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Low Soil Mercury Caused High Rice Mercury in High Geological Background Region and Its Possible Mechanism

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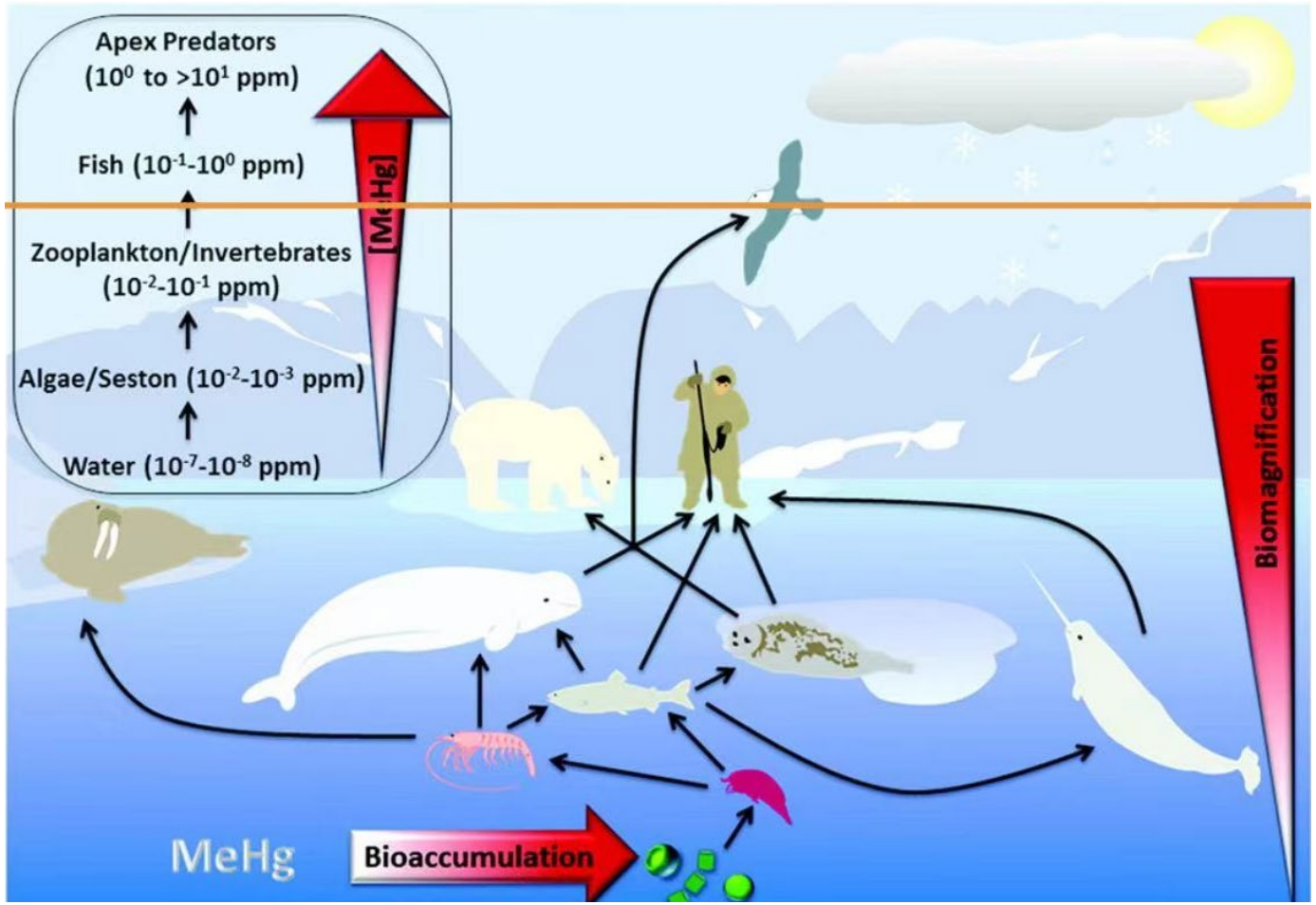
Toxicity of Mercury (Hg)

The most toxic form: **MeHg**

- Neurotoxicity
- Cardiovascular system toxicity
- Reproductive system toxicity
- IQ loss
- ……

Minamata disease in JAPAN (1950's)

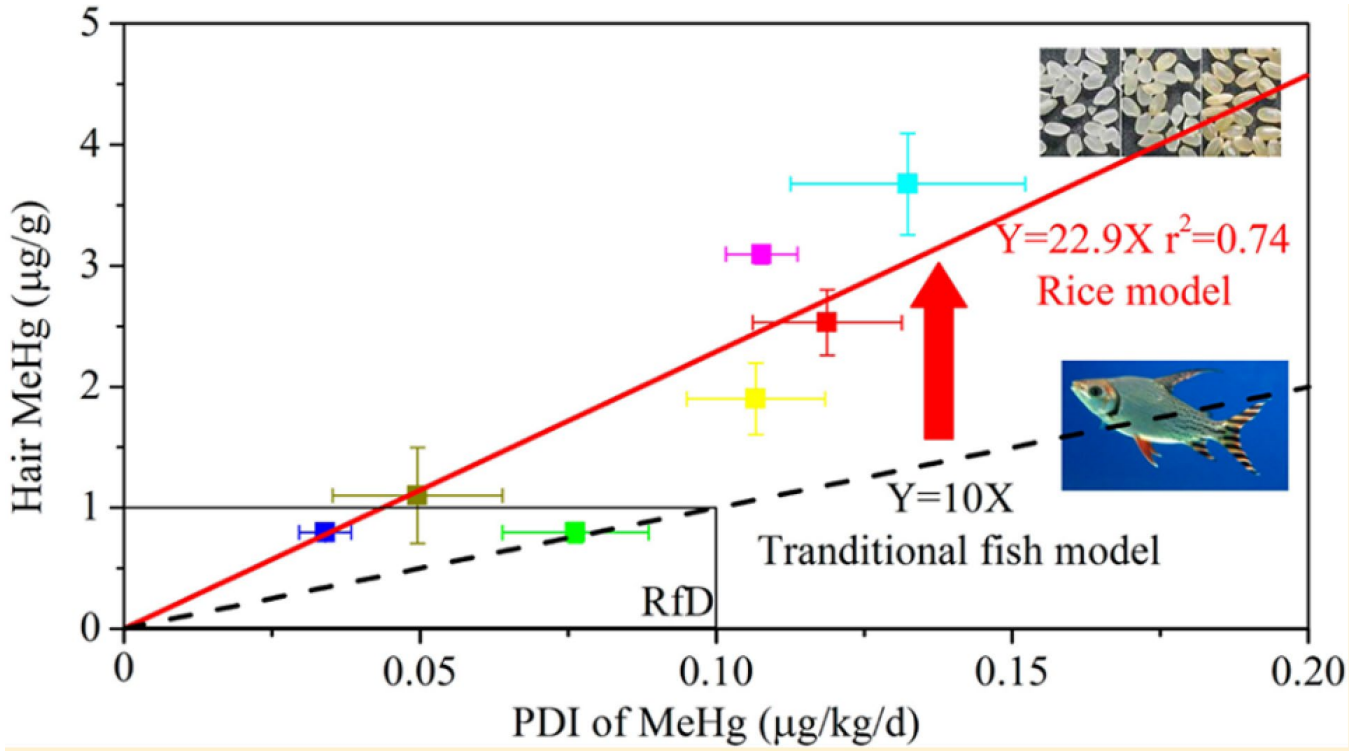
Biomagnification of MeHg in aquatic food chains



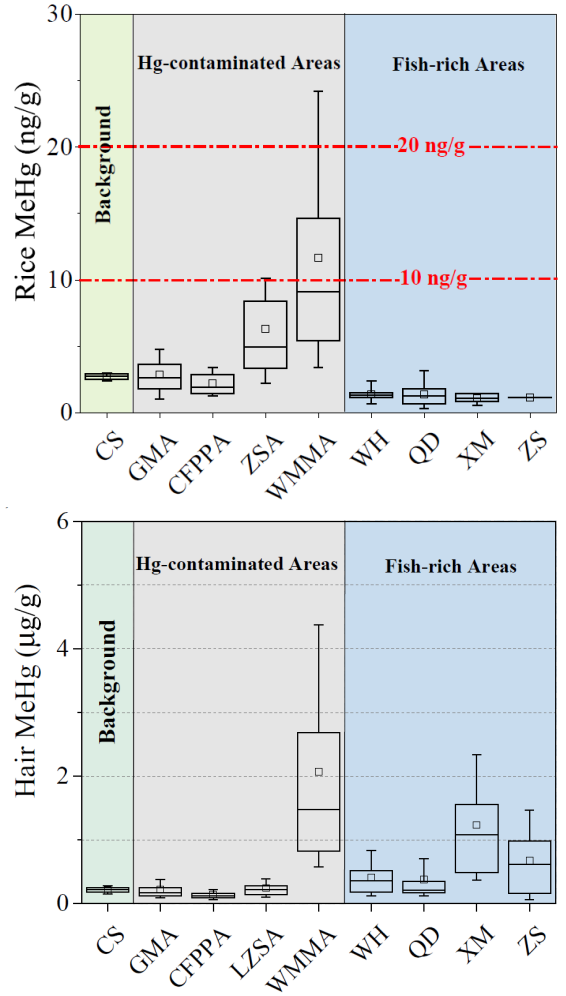
(Hammerschmidt et al., 2007, ES&T)

- Tissue concentrations in certain fish species were more than **10^6 times** higher than ambient water Hg concentrations

Rice was the primary pathway for MeHg exposure in inland Hg-contaminated areas



(Li et al., 2015, ES&T)

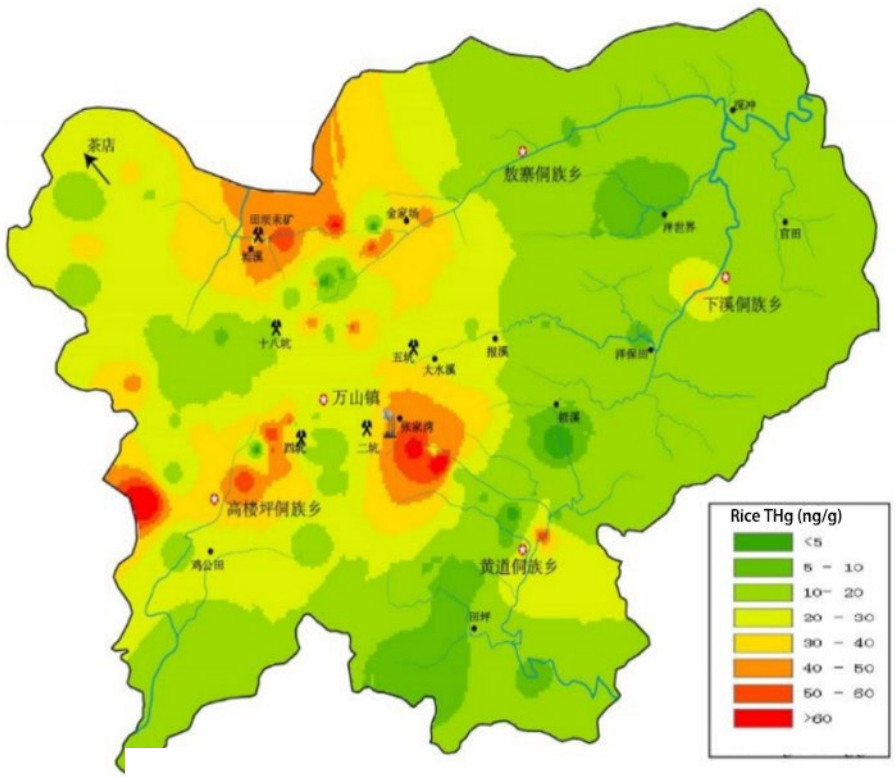


(Wang et al., 2021, Environ. Int.)

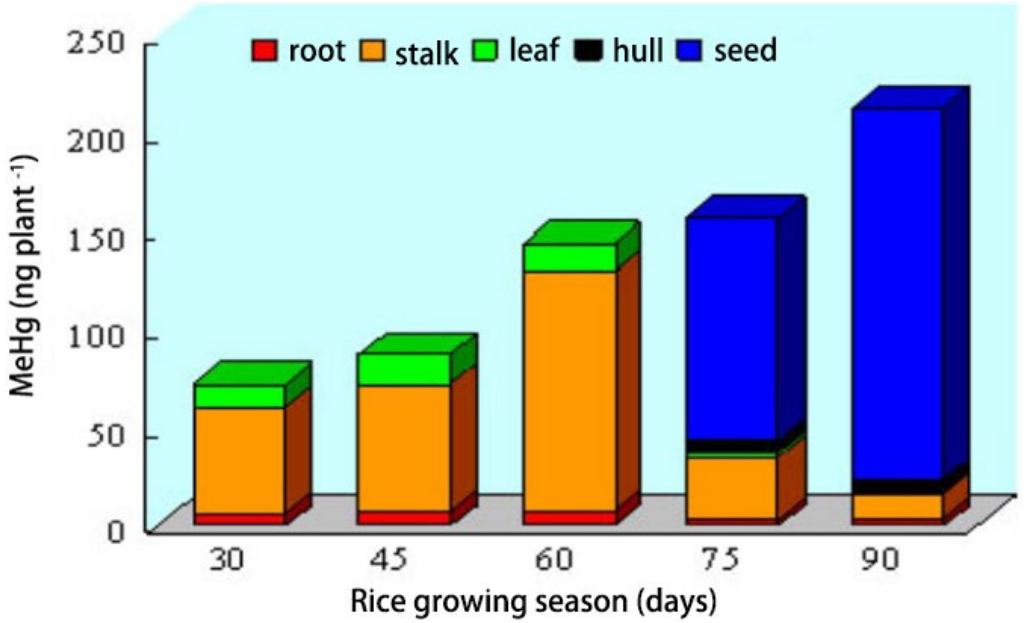
- MeHg exposure mainly came from fish consumption for **coastal residents** and mainly came from rice consumption for **residents in inland Hg-contaminated areas**.

The soil and rice in Wanshan Hg mining areas (WSMA) were seriously contaminated

Rice THg content in WSMA



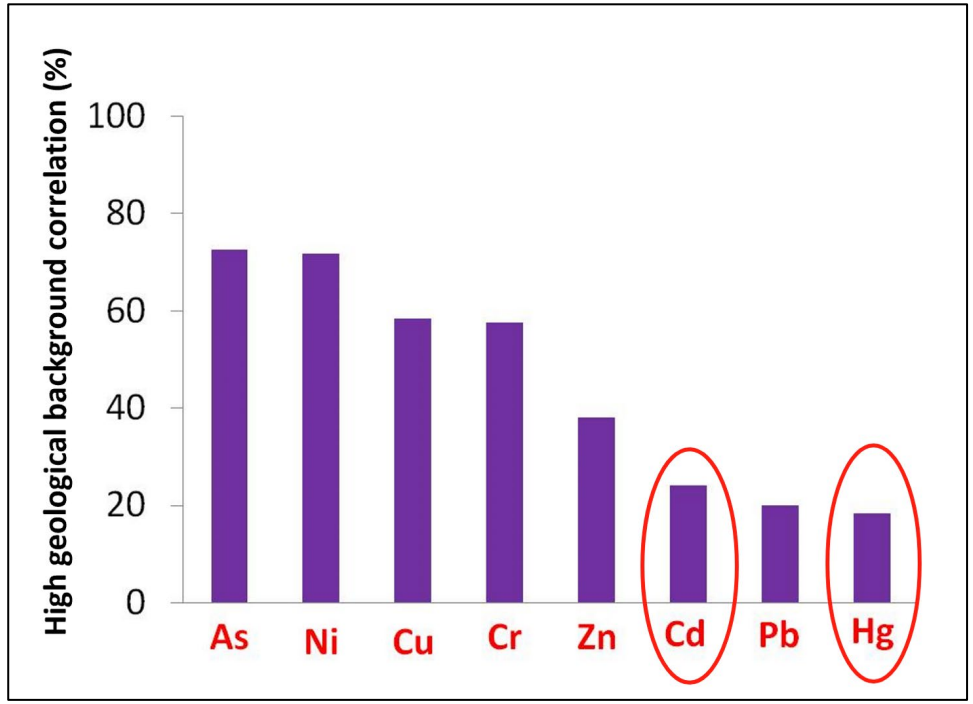
(Zhu et al., MD, 2018)



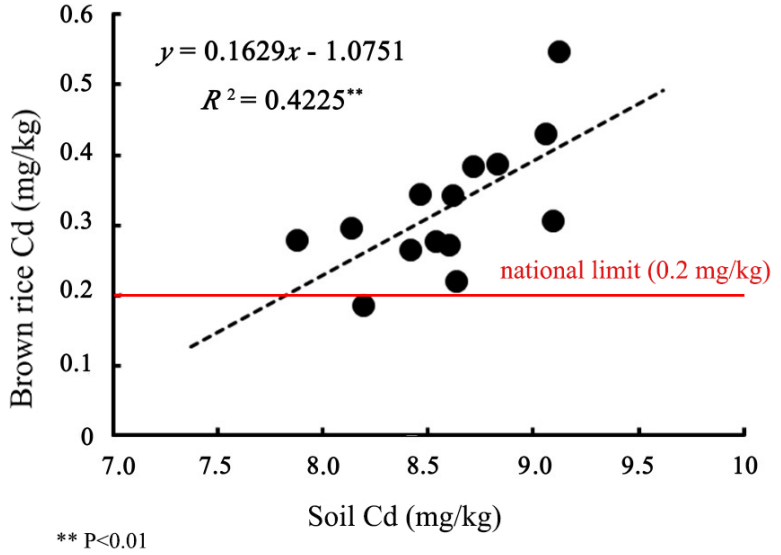
(Meng et al., 2011, ES&T)

- The **enrichment of MeHg** in rice plants was a **dynamic process** of absorption, accumulation, and transportation

Elevated rice Cd content was observed in the high Cd geological background area



(Soil Environmental Background Value in China [M], 1990)



(Yang et al., 2021, EARTH AND ENVIRONMENT)

- The content of **Hg** and **Cd** in limestone soil (**karst region**) was higher than the average in Chinese soil

What is the Hg level in rice in the karst area with high geochemical background?

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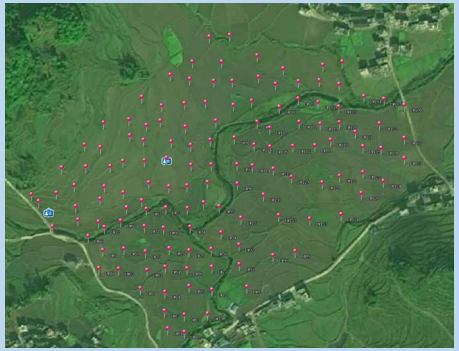
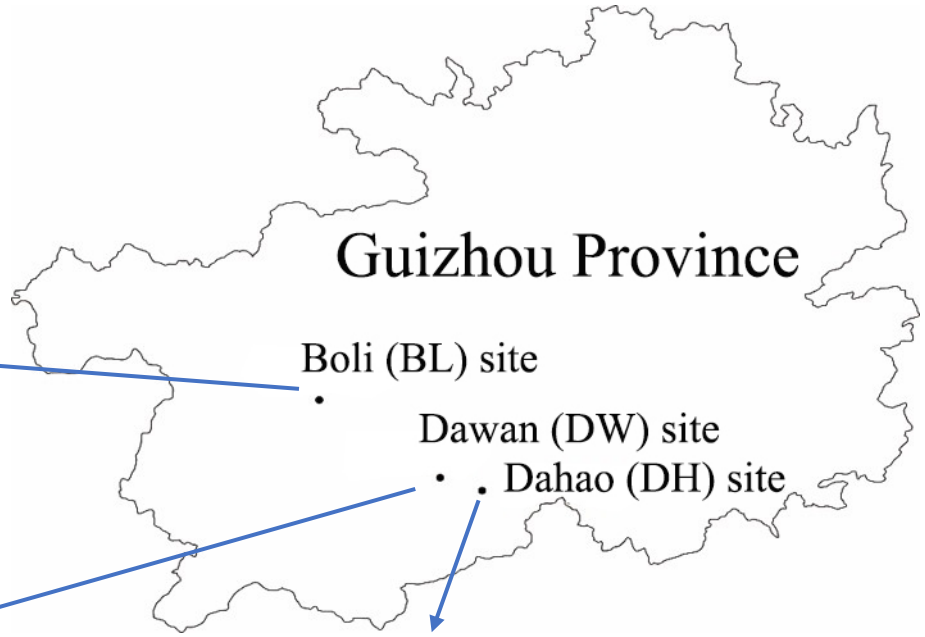
Sampling sites selected according to soil Cd content (Hg and Cd content in the soil were related)

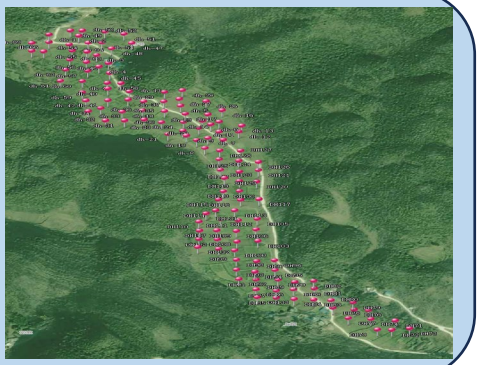
BL Soil Cd content: 1.21 mg/kg; 142 samples

DW Soil Cd content: 0.30 mg/kg; 140 samples





DH Soil Cd content: 4.94 mg/kg; 130 samples



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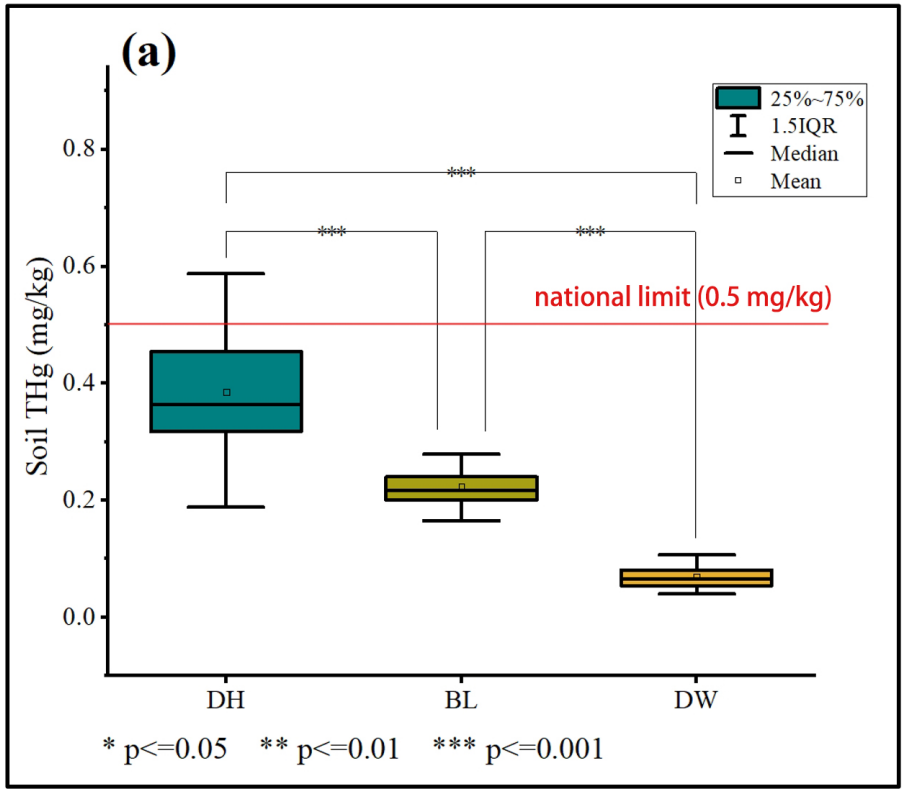
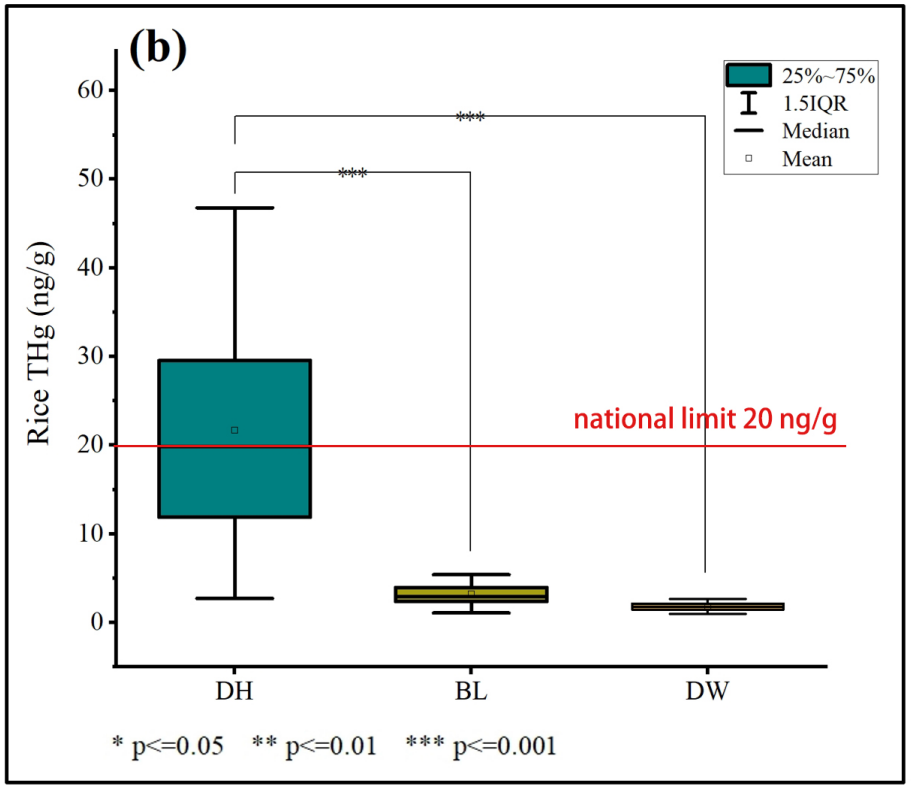
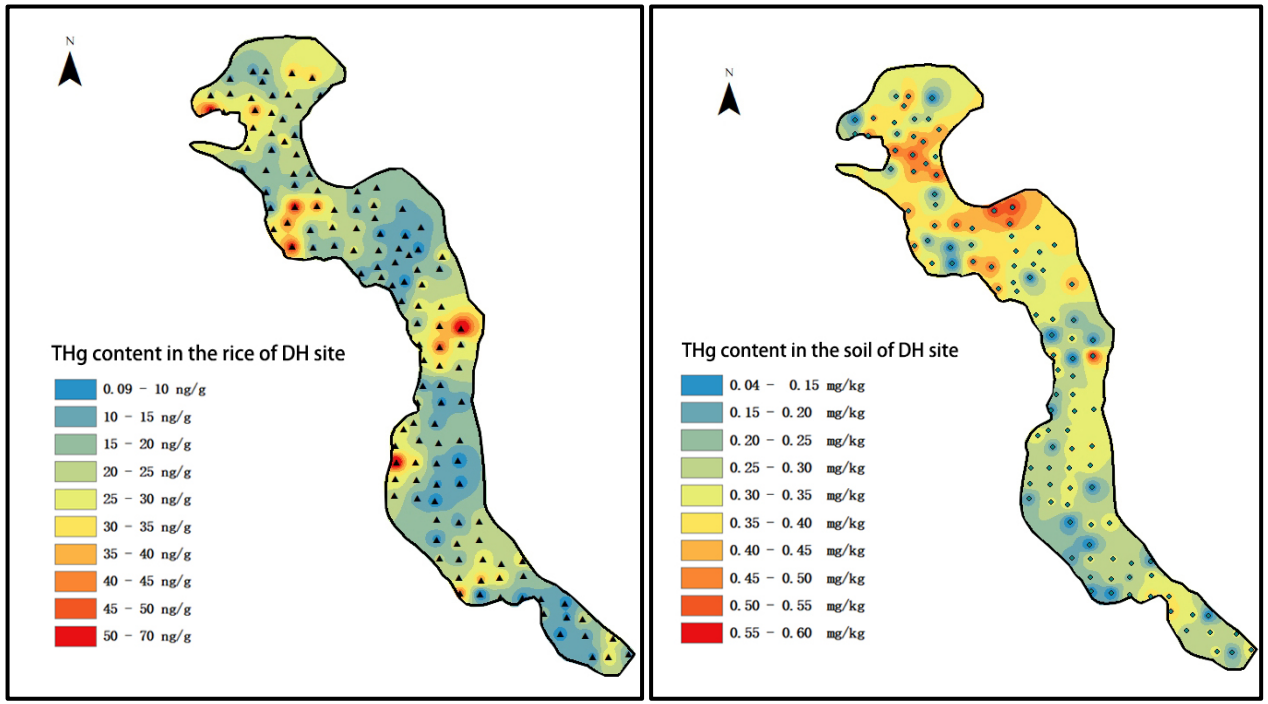
Elevated rice Hg content at DH site even with low soil Hg level

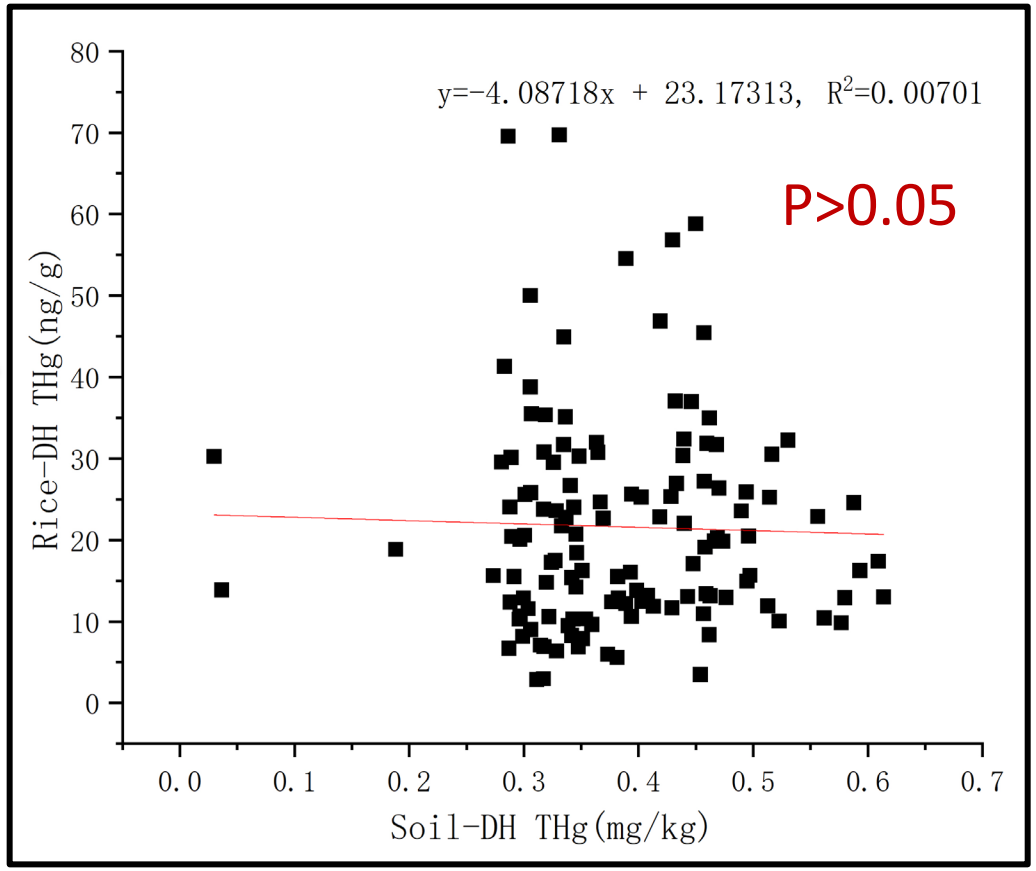




- About **48.5%** of rice THg content at DH site exceeded 20 ng/g, higher than **40%** of **WSMA**

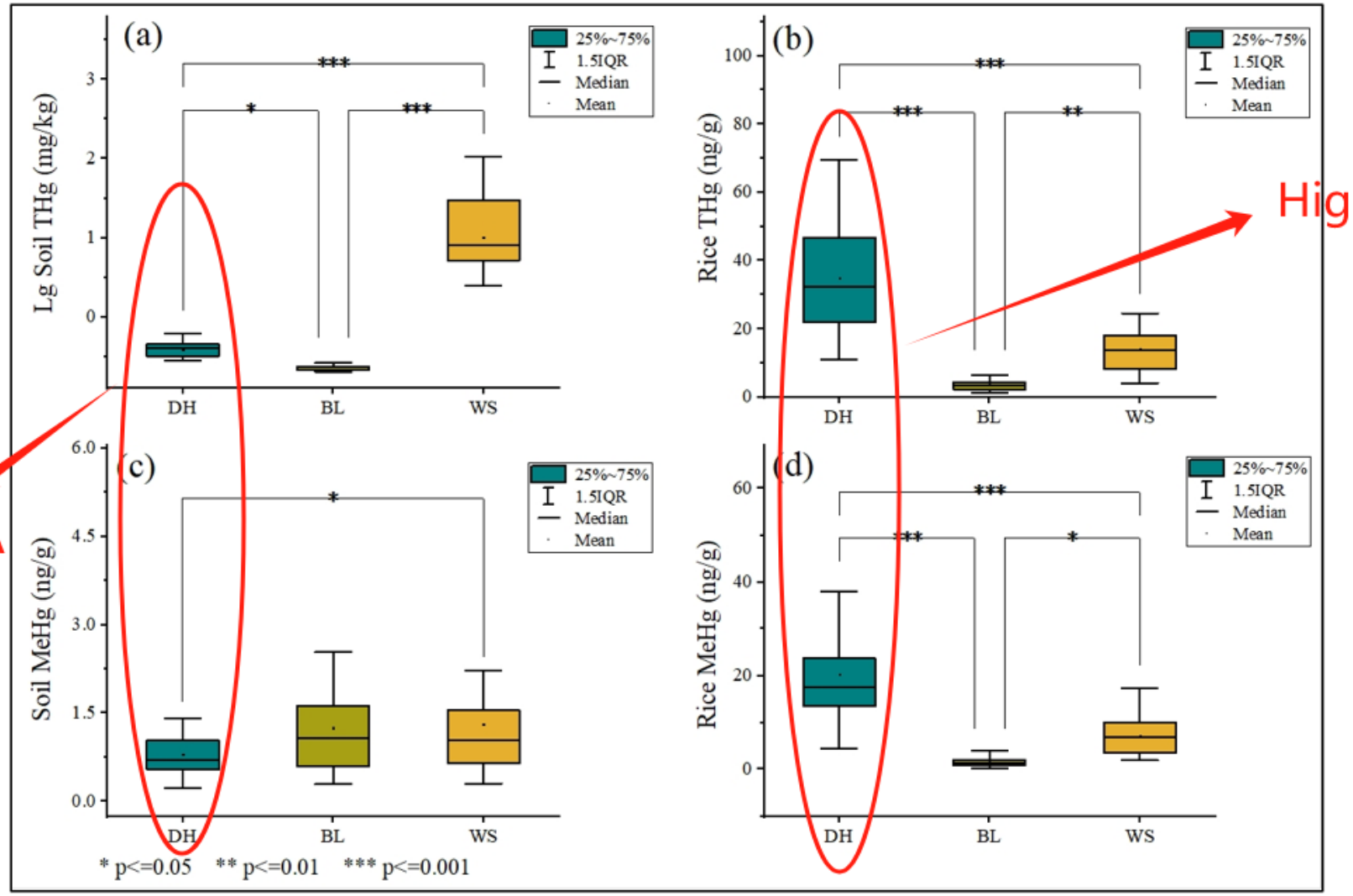
No significant correlation between the THg content in rice grains and corresponding soil





- Different distribution characteristics of THg content in the soil and rice grains

Elevated rice Hg content at DH site even with low soil Hg level

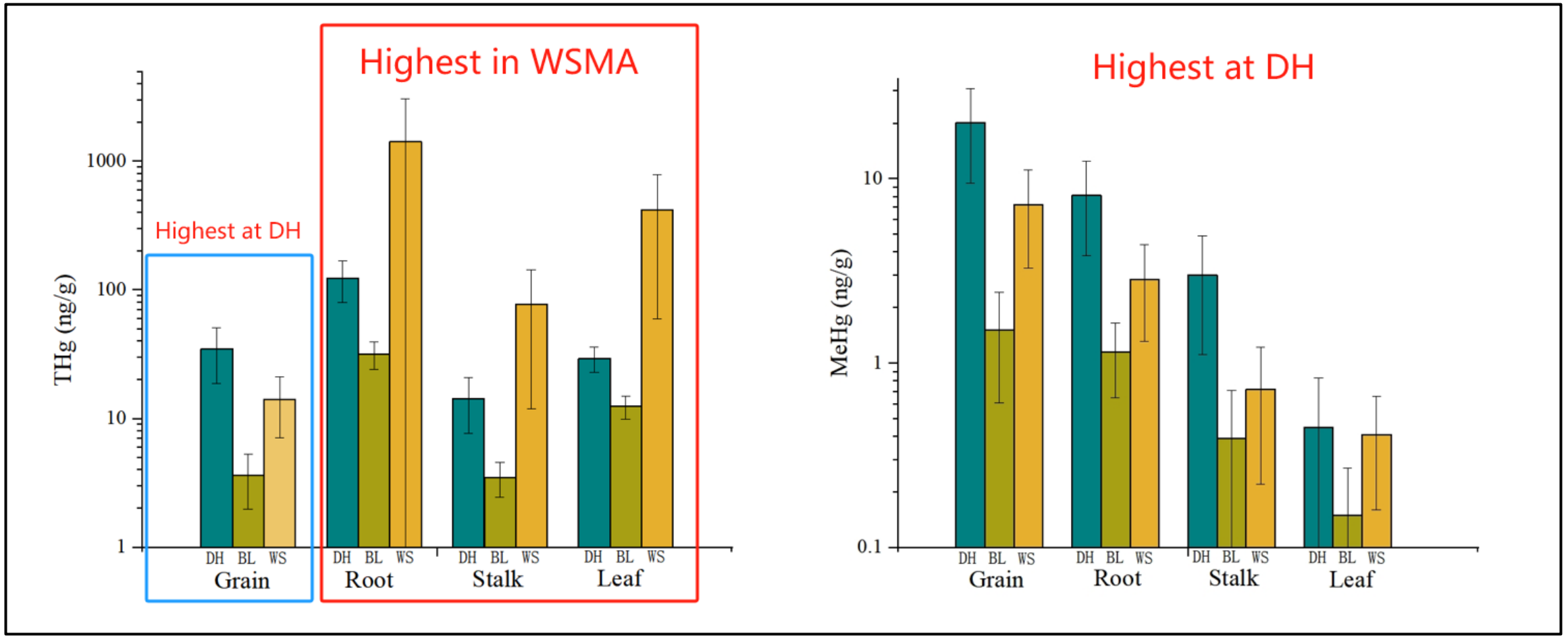


Lower than WSMA

Higher than WSMA

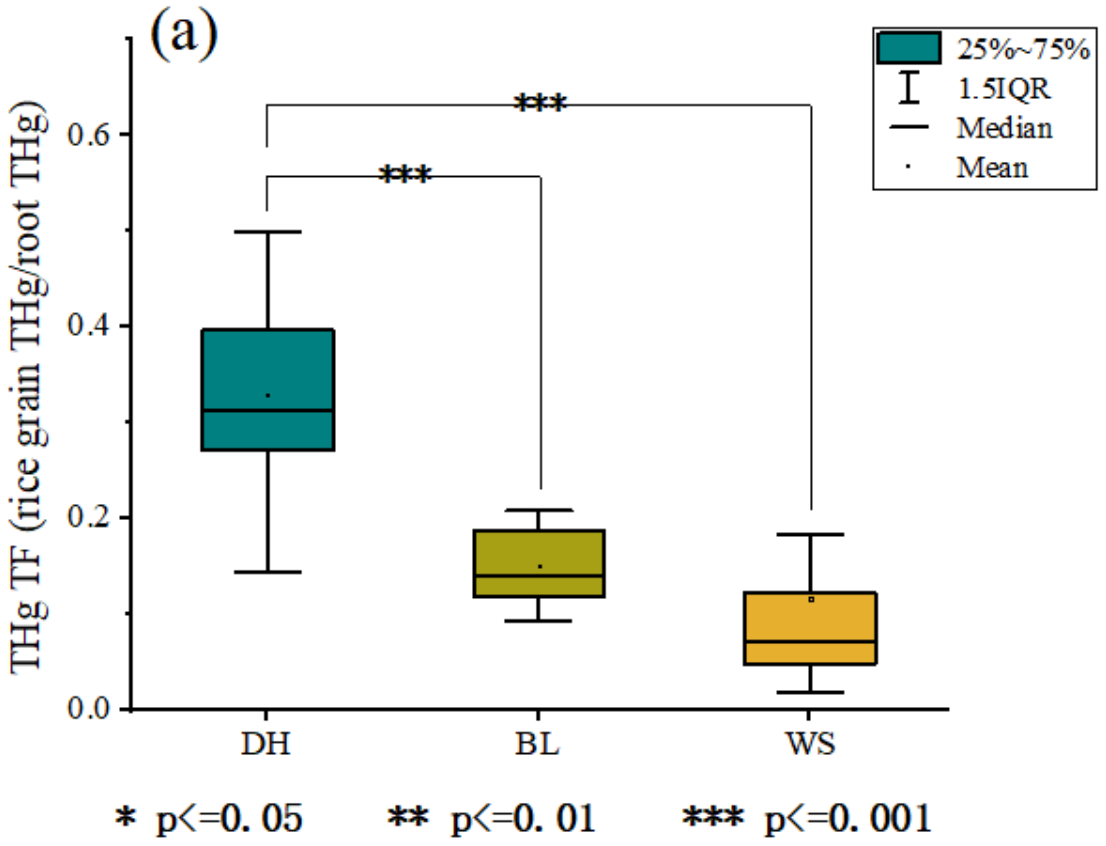
- A high Hg bioaccumulation capacity in rice plants of DH site
- **The Hg exposure risk from rice consumption in high geological background areas could not be negligible**

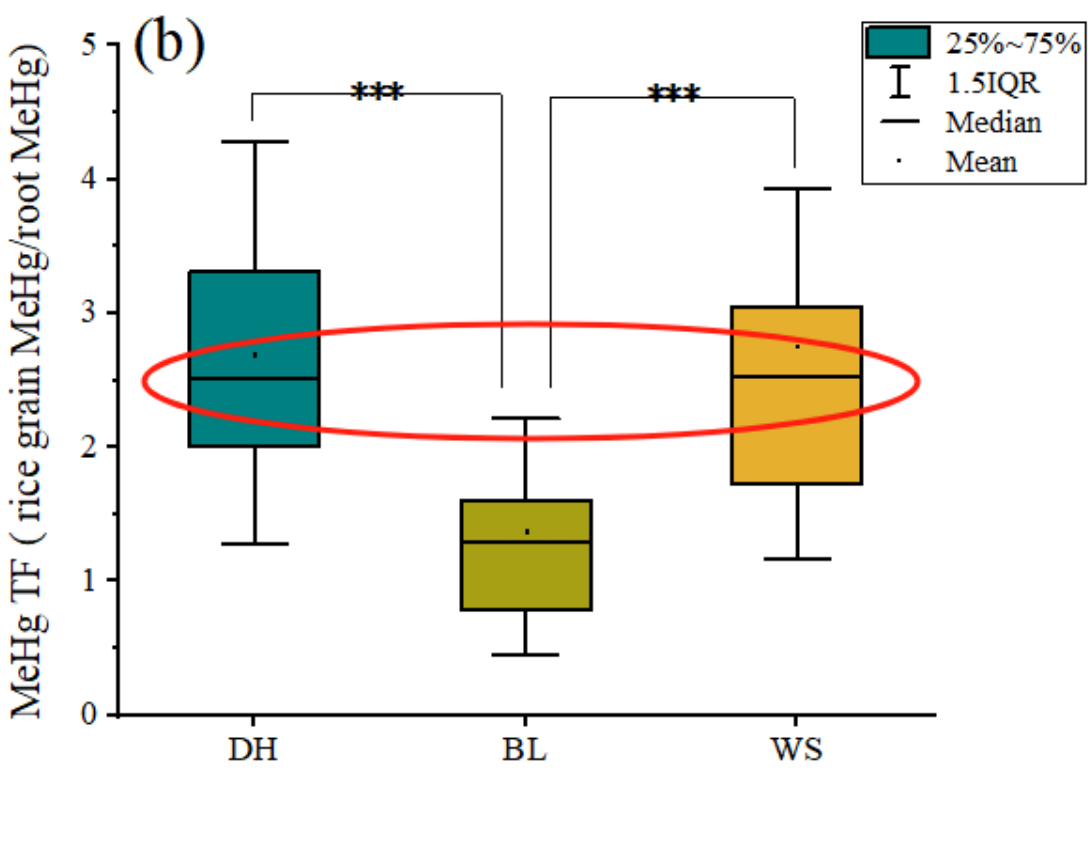
High MeHg bioaccumulation occurred in DH paddy fields



- DH site had **the highest grain THg content**, even with much lower THg content in the rice inedible part than WSMA
- The **highest MeHg contents** in rice tissues were all observed at DH site

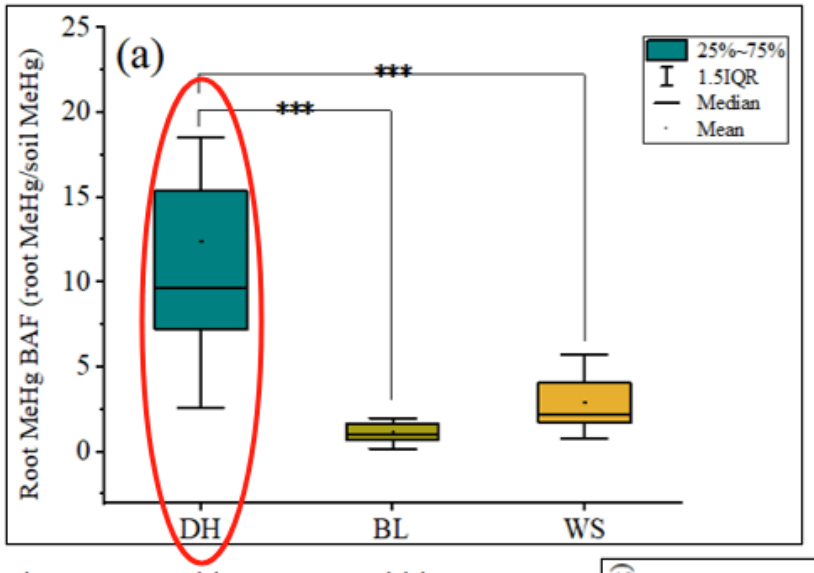
Comparable migration and accumulation capacity of MeHg inside the rice plants between DH and WSMA

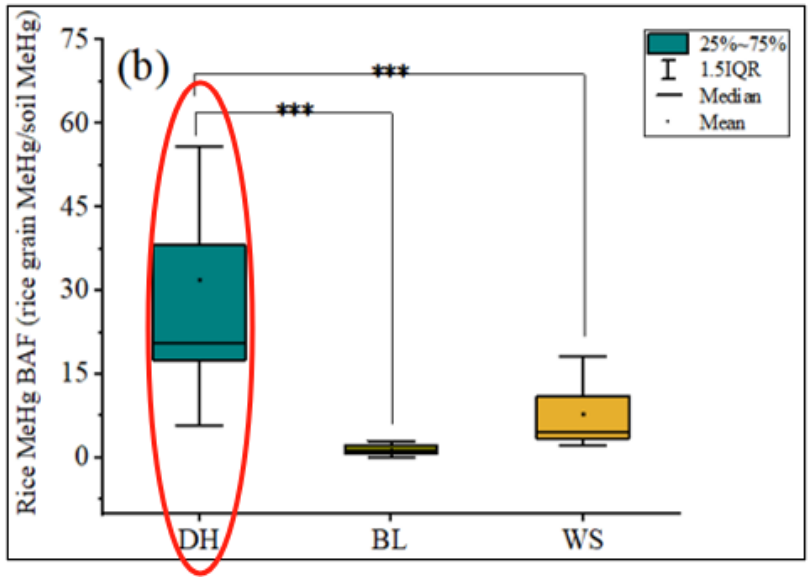




- Similar MeHg transfer factor (TF, from root to rice grain) between DH site and WSMA

The process of Hg absorption in rice root is the key step to determine the high Hg content in DH rice



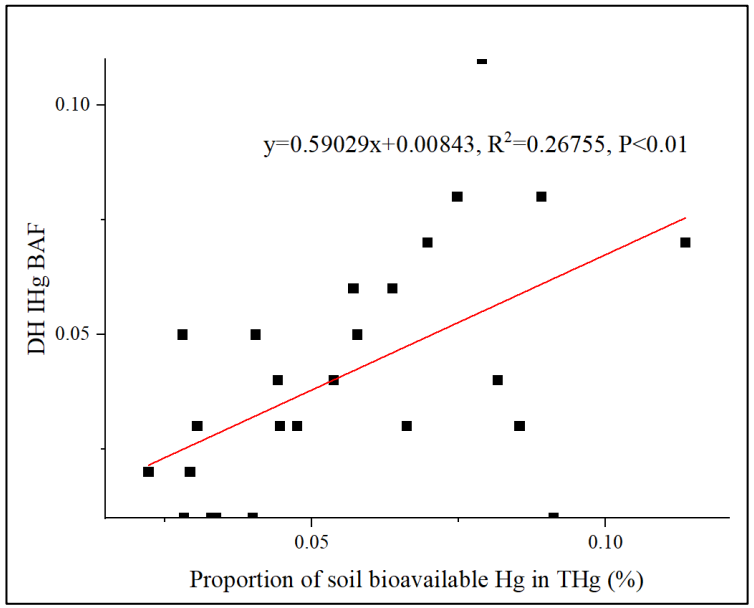


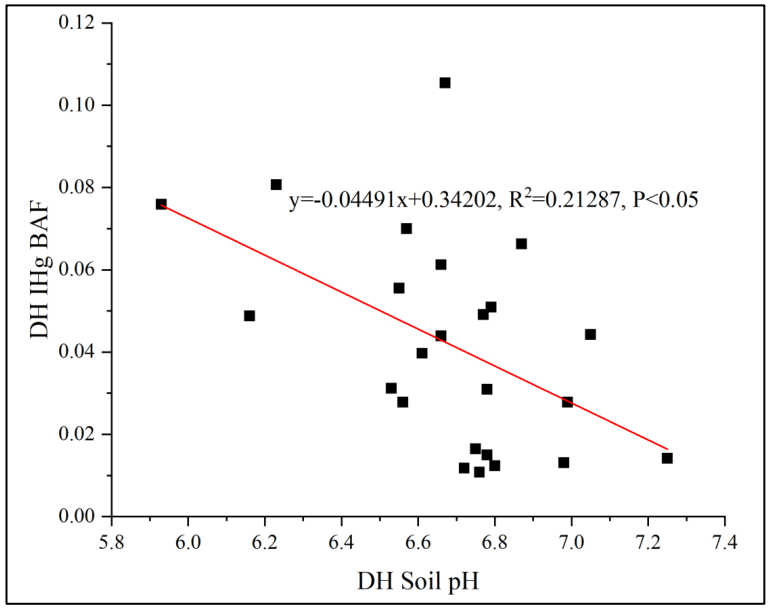
The **comparable** MeHg TF inside rice plants between DH and WSMA

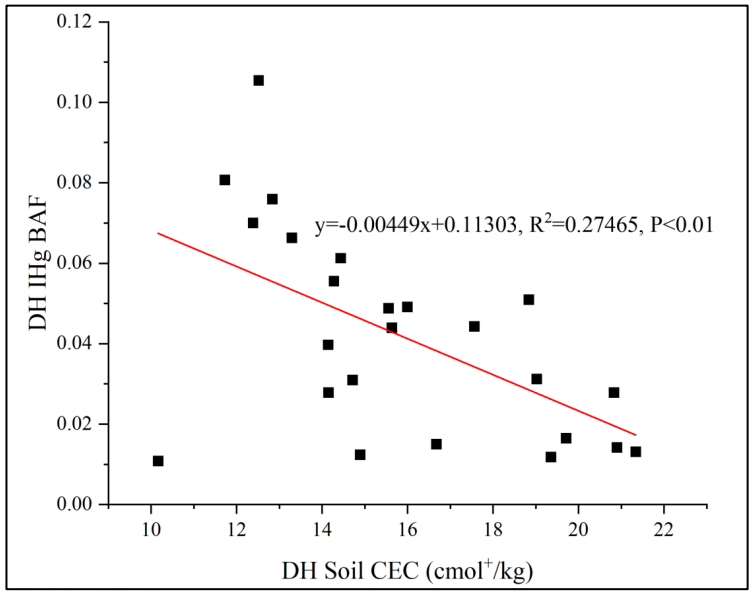
Highest rice and root BAF at DH

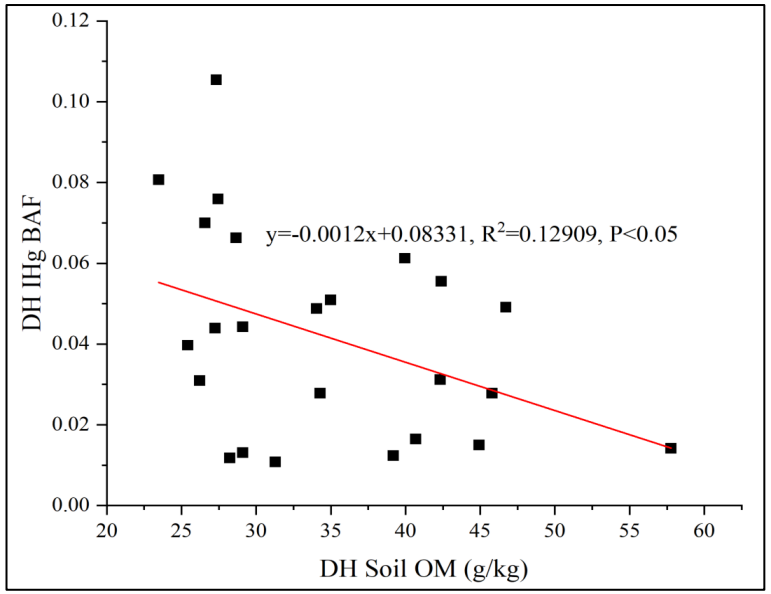
Root absorption and transport was the most important process of high Hg bioaccumulation in DH rice plants

Discussion on factors controlling Hg accumulation in DH rice









- The soil **pH, CEC, OM, and bioavailable Hg** content were the key factors controlling the **rice IHg bioaccumulation** at DH site

- The **rice MeHg bioaccumulation** at DH site may was controlled by other factors such as **microorganisms, iron and sulfur content, or redox conditions,** which needed further research.

CONTENTS

ENVIRONMENTAL IMPLICATION

01

The risk of Hg exposure from rice consumption in karst high geological background areas and even globally may be seriously **underestimated**

02

The accumulation characteristic of Hg in rice in karst high geological background areas may be **inconsistent with** the traditional understanding of Hg-contaminated areas

03

It is very important to clarify the **cause and risk range** of rice Hg pollution in karst high geological background areas and even globally and provide theoretical support for risk control in the future

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