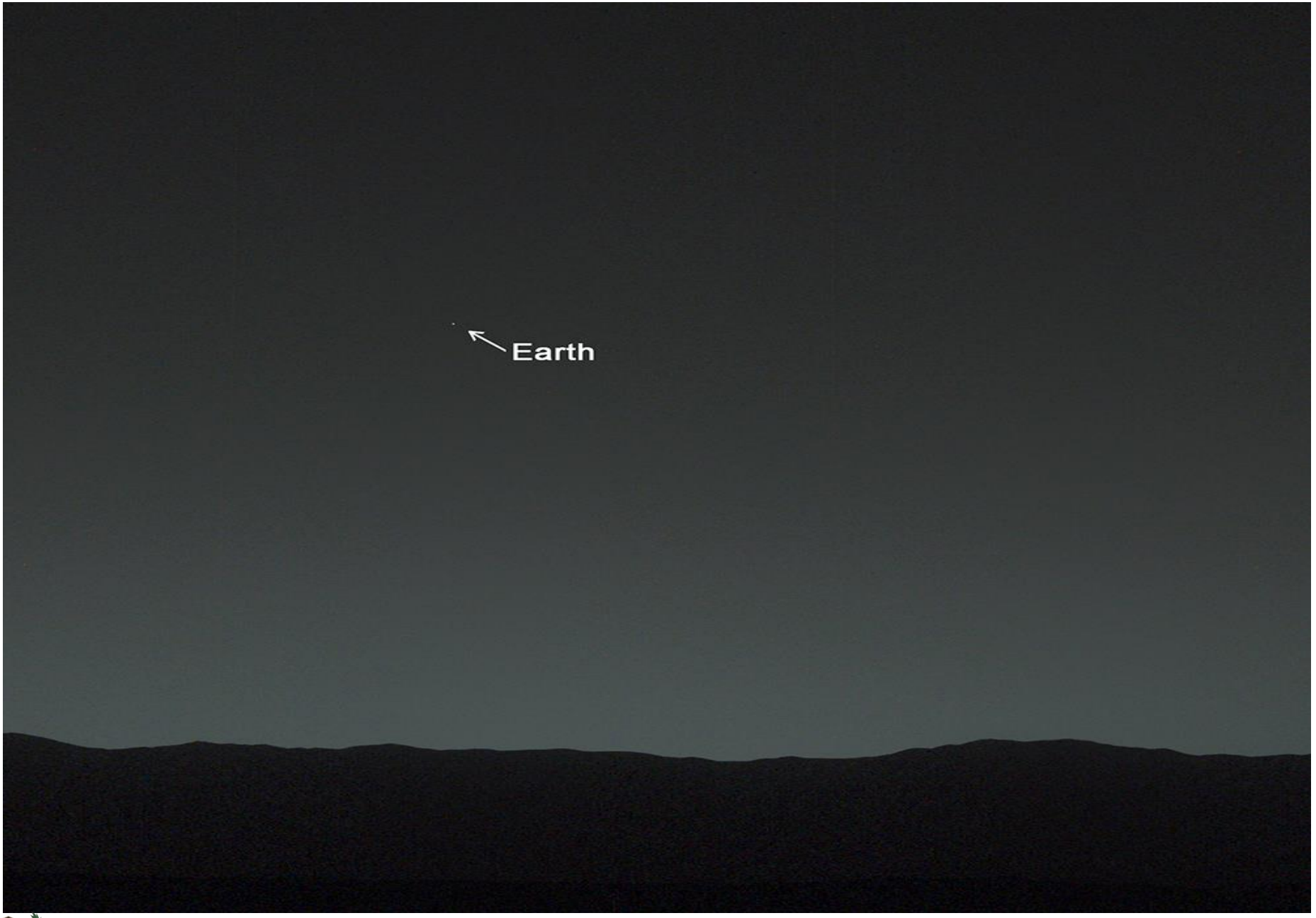
Temario

- **Conceptos generales**
- **Exposición humana**
- **Mecanismos de toxicidad**
- **Efectos del mercurio en humanos**
- **Respuestas**

Conceptos Generales

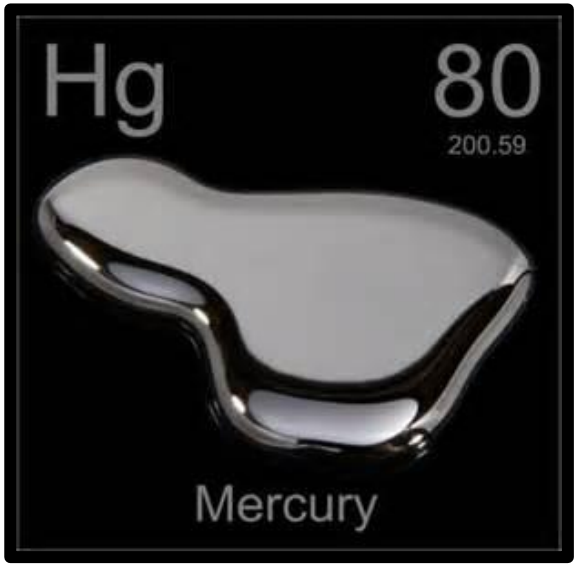

Earth

Hg

Mercurio

Alta densidad relativa

Líquido: Presión de vapor



Amalgama es la mezcla (aleación) de mercurio con otros elementos.

Especies de mercurio

- **Mercurio elemental**

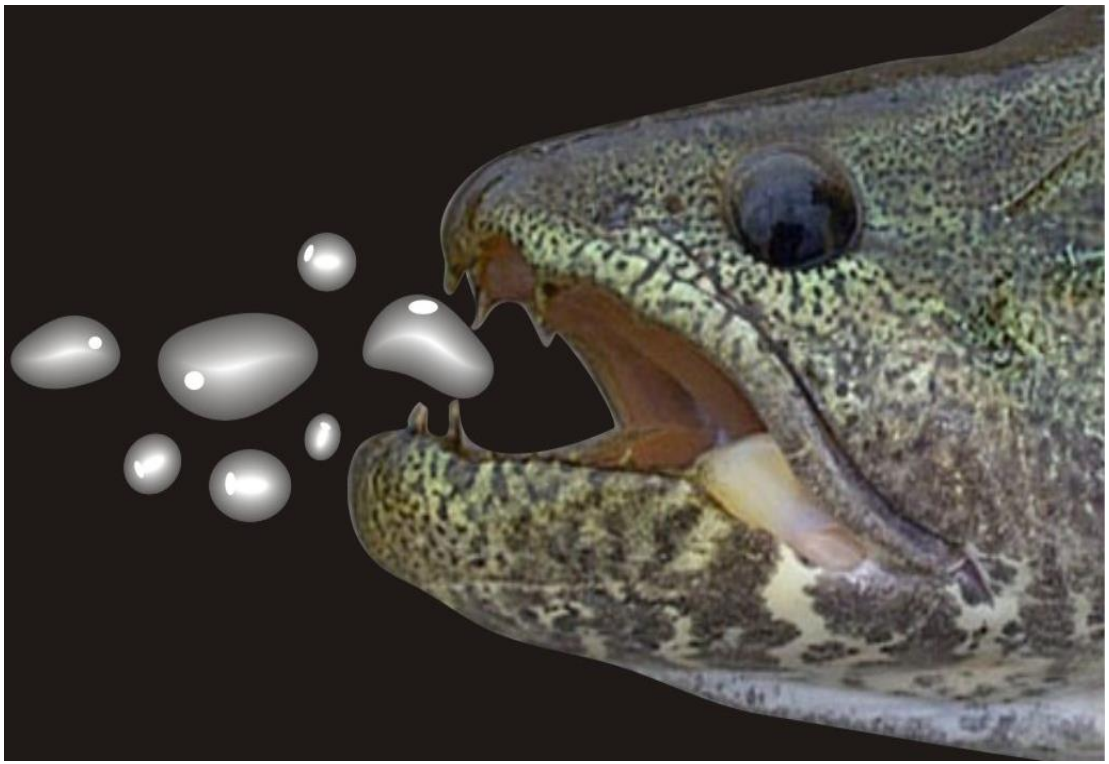
- **Mercurio inorgánico** ($HgCl_2$, HgS)

- **Mercurio orgánico (Metilmercurio)**

Mercurio Orgánico

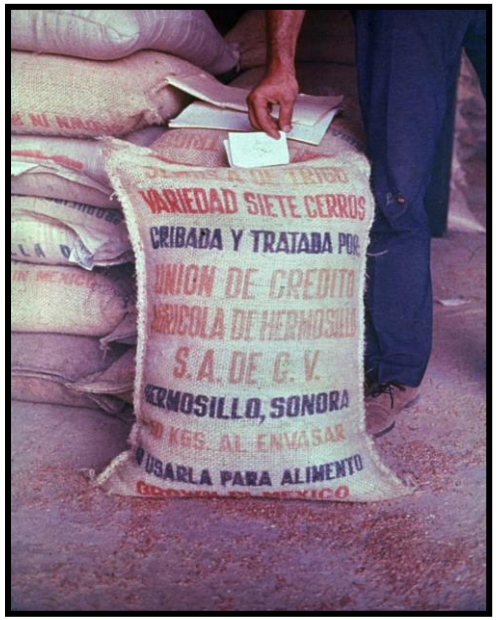
Hg^{+}

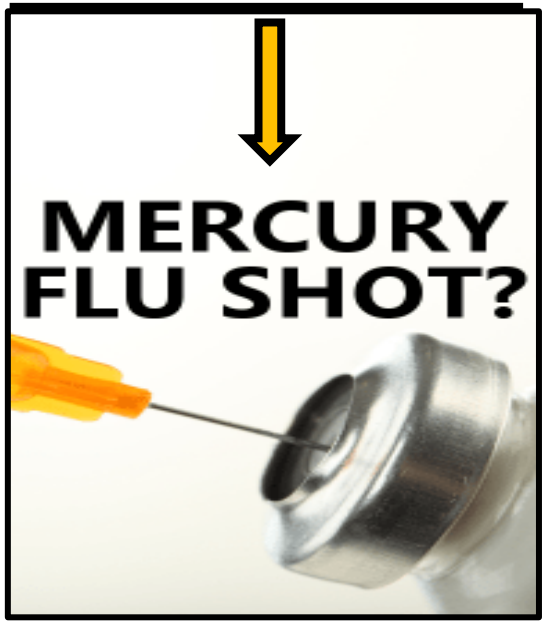
CH_3



Conceptos Generales

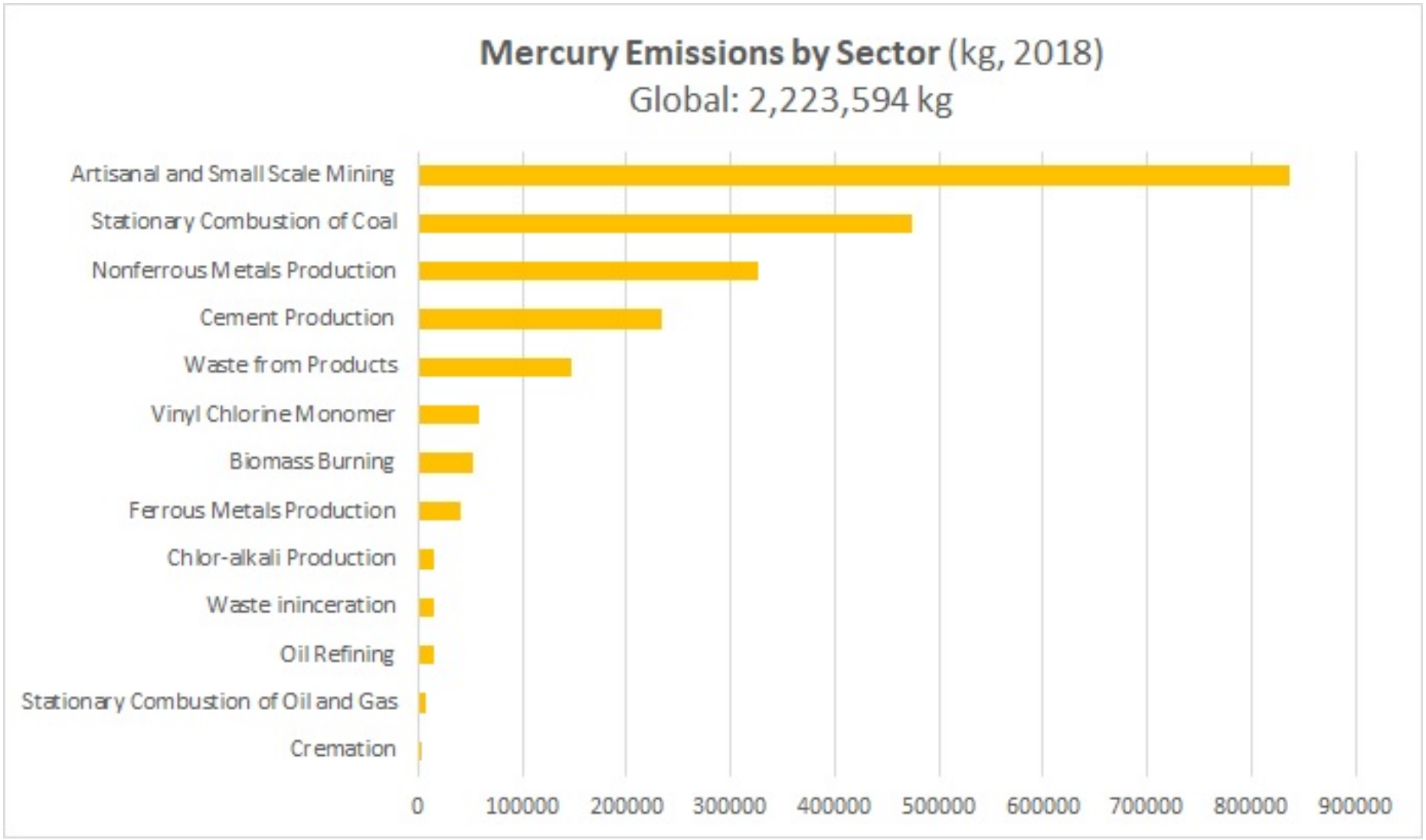
Fuentes





Conceptos Generales

Fuentes

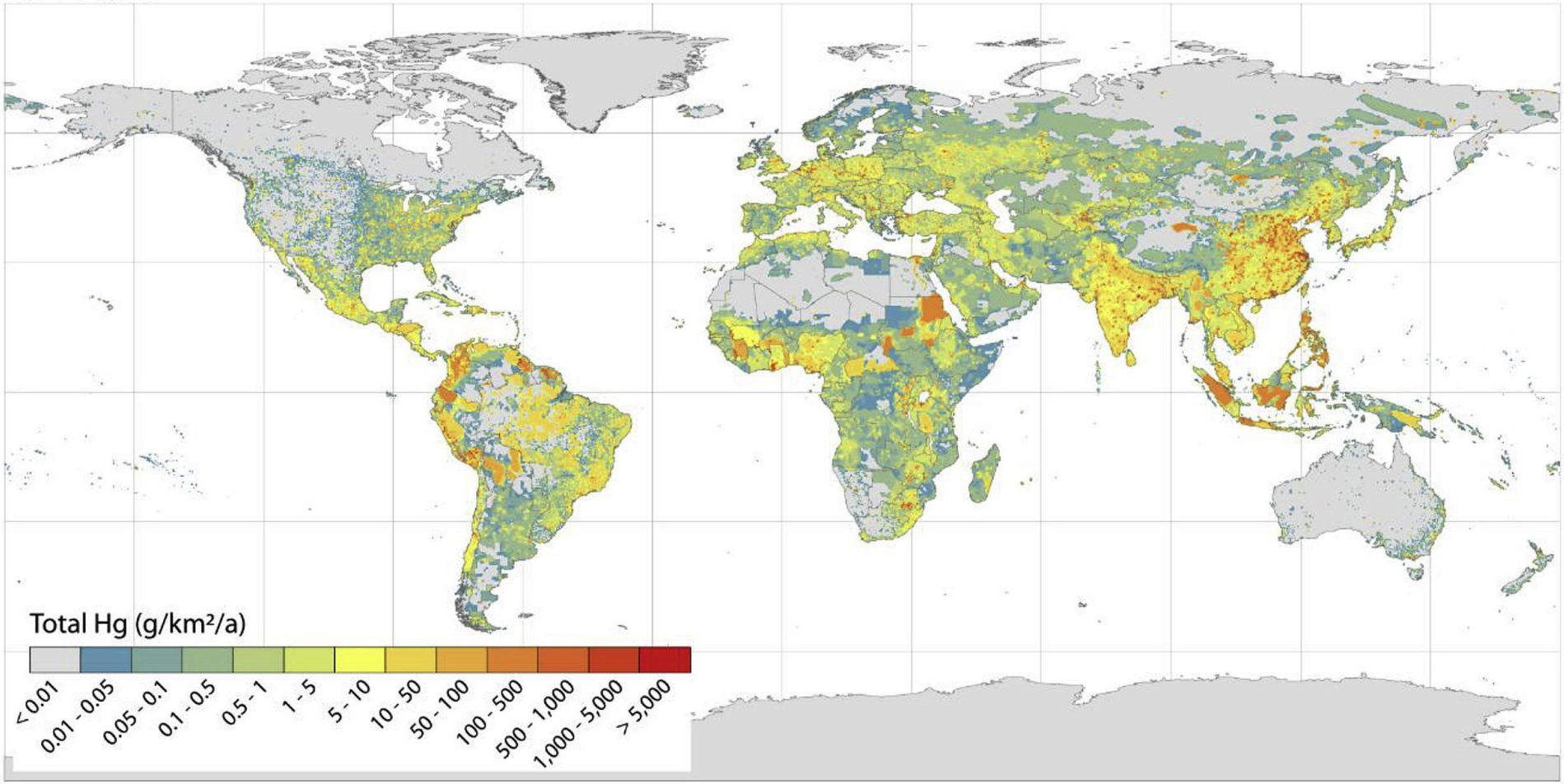


https://www.epa.gov/international-cooperation/mercury-emissions-global-context#types

Conceptos Generales

Fuentes

All sectors

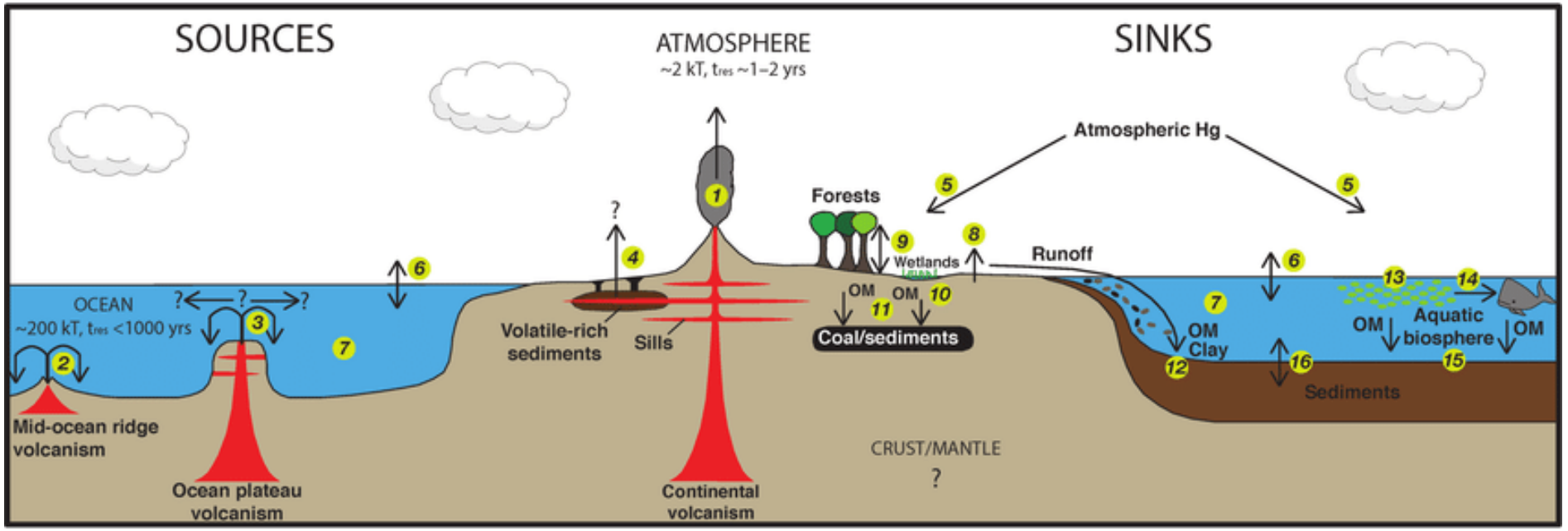


Año: 2015 (g/km2/a)

https://www.epa.gov/international-cooperation/mercury-emissions-global-context#types

Conceptos Generales

Fuentes



DOI: 10.2475/08.2018.01

Conceptos Generales

Dinámica ambiental

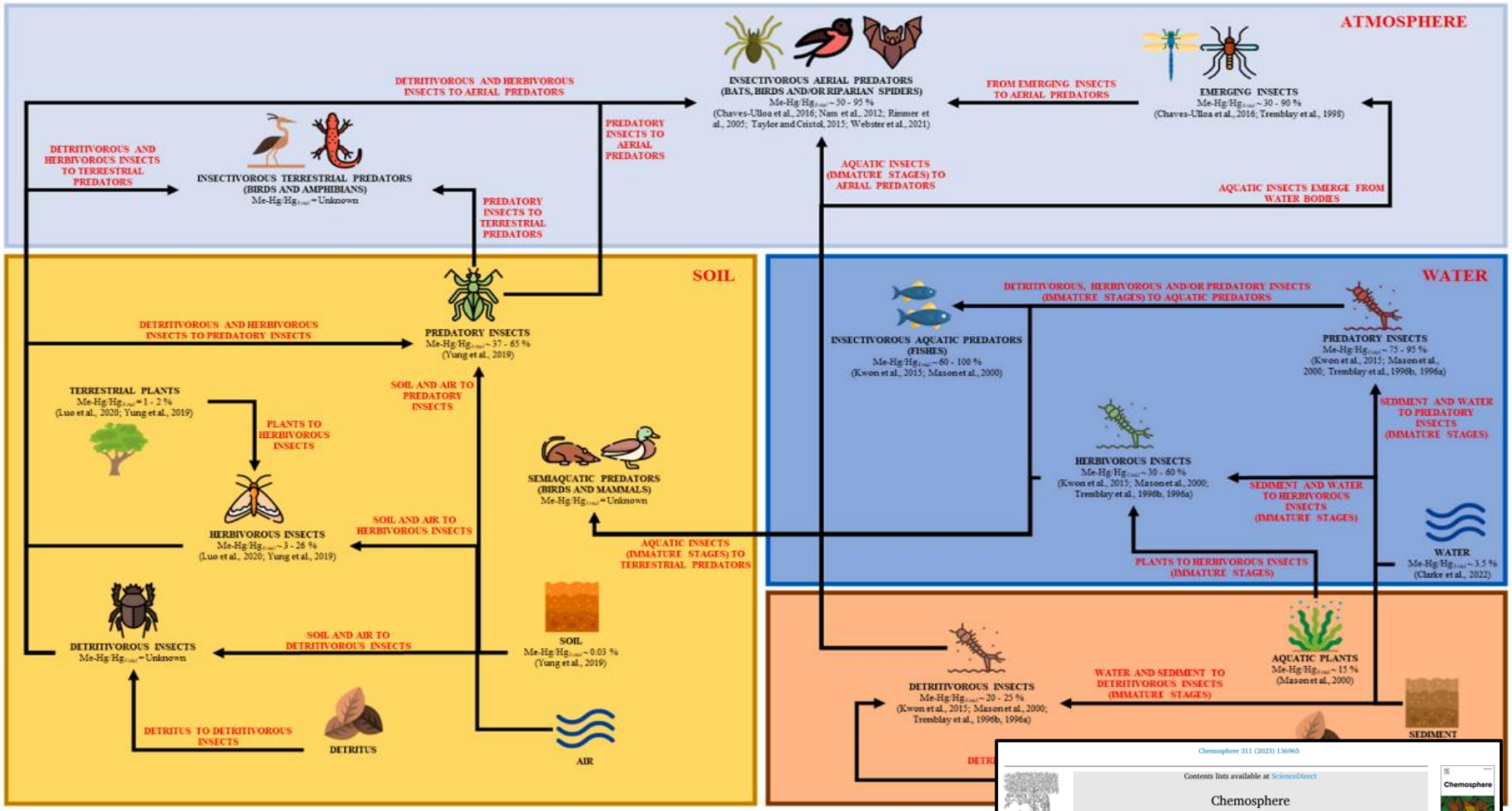
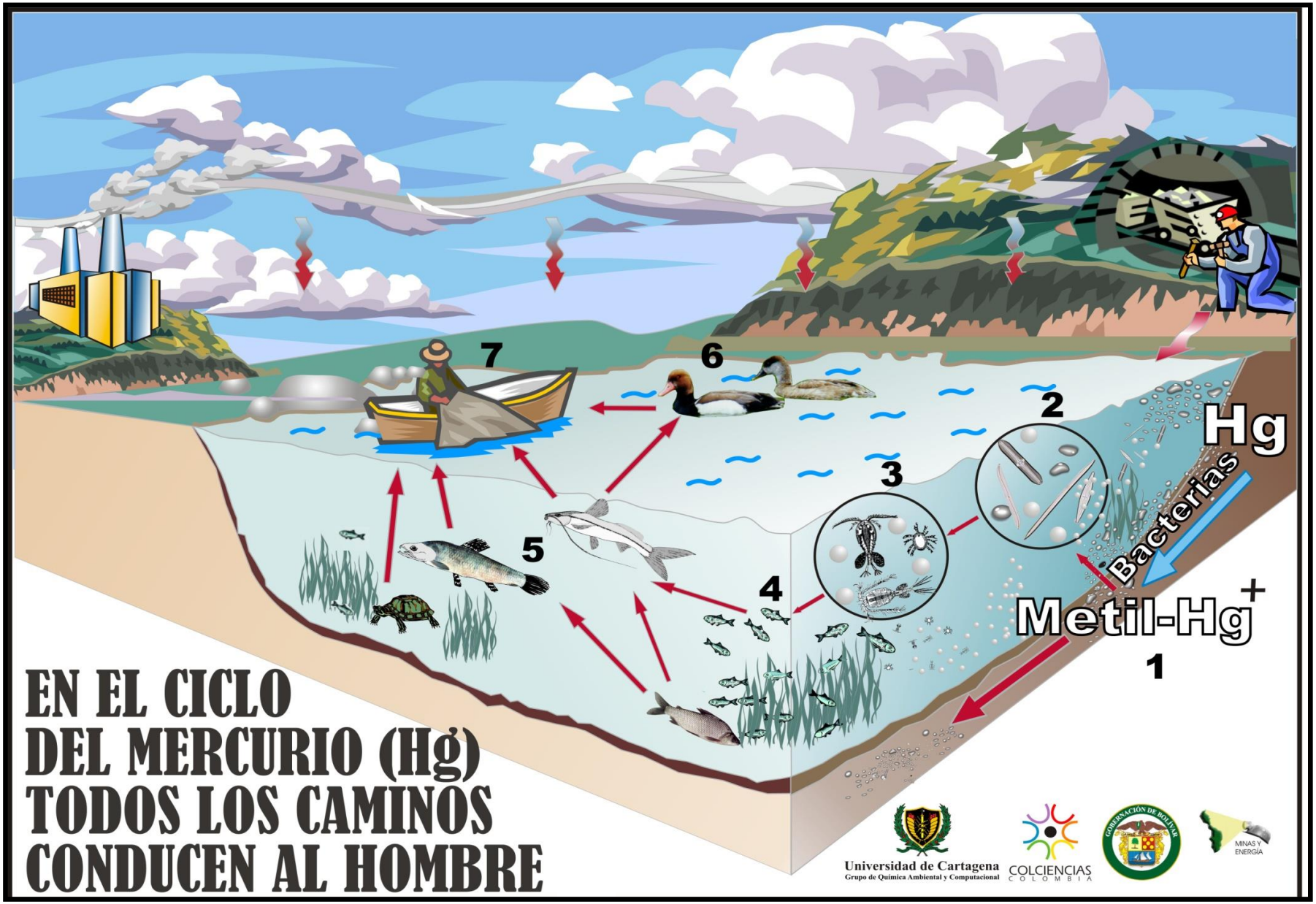


Fig. 1. Insects in mercury cycle.

Conceptos Generales

Dinámica ambiental



Exposición humana al mercurio

Exposición humana al mercurio

General Exposure

Vegetables from contaminated soils

Large predatory Fish

Cosmetics & Soaps

Used & damaged products containing mercury

Occupational Exposure

Industry

Small-scale gold minning

Manufacturing of products containing mercury

Waste

Chemosphere 312 (2023) 137314

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Mercury sources, contaminations, mercury cycle, detection and treatment techniques: A review

K. Grace Pavithra [a], P. SundarRajan [b], P. Senthil Kumar [c,d,e,*], Gayathri Rangasamy [f,*]

Exposición humana al mercurio

https://emeramed.com/study-mercury-poisoned-gold-miners/

Exposición humana al mercurio

Critical Reviews in Toxicology, 36:609–662, 2006
Copyright © Informa Healthcare
ISSN: 1040-8444 print / 1547-6898 online
DOI: 10.1080/10408440600845619

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healthcare

The Toxicology of Mercury and Its Chemical Compounds

Thomas W. Clarkson
Department of Environmental Medicine, University of Rochester School of Medicine, Rochester, New York, USA

Laszlo Magos
Retired from Medical Research Council, Toxicology Unit, Surrey, United Kingdom

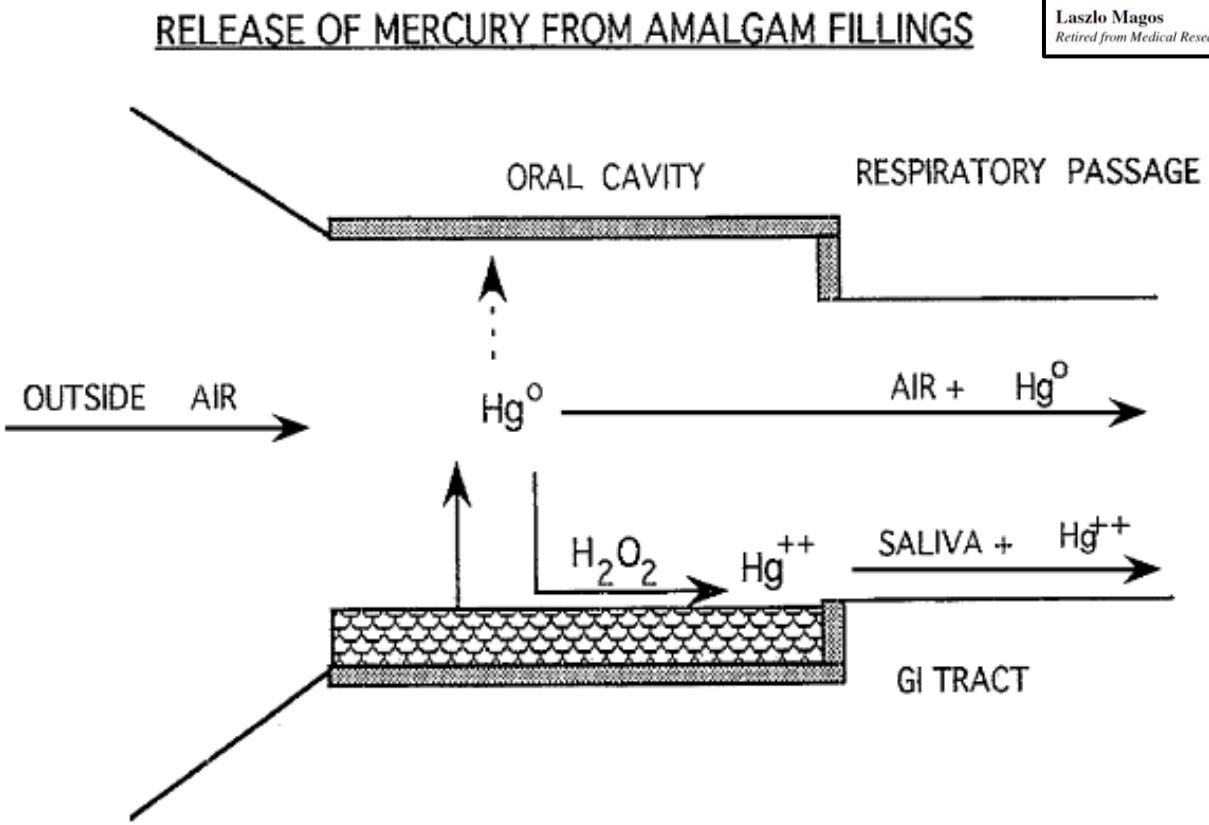
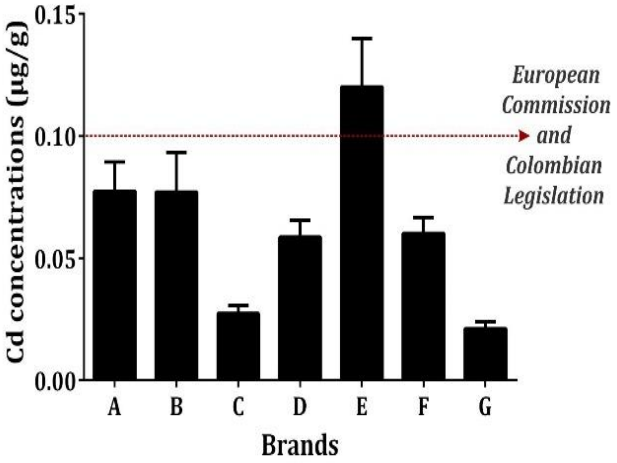
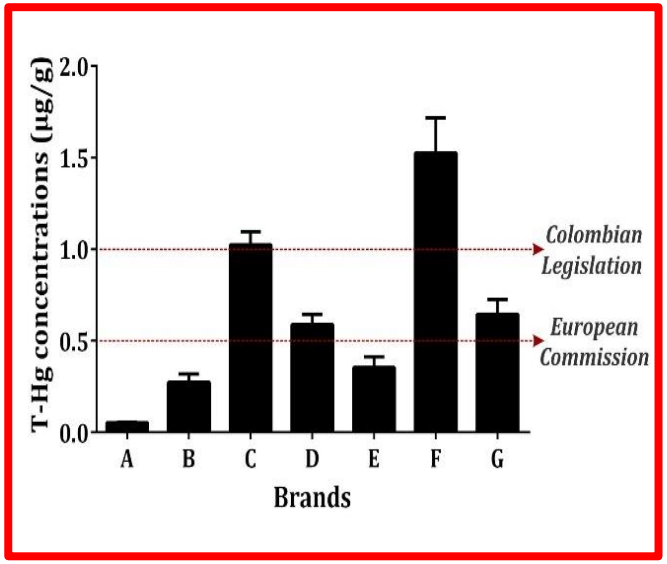
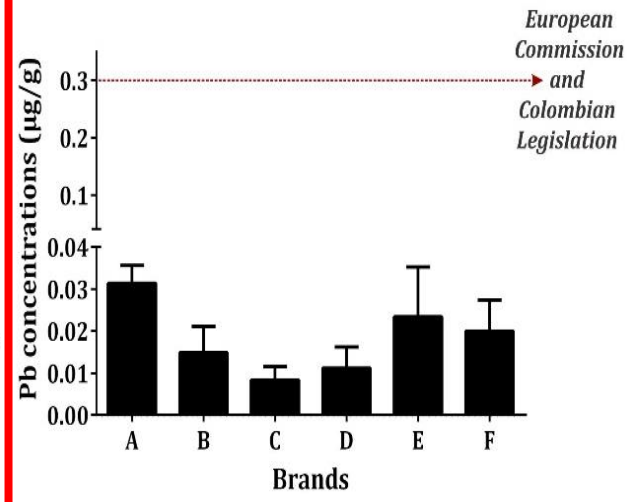


FIG. 3. A diagram of the release of mercury from dental amalgam in the oral cavity. Mercury vapor is emitted from the amalgam surfaces and inhaled or oxidized to Hg^{2+} and swallowed along with particulates of amalgam released by abrasion of the amalgam surfaces.

Exposición humana al mercurio







Exposición humana al mercurio

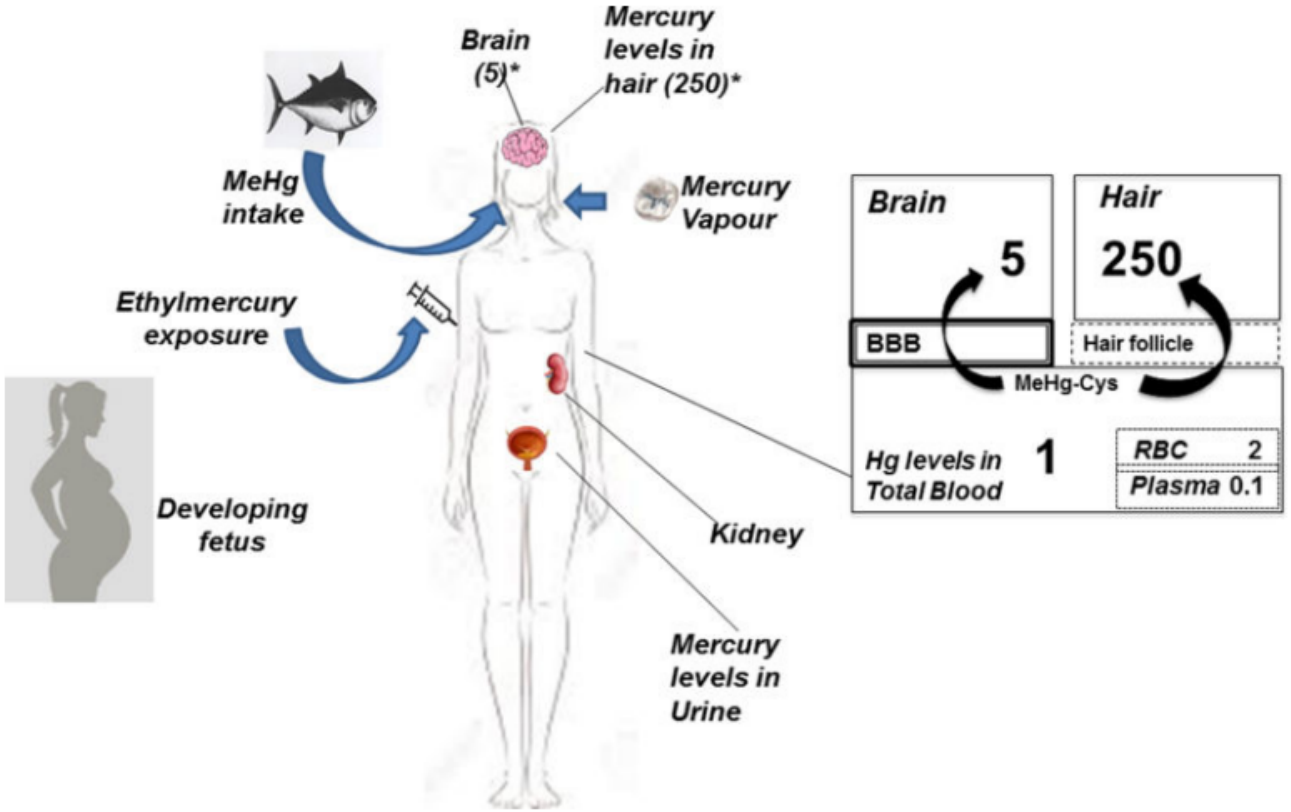


Figure 3. Main pathways of exposure to mercury compounds, exposure biomarkers and relative concentrations of MeHg in hair, brain and blood.

Humans are exposed to different mercury compounds by different routes, such as MeHg (fish consumption), Hg^0 (dental amalgams), and EtHg (TCV). The major target organs include the brain, kidney and the developing fetus, and exposure levels are normally assessed by measuring mercury levels in hair, blood and urine. In the case of MeHg levels in hair and blood correlate well with the values found in the brain in the proportion 250:5:1. (adapted from Clarkson et al., 2007)

Exposición humana al mercurio

Chemosphere 193 (2018) 421–430

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Mercury pollution by gold mining in a global biodiversity hotspot, the Choco biogeographic region, Colombia

Yuber Palacios-Torres [a, b], Karina Caballero-Gallardo [a], Jesus Olivero-Verbel [a, *]

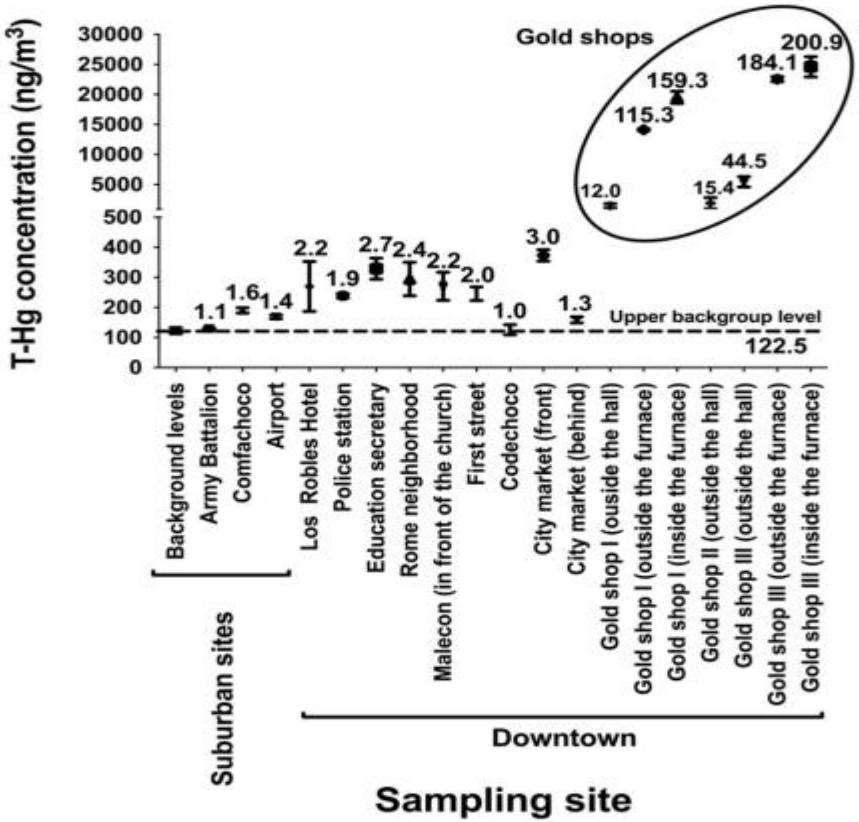


Fig. 4. Distribution of air T-Hg concentrations in Quibdo, Choco. Dotted lines correspond to the background level. The value on top of each point depicts the number of times the average T-Hg reading for the location exceeds the upper background limit.

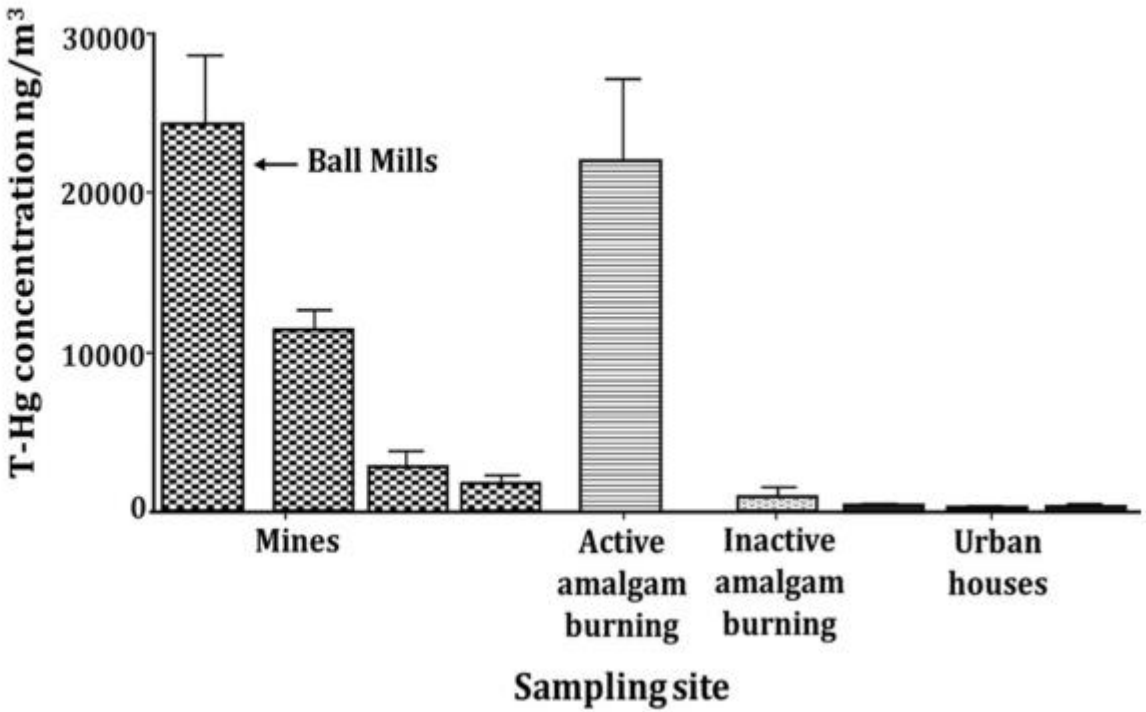
Exposición humana al mercurio

Archives of Environmental Contamination and Toxicology (2019) 76:640–649
https://doi.org/10.1007/s00244-019-00609-w

Multicompartment Mercury Contamination in Major Gold Mining Districts at the Department of Bolivar, Colombia

Liliana Carranza-Lopez[1,2] · Karina Caballero-Gallardo[1] · Leonor Cervantes-Ceballos[1] · Alexi Turizo-Tapia[1] · Jesus Olivero-Verbel[1]

Fig. 3 Air T-Hg levels in Middle Magdalena Gold Mining District at the Department of Bolivar

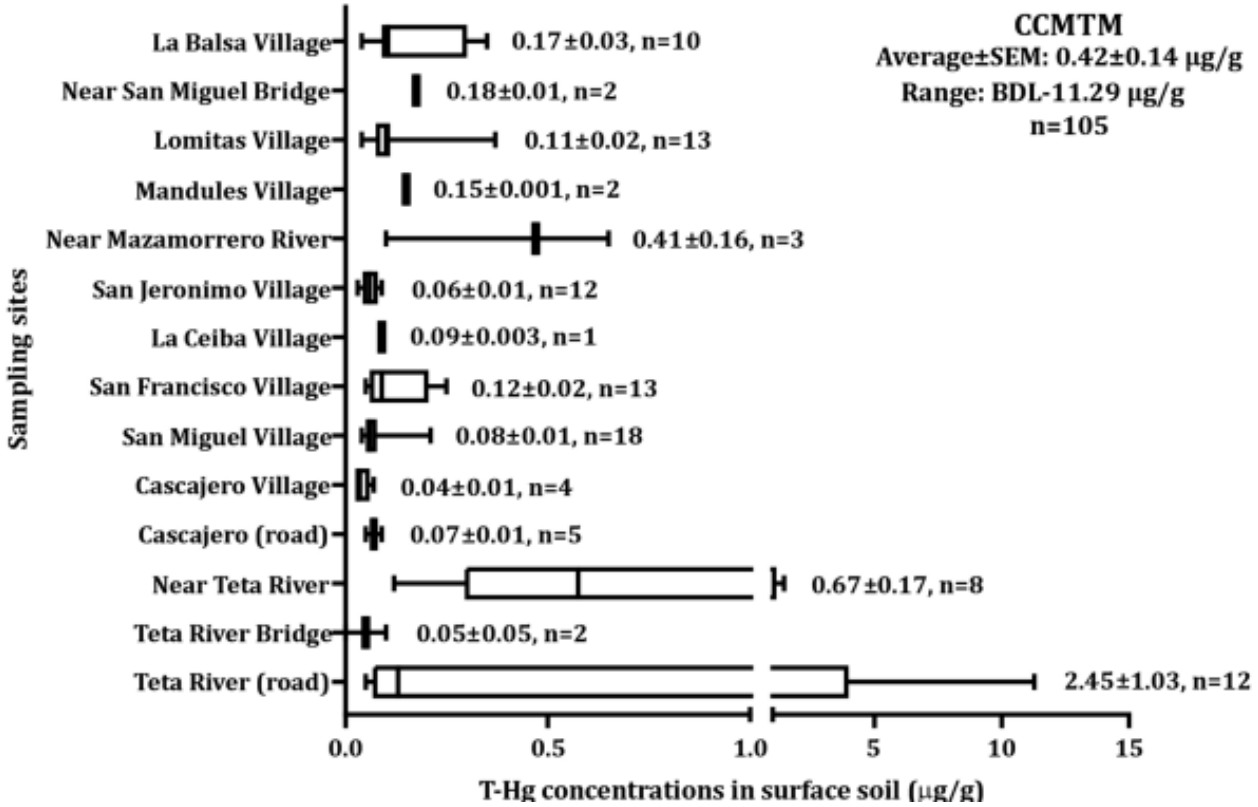


Exposición humana al mercurio

Water Air Soil Pollut (2022) 233: 393
https://doi.org/10.1007/s11270-022-05779-3

Mercury Concentrations in Water, Sediments, Soil, and Fish Around Ancestral Afro-Descendant Territories Impacted by Gold Mining in the Cauca Department, Colombia

Karina Caballero-Gallardo · Jenny Palomares-Bolaños · Jesus Olivero-Verbel



Exposición humana al mercurio

ELSEVIER

Available online at www.sciencedirect.com
ScienceDirect
Environment International 34 (2008) 476–482

ENVIRONMENT INTERNATIONAL
www.elsevier.com/locate/envint

Human and crab exposure to mercury in the Caribbean coastal shoreline of Colombia: Impact from an abandoned chlor-alkali plant

Jesus Olivero-Verbel [a,*], Boris Johnson-Restrepo [a], Rosa Baldiris-Avila [a], Jorge Güette-Fernández [a], Elizabeth Magallanes-Carreazo [b], Lenis Vanegas-Ramírez [b], Nakamura Kunihiko [c]

J. Olivero-Verbel et al. / Environment International 34 (2008) 476–482

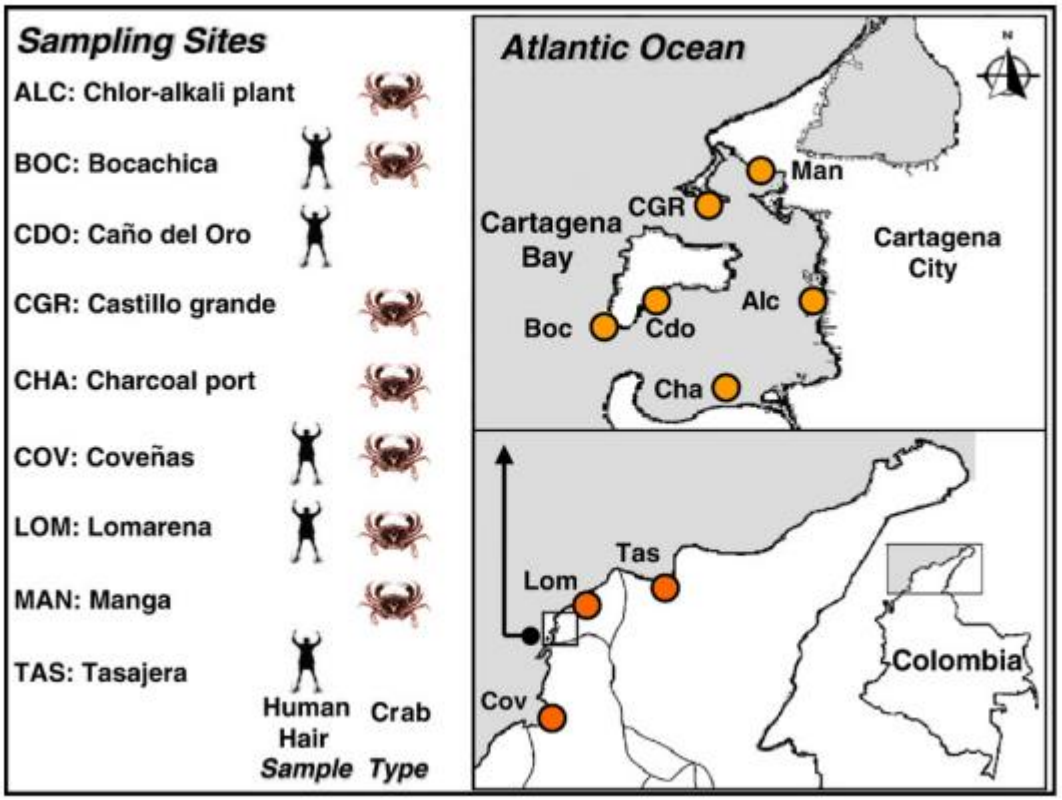


Fig. 1. Map of study area showing the locations and different types of samples collected at the Caribbean coastal shoreline of Colombia.

Exposición humana al mercurio

ELSEVIER

Available online at www.sciencedirect.com
ScienceDirect
Environment International 34 (2008) 476–482

ENVIRONMENT INTERNATIONAL
www.elsevier.com/locate/envint

Human and crab exposure to mercury in the Caribbean coastal shoreline of Colombia: Impact from an abandoned chlor-alkali plant

Jesus Olivero-Verbel [a,*], Boris Johnson-Restrepo [a], Rosa Baldiris-Avila [a], Jorge Güette-Fernández [a], Elizabeth Magallanes-Carreazo [b], Lenis Vanegas-Ramírez [b], Nakamura Kunihiko [c]

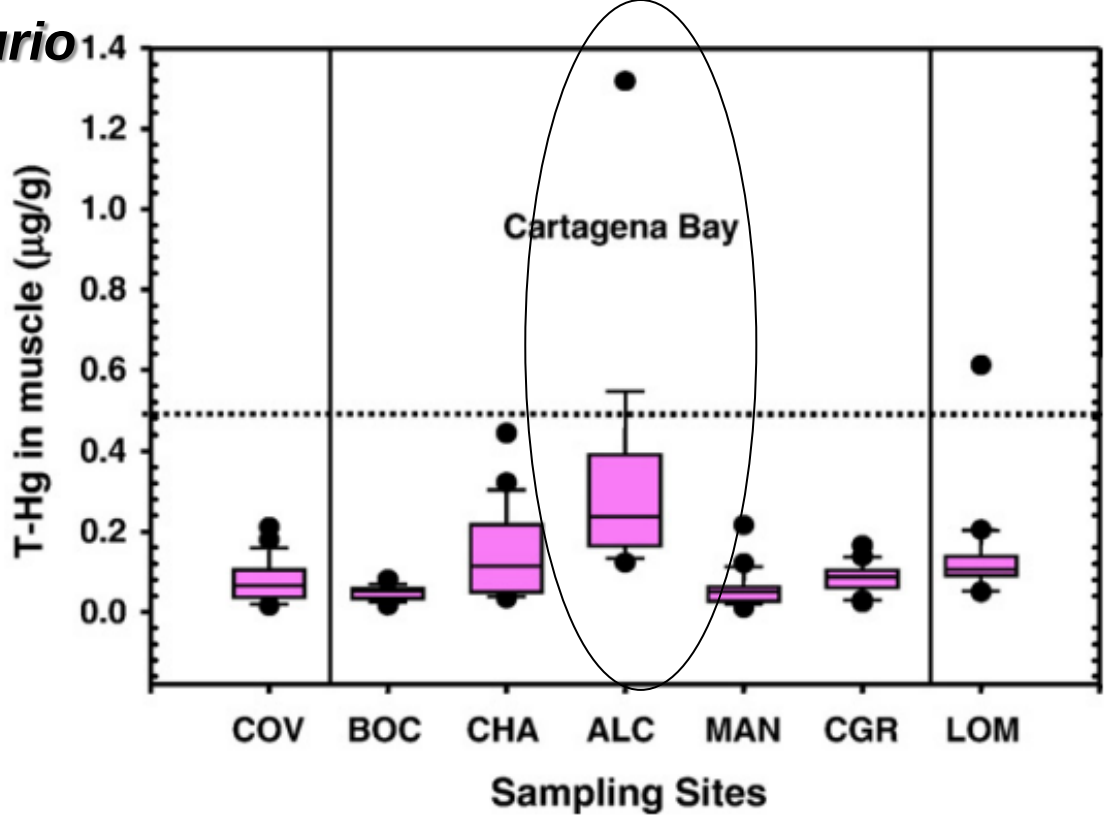


Fig. 5. T-Hg levels in muscle of crabs collected at the Caribbean coastal shoreline of Colombia.

Table 2
Correlations between T-Hg in hair, age, size, weight and fish consumption for people from the Caribbean coastal shoreline of Colombia

Age (years)	Size (cm)	Weight (kg)	Fish consumption (fish meals/week)
$R=0.201$	$R=0.303$	$R=0.129$	$R=0.144$
$P<0.0001$	$P<0.0001$	$P=0.0116$	$P<=0.005$

Mecanismos de toxicidad

Mecanismos de toxicidad

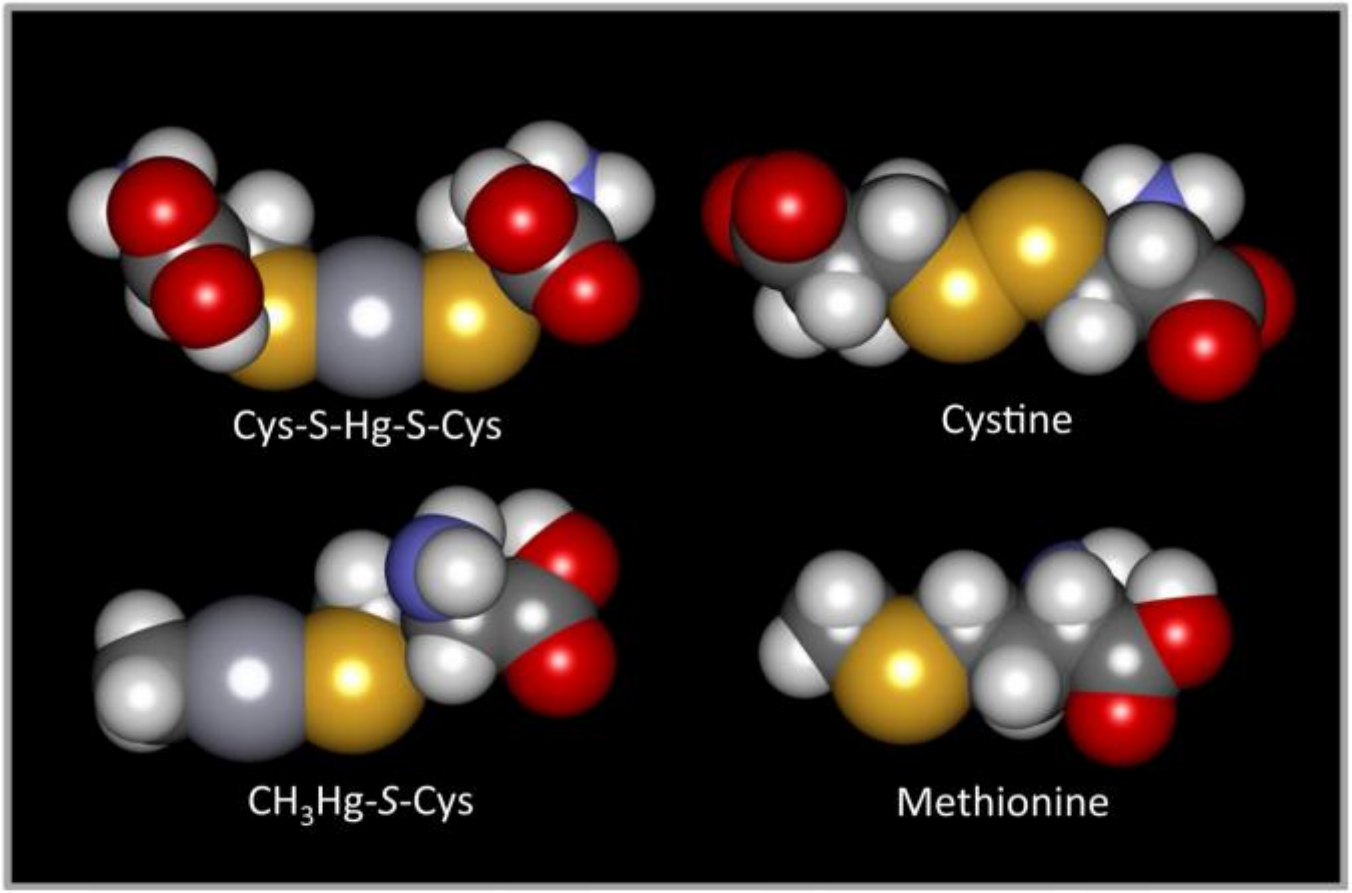


Fig. 1.

Space-fill models of Cys *S*-conjugates of Hg^{2+} and CH_3Hg^+ compared with the amino acids, cystine, and methionine. The Cys *S*-conjugate of Hg^{2+} (Cys-*S*-Hg-*S*-Cys) is similar in shape and size to cystine, while the Cys *S*-conjugate of CH_3Hg^+ (CH_3Hg^+-*S*Cys) is similar to methionine. Owing to these similarities, it has been hypothesized that Cys- *S*-Hg-*S*-Cys and Cys-*S*-CH_3Hg^+ are transportable substrates of carrier proteins that mediate the transport of cystine and methionine, respectively

Mechanisms involved in the transport of mercuric ions in target tissues

Christy C. Bridges[1] and Rudolfs K. Zalups[1]

Mecanismos de toxicidad

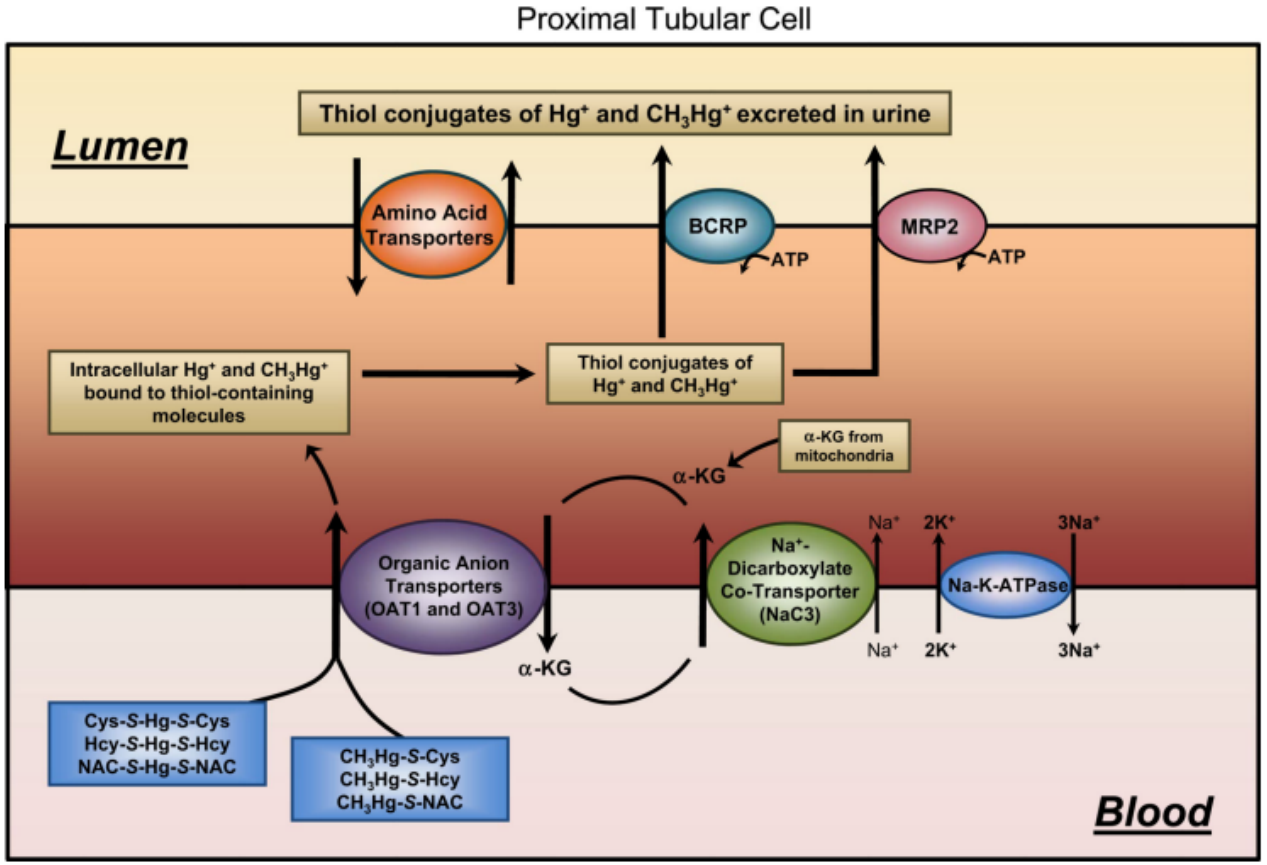


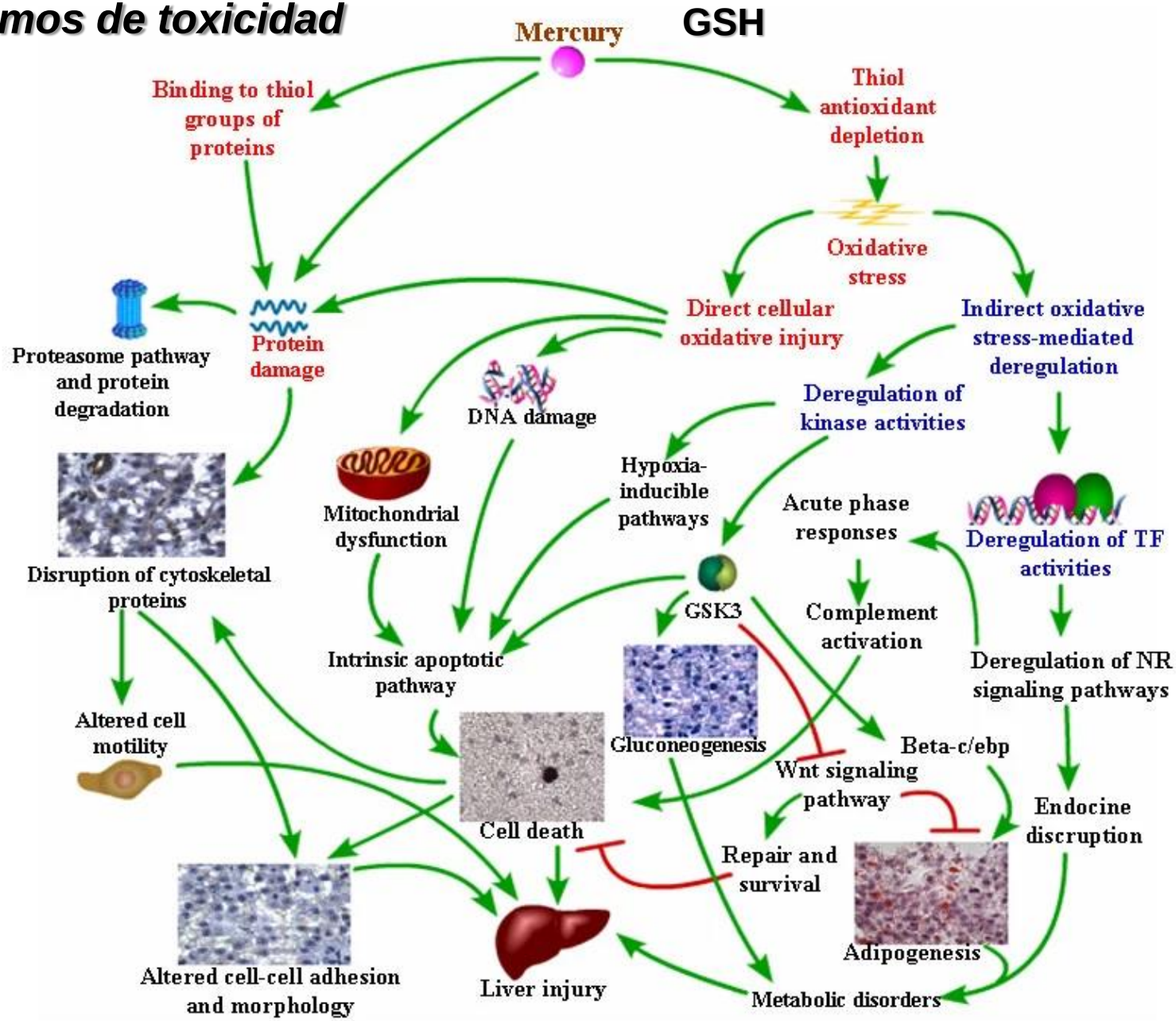
Fig. 2.

Diagram of a proximal tubular cell outlining the mechanisms involved in the uptake and export of Hg^{2+} and CH_3Hg^+. At the luminal plasma membrane of proximal tubular cells, it appears that amino acid transporters are the primary mechanisms by which mercuric ions are taken up into cells. At the basolateral membrane, organic anion transporters (OAT) appear to be primarily involved in this uptake. Mercuric species may be secreted from proximal tubular cells into the tubular lumen via the actions of the breast cancer resistance protein (BCRP) or the multidrug resistance-associated protein (MRP2) located on the luminal plasma membrane

Mechanisms involved in the transport of mercuric ions in target tissues

Christy C. Bridges[1] and Rudolfs K. Zalups[1]

Mecanismos de toxicidad



Mercury-induced hepatotoxicity in zebrafish: *in vivo* mechanistic insights from transcriptome analysis, phenotype anchoring and targeted gene expression validation.

Mecanismos de toxicidad

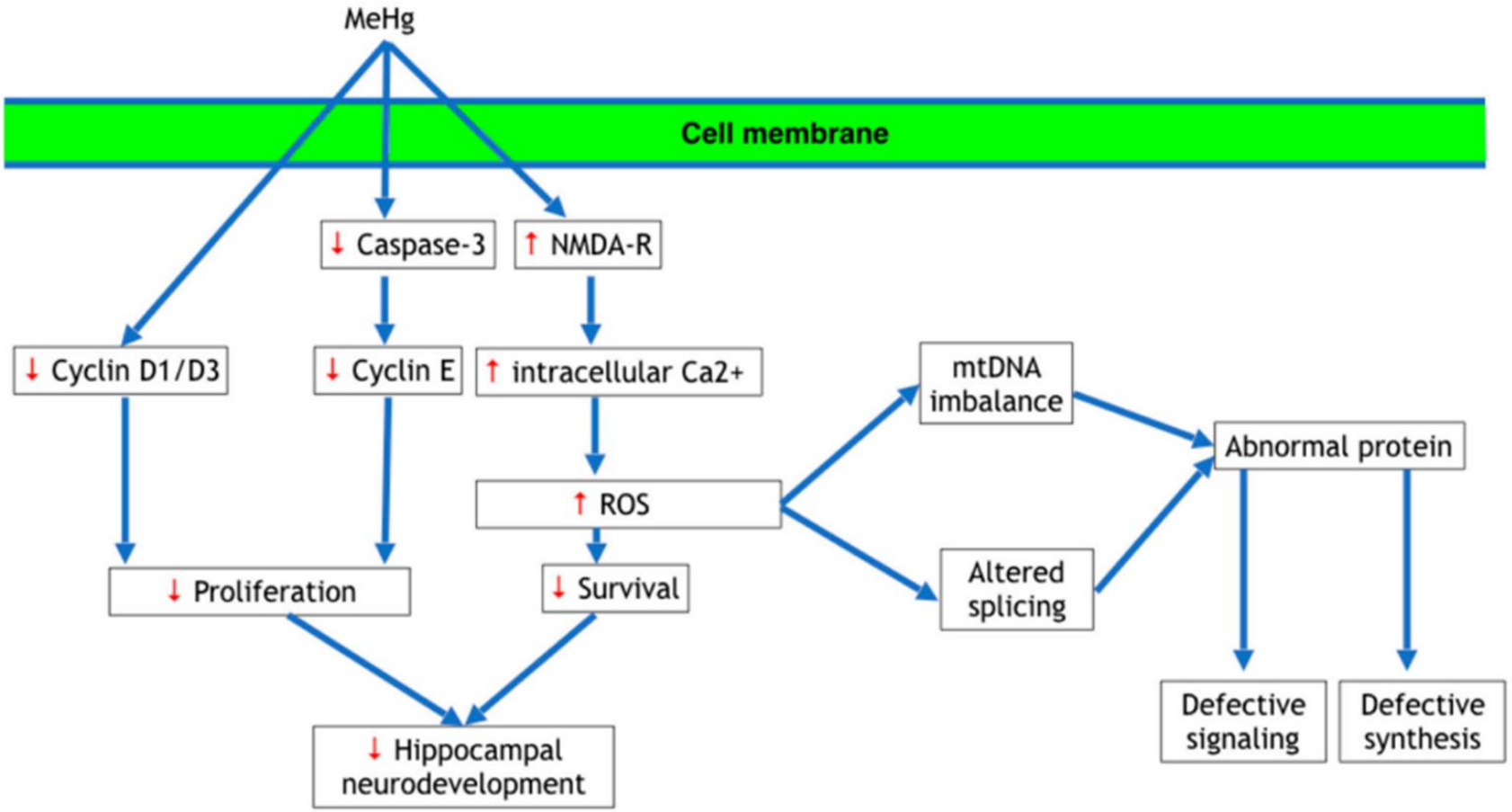


Figure 3. Summary of the neurotoxic effects of methylmercury during neurogenesis. This diagram summarizes the neurotoxic effects of methylmercury after it enters into developing cells, including neuroepithelial cells, intermediate progenitor cells, and migrating and differentiating neurons. Abbreviations: MeHg, methylmercury; NMDA-R, NMDA receptors; Ca^{2+}, calcium ion; ROS, reactive oxygen species; mtDNA, mitochondrial DNA. Sources used to create this summary include references [38,42,59,64,84,106].

International Journal of Molecular Sciences
MDPI
Review
Mercury Toxicity and Neurogenesis in the Mammalian Brain
Louise C. Abbott [1,*] and Fikru Nigussie [2]

Mecanismos de toxicidad

Journal of Trace Elements in Medicine and Biology 62 (2020) 126504

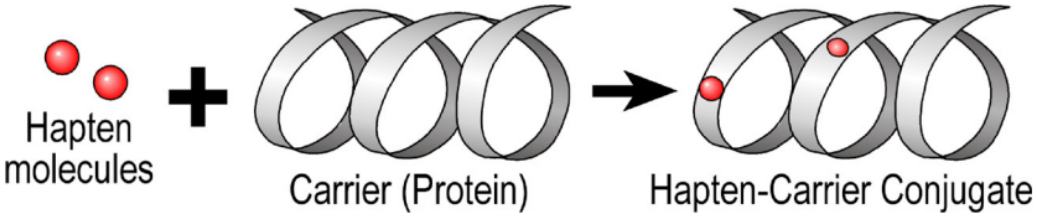
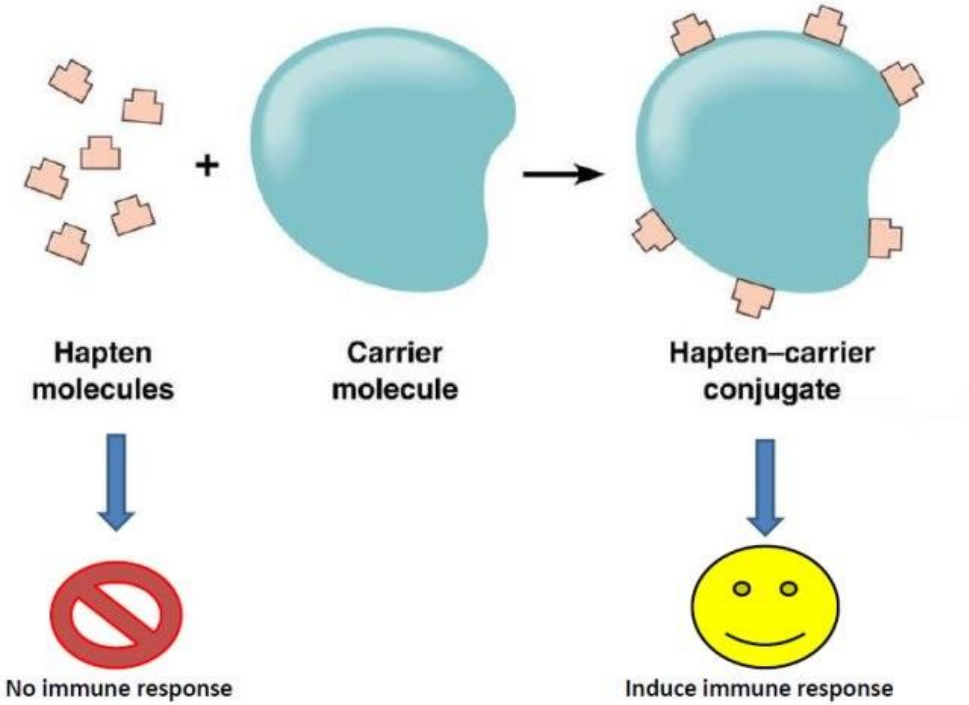


Fig. 1. Diagrammatic representation of the immunogenicity of a hapten.



Mecanismos de toxicidad

Neurotoxicology 97 (2023) 34–46

ELSEVIER

Toxicology
Volume 386, 1 July 2017, Pages 28-39

Mercury exposure induces cytoskeleton disruption and loss of renal function through epigenetic modulation of MMP9 expression

Hafizurrahman Khan [a d], Radha Dutt Singh [a d], Ratnakar Tiwari [a e], Siddhartha Gangopadhyay [a d], Somendu Kumar Roy [b d], Dhirendra Singh [c d], Vikas Srivastava [a d]

Contents lists available at ScienceDirect

Neurotoxicology

journal homepage: www.elsevier.com/locate/neuro

Epigenetics of methylmercury

Andrea Cediel-Ulloa [a], Sabrina Lindner [b], Joëlle Rüegg [a], Karin Broberg [b,c,*]

[a] Department of Organism Biology, Uppsala University, Kålbovägen 4, 752 36 Uppsala, Sweden
[b] Division of Occupational and Environmental Medicine, Department of Laboratory Medicine, Lund University, Lund, Sweden
[c] Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden

JAMA Network Open

JAMA Netw Open. 2020 Mar; 3(3): e201007. PMCID: PMC7076335
Published online 2020 Mar 16. doi: 10.1001/jamanetworkopen.2020.1007 PMID: 32176304

Association of Fish Consumption and Mercury Exposure During Pregnancy With Metabolic Health and Inflammatory Biomarkers in Children

Nikos Stratakis, PhD,[1,2] David V. Conti, PhD,[1] Eva Borras, PhD,[3,4] Eduardo Sabido, PhD,[3,4] Theano Roumeliotaki, MPH,[5] Eleni Papadopoulou, PhD,[6] Lydiane Agier, PhD,[7] Xavier Basagana, PhD,[3,8,9] Mariona Bustamante, PhD,[3,8,9] Maribel Casas, PhD,[3,8,9] Shohreh F. Farzan, PhD,[1] Serena Fossati, MD, PhD,[3,8,9] Juan R. Gonzalez, PhD,[3,8,9] Regina Grazuleviciene, MD,[10] Barbara Heude, PhD,[11] Lea Maitre, PhD,[3,8,9] Rosemary R. C. McEachan, PhD,[12] Ioannis Theologidis, PhD,[13] Jose Urquiza, PhD,[3,8,9] Marina Vafeiadi, PhD,[5] Jane West, PhD,[12] John Wright, MD,[12] Rob McConnell, MD, PhD,[1] Anne-Lise Brantsaeter, PhD,[6] Helle-Margrete Meltzer, PhD,[6] Martine Vrijheid, PhD,[3,8,9] and Leda Chatzi, MD, PhD[1,2]

World J Clin Pediatr. 2023 Mar 9; 12(2): 25–37.
Published online 2023 Mar 9. doi: 10.5409/wjcp.v12.i2.25

PMCID: PMC10075020
PMID: 37034430

Higher rates of autism and attention deficit/hyperactivity disorder in American children: Are food quality issues impacting epigenetic inheritance?

Renee J Dufault, Raquel A Crider, Richard C Deth, Roseanne Schnoll, Steven G Gilbert, Walter J Lukiw, and Amanda L Hitt

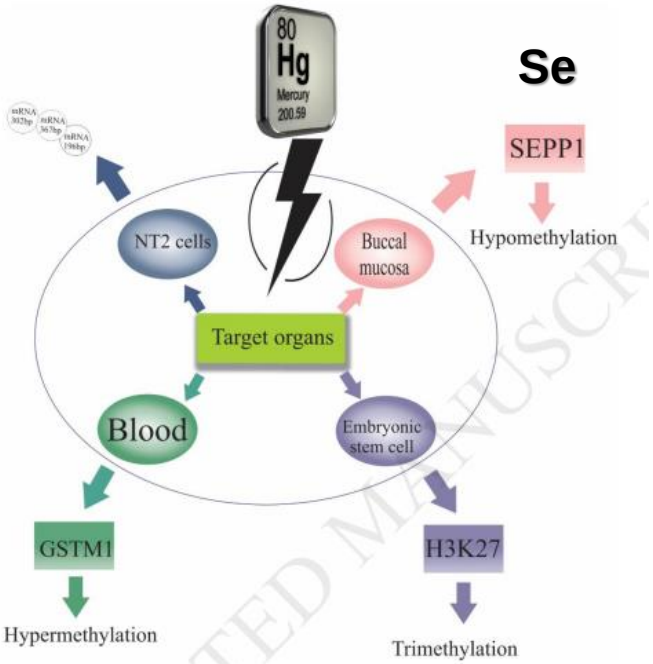
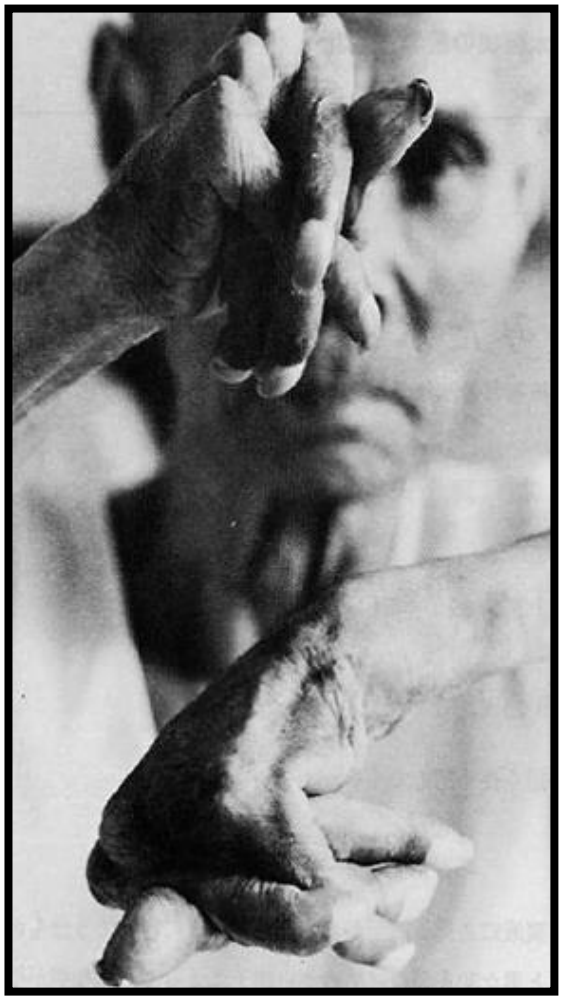


Figure 2. Mercury-induced epigenetic alterations in various genes.

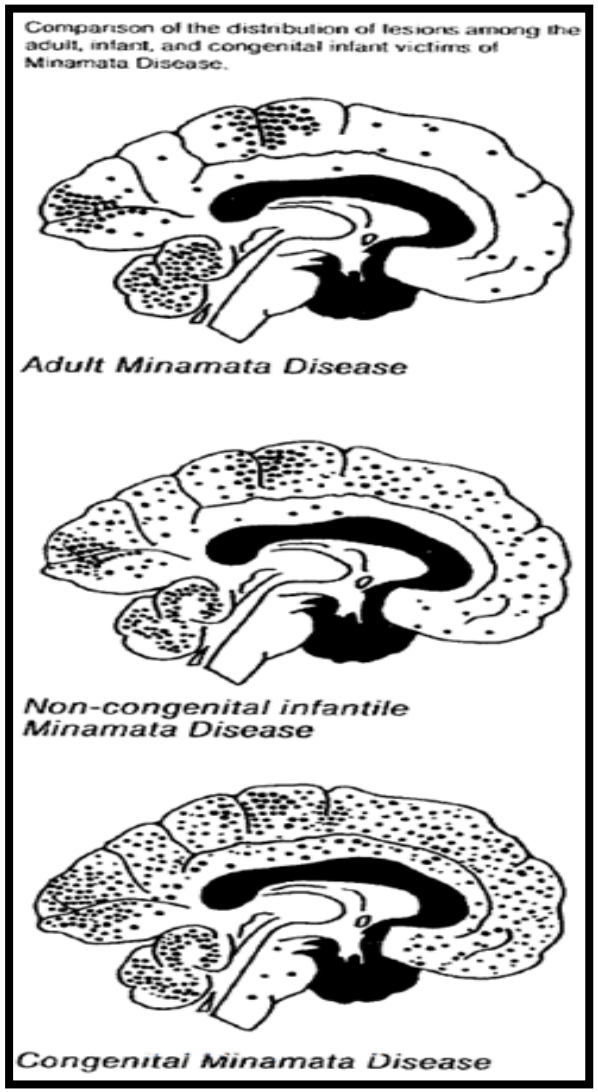
Efectos en humanos

La Enfermedad de Minamata

La Enfermedad de Minamata



La Enfermedad de Minamata

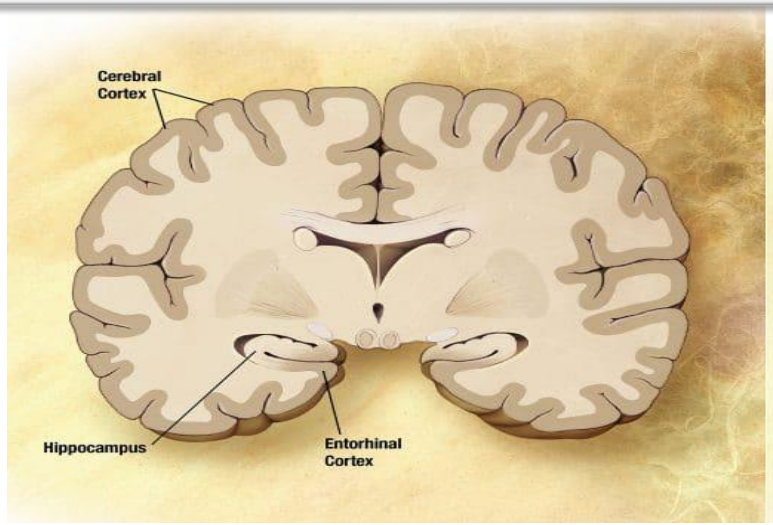


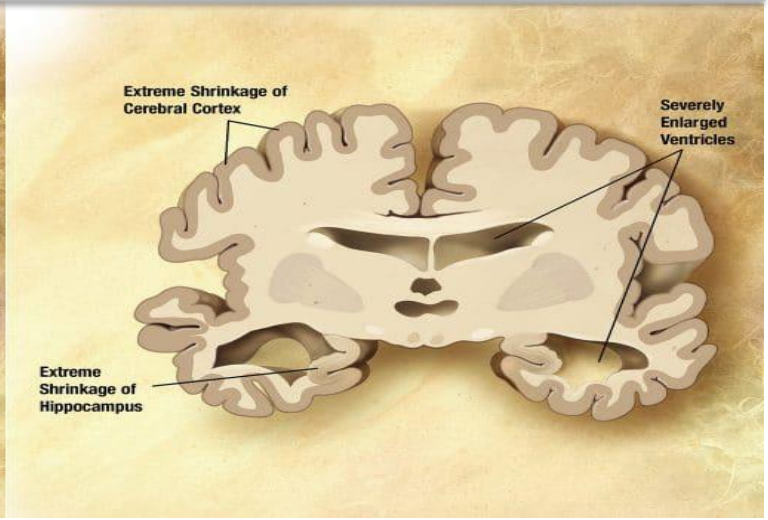
Efectos en humanos

Río Caquetá
2022

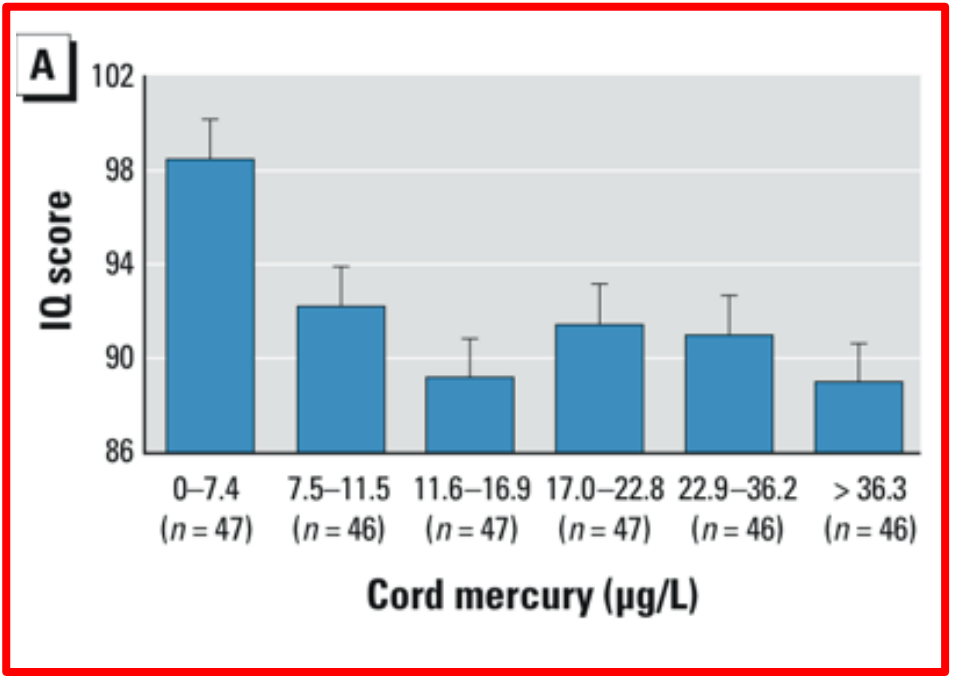
¿Enfermedad de Minamata?

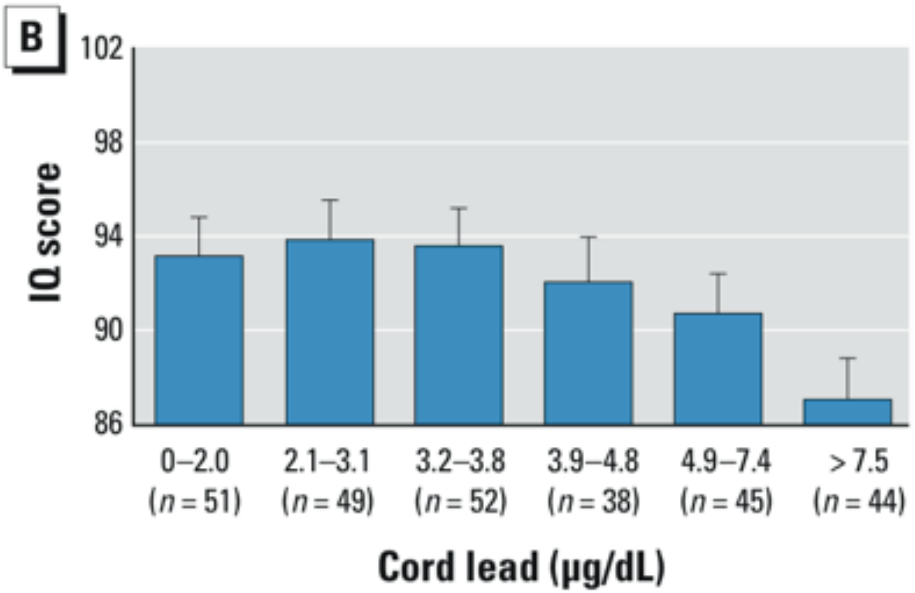
La Enfermedad de Minamata





Daño Cerebral





Environ Health Perspect; DOI:10.1289/chp.1408554

Relation of Prenatal Methylmercury Exposure from Environmental Sources to Childhood IQ

Eretismo

Cambios de comportamiento

Irritabilidad

Depresión

Delirio

Apatía

Aislamiento social

Tremor

Palpitaciones irregulares

Timidez

Dolor general

Efectos en humanos

Acrodinia

Weinstein M , Bernstein S CMAJ 2003;168:201-201

Efectos en humanos

Role of Mercury Toxicity in Hypertension, Cardiovascular Disease, and Stroke

Review > Environ Res. 2021 Feb;193:110538. doi: 10.1016/j.envres.2020.110538. Epub 2020 Dec 5.

Mercury exposure, cardiovascular disease, and mortality: A systematic review and dose-response meta-analysis

Xue Feng Hu [1], Mackenzie Lowe [1], Hing Man Chan [2]

Conclusion: Chronic exposure to Hg was associated with an increased risk of all-cause mortality and fatal/nonfatal IHD. The risk of multiple cardiovascular endpoints starts to increase consistently at a hair Hg concentration of 2 µg/g.

Daño renal

¿Polidactilia y mercurio?

Efectos en peces

Fig. 2 Nematode prevalence and abundance, and T-Hg concentrations in fish from the Dique Channel

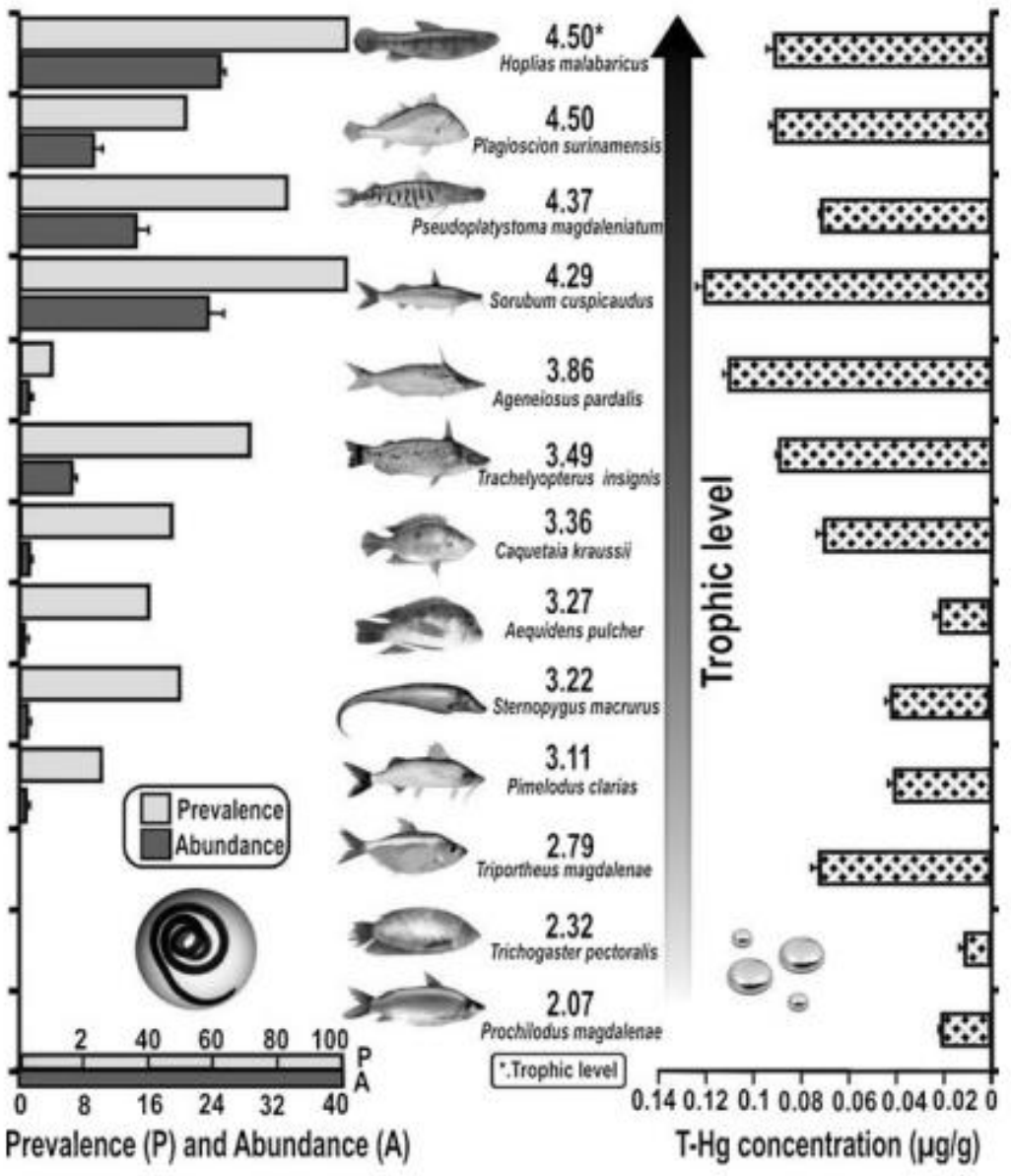
Parasitol Res (2013) 112:2187–2195
DOI 10.1007/s00436-013-3378-3

ORIGINAL PAPER

Nematode and mercury content in freshwater fish belonging to different trophic levels

Jesus Olivero-Verbel · Karina Caballero-Gallardo

Fish Parasites and Hg in muscle

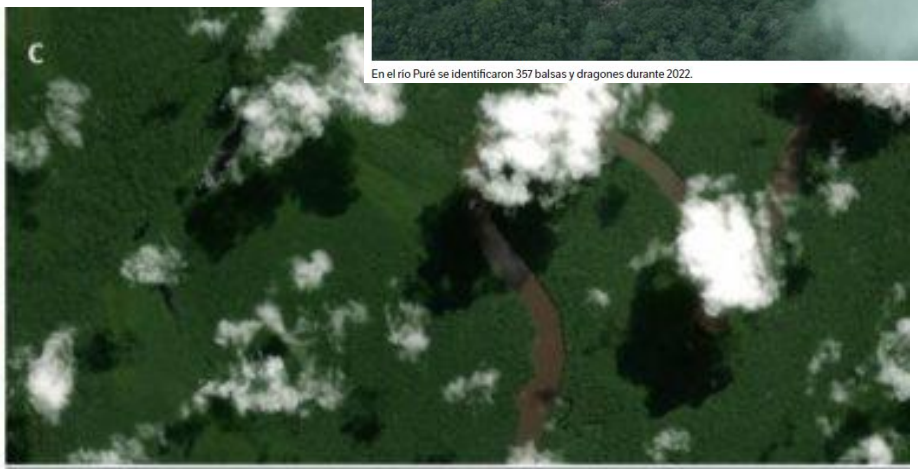


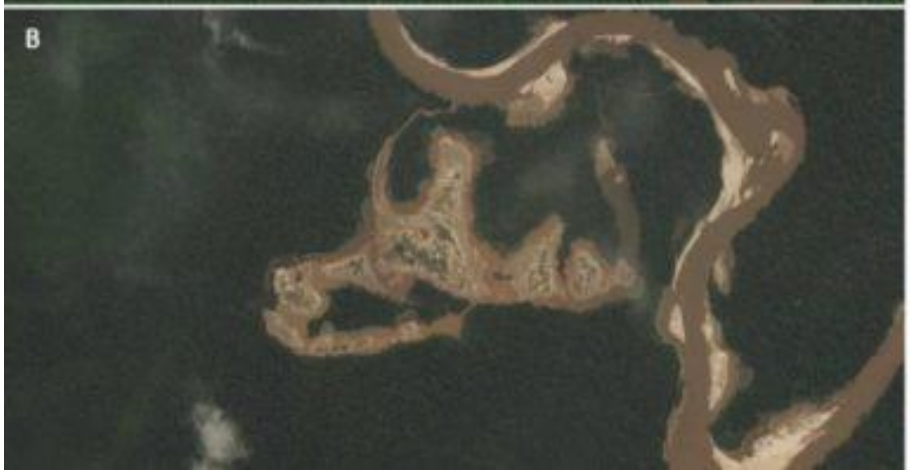
Mercurio en el Amazonas

María Paula Lizarazo
09 de abril de 2023 - 10:00 a. m.

AVATAR

En el río Puré se identificaron 357 balsas y dragones durante 2022.





Mercury use in the Amazon

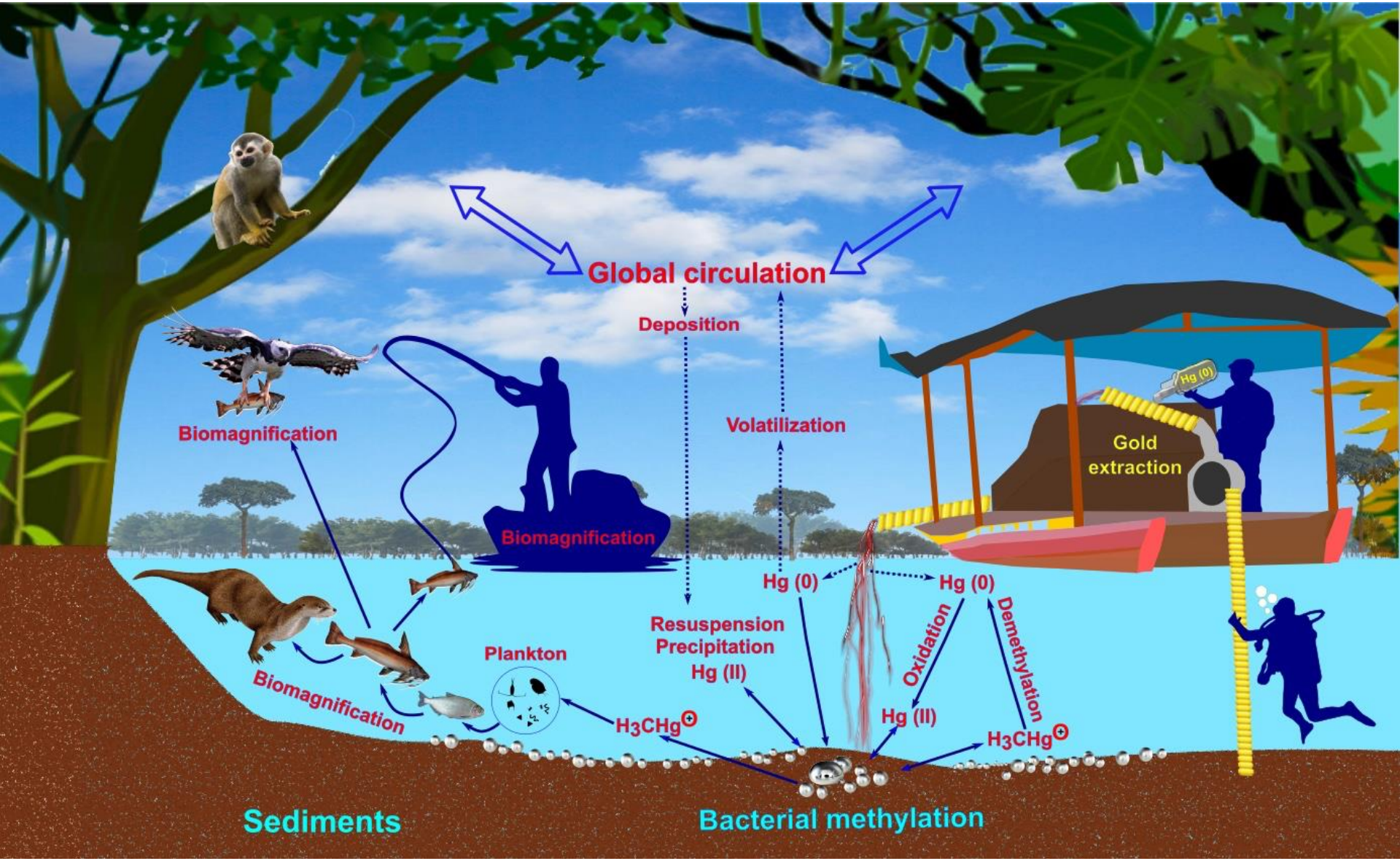
Mercury use in the Amazon

Mercury use in the Amazon

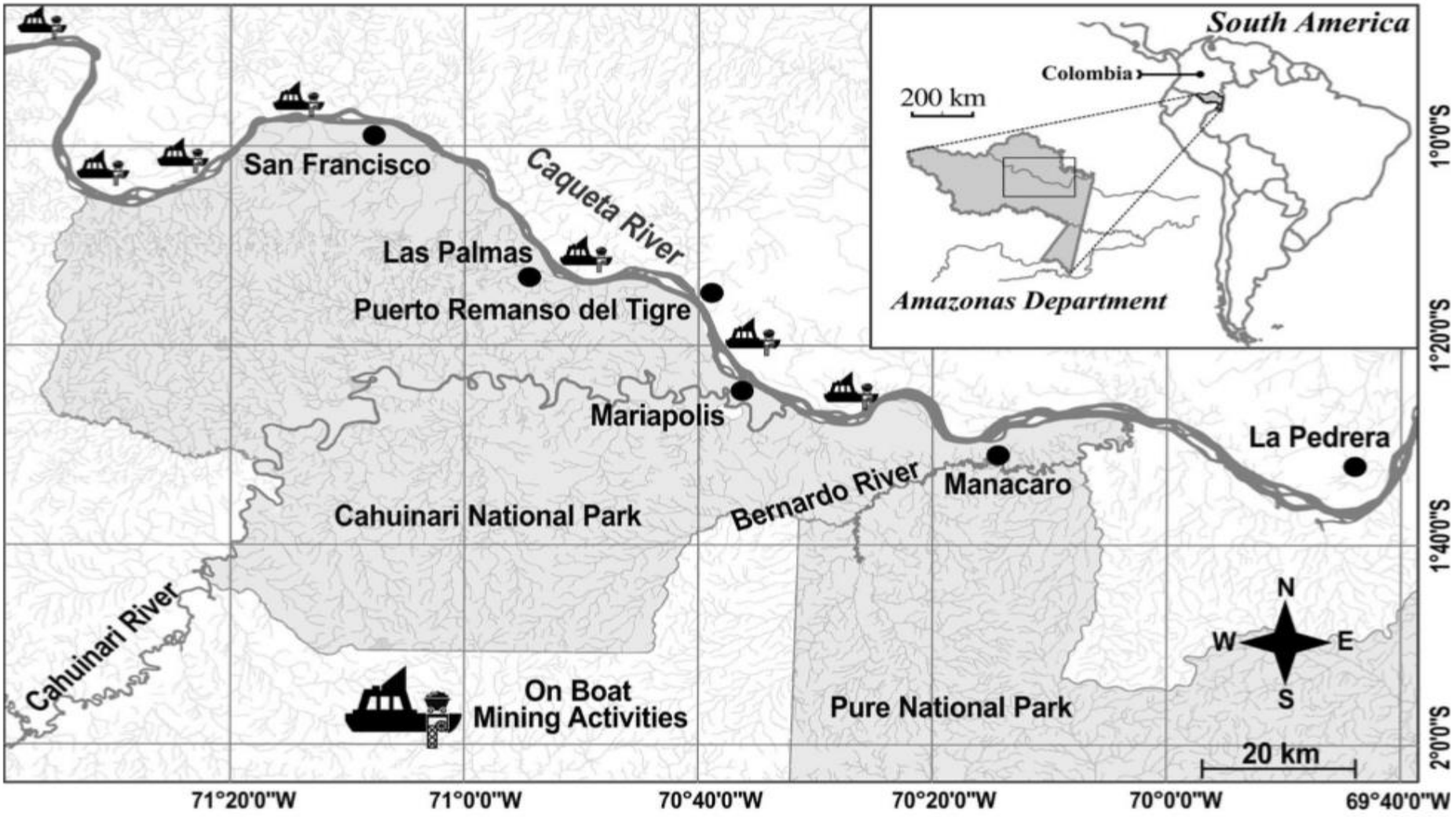
https://www.gaiaamazonas.org/

Mercury in the Amazon

Hg cycle in the Colombian Amazon



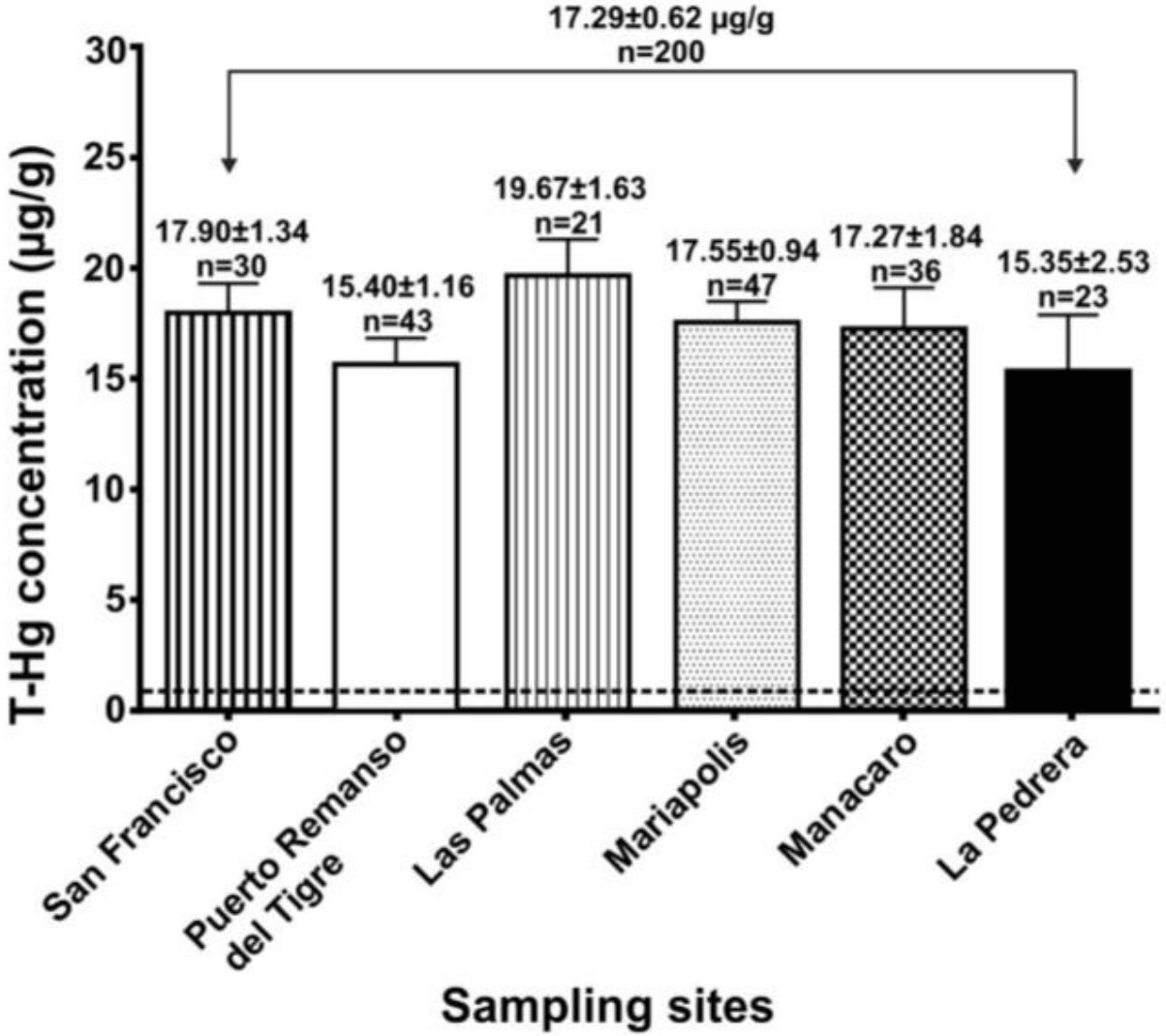
Caqueta River. Sampling Stations



Climate change-related process?

Caqueta River: Hg in humans

Hair



Caqueta River: Hg in humans

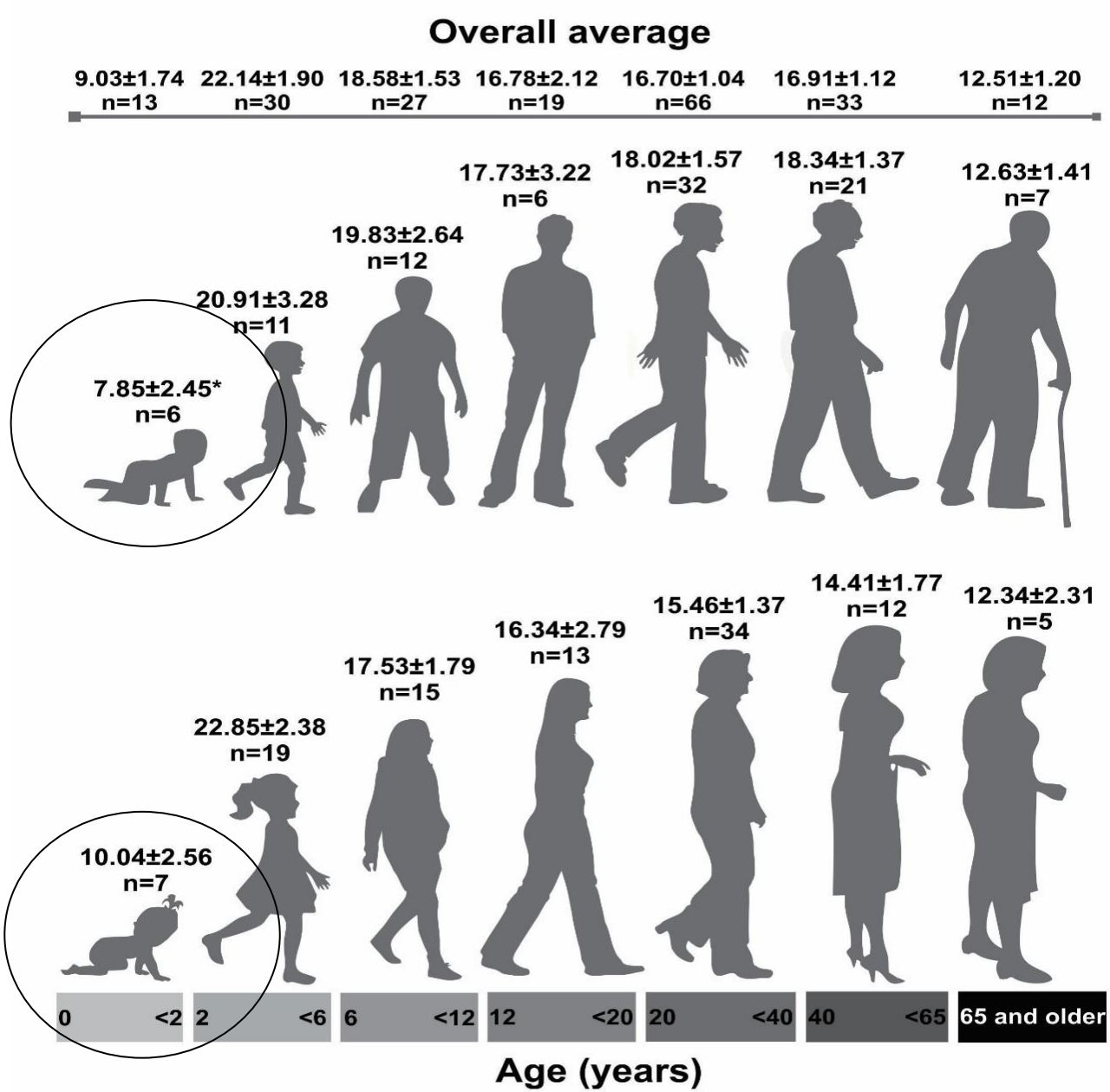
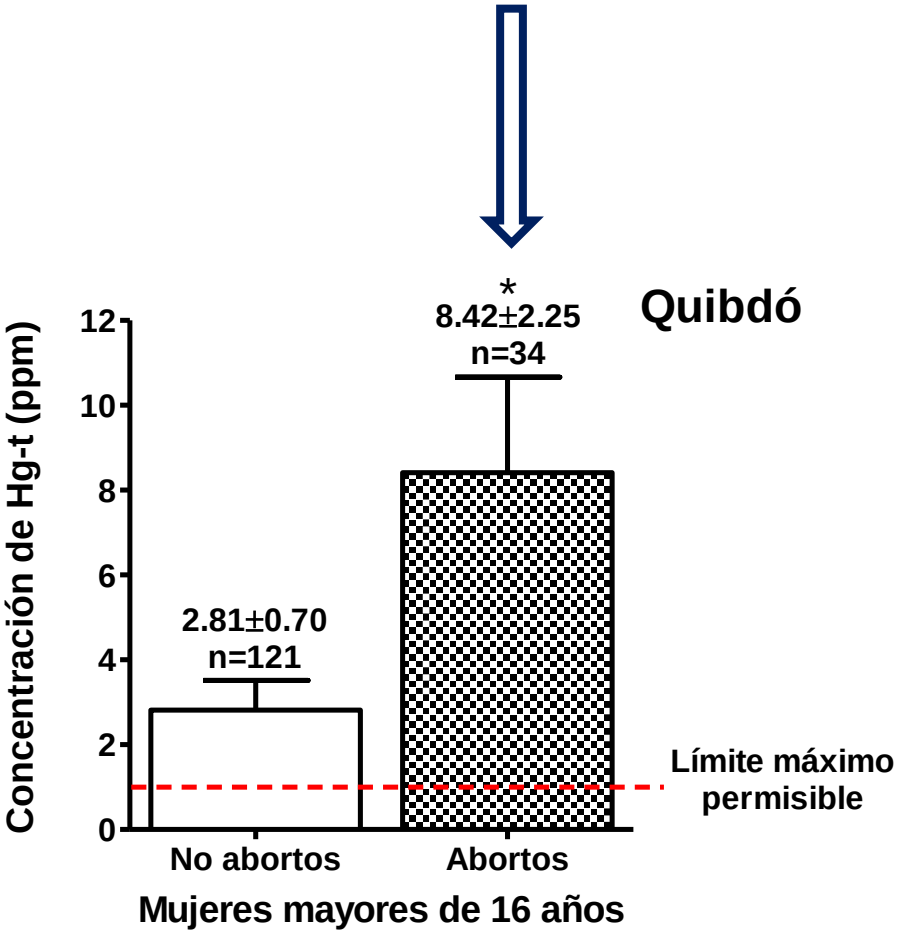


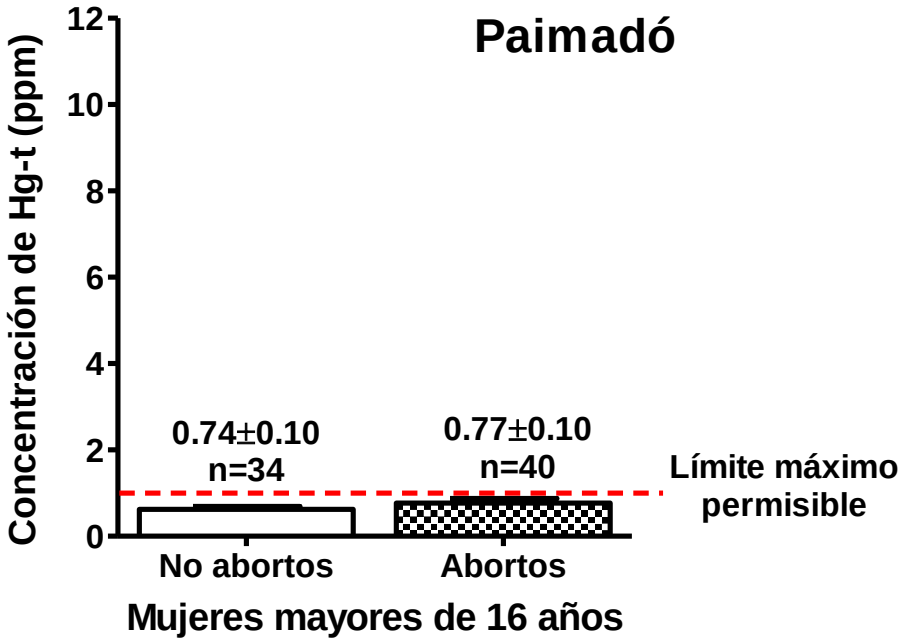
Table 2 Spearman correlations between the elements concentrations and age, morphometric characteristics, feeding habits, and hematology

Parameters ($n=44$)	Hg in hair		Hg in blood		Cd in blood		Se in blood	
	Spearman correlation	p value	Spearman correlation	p value	Spearman correlation	p value	Spearman correlation	p value
Age ($n=44$)	0.091	0.558	0.073	0.636	0.267	0.080	0.075	0.628
Morphometric characteristics ($n=44$)								
Weight	−0.069	0.658	0.099	0.523	−0.083	0.592	0.141	0.360
Height	−0.040	0.794	0.210	0.171	0.088	0.570	0.065	0.678
Feeding habits ($n=44$)								
Fish intake	0.323	0.032*	0.381	0.011*	0.037	0.812	−0.116	0.452
Hematological parameters ($n=44$)								
HGB	−0.076	0.624	0.253	0.097	0.087	0.573	0.274	0.072
HCT	−0.076	0.622	0.251	0.101	0.099	0.522	0.313	0.039*
ERI	−0.055	0.723	0.317	0.036*	0.138	0.371	0.316	0.037*
MCV	−0.113	0.467	−0.201	0.190	−0.119	0.442	−0.042	0.788
MCH	−0.088	0.571	−0.150	0.330	−0.109	0.482	−0.014	0.926
MCHC	0.053	0.731	0.139	0.367	−0.028	0.855	0.083	0.591
WBCs	0.233	0.129	0.153	0.321	−0.077	0.621	0.190	0.218
NEU	0.299	0.049*	0.228	0.137	−0.132	0.393	−0.151	0.328
EOS	0.129	0.403	0.333	0.027*	0.128	0.409	0.087	0.573
BAS*	0.242	0.224	0.439	0.022*	0.166	0.407	0.166	0.407
LYM	−0.428	0.004*	−0.418	0.005*	−0.054	0.727	−0.046	0.767
PLT	0.123	0.427	0.101	0.515	−0.036	0.818	0.195	0.205
MPV	−0.081	0.600	−0.012	0.941	0.044	0.777	−0.076	0.625

Mercury in a Biodiversity Hotspot: The Colombian Pacific (Choco)

The Atrato River





Mercury levels in human hair and reported abortions

Mercurio en el Amazonas

El Mercurio es la punta del iceberg en el Amazonas

Respuestas

Educación Ambiental

We Need More Environmental Education!

Respuestas

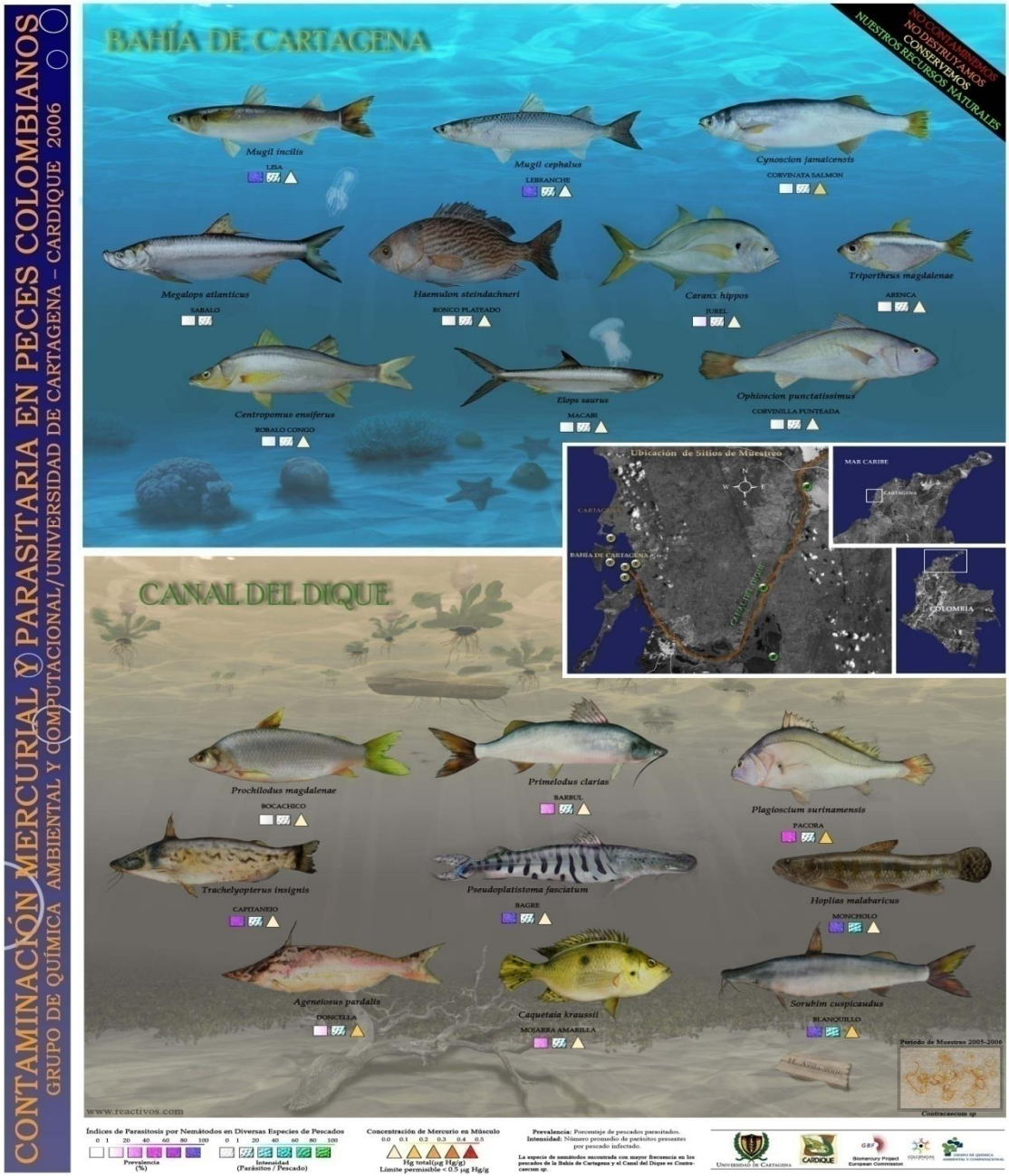

EL MERCURIO PUEDE
AFECTARNOS AÚN
SIN HABER NACIDO.
Hg
Su hijo puede estar en riesgo
de contaminación por Mercurio
Universidad de Cartagena
Grupo de Química Ambiental y Computacional
COLCIENCIAS
COLOMBIA
GOBERNACIÓN DE BOLÍVAR

Respuestas


EL MERCURIO AFECTA
NUESTRA CAPACIDAD
DE APRENDIZAJE
Hg
Eliminarlo de las Escuelas
es Cuestión de Inteligencia !!!
Universidad de Cartagena
Grupo de Química Ambiental y Computacional
COLCIENCIAS
COLOMBIA
METHODS IN
PLANT BIOCHEMISTRY

Respuestas

Educación Ambiental



Respuestas

Guía para el diagnóstico de intoxicación crónica por mercurio elemental (Azogue)

El mercurio es perjudicial para la salud

Signos y Síntomas frecuentes en una persona intoxicada con mercurio

Parestesia
Sensación de ardor, entumecimiento, hormigueo, picazón o pinchazos en dedos y rostro.

Temblor fino

Problemas visuales

Irritabilidad y angustia

Encías azuladas

Estomatitis
Inflamación de la mucosa oral.

Acrodinia
Coloración rosa en manos y pies, manifestada en niños de 2 a 3 años.

Eretismo
Psicosis caracterizada por excesiva timidez, dificultad para concentrarse, depresión y somnolencia.

Insomnio

Sabor metálico constante

Pérdida prematura de los dientes y sensación de alargamiento de los mismos

Sialorrea

Vómito y diarrea

Pruebas sencillas para identificar signos neurológicos en intoxicación crónica por mercurio elemental

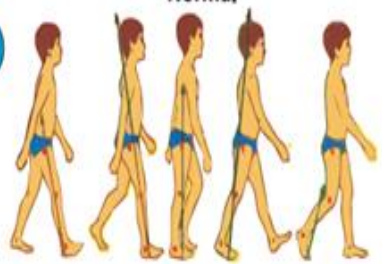
Respuestas

PRUEBAS SENCILLAS PARA IDENTIFICAR SIGNOS NEUROLÓGICOS EN INTOXICACIÓN CRÓNICA POR MERCURIO ELEMENTAL

Observar la marcha

Normal

1



Anormal

2

El médico observa al paciente en desplazamiento y mira el recorrido, postura de los pies y equilibrio del cuerpo al caminar. Si el paciente describe un comportamiento parecido a la figura superior [1], se considera como normal, de lo contrario (imagen inferior [2]) podrá suponer la posible existencia de un trastorno neurológico.

Prueba de coordinación motriz dedo-nariz

Normal

1

Anormal

2

El médico ordena al paciente tocar su nariz con el índice derecho y luego llevarlo hasta el dedo de la persona que está al frente. El médico debe observar el recorrido hasta el punto final. Si el movimiento es lineal la prueba calificará como normal [1]. Por el contrario, si al acercar el dedo el paciente hace curvas y no logra interceptar el dedo de la mano [2], entonces es posible que este tenga

Prueba de coordinación motriz talón-rodilla

Normal

1

Anormal

2

El paciente se recostará, mientras el médico le ordena llevar el talón desde la rodilla hasta el tobillo deslizándolo sobre la tibia, observando el recorrido que hace el pie del individuo. Si no describe movimientos curvilíneos y no tiene dificultad para llegar al tobillo, se entenderá que el paciente no presenta afección neurológica [1]; pero si no hay precisión y coordinación del movimiento se debe sospechar de algún trastorno [2].

joliverov@unicartagena.edu.co