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Molecular study on Cytoplasmic Male Sterility in Rice

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Cytoplasmic male sterility (CMS) is a maternally inherited trait that results in the inability to produce fertile pollen and is often associated with an unusual open reading frame (*orf*) found in mitochondrial genomes. In rice, various types of CMS, such as BT-CMS originating from Chinsurah boro II (Shinjyo 1969), LD-CMS from Lead Rice (Watanabe 1971), WA-CMS from a wild abortive line (Lin and Yuan 1980) and HL-CMS from Hong Lian wild rice (Rao 1988), have been identified. In these CMS lines, pollen fertility is recovered by a nuclear-encoded gene known as a fertility restorer gene (*Rf*).

We have been studying BT-CMS, LD-CMS and CW-CMS.

Type	Origin of cytoplasm	Fertility restorer gene	CMS-associated gene
BT	Chinsurah Boro II	<i>Rf1</i> (Chr.10) = PPR	<i>orf79</i>
LD	Lead Rice	<i>Rf2</i> (Chr.2) = ?	?
CW	Chinese Wild rice	<i>Rf1</i> (Chr.4) = ?	?

In the BT-CMS line, the mitochondrial genome of the BT-cytoplasm contains two duplicated copies of the *atp6* gene encoding a subunit of the ATPase complex. It has been reported that a unique sequence (*orf79*) located downstream from one of *atp6* genes causes male sterility. The *orf79* encodes a predicted transmembrane protein with a novel C-terminal region and an N-terminus showing similarity to rice mitochondrial cytochrome oxidase subunit I. In the BT-CMS line, the abnormal *atp6* (B-*atp6*) is transcribed as a 2.0-kb RNA consisting of normal *atp6* and the unique *orf79* sequence, whereas two discontinuous RNAs of 1.5 and 0.45-kb are generated from the 2.0-kb RNA by RNA processing in the presence of *Rf1*. We found that the LD-CMS also carries *orf79*. Our recent study on BT-CMS and LD-CMS suggests that *orf79* is the cause of CMS in BT-cytoplasm, but not the cause of CMS in LD-cytoplasm, and the function of *Rf2* is different from that of *Rf1*. We are currently surveying CMS-associated gene in LD-CMS and CW-CMS.

We have achieved map-based cloning of the *Rf1* gene and have shown that the *Rf1* gene encode pentatricopeptide repeat (PPR)-containing protein (Kazama and Toriyama 2003). *Rf2* for LD-CMS has been mapped on chromosome 2 (Iwata et al. 2006) and *Rf17* on chromosome 4 (Fujii and Toriyama 2005). We have identified candidate genes and complementation tests are now in progress. Comparison of three types of CMS/*Rf* system will elucidate the thorough molecular mechanism of CMS induction and fertility restoration in rice.