Inoculation Experiments with Heteroecious Species of the Japanese Rust Fungi II¹⁾

By

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9. *Coleosporium Campanulae* (PERS.) DE BARY

To determine the aecidial connection and host relation of a form of this species on *Adenophora verticillata* FISCH. var. *typica* RGL., the following experiments were made.

Experiment 1—The writer collected the teleutospores of the present fungus on leaves of *Adenophora verticillata* var. *typica* at Tachikawa, Tottori on June 18, 1929, and the next day he inoculated on young needles of *Pinus densiflora* SIEB. et ZUCC. and *P. Thunbergii* PARL. with the sporidia from those teleutospores. In November of the same year, spermogonia began to appear on both species of *Pinus*, and aecidia appeared in March of the next year as follows:

TABLE 1. Results of inoculation experiments with sporidia of *Coleosporium Campanulae* on *Adenophora verticillata* var. *typica*—1

Plants inoculated	Date of inoculation	Date of first appearance of spermogonia	Date of first appearance of aecidia
<i>Pinus densiflora</i>	June 19, 1929	Nov. 27, 1929	March 9, 1930
<i>P. Thunbergii</i>	June 19, 1929	Nov. 20, 1929	March 16, 1930

Experiment 2—In this series, the aecidiospores forming on *Pinus Thunbergii* from Experiment 1, were transferred onto leaves of *Campanula punctata* LAM. var. *typica* MAK., *Adenophora verticillata* var. *typica*, *Lobelia sessilifolia* LAMB., *Wahlenbergia gracilis* A. DC. and *Petasites japonicus* MIQ.

Ten days after sowing of the aecidiospores, uredosori appeared only on *Adenophora verticillata* var. *typica*, while on the other plants no sign occurred.

Experiment 3—The sporidia from the teleutospores on leaves of *Adenophora verticillata* var. *typica* which had been collected at Tottori on

1) The present work is a continuation of the previous one which was published under the title, "Inoculation Experiments with Heteroecious Species of the Japanese Rust Fungi I", in this Magazine, 47 (1933), 710-714.

May 31, 1932, were inoculated on young needles of *Pinus densiflora*, *P. koraiensis* SIEB. et ZUCC., *P. pentaphylla* MAYR and *P. Thunbergii* on the next day. The results are shown in the following table.

TABLE 2. Results of inoculation experiments with sporidia of *Coleosporium Campanulae* on *Adenophora verticillata* var. *typica*—2

Plants inoculated	Date of inoculation	Date of first appearance of spermogonia	Date of first appearance of aecidia
<i>Pinus densiflora</i>	June 1, 1932	Sept. 29, 1932	March 25, 1932
<i>P. koraiensis</i>	June 1, 1932		
<i>P. pentaphylla</i>	June 1, 1932		
<i>P. Thunbergii</i>	June 1, 1932	Nov. 17, 1932	April 7, 1932

As shown in the table, aecidia occurred on *Pinus densiflora* and *P. Thunbergii*, while on the remaining species, *Pinus pentaphylla* and *P. koraiensis* the inoculations were unsuccessful.

Experiment 4—In this experiment, the accidiospores on *Pinus densiflora* from Experiment 3 were used as the inoculum. The inoculations were made on leaves of *Adenophora verticillata* var. *typica*, *A. verticillata* var. *triphylla* MIQ., *A. nikoensis* FRANCH. et SAV. f. *genuina* TAKEDA, *A. Takedai* MAK., *Campanula punctata* var. *typica*, *C. pilosa* PALL. var. *dasynatha* HERD., *Codonopsis lanceolata* BENTH. et HOOK. f., *Artemisia vulgaris* L. var. *indica* MAXIM., *Solidago Virgaurea* L., *Petasites japonicus* MIQ., *Aster Laulureanus* FRANCH. and *A. leiophyllus* FRANCH. et SAV. The results are shown in the following table.

TABLE 3. Results of inoculation experiments with accidiospores of *Coleosporium Campanulae* on *Pinus densiflora*

Plants inoculated	Date of inoculation	Date of first appearance of uredosori
<i>Adenophora nikoensis</i> f. <i>genuina</i>	April 15, 1933	April 27
<i>A. Takedai</i>	April 15, 1933	April 28
<i>A. verticillata</i> var. <i>triphylla</i>	April 15, 1933	April 28
<i>A. verticillata</i> var. <i>typica</i>	April 15, 1933	April 28
<i>Campanula lasiocarpa</i>	April 15, 1933	
<i>C. pilosa</i> var. <i>dasynatha</i>	April 15, 1933	
<i>Artemisia vulgaris</i> var. <i>indica</i>	April 15, 1933	
<i>Aster Laulureanus</i>	April 15, 1933	
<i>A. leiophyllus</i>	April 15, 1933	
<i>Petasites japonicus</i>	April 15, 1933	
<i>Solidago Virgaurea</i>	April 15, 1933	
<i>Adenophora verticillata</i> var. <i>typica</i>	April 28, 1933	May 10
<i>Campanula punctata</i> var. <i>typica</i>	April 28, 1933	
<i>Adenophora verticillata</i> var. <i>typica</i>	May 1, 1933	May 12
<i>Codonopsis lanceolata</i>	May 1, 1933	

It is clearly shown from the above data that of the thirteen species of host tried, uredosori appeared only on species of *Adenophora*, viz. *Adenophora verticillata* var. *typica*, *A. verticillata* var. *triphylla*, *A. nikoensis* f. *genuina* and *A. Takedai*, and no sign occurred on the other plants.

Experiment 5—In this series, the uredospores on *Adenophora verticillata* var. *typica* from Experiment 4, were used as the inoculum. They were transferred onto leaves of *Adenophora verticillata* var. *typica*, *Campanula lasiocarpa*, *C. pilosa* var. *dasyantha* and *Codonopsis lanceolata* on May 12, 1933.

Nine days after sowing of the spores, uredosori began to appear on *Adenophora verticillata* var. *typica* and then occurred abundantly day after day, while on the remaining plants the inoculations were unsuccessful, as in the case of the experiments with the aecidiospores in Experiment 4.

Remarks—From the preceding experiments, the following conclusions may be drawn: 1) A form of *Coleosporium Campanulae* from *Adenophora verticillata* var. *typica* has its aecidial stage on *Pinus densiflora* and *P. Thunbergii*, while it does not occur on *Pinus koraiensis* and *P. pentaphylla*. 2) Favorable hosts for the uredo- and teleutostages of the present fungus are *Adenophora verticillata* var. *typica*, *A. verticillata* var. *triphylla*, *A. nikoensis* f. *genuina* and *A. Takedai*. It has not been possible to transfer this fungus onto *Artemisia vulgaris* var. *indica*, *Aster leiophyllus*, *A. Laulureanus*, *Solidago Virgaurea*, *Petasites japonicus*, *Campanula lasiocarpa*, *C. pilosa* var. *dasyantha*, *C. punctata* var. *typica*, *Codonopsis lanceolata*, *Lobelia sessilifolia* and *Wahlenbergia gracilis*.

The aecidial stage on *Pinus Thunbergii* resulting from the experiments may be described as follows: Spermogonia amphigenous, subepidermal, low-conical, 0.5–1.2 mm across, 50–80 μ high, yellowish brown in colour. Aecidia amphigenous, flattened laterally, 1–3 mm long, rarely elongated, up to 7 mm long, 0.8–1.5 mm high; peridia delicate, hyaline; peridial cells ovoid to ellipsoidal in face view, 40–60 $\times$ 20–36 μ , often attenuate at one or both ends, slightly overlapping and early separating, inner walls 9–18 μ thick, closely verrucose, colourless, outer walls thin, smooth; aecidiospores ellipsoidal, ovate or oblong, 22.5–36 $\times$ 16.5–24 μ ; epispore 2.5–4.2 μ , colourless, verruculose; contents orange-yellow in colour.

10. *Coleosporium Asterum* (DIET.) SYDOW

To determine the aecidial connection of a form of *Coleosporium Asterum* (DIET.) SYD. on *Aster leiophyllus* FRANCH. et SAV. (*A. trinervis* ROXB. var. *adustus* MAXIM.), the following experiments were made.

Experiment 1—The teleutospores on leaves of *Aster leiophyllus* which were collected at Tottori on September 29, 1932 were used as an inoculum.

On the next day, inoculations were made with sporidia from the teleutospores on new needles of *Pinus densiflora*. On March 10 of the next year, spermogonia began to appear on the inoculated needles and four weeks later, there was a sign of peridermia which developed day after day.

Experiment 2—This experiment was carried out in order to determine the return infection with the aecidiospores on *Aster leiophyllus*, *A. Laulureanus* FRANCH., *A. scaber* THUNB., *Petasites japonicus* MIQ. and *Solidago Virgaurea* L.; as an inoculum the aecidiospores from Experiment 1 were used. The results of the experiment are given in the following table.

TABLE 4. Results of inoculation experiments with aecidiospores of a form of *Coleosporium Asterum* on *Aster leiophyllus*

Plants inoculated	Date of inoculation	Date of first appearance of uredosori
<i>Aster leiophyllus</i>	May 4, 1933	May 18
<i>A. Laulureanus</i>	May 4, 1933	
<i>A. scaber</i>	May 4, 1933	
<i>Petasites japonicus</i>	May 4, 1933	
<i>Solidago Virgaurea</i>	May 4, 1933	
<i>Aster leiophyllus</i>	May 8, 1933	May 20
<i>A. scaber</i>	May 8, 1933	
<i>A. leiophyllus</i>	May 10, 1933	May 24
<i>A. scaber</i>	May 10, 1933	

As shown in the table, positive results were readily secured on the leaves of *Aster leiophyllus* only, while on the other plants inoculations were unsuccessful.

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