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Short Communication

Rust Disease of Raspberry Caused by *Pucciniastrum americanum* Intercepted in Plant Quarantine

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Abstract: Red raspberry (*Rubus idaeus* L.) fruit showing yellow spore masses were found at the plant quarantine inspection in Cargo Area of Narita Airport, in late fall of 1997 and in spring of 1998. The causal rust fungus was identified as *Pucciniastrum americanum* (FARLOW) ARTHUR on the basis of its morphological and physiological characteristics. This is the first report on the rust disease of raspberry caused by *P. americanum* intercepted at plant quarantine inspection in Japan.
Key words: rust, *Pucciniastrum americanum*, raspberry

In November and December of 1997 and in May of 1998, red raspberry (*Rubus idaeus* L.) fruit showing powdery yellow spore masses on several drupelets were found at the plant quarantine inspection in Narita, Japan (Plate I, A). They were imported from California State, USA. Some diseased fruit were collected and used for this study. This paper describes the results of etiological studies including the symptoms and identification of a causal organism.

Symptoms

The infected individual drupelets of fruit were contracted, sunk somewhat, and firmer than other healthy ones. These drupelets were converted by orangish yellow uredinial pustules. Uredinia produced yellow masses of urediniospores, and/or yellow spore chains like a thread from their ostioles (Plate I, B). Telia were not observed on diseased fruit.

Inoculation tests

Urediniospores from diseased fruit were suspended in distilled water and used as an inoculum. Inocula prepared in December of 1997 and May of 1998 were representatively used for the inoculation tests. For inoculation, the urediniospore suspension was brushed over both surfaces of the mature leaves, petioles and canes of the American red raspberry (*Rubus idaeus* subsp. *strigosus* MICHX.)(cv. Indian summer and cv. Meeker). Inoculated plants were placed in a moist chamber or in a plastic container in the dark at about 20℃ for 1 day and moved to a glasshouse (11- 25℃) or kept indoor (18-25℃). Noninoculated red raspberry cv. Meeker served as control. Results were shown in Table 1.

About eight days after inoculation, the symptoms were observed. A lot of small spots

Table 1. Pathogenicity of the rust fungus (urediniospores) on red raspberry to two cultivars of american red raspberry

Cultivar	Part inoculated	Pathogenicity
Indian summer	Leaves	10/18 [a]
	Petioles	0/6
	Canes	0/2
Meeker	Leaves	29/42 [b]
	Petioles	0/14
	Canes	0/3
Control [c]	Leaves	0/24
	Petioles	0/8
	Canes	0/2

a): No. of parts produced uredinia and telia / no. of parts inoculated in December, 1997
b): No. of parts produced uredinia / no. of parts inoculated in June, 1998
c): Cv. Meeker was used as control

appeared on inoculated mature leaves, and they came yellow to brown. As the disease progresses, lesions coalesced (Plate I, C, D), heavily infected leaves died by ca. 1.5 month after the inoculation. No defoliation was observed. Ten to twelve days after inoculation, minute, light yellow uredinia filled with powdery yellow spores appeared on the lower leaf surfaces of inoculated leaves, eventually produced yellow spore chains and/or spore masses of urediniospores (Plate I, D). Telia were also formed ca. twenty days later between several uredinia or neighboring uredinia just beneath the epidermis on the both leaf surfaces (mostly lower leaves), but they were indistinct apparently. No symptom was observed on petioles and canes of inoculated plants as well as noninoculated plants in this experiment.

Morphology of the fungus

Uredinia are hypophyllous, subepidermal, fructicolous, minute, orangish yellow on the fruit and light yellow on the leaves. They are peridiate, and their peridia are conical, hemispherical or nearly globular (Plate I, E, H), 75 - 310 × 60 - 280 μm in size. They rupture at the apex, while some of nearly globular ones are rather deeply embedded in the drupelets of the fruit. Peridial cells are polygonal, smooth, 5 - 20 × 5 - 15 μm in size. The peridium has about six ostiolar cells, which are constricted in the middle, and laterally free (Plate I, F, H). Ostiolar cells are 18.6 - 33 × 12.5 - 20(- 25) μm in size, smooth, thickened below, aculeate above, with large spines (3 - 5 × 1.25 - 3 μm) increasing the size gradually away from the constricted middle to the apex side. Urediniospores are obovate to elliptic (Plate I, E, H) with bright yellow contents, echinulate (Plate I, G) and 15 - 25 × 10 - 15 μm in size. Walls of urediniospores are hyaline, about 1.2 μm thick. Its germ pores are obscure. Telia are amphigenous (mostly hypophyllous), scattered, subepidermal (Plate I, I), not erumpent, indistinct apparently. Teliospores are sessile, globose to elliptic (Plate I, J), 15 - 22.5 × 15 -

30 μm in size, with 2 - 4 or more celled by vertical septa, embedded just beneath epidermis, as one spore or crusts of laterally adherent spores (Plate I, I). Their walls are light brown to brown, about 1.0 μm thick and smooth (Plate I, J).

Identification

Morphology of uredinia and urediniospores on fruit and inoculated leaves were similar to that described in *Pucciniastrum americanum* (FARLOW) ARTHUR (LAUDON and RAINBOW, 1969). Morphology of telia and teliospores on inoculated leaves were also similar to that described in *Pucciniastrum americanum* (FARLOW) ARTHUR (LAUDON and RAINBOW, 1969). The fungus showed pathogenicity against American red raspberry.

The rust fungus was identified as *Pucciniastrum americanum* (FARLOW) ARTHUR on the basis of its morphological characteristics and the results of inoculation tests.

Pucciniastrum americanum and *Pucciniastrum arcticum* TRANZSCHEL are known as causal organism of rust diseases of *Rubus* spp. in North America (ARTHUR, 1934, FARR *et al.*, 1989 and NICKERSON *et al.*, 1991). Morphological differences of them are shown in Table 2.

Table 2. Morphological differences between the author's rust fungus, *Pucciniastrum americanum* and *Pucciniastrum arcticum*.

Material in origin	Author's rust fungus	*P. americanum* [a)]	*P. arcticum* [b), c)]
Ostiolar cells Shapes	constricted in the middle, laterally free	constricted in the middle, laterally free	not constricted in the middle, laterally adherent [b)]
Height (μm)	18.6-33	23-31	35-50 [c)]

a): LAUDON and RAINBOW, 1969, b): ARTHUR, 1934, c): ITO, 1938

It is reported that *Pucciniastrum arcticum* and *Pucciniastrum americanum* is physiologically distinct because urediniospores of the former did not infect the respective *Rubus* hosts (such as *Rubus idaeus* subsp. *strigosus*) of the latter (DAVIS, 1922). *P. americanum* is known as a causal fungus of "late leaf rust of raspberry" or "American spruce-raspberry rust" in USA and Canada (NICKERSON *et al.*, 1991), but is not known in Japan. It has also been known as a heteroecious rust fungus which produces spermagonia and aecia on white spruce (*Picea glauca* (MOENCH) VOSS), or Engelmann spruce (*Picea engelmanii* PARRY ex ENGELM.) and uredinia and telia on *Rubus* spp. including *R. idaeus* L., *R.* × *neglectus* PECK, *R. leucodermis* DOUGLAS ex TORR. & A. GREY, *R. occidentalis* L., *R. ursinus* CHAM. & SCHLECHLEND (NICKERSON *et al.*, 1991). However, the study on heteroecism for *Picea* spp. of the rust fungus on red raspberry was not conducted in here.

It is reported that recently been serious outbreaks of the rust disease caused by *P. americanum* have occurred, particularly in California state of USA and Atlantic provinces of Canada (NICKERSON *et al.*, 1991), and that in an outbreak in Ohio, about 30% of the fruits from a planting (3.2 - ha field) of cv. Heritage was infected and unfit for sale (ELLIS and ELLETT, 1981).

This is the first description of rust disease of raspberry caused by *P. americanum* in

Japan.

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Explanation of plate

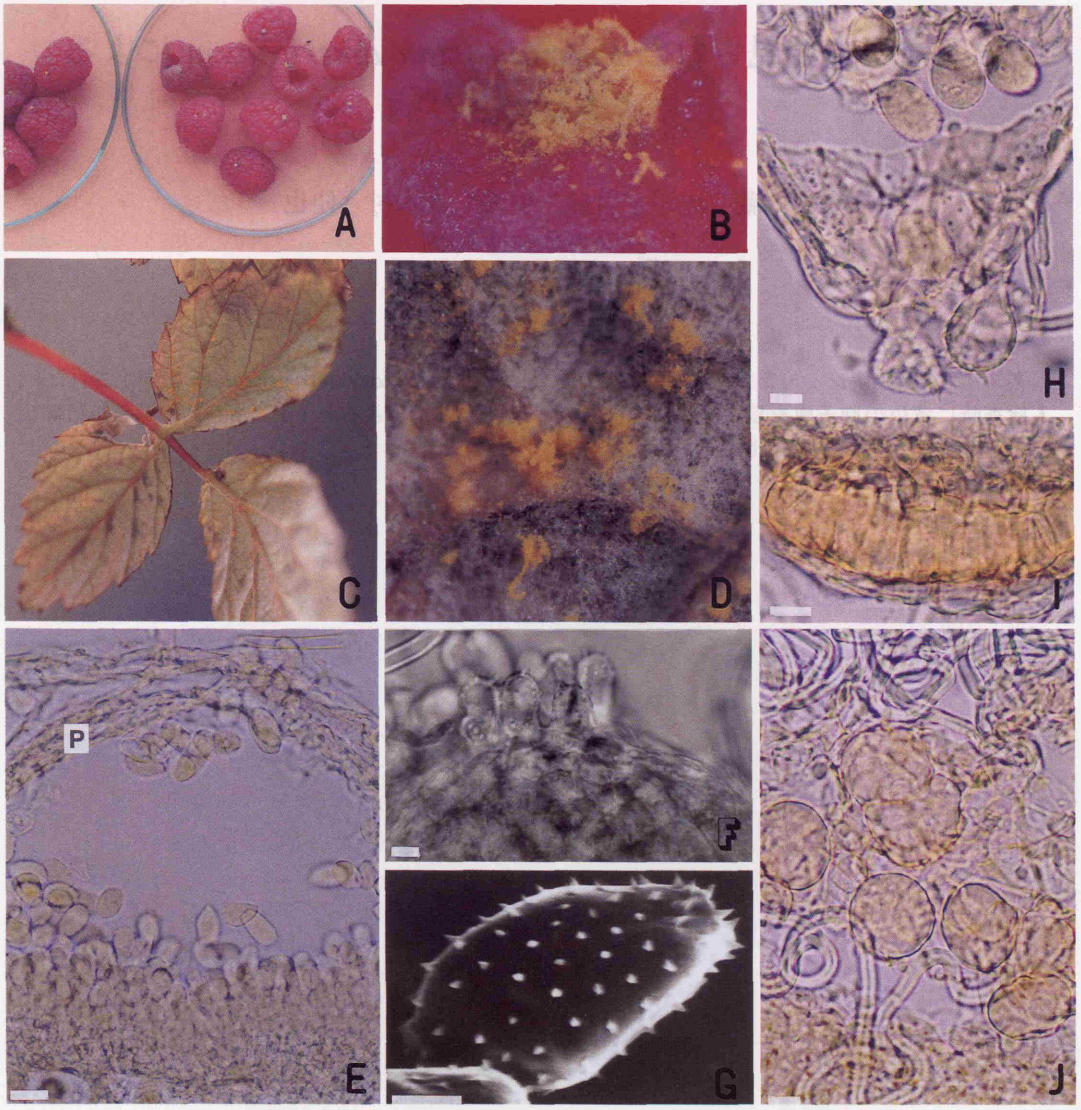

Plate I

A : Red raspberry fruit showing rust on drupelets.

B : Drupelet having spore masses and spore chanes of urediniospores.

C-D:Symptoms and signs produced on cv. Indian summer red raspberry leaves (lower surfaces) inoculated with urediniospores from diseased red raspberry fruits.

E : Hemispherical peridium of uredinia on red raspberry fruit; P is showing peridium (Bar=20μm).

F : Ostiolar cells of uredinium on red raspberry fruit (Bar=10μm).

G : Urediniospores on red raspberry fruit observed under SEM (Bar=3μm).

H : Uredinium and it's ostiolar cells produced on the red raspberry leaf (lower surface) inoculated with urediniospores from diseased red raspberry fruit (Bar=10μm).

I : Telium produced on the red raspberry leaf (lower surface) inoculated with urediniospores from diseased red raspberry fruit (Bar=10μm).

J : Teliospores from telium crushed (Bar=10μm).

和 文 摘 要

輸入検疫で発見された *Pucciniastrum americanum* によるキイチゴのさび病

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アメリカ合衆国産レッドラズベリー生果実の輸入検査時に黄色の胞子塊を呈する果実を発見した。当病原菌は，形態観察及び接種試験の結果等から，*Pucciniastrum americanum* と同定された。本報は本菌によるキイチゴさび病の本邦初記載である。