



With the 6 months treatment of *Pteris vittata*, the water soluble arsenic in soil (upper and under) was moderately decreased.

# Field study on phytoremediation of the arsenic contaminated site in northeast Japan using arsenic-hyperaccumulator *Pteris vittata*

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Environment Fund.



# Pteris vittata(Chinese brake fern)



Lena Ma 2001



22,000 mg/kg As  
90% As stored in fronds  
Free arsenite(As(III))  
1-2kg biomass/m<sup>2</sup>



2006

## brief communications

### A fern that hyperaccumulates arsenic

A hardy, versatile, fast-growing plant helps to remove arsenic from contaminated soils.

Contamination of soils with arsenic, which is both toxic and carcinogenic, is widespread<sup>1</sup>. We have discovered that the fern *Pteris vittata* (brake fern) is extremely efficient in extracting arsenic from soils and translocating it into its above-ground biomass. This plant — which, to our knowledge, is the first known arsenic hyperaccumulator as well as the first fern found to function as a hyper-



with the control (data not shown).

After 20 weeks of growth, the plant was extracted using a solution of 1:1 methanol:water to speciate arsenic with high-performance liquid chromatography-inductively coupled plasma mass spectrometry. Almost all arsenic was present as relatively toxic inorganic forms, with little detectable organoarsenic species<sup>2</sup>. The concentration of As(III) was greater in the fronds





# Pteris vittata and I



Rhizomes

Roots





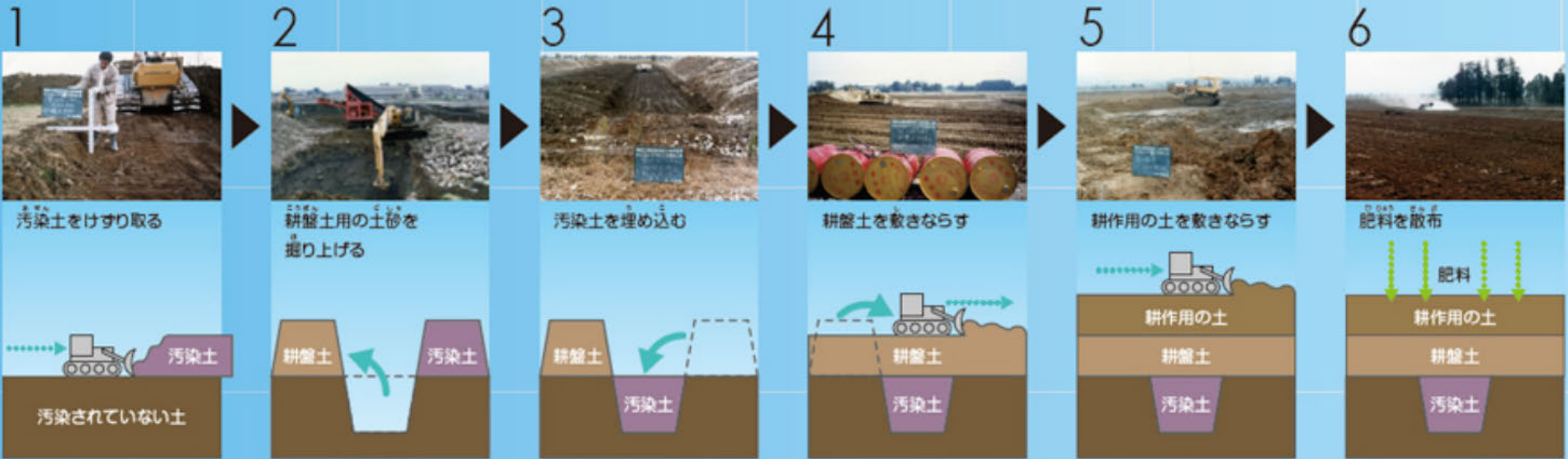
# Fern in Vietnam





# Heavy metal contaminated soil remediation

## 土壤復元工事 (埋込客土工法の場合) の流れ



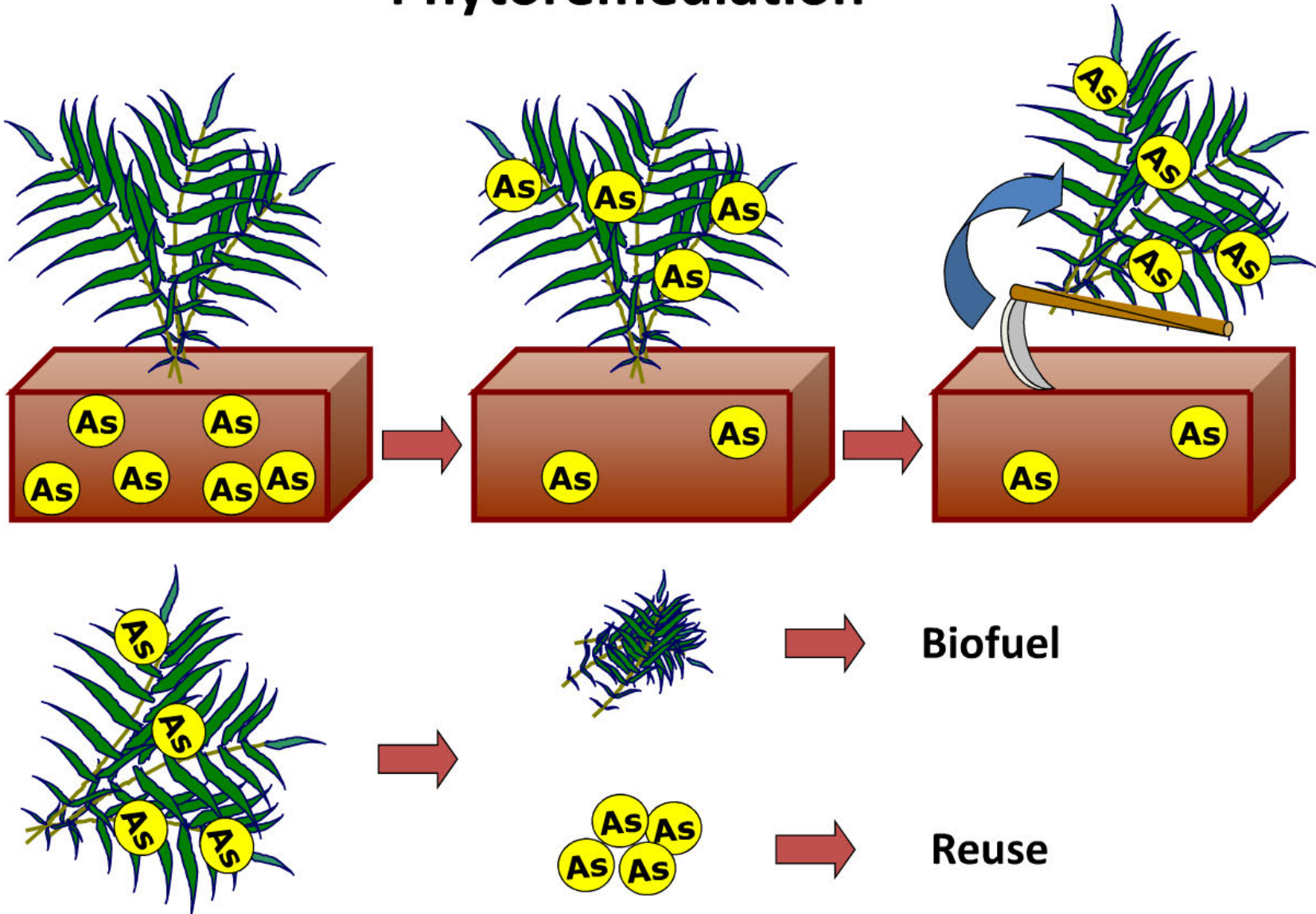
863 ha

33 yrs

40 billions yen

# Plan B

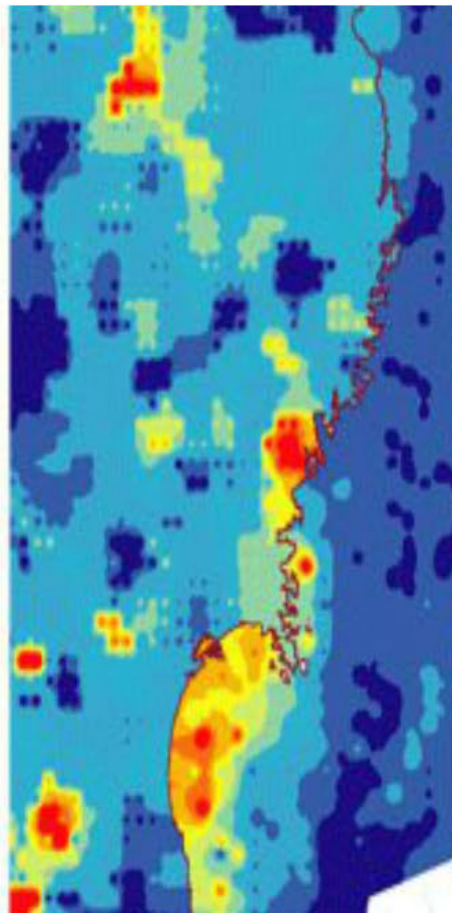
# Phytoremediation





# Arsenic contaminated soil in Tohoku Japan

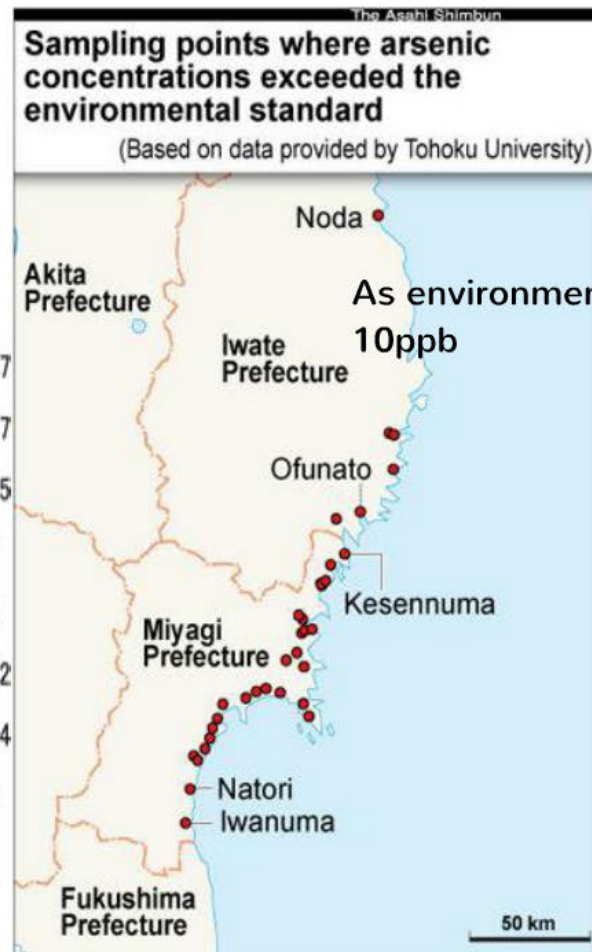
## Arsenic concentration in soil, Tohoku Japan



AIST Geochemical Map of Sea and Land of Japan

### Arsenic

Sea	As, ppm	Land
20.66 - 141		50.17 - 2,007
18.26 - 20.66		42.05 - 50.17
16.18 - 18.26		36.27 - 42.05
13.78 - 16.18		30.5 - 36.27
11.38 - 13.78		24.72 - 30.5
9.292 - 11.38		18.94 - 24.72
7.523 - 9.292		12.17 - 18.94
5.818 - 7.523		6.39 - 12.17
4.113 - 5.818		3.61 - 6.39
0 - 4.113		0 - 3.61



Asahi news 9. 3. 2011

The Asahi Shimbun

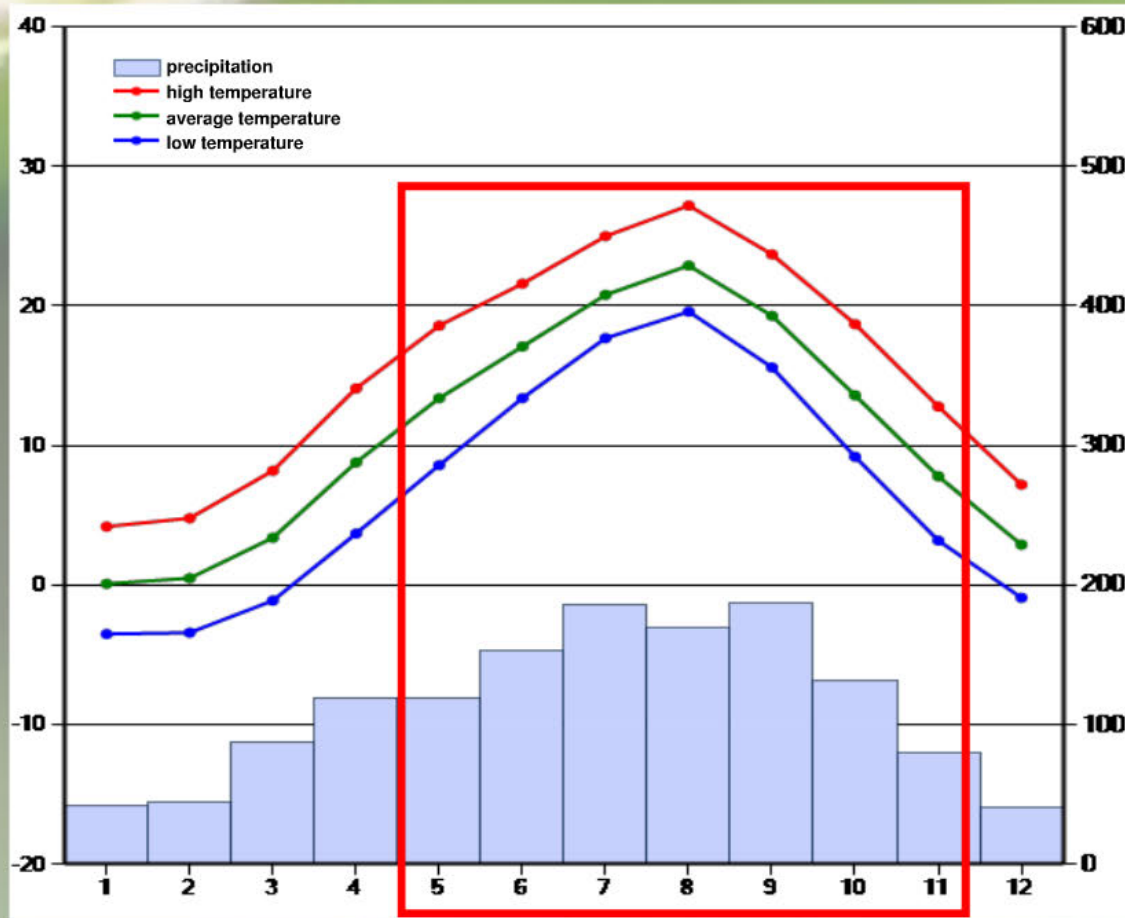
### Sampling points where arsenic concentrations exceeded the environmental standard

(Based on data provided by Tohoku University)

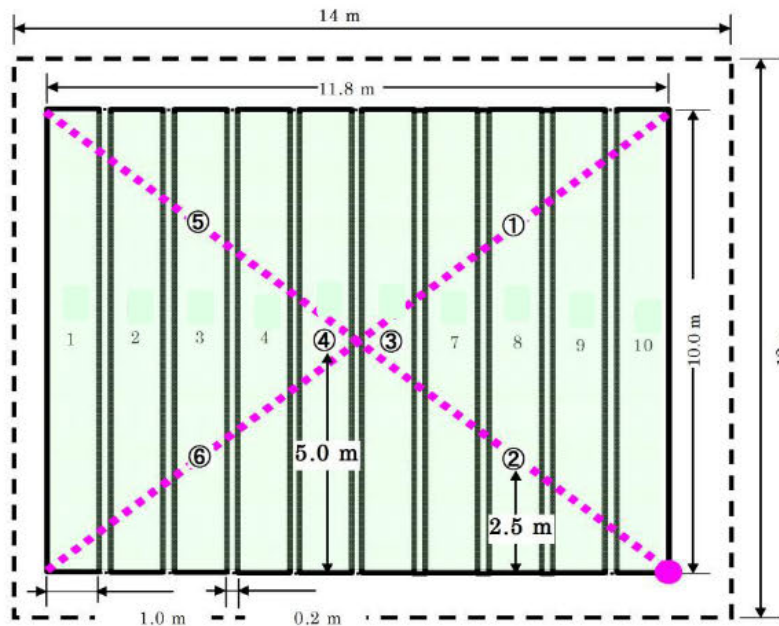
As environmental standard  
10ppb



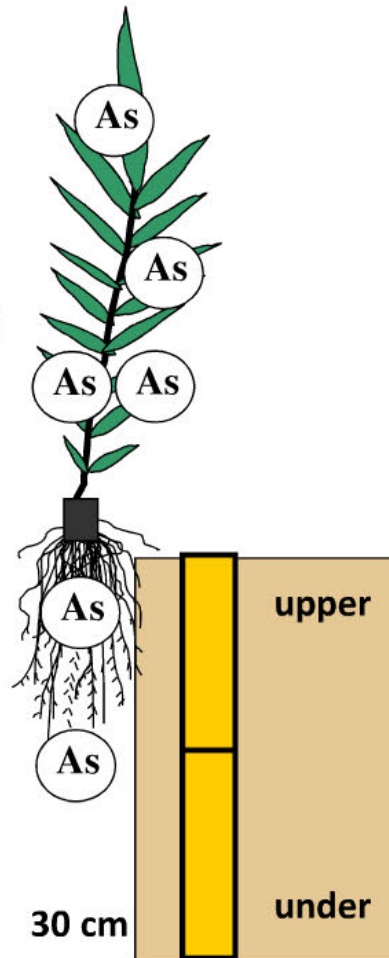
# Weather data in Kesennuma



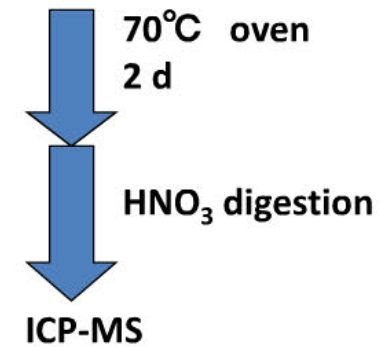
# Experimental site and Sampling



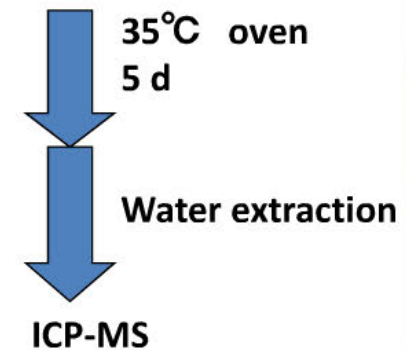
**1000 ferns**  
**density : 10 ferns/m<sup>2</sup>**  
**Seedlings were planted in May 2012**  
**and harvested in November 2012**  
**to prevent the cold season, and the soil**  
**and plant samples were collected**  
**every month.**



**Plant sample**  
**(fronds • rhizomes • roots)**

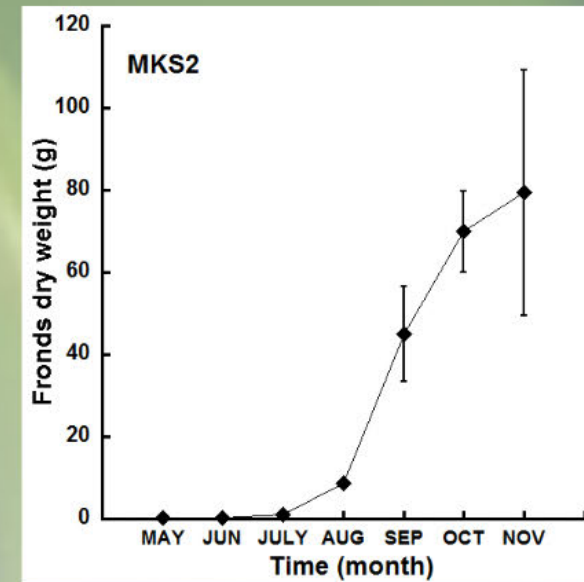


**Soil sample**  
**(upper • under)**

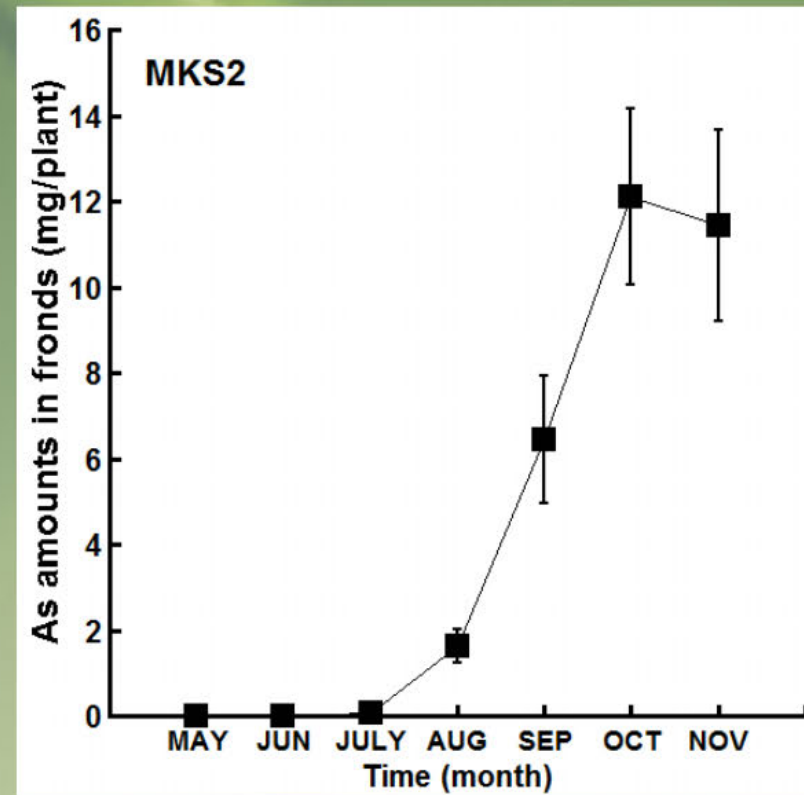
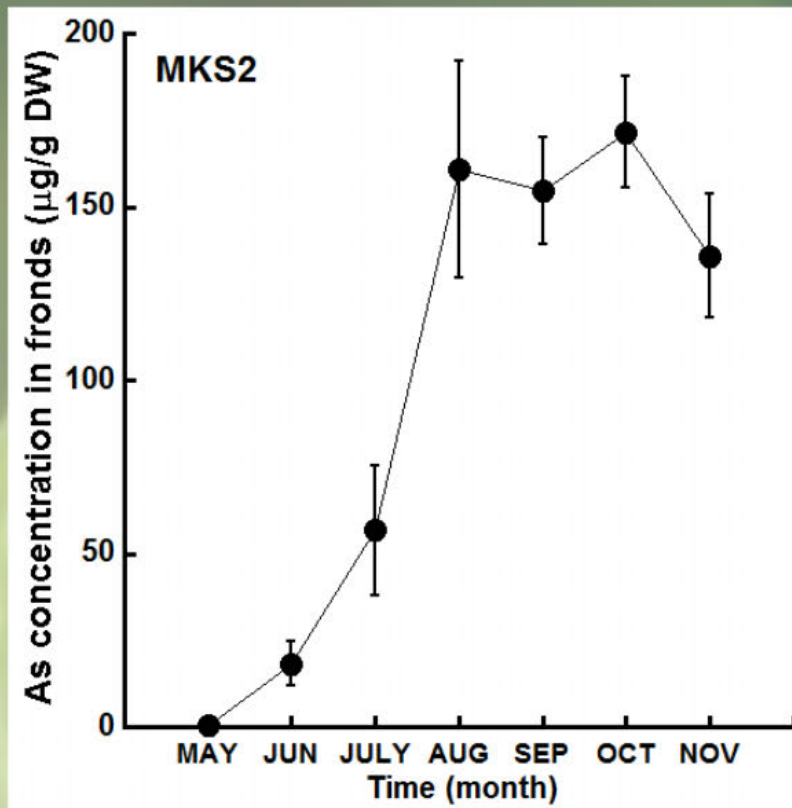




## Fronds biomass of *Pteris vittata*



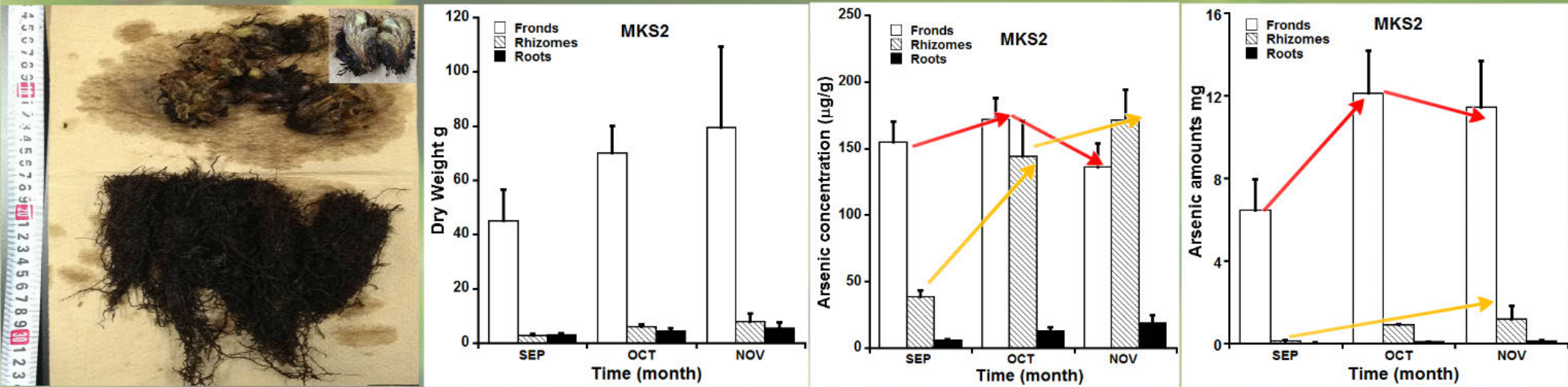
# Arsenic in Fronds



Both arsenic concentrations and amounts in fronds of the *Pteris vittata* were increased till to October but decreased in November.

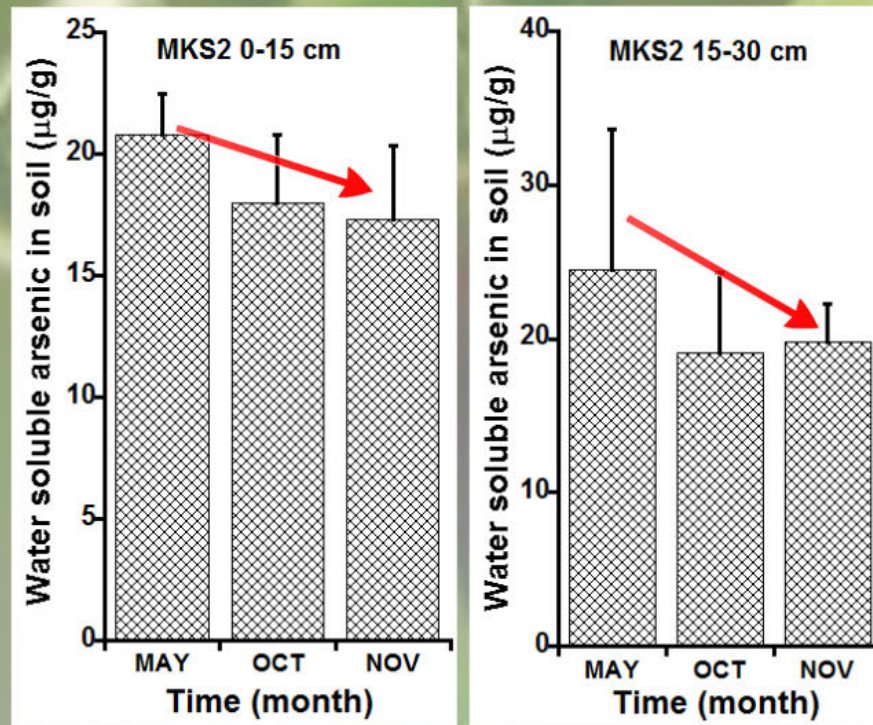


# Arsenic in Fronds, Rhizomes, Roots



Comparison of the fronds, rhizomes, roots arsenic concentrations and amounts in the last three months (Sep, Oct, Nov.) resulted in the extremely increased concentration of arsenic in rhizomes from September to November.

# Arsenic in soils(water soluble)



With the 6 months treatment of *Pteris vittata*, the water soluble arsenic in soil (upper and under) was moderately decreased.



# Summary

***Pteris vittata* is capable of accumulating arsenic from the contaminated agricultural sites in Northeast Japan.**

**Fern fronds and rhizomes should be harvested in autumn and the seedlings must be replanted every spring.**

**From the results we can indicate that Arsenic was translocated from fronds to rhizomes of *Pteris vittata* in the late autumn by low temperature.**



**2013**



Thank you



Thank you

Just started



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