

The background features a dark blue gradient with faint, light-colored circular patterns and a scale. The scale is a large arc on the left side, with numerical markings from 140 to 260 in increments of 10. Several smaller circles and arcs are scattered across the background, some with arrows indicating direction. The overall aesthetic is technical and modern.

# AUDIÊNCIA PÚBLICA

COMISSÃO DE SEGURIDADE SOCIAL E FAMÍLIA (CSSF)

11 DE NOVEMBRO DE 2019


# UNIVERSIDADE FEDERAL RURAL DE PERNAMBUCO

UNIDADE ACADÊMICA DE GARANHUNS

PROF. DR. RENATO MOLICA





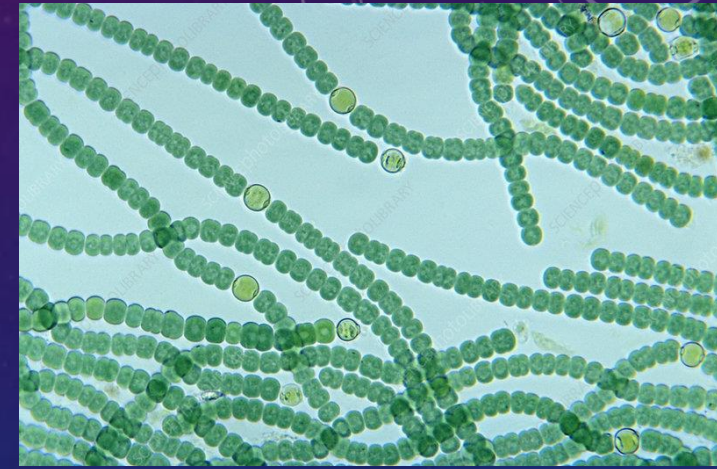
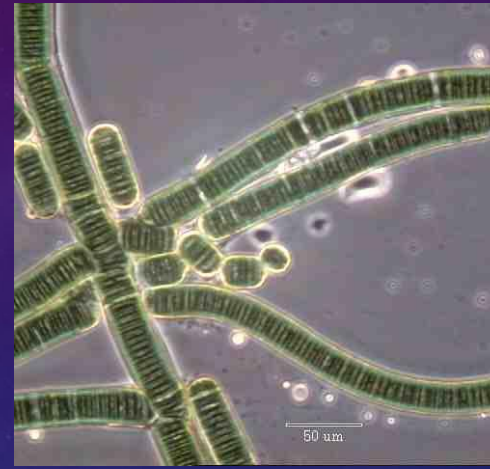
An aerial photograph of the Federal University of Pernambuco (UFPE) campus. The image shows several large, modern buildings with flat roofs, surrounded by green spaces and parking lots. A large, semi-transparent circular graphic is overlaid on the right side of the image, containing the university's name and the date of its creation. The background shows a residential area with smaller houses and trees.

# UNIVERSIDADE FEDERAL DO AGRESTE DE PERNAMBUCO (UFAPE)

**LEI Nº 13.651, DE 11 DE ABRIL DE 2018**




# CIANOBACTÉRIAS



**Procariotos fotossintetizantes**

**Origem: Cerca de 3,5 bilhões de anos**



The image shows a microscopic view of cyanobacteria, which are green, filamentous organisms. They are arranged in several parallel chains that curve across the frame. Each chain is composed of individual cells, some of which are larger and more rounded, possibly representing heterocysts. The background is a light, slightly grainy texture. Overlaid on the right side of the image is a large, dark circular area containing white text. The text is in Portuguese and discusses the ecological role of cyanobacteria.

CIANOBACTÉRIAS  
ESTÃO PRESENTES NA  
MAIORIA DOS  
ECOSSISTEMAS DO  
MUNDO

TÊM UM IMPORTANTE PAPEL ECOLÓGICO:  
INICIAM AS TEIAS ALIMENTARES





# EUTROFIZAÇÃO

- Aumento da concentração de nutrientes nos ecossistemas aquáticos: nitrogênio e fósforo
- Principal causa da ocorrência de florações de cianobactérias



# EUTROFIZAÇÃO

- Falta de saneamento básico e tratamento adequado dos efluentes urbanos, rurais e industriais.
- 52,4% dos esgotos são coletados no país (SNIS, 2017)
- 46% dos esgotos do país são tratados (SNIS, 2017)





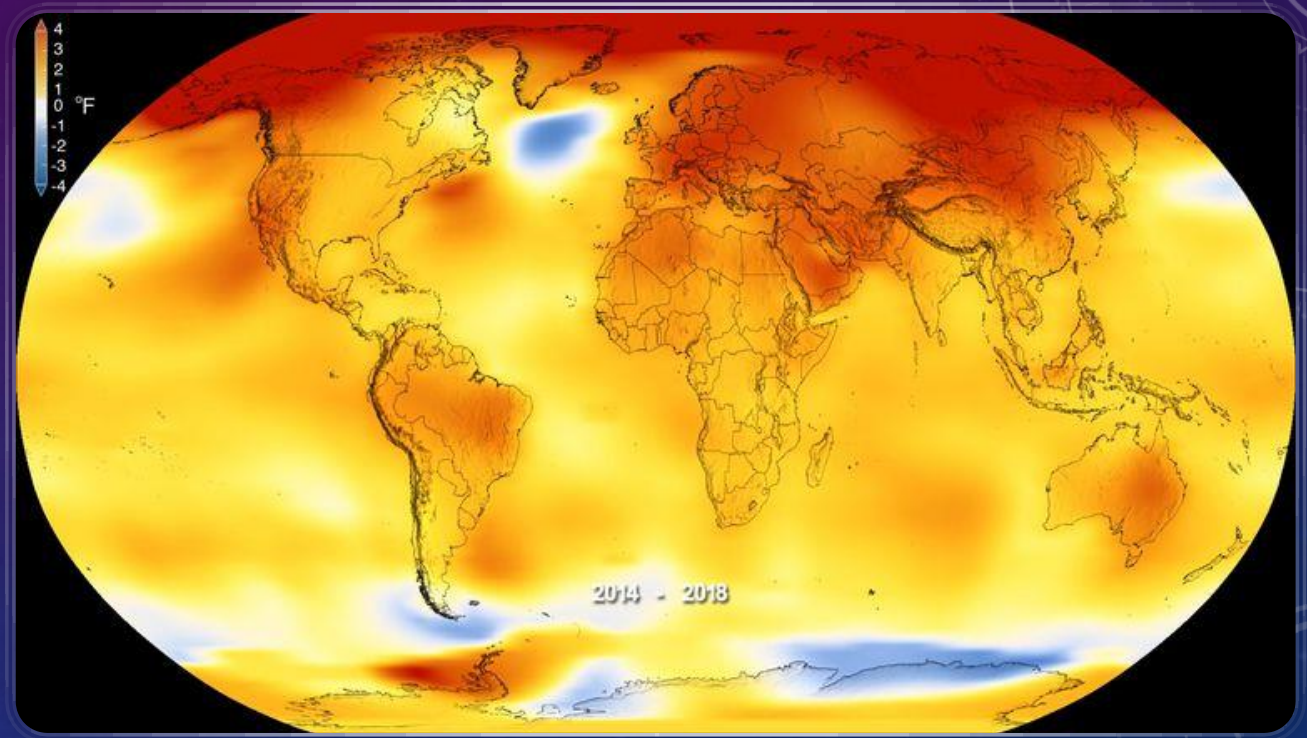


# FLORAÇÕES DE CIANOBACTÉRIAS

EVENTOS EM QUE A DENSIDADE DE  
CIANOBACTÉRIAS AUMENTA  
DRASTICAMENTE



# AQUECIMENTO GLOBAL







FLORAÇÕES DE  
CIANOBACTÉRIAS OCORREM  
NO MUNDO TODO







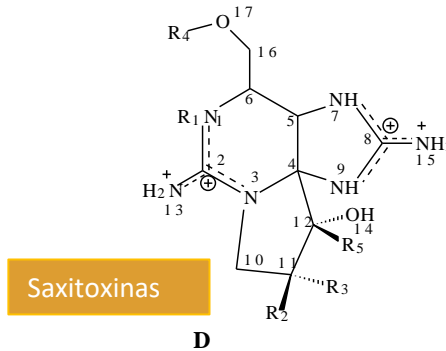
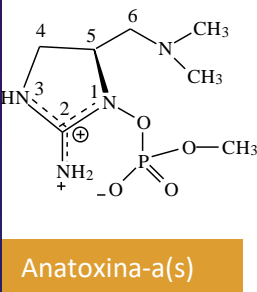
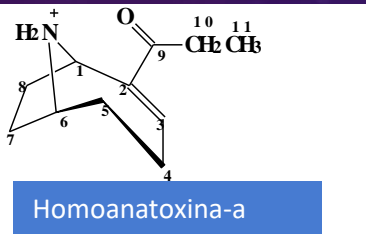
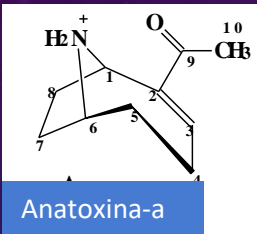




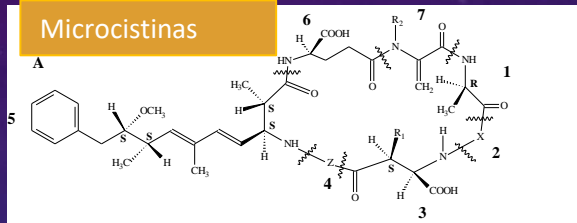
# CIANOTOXINAS

## Hepatotoxinas

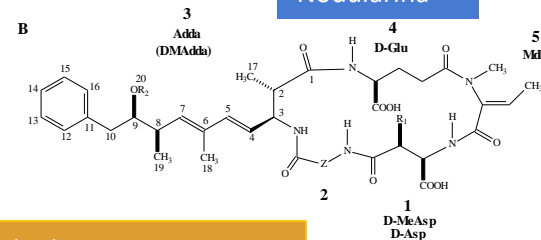
## Neurotoxinas



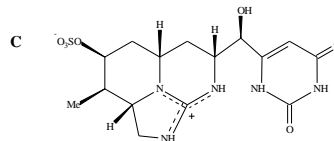
## Microcistinas



## Nodularina



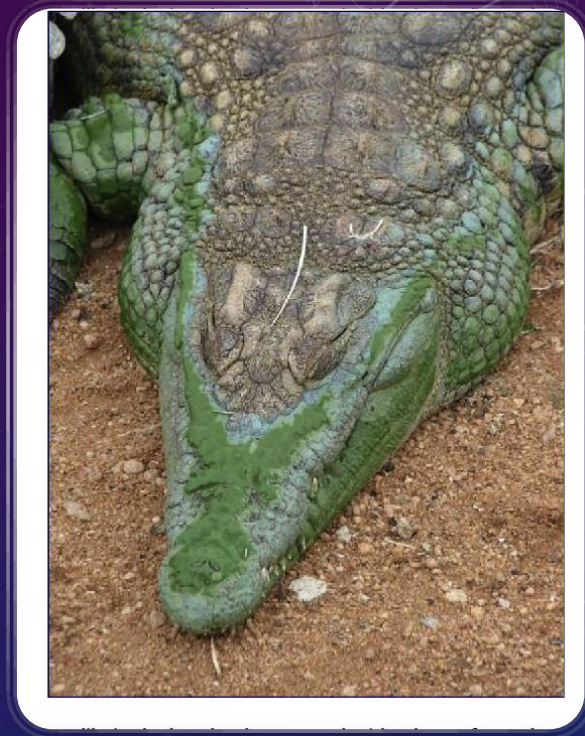
## Cilindrospermopsina



- Cianobactérias produzem uma variedade de compostos, cuja função não é clara, entretanto, alguns são bastante tóxicos aos vertebrados



# INTOXICAÇÃO DE ANIMAIS





# INTOXICAÇÃO EM SERES HUMANOS

## TRAGÉDIA DE CARUARU

Articles

### Human Fatalities from Cyanobacteria: Chemical and Biological Evidence for Cyanotoxins

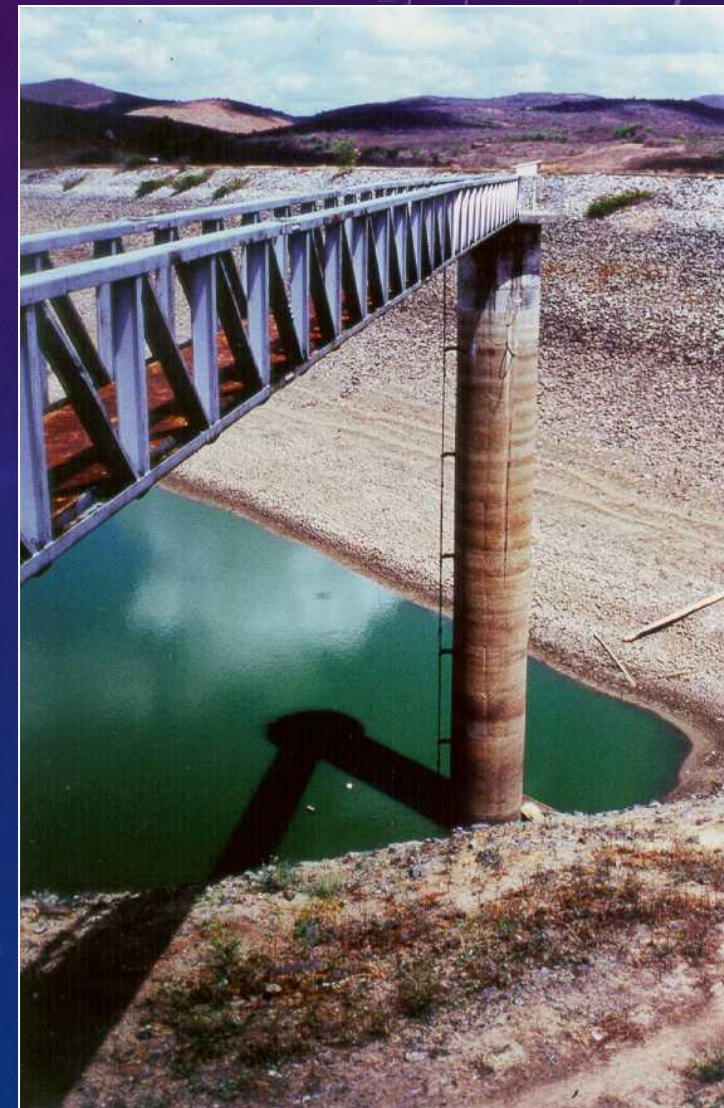
Wayne W. Carmichael,<sup>1</sup> Sandra M.F.O. Azevedo,<sup>2</sup> Ji Si An,<sup>1</sup> Renato J. R. Molica,<sup>3</sup> Elise M. Jochimsen,<sup>4</sup> Sharon Lau,<sup>5</sup> Kenneth L. Rinehart,<sup>5</sup> Glen R. Shaw,<sup>6</sup> and Geoff K. Eaglesham<sup>7</sup>

<sup>1</sup>Department of Biological Sciences, Wright State University, Dayton, Ohio, USA; <sup>2</sup>Instituto de Biofísica Carlos Chagas Filho, Universidade do Brasil, Rio de Janeiro, Brasil; <sup>3</sup>Instituto Tecnológico de Pernambuco, Recife, Brasil; <sup>4</sup>Hospital Infections Program, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia, USA; <sup>5</sup>Roger Adams Laboratory, School of Chemical Sciences, University of Illinois, Urbana, Illinois, USA; <sup>6</sup>National Research Center for Environmental Toxicology, Coopers Plains, Queensland, Australia; <sup>7</sup>Queensland Health Scientific Services, Coopers Plains, Queensland, Australia

An outbreak of acute liver failure occurred at a dialysis center in Caruaru, Brazil (8°17' S, 35°58' W), 134 km from Recife, the state capital of Pernambuco. At the clinic, 116 (89%) of 131 patients experienced visual disturbances, nausea, and vomiting after routine hemodialysis treatment on 13–20 February 1996. Subsequently, 100 patients developed acute liver failure, and of these 76 died. As of December 1996, 52 of the deaths could be attributed to a common syndrome now called Caruaru syndrome. Examination of phytoplankton from the dialysis clinic's water source, analyses of the clinic's water treatment system, plus serum and liver tissue of clinic patients led to the identification of two groups of cyanobacterial toxins, the hepatotoxic cyclic peptide microcystins and the hepatotoxic alkaloid cylindrospermopsin. Comparison of victims' symptoms and pathology using animal studies of these two cyanotoxins leads us to conclude that the major contributing factor to death of the dialyses patients was intravenous exposure to microcystins, specifically microcystin-YR, -LR, and -AR. From liver concentrations and exposure volumes, it was estimated that 19.5 µg/L microcystin was in the water used for dialysis treatments. This is 19.5 times the level set as a guideline for safe drinking water supplies by the World Health Organization. **Key words:** cyanobacteria, cyanotoxins, cylindrospermopsins, microcystins, toxins. *Environ Health Perspect* 109:663–668 (2001). [Online 20 June 2001] <http://ehpnet1.niehs.nih.gov/docs/2001/109p663-668carmichael/abstract.html>

hypertriglyceridemia; and disruption of liver plates, liver cell deformity, necrosis, apoptosis, cholestasis, cytoplasmic vacuolization, mixed leukocyte infiltration and multinucleated hepatocytes observed upon light microscopy and intracellular edema, mitochondrial changes, rough and smooth endoplasmic reticulum injuries, lipid vacuoles, and residual bodies observed upon electron microscopy (5–7).

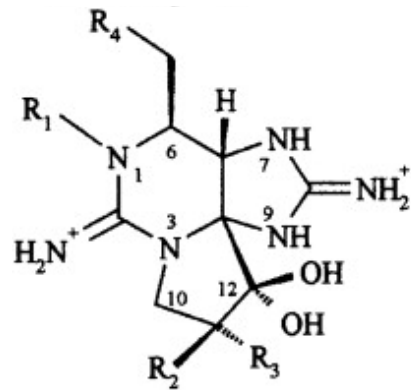
This outbreak received much attention from the media and public health authorities in Brazil and has been reported in many countries. The background of this case and a summary of the epidemiology have been published (6,7). Over the intervening period, we have examined the limnological and case report data and analyzed most of the liver tissues provided and some of the serum samples. These results have allowed us to address some important questions regarding these human fatali-





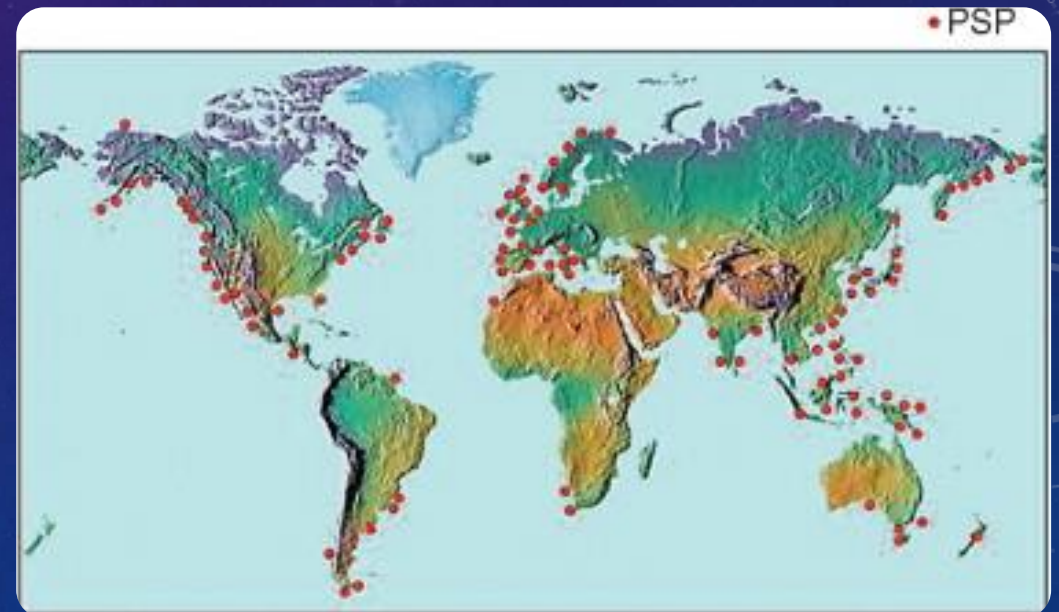
# SAXITOXINAS – TOXINAS PARALISANTES DE MARISCOS

Produzidas por dinoflagelados marinhos e por cianobactérias



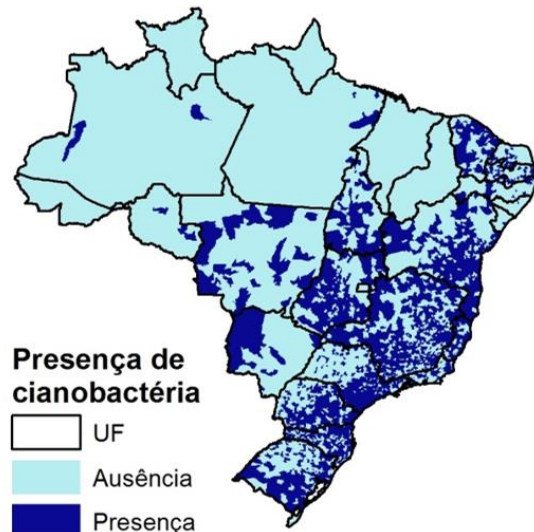
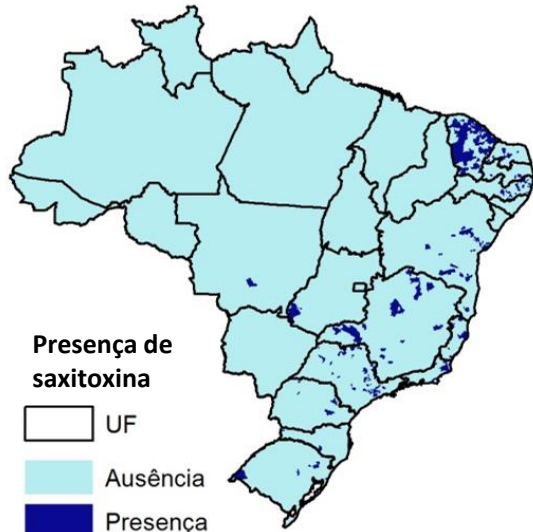
STX = saxitoxin  
 NEO = neosaxitoxin  
 GTX = gonyautoxins

				Carbamate toxins	N-Sulfocarbamoyl toxins	Decarbamoyl toxins
<u>R<sub>1</sub></u>	<u>R<sub>2</sub></u>	<u>R<sub>3</sub></u>	<u>R<sub>4</sub></u>			
H	H	H	—	STX	B1, GTX5	dcSTX
H	H	OSO <sub>3</sub> <sup>-</sup>	—	GTX2	C1	dcGTX2
H	OSO <sub>3</sub> <sup>-</sup>	H	—	GTX3	C2	dcGTX3
OH	H	H	—	NEO	B2, GTX6	dcNEO
OH	H	OSO <sub>3</sub> <sup>-</sup>	—	GTX1	C3	dcGTX1
OH	OSO <sub>3</sub> <sup>-</sup>	H	—	GTX4	C4	dcGTX4





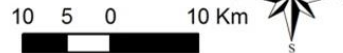
## Saxitoxinas Cianobactérias



Fonte de dados: SINAN, IBGE e SISAGUA

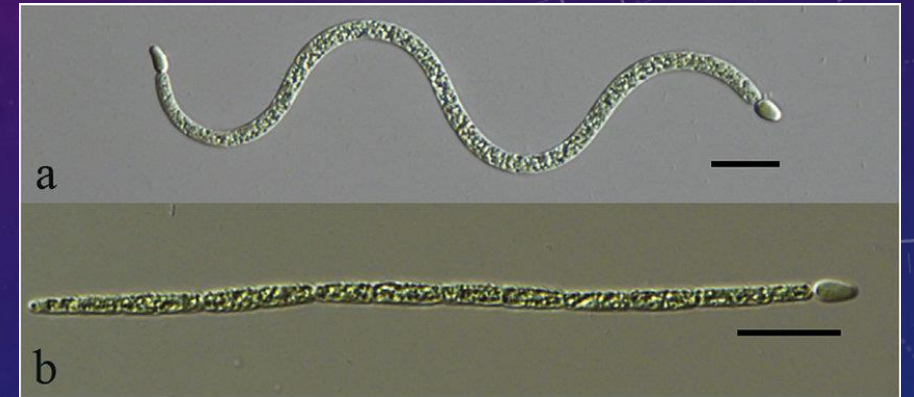
Digitalização dos mapas: IBGE

Estruturação dos mapas: Núcleo de Geoprocessamento-LIS/ICICT/Fiocruz



Cedido gentilmente pelo Dr. Flávio Lara

# SAXITOXINAS NO BRASIL



*Raphidiopsis* (*Cylindrospermopsis*) *raciborskii*



# PORTARIAS DO MINISTÉRIO DA SAÚDE – ÁGUA PARA CONSUMO

CIANOTOXINAS	1.469/00	518/04	2.914/11	Consolidação No. 5/17
Microcistinas (1µg/L)	Análise obrigatória	Análise obrigatória	Análise obrigatória	Análise obrigatória
Saxitoxinas (3µg <sub>eq. Stx</sub> /L)	Análise recomendada	Análise recomendada	Análise obrigatória	Análise obrigatória
Cilindrospermopsina (15 para 1µg/L)	Análise recomendada	Análise recomendada	Análise recomendada	Análise recomendada
Anatoxina-a(s)	-	-	Análise recomendada	Análise recomendada

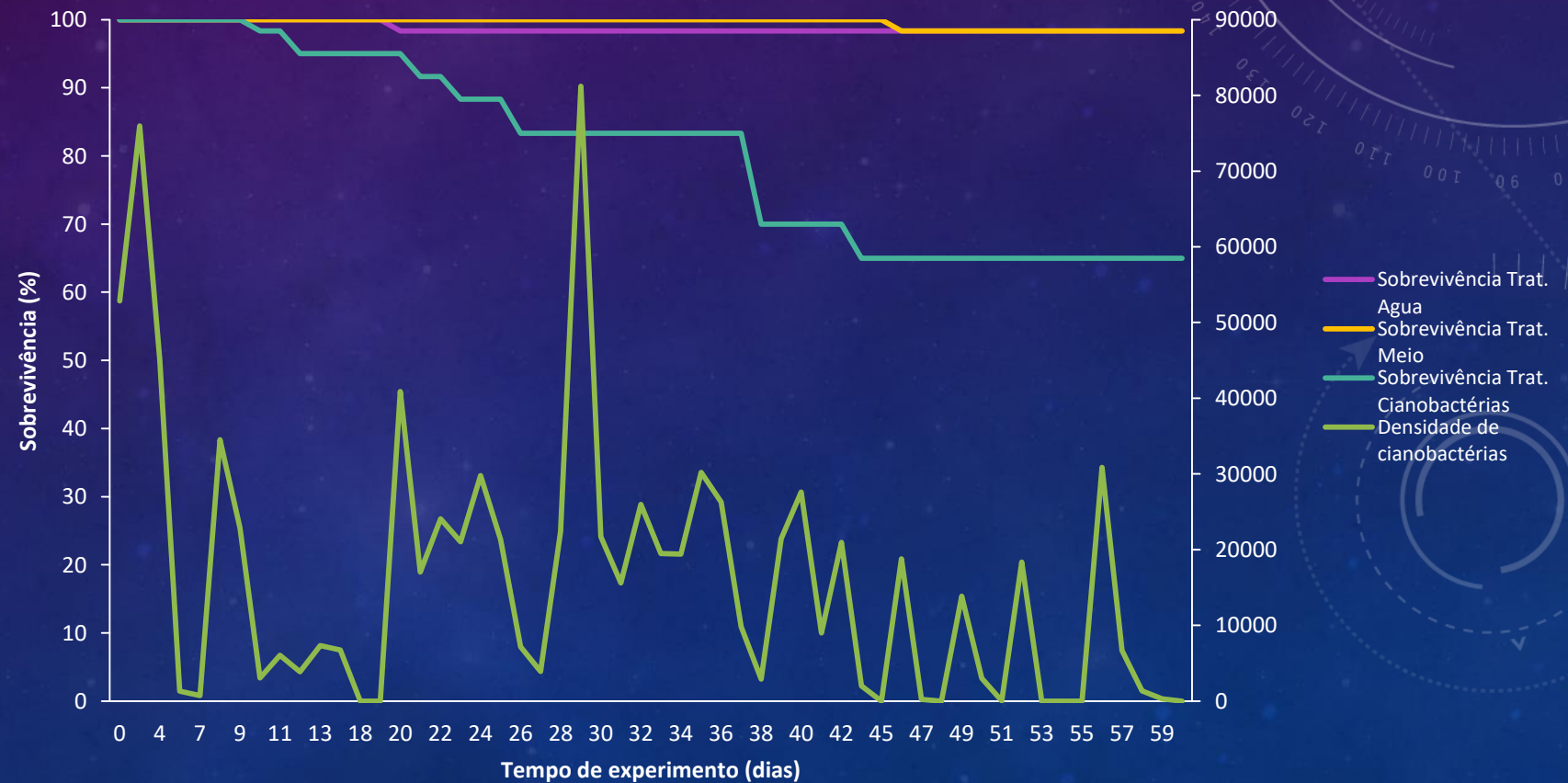


# EXPOSURE OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*) FINGERLINGS TO SAXITOXIN-PRODUCING STRAIN OF *RAPHIDIOPSIS (CYLINDROSPERMOPSIS) RACIBORSKII* (CYANOBACTERIUM) REDUCES GROWTH PERFORMANCE AND INCREASES MORTALITY RATE

MARIANA DE BOCK, GLÁUCIA MORAES, RÔMULLO ALMEIDA, KARLA VIEIRA, KLEBER, SANTORO ÁLVARO BICUDO, RENATO MOLICA



### Sobrevivência de tilápias e densidade de cianobactérias no tempo








New Results

[Comment on this paper](#)

## The cyanobacterial saxitoxin exacerbates neural cell death and brain malformations induced by Zika virus

Carolina da S. G. Pedrosa, Leticia R. Q. Souza, Caroline V. F. de Lima, Pitia F. Ledur, Karina Karmirian, Tiago A. Gomes, Jimena Barbeito-Andres, Marcelo do N. Costa, Luiza M. Higa, Maria Bellio, Flavio A. Lara, Amilcar Tanuri, Patricia P. Garcez, Arnaldo Prata-Barbosa, Fernanda Tovar-Moll, Renato J. R. Molica,  Stevens K. Rehen

doi: <https://doi.org/10.1101/755066>

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# RESUMO

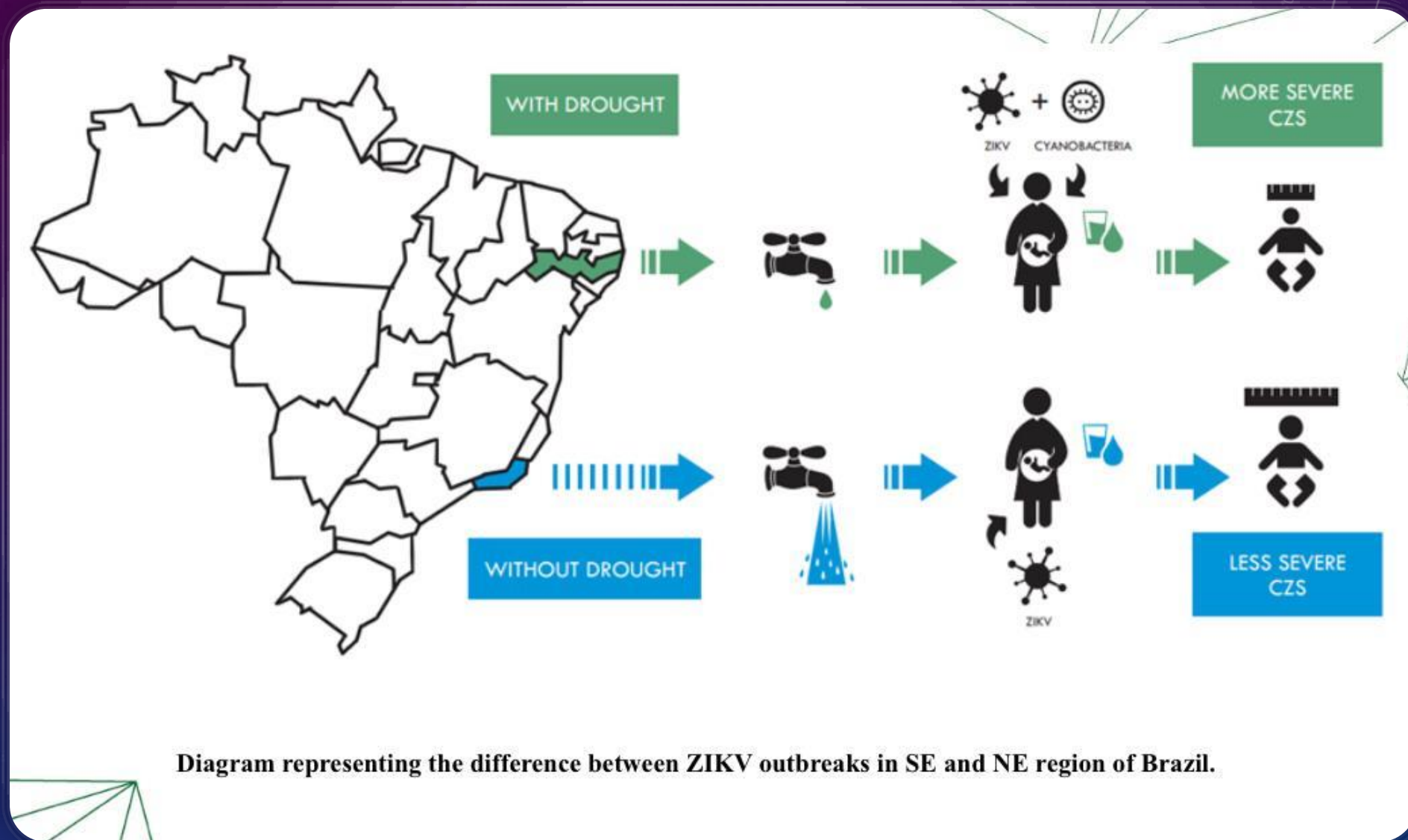


Diagram representing the difference between ZIKV outbreaks in SE and NE region of Brazil.



## AGRADECIMENTOS

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Carolina da S. G. Pedrosa - IDOR

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Flavio A. Lara - FIOCRUZ

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Amilcar Tanuri - UFRJ

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Patricia P. Garcez - UFRJ

---

Arnaldo Prata-Barbosa - IDOR

---

Fernanda Tovar-Moll - IDOR

---

Stevens K. Rehen - UFRJ / IDOR



# PESQUISA ATUAL

## Efeitos de fertilizantes e agrotóxicos no crescimento e produção de saxitoxinas por *Raphidiopsis raciborskii*

Coordenação do projeto: Dr. Flávio Lara

Financiamento: Ministério da Saúde



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