Chemical warfare agents containing aromatic arsenicals (AAs) such as Clark I (diphenylchloroarsine) are well-known. They were mainly produced as vomiting or vesicant agents during World Wars I and II, and after World War II, these agents as well as other chemical weapons were abandoned by Europe, China, Japan, and other countries by dumping in the sea or by burying in the earth. These agents can be metabolized in groundwater, soils, and sediments via hydrolysis and oxidation, resulting in the formation of diphenylarsinic acid (DPAA) and other AAs. Groundwater is widely used for the irrigation of crops, and particularly for the irrigation of paddy rice, which is a staple crop in Asia. In 2004, DPAA was detected in the groundwater used for the irrigation of paddy fields in Kamisu town, Ibaraki, Japan. DPAA and methylphenylarsinic acid (MPAA) were also detected in the paddy rice cultivated in the paddy fields that were irrigated with the contaminated groundwater.

We investigated the uptake of AAs in agricultural soils by rice. DPAA, phenylarsonic acid (PAA), MPAA, methylidiphenylarsineoxide (MDPAO), and Dimethylphenylarsine oxide (DMPAO) were detected in the contaminated soil. PAA and MPAA concentrations decreased and DMPAO concentration increased under the flooded conditions; however, the concentrations of the AAs did not change under the upland conditions. MPAA was detected in brown rice grown in contaminated soil. DMPAO and MDPAO were detected in the straw but not in the grains grown in the contaminated soil. DMPAO was detected in the straw of the rice grown in PAA- or MPAA-amended soil but was not detected in that grown in a PAA- or MPAA-added solution culture. MDPAO was detected in the straw of the rice grown in diphenylarsinic acid (DPAA)-amended soil but was not detected in that grown in a DPAA-added solution culture. Thus, MPAA and DPAA were methylated not in the rice plant but in the soil under the flooded conditions. Dephenylated products were detected in the straw grown in AA-added solution cultures, but demethylated products were not detected. DMPAO and MDPAO absorbed by the shoots were retained, and MPAA and DPAA absorbed by the shoots were translocated to the grains more easily than other AAs.