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# Life cycle of *Melampsora coleosporioides*, a leaf rust of *Salix babylonica* in Japan☆

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ABSTRACT

*Melampsora coleosporioides* produces uredinia and telia on the leaves of *Salix babylonica*. Since the life cycle of this fungus is largely unknown, inoculation experiments were conducted to find alternate host plants. Results showed that *M. coleosporioides* can use *Corydalis incisa* as a spermogonial and aecial host. The morphological characteristics of the spermogonial and aecial states of the fungus are first described. Furthermore, field observations and histological studies demonstrated that the fungus was able to overwinter in twigs of *S. babylonica* and produced urediniospores in early spring. Thus, the leaf rust occurs on *S. babylonica* every year and alternation with the spermogonial and aecial host is not necessary.



## 1. Introduction

*Salix babylonica* L. is one of the most popular willows in Japan. It is planted in parks, roadsides, riversides and lakesides in many areas from Okinawa to Hokkaido. One species of willow leaf rust, *Melampsora coleosporioides* Dietel parasitizes *S. babylonica* and causes leaf rust (Hiratsuka et al. 1992). *Melampsora coleosporioides* was first described by Dietel (1902) based on a specimen collected in Kanagawa Pref., Central Honshu, Japan by Dr. S. Kusano. It is known to be distributed in China, Taiwan, Russia, Australia, and South America (Hiratsuka et al. 1992).

Most species of *Melampsora* that are parasites of willows are heteroecious and produce their uredinial and telial states on willows. Alternate hosts (spermogonial–aecial hosts) belong to Pinaceae (e.g. *Abies*, *Larix*, *Tsuga*), *Allium*, *Euonymus*, *Galanthus*, *Ribes*, *Saxifraga*, *Viola*, Orchidaceae and Papaveraceae (*Chelidonium*, *Corydalis*) (Gäumann 1959; Wilson and Henderson 1966; Ziller 1974; Hiratsuka and Kaneko 1982). Both *Melampsora* spp. with the spermogonial–aecial state on Papaveraceae, *M. chelidonii-pierotii* and

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**Table 1 – Teliospores used for inoculation experiments.**

| Inoculum no. | Host plant | Locality of collection | Date of coll. | Voucher specimen no. |
|---|---|---|---|---|
| 1 | *Salix babylonica* f. *rokkaku* | Botanical garden, Tohoku University, Sendai, Miyagi Pref. | 13 Mar 2007 | TSH-R7200 |
| 2 | *S. babylonica* f. *rokkaku* | Botanical garden, Tohoku University, Sendai, Miyagi Pref. | 25 Feb 2009 | TSH-R7222 |
| 3 | *S. babylonica* f. *seiko* | Botanical garden, Tohoku University, Sendai, Miyagi Pref. | 13 Mar 2007 | TSH-R7205 |
| 4 | *S. babylonica* f. *seiko* | Botanical garden, Tohoku University, Sendai, Miyagi Pref. | 25 Feb 2009 | TSH-R7225 |
| 5 | *S. babylonica* | University of Tsukuba, Tsukuba, Ibaraki Pref. | 4 Mar 2007 | TSH-R10917 |
| 6 | *S. babylonica* | University of Tsukuba, Tsukuba, Ibaraki Pref. | 15 Feb 2009 | TSH-R7219 |
| 7 | *S. babylonica* | Yamabato park, Tsukuba, Ibaraki Pref. | 1 Feb 2008 | TSH-R10879 |
| 8 | *S. babylonica* | Yamabato park, Tsukuba, Ibaraki Pref. | 10 Feb 2009 | TSH-R7299 |
| 9 | *S. babylonica* | Ibaraki Nature Museum, Bando, Ibaraki Pref. | 13 Feb 2008 | TSH-R10861 |
| 10 | *S. babylonica* | Sunpu park, Shizuoka, Shizuoka Pref. | 5 Jan 2009 | TSH-R7301 |

*M. yezoensis*, have been experimentally revealed to be able to use *Corydalis incisa* as a spermogonial and aecial host (Kaneko and Hiratsuka 1981; Hiratsuka et al. 1992; Kondo et al. 1997; Nakamura et al. 1998; Pei 2005; Yamaoka et al. 2010; Shinyama and Yamaoka 2012). Meanwhile, the alternate hosts of *M. coleosporioides* have been stated to be unknown (Hiratsuka and Kaneko 1982; Hiratsuka et al. 1992; Katumoto 2010).

Field observations suggest that *M. coleosporioides* may be able to overwinter in woody parts of *S. babylonica* as mycelium or may alternate to a widespread and common spermogonial–aecial host because (1) leaves of *S. babylonica* fall off each winter and we consider it unlikely that the rust fungus overwinters on fallen leaves in the uredinial state, and (2) the uredinial state is often observed even on *S. babylonica* planted along roadsides in urban areas. This could indicate hibernation in woody parts of the willow as well or hint at the presence of alternate host from which infection of the willow could take place in spring.

The purpose of this study was to clarify the life cycle of *M. coleosporioides* and to identify possible spermogonial–aecial hosts using inoculation experiments.

**Table 2 – Results of the inoculation experiments with basidiospores.**

| Teliospore inoculum no. | Plants inoculated | The number of times inoculated | The number of times for appearance of | | Voucher specimen no. |
|---|---|---|---|---|---|
| | | | Spermogonia | Caeoma | |
| 1 | *Corydalis incisa* | 2 | 2 | 2 | TSH-R7201, TSH-R7203 |
| | *Chelidonium majus* var. *asiaticum* | 2 | 0 | 0 | |
| 2 | *C. incisa* | 1 | 1 | 1 | TSH-R7223 |
| | *Ch. majus var. asiaticum* | 1 | 0 | 0 | |
| | *Larix kaempferi* | 1 | 0 | 0 | |
| | *Salix babylonica* f. *seiko* | 1 | 0 | 0 | |
| 3 | *C. incisa* | 1 | 1 | 1 | TSH-R7206 |
| | *Ch. majus* var. *asiaticum* | 1 | 0 | 0 | |
| 4 | *C. incisa* | 2 | 2 | 2 | TSH-R7226 |
| | *Ch. majus* var. *asiaticum* | 2 | 0 | 0 | |
| | *L. kaempferi* | 2 | 0 | 0 | |
| | *S. babylonica* f. *seiko* | 2 | 0 | 0 | |
| 5 | *C. incisa* | 1 | 1 | 1 | TSH-R7208 |
| | *Ch. majus* var. *asiaticum* | 1 | 0 | 0 | |
| 6 | *C. incisa* | 5 | 4 | 4 | TSH-R7220 |
| | *Ch. majus* var. *asiaticum* | 4 | 0 | 0 | |
| | *L. kaempferi* | 4 | 0 | 0 | |
| | *S. babylonica* f. *seiko* | 1 | 0 | 0 | |
| | *S. babylonica* | 3 | 0 | 0 | |
| 7 | *C. incisa* | 1 | 1 | 1 | TSH-R7213 |
| | *Ch. majus* var. *asiaticum* | 1 | 0 | 0 | |
| 8 | *C. incisa* | 3 | 2 | 2 | TSH-R7306, TSH-R7311 |
| | *Ch. majus* var. *asiaticum* | 2 | 0 | 0 | |
| | *L. kaempferi* | 2 | 0 | 0 | |
| | *S. babylonica* | 2 | 0 | 0 | |
| 9 | *C. incisa* | 3 | 3 | 3 | TSH-R7215, TSH-R7217, TSH-R7218 |
| | *Ch. majus* var. *asiaticum* | 3 | 0 | 0 | |
| 10 | *C. incisa* | 3 | 1 | 1 | TSH-R7307 |
| | *Ch. majus* var. *asiaticum* | 2 | 0 | 0 | |
| | *L. kaempferi* | 2 | 0 | 0 | |
| | *S. babylonica* | 2 | 0 | 0 | |