

Mercury methylation and bacterial activity in macrophyte-associated periphyton in floodplain lakes of the Amazon basin

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Abstract: We used radiotracer techniques to measure the net mercury methylation potentials (24 h incubation with ²⁰³Hg) and bacterial secondary productivity (BSP, 30 min. incubation with ³H-leucine) in periphyton associated to the roots of floating macrophytes from two different regions of the Amazon basin. The first study area was the lower Tapajós river where *Paspalum repens* was the dominant macrophyte. Net Me²⁰³Hg formation in *P. repens* periphyton was high but varied considerably among sites (2.2 - 44 %). BSP varied from 0,07 to 3,2 ngC. g⁻¹.h⁻¹ in periphyton samples. The second study area was the Beni River, Bolivia, where we measured the methylation potential and BSP of floodplain lake sediments and of periphyton associated to roots of *Polygonum densiflorum*, *Hymenachne donacifolia*, *Ludwigia helminthorrhiza* and *Eichhornia crassipes* at four lakes. The higher methylation in sediments was found in Rio Viejo lake (12 %) while Granja lake showed the highest methylation potentials in root-associated periphyton (36 %). BSP varied from 0.05 to 0.55 ngC. g⁻¹.h⁻¹ for sediments and from 0.07 to 1.45 ngC. g⁻¹.h⁻¹ for periphyton. The root-associated periphyton is an important biogeochemical microenvironment and a major link for biomethylation of mercury in tropical ecosystems.

Key words: sediment, methylation, bacterial activity

INTRODUCTION

Tropical lakes and rivers have high diversity and abundance of aquatic macrophytes that can form dense floating mats. Previous studies on mercury methylation showed that methylmercury (MeHg) production is considerably higher in the periphyton associated to the roots of floating aquatic macrophytes than in the sediments and water column. The key factor controlling the availability of methylmercury to the biota is the relative efficiency of the methylation and demethylation process. In this study we used radiotracer techniques to measure net mercury methylation potentials^[1] and bacterial secondary productivity^[2] (BSP) in macrophyte root-associated periphyton from two different regions of the Amazon basin. The periphyton associated to roots was extracted by hand-shaking in a plastic bag, sieved and centrifugated. The supernatant was discarded and 2 mL (wet weight) of the periphyton extract were transferred to the tubes with 30 mL of lake water and incubated with ²⁰³Hg for 24 h in the dark. For BSP measurements aliquots (30 µL) of the same extract were incubated with ³H-leucine in 5 mL filtered (0.22 µm) lake water for 30 min in the dark. Superficial sediments were collected at the center of each lake and incubated as above.

RESULTS AND DISCUSSION

The first study area was the lower Tapajós river, a major tributary of the Amazon, where *Paspalum repens* was the dominant floating macrophyte. Net Me²⁰³Hg formation in *P. repens*, periphyton, expressed as % of total added ²⁰³Hg, was high but varied considerably among sites (Table 1).

Table 1. Net Me²⁰³Hg formation and BSP in *P. repens* periphyton from the Tapajós river.

Tapajós river	Net Me ²⁰³ Hg(%)	BSP (ngC. g ⁻¹ .h ⁻¹)
Capituã lake	44	0.25
Igapó Barroso	15	0.07
Jacaré lake	14	0.12
Igapó Mussum	12	0.75
Cupari river	2.2	0.30
Santo Antônio channel		
Dish lake	32	3.2
Downstream	29	0.94
Upstream	4,4	0.21

The second study area was the Beni River, Bolivia, where we measured the methylation potential and BSP of lake sediments and of periphyton associated to roots of *Polygonum densiflorum*, *Hymenachne donacifolia*, *Ludwigia helminthorrhiza* and *Eichhornia crassipes* at four lakes. The higher methylation in sediments was found in Rio Viejo lake, followed by Salinas lake, Granja lake and San Juan lake. Granja lake showed the highest methylation potentials in root-associated periphyton (Table 2).

Table 2. Net Me²⁰³Hg formation and BSP in *Polygonum densiflorum*, *Hymenachne donacifolia*, *Ludwigia helminthorrhiza* and *Eichhornia crassipes* on periphyton and superficial sediments at the Beni river.

Bolivian Lakes	Sediment		Periphyton	
	Net Me ²⁰³ Hg(%)	BSP (ngC. g ⁻¹ .h ⁻¹)	Net Me ²⁰³ Hg(%)	BSP (ngC. g ⁻¹ .h ⁻¹)
Rio Viejo	12	0.07	3.3 - 4.3	0.48
Salinas	0.2 - 7.9	0.18 - 0.55	0.2	0.7
Granja	6.4	0.05	0.2 - 36	0.92 - 1.45
San Juan	0.37	0.05	-	-

We found no significant correlation between bacterial activity and mercury methylation in none of matrixes or study areas. Mercury is methylated mainly by sulfate-reducing bacteria while ^3H -leucine can be incorporated by all bacteria. At the same Bolivian lakes a diverse SRB community associated to the roots of floating macrophytes were founded^[3]. Nevertheless, the roots of aquatic macrophytes host a diversity of organisms others than bacteria, such as algae, fungi, invertebrates, etc, and the variable community composition should affect the rates of carbon cycling and mercury biomethylation. Studies on methylmercury formation^[4] founded a positive correlation between the age of the lake, enrichment and quality of organic matter and methylation potential at the surface of sediments.

CONCLUSIONS

The periphyton associated to the roots of aquatic macrophyte seems to be a suitable environment to bacteria due to their high production and retention of organic matter, large contact surface area and optimal physico-chemical conditions for microbial growth. Methylmercury produced in the root-associated periphyton may be regarded as highly bioavailable and this complex matrix should receive more attention in the context of Hg biogeochemistry studies.

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