

Short Communication

A new rust species of *Roestelia* on *Sorbus* collected in China*Seung Kyu Lee¹⁾, Makoto Kakishima^{1)**} and Jian-yun Zhuang²⁾¹⁾ Institute of Agriculture and Forestry, University of Tsukuba, Tsukuba, Ibaraki 305–8572, Japan²⁾ Institute of Microbiology, Academia Sinica, Beijing 100080, China

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A rust species of *Roestelia* on *Sorbus* collected in China is newly described as *R. echinulata*. This species is morphologically different from the other *Roestelia* spp. and aecial stages of *Gymnosporangium* species in surface structures of aeciospores and peridial cells.

Key Words—*Gymnosporangium*; *Roestelia echinulata*; rust fungus; *Sorbus*; Uredinales.

Roestelia is an anamorphic genus of the Uredinales and is characterized by roestelioid aecia (Cummins and Hiratsuka, 1983). Most species of *Gymnosporangium* have this anamorph as spermogonial and aecial stages (Kern, 1973; Littlefield and Heath, 1979). Fourteen species of *Roestelia* have been reported (Kern, 1973). In taxonomy of *Roestelia* and the aecial stage of *Gymnosporangium*, morphological characteristics such as sorus structures, surface structures and size of peridial cells, and shape, size, and color of aeciospores have been used as important taxonomic criteria (Parmelee, 1965, 1971; Kern, 1973; Ziller, 1974; Peterson, 1982; Wang and Guo, 1985; Hiratsuka et al., 1992).

Lee and Kakishima (1999a, b) observed surface structures of aeciospores and peridial cells by scanning electron microscopy (SEM) and classified them into 12 and 10 types, respectively. They also reported that these types were stable within a species and could be used as important taxonomic and diagnostic criteria of identifying *Gymnosporangium* and *Roestelia*.

We observed by SEM the surface structures of aeciospores and peridial cells of Chinese specimens of *Sorbus* spp. which were labeled as *G. tremelloides* or *G. nipponicum* and deposited in the Mycological Herbarium, Institute of Microbiology, Academia Sinica, Beijing, China (HMAS) (Zhuang, 1986; Zhuang and Wei, 1994). According to the classification of types of aeciospores and peridial cell surfaces described by Lee and Kakishima (1999a, b), aeciospore surface structures of these specimens were of type LA (large annulate) (Fig. 1 E, F), and surface structures of their peridial cells were of type S (smooth), type R (rugose), and type SE (sparsely echinulate) in outer, side and inner walls, respectively (Fig. 1

G, H). These surface structure types were different from those of *G. tremelloides* or *G. nipponicum*. Aeciospore surface structure of *G. tremelloides* was of type E (echinulate), and surface structures of its inner walls of peridial cells were of type S (smooth) or type R (rugose) (Lee and Kakishima, 1999a, b). We could not observe the specimen of aecial stage of *G. nipponicum*. However, Hiratsuka (1936) reported that its aeciospores were verrucose and that inner and side walls of peridial cells were verruculose with papillae.

The Chinese specimens were morphologically distinct from those of *G. tremelloides* or *G. nipponicum* in aeciospore size and wall thickness (Table 1). Aeciospore size (26–35 × 22–32 μm) of the Chinese specimens was larger than those of *G. nipponicum* (23–27 × 20–24 μm in Hiratsuka, 1936; 23–31 × 20–26, Kern, 1973), and smaller than those of *G. tremelloides* (32–46 × 30–37 μm in Parmelee, 1971; 30–45 × 28–35 μm in Kern, 1973). Aeciospore wall thickness (1.0–2.4 μm) of the Chinese specimens was thinner than those of *G. tremelloides* (1.6–4.2 μm in Parmelee, 1971; 3–5 μm in Kern, 1973) and *G. nipponicum* (2–3 μm) (Hiratsuka, 1936; Kern, 1973). Length of peridial cells of the Chinese specimens (38–120 μm) was also longer than those of *G. nipponicum* (40–75 μm, Hiratsuka, 1936; 40–86 μm, Kern, 1973). Therefore, we concluded that the Chinese specimens labeled as *G. tremelloides* or *G. nipponicum* were different from these two species.

Wang and Guo (1985) reported that 15 species of *Gymnosporangium* and 4 species of *Roestelia* were distributed in China. Four of these species including *G. tremelloides* and *G. nipponicum*, are known to have aecial stages on *Sorbus* spp. (Kern, 1973; Wang and Guo, 1985; Hiratsuka et al., 1992). Two other species, *G. clavariiforme* and *G. cornutum*, are also morphologically different from the Chinese specimens in surface structures of aeciospores and peridial cells, and size and wall thickness of aeciospores (Table 1) (Kern, 1973; Lee and

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Kakishima, 1999a, b). Furthermore, morphological characteristics of the Chinese specimens are different from those of 12 *Gymnosporangium* species which have aecial stages on *Sorbus* spp. (Table 1) (Hiratsuka, 1936; Parmelee, 1965, 1971; Kern, 1973; Ziller, 1974; Wang and Guo, 1985; Lee and Kakishima, 1999a, b).

Roestelia distorta (Arth. et Cumm.) Kern, which has been reported from the northwest Himalayas (Kern, 1973), is the only species which has aeciospores of type LA (large annulate) among *Gymnosporangium* and *Roestelia* species (Lee and Kakishima, 1999a). However, aeciospore size ($26\text{--}35 \times 22\text{--}32 \mu\text{m}$) of the Chinese specimens is larger than that of *R. distorta* ($24\text{--}29 \times 20\text{--}24 \mu\text{m}$) (Kern, 1973). Moreover, these two fungi were distinguished from each other in surface structure of inner walls of peridial cells. The Chinese specimens have type E (echinulate), whereas *R. distorta* have type R (rugose) (Lee and Kakishima, 1999b).

We, therefore, concluded that the Chinese specimens represent a new species and named it as follows:

***Roestelia echinulata* S. K. Lee et Kakishima, sp. nov.**

Fig. 1

Spermogoniis epiphyllis et globosis, aggregatis, subepidermicis, ad typum 4 (teste Hiratsuka et Cummins, 1963) pertinentibus; aeciis hypophyllis, raro epiphyllis, roestelioidibus; peridiis cinerascentibus, cylindricis vel conicis, circa 4.0 mm longis, apice rumpentibus; aeciosporis globosis vel late ellipsoideis, $25\text{--}36 \times 22\text{--}32 \mu\text{m}$, episporio $1.0\text{--}2.4 \mu\text{m}$ crasso, luteo-brunneo, annulariter aciculari; cellulis peridii longe rhomboideis, hyalinis, 38--

$120 \mu\text{m}$ longae, pariete exteriori laevi, pariete laterali rugoso, pariete interiore sparse echinulato.

Spermogonia epiphyllous and globoid, subepidermal and in groups on discolored spots, type 4 of Hiratsuka and Cummins (1963). Aecia hypophyllous, rarely epiphyllous, roestelioid. Peridia grayish, cylindrical to cornute, ca. 4.0 mm long, rupturing from the apex but retaining cylindrical form. Aeciospores globoid to broadly ellipsoid, $25\text{--}36 \times 22\text{--}32 \mu\text{m}$, wall $1.0\text{--}2.4 \mu\text{m}$, yellowish brown, aciculate with annulations (type LA of Lee and Kakishima, 1999a). Peridial cells linear rhomboid, hyaline, $38\text{--}120 \mu\text{m}$, outer walls smooth (type S), side walls rugose (type R), inner walls sparsely echinulate (type SE) (Lee and Kakishima, 1999b).

Holotype: 0, I on *Sorbus globosa* Yu et Tsai. Medog, Xizang, China (Aug. 17, 1982, J. Y. Zhuang, HMAS-45208)

Other specimens examined: 0, I on *S. cuspidata* (Spach.) Hedl. Jilong, Xizang, China (Sept. 1990, J. Y. Zhuang, HMAS-67336; Sept. 4, 1990, J. Y. Zhuang, HMAS-67338); on *Sorbus* sp. Medog, Xizang, China (Aug. 22, 1982, J. Y. Zhuang, HMAS-45209); on *Sorbus* sp. Dali, Yunnan, China (Aug. 26, 1938, H. S. Yao, HMAS-00362).

Distribution: China (Xizang, Yunnan).

Note: In China, there are two *Gymnosporangium* species whose aecial stage is not reported (Kern, 1973, Wang and Guo, 1985). Of these species, *G. taianum* Kern is known only from Yunnan, and *G. tsingchensis* Wei from Szechuan and Chekiang (Kern, 1973, Wang and Guo, 1985). Considering the locality of *R. echinu-*

Table 1. Morphological features of aeciospores and peridial cells of *Roestelia echinulata* and *Gymnosporangium* species on *Sorbus* spp.

Species	Aeciospores			Peridial cells			
	Surface structure type	Wall ²⁾ thickness	Size ²⁾ (μm)	Surface structure type ³⁾			Length ²⁾ (μm)
				OW	SW	IW	
<i>R. echinulata</i> S. K. Lee et Kakishima	LA	1–2.4	$26\text{--}35 \times 22\text{--}32$	S	R	SE	40–120
<i>G. clavariiforme</i> (Pers.) DC.	E	2–3.5	$22\text{--}30 \times 18\text{--}27$	S	SE	SE	80–130
<i>G. clavipes</i> (Cooke et Peck) Cooke et Peck	E, SA	2–5	$24\text{--}50 \times 19\text{--}40$	S	T	T	45–90
<i>G. confusum</i> Plowr.	LC	2.5–3.5	$19\text{--}27 \times 19\text{--}22$	S	R	T	60–90
<i>G. cornutum</i> Arth. ex Kern	MC	2–2.5	$21\text{--}29 \times 16\text{--}25$	S	MR	SP	60–110
<i>G. globosum</i> (Farl.) Farl.	SC	1.5–2	$18\text{--}25 \times 15\text{--}19$	S	R	SP	60–90
<i>G. libocedri</i> (P. Henn.) Kern	RV	1–1.5	$14\text{--}23 \times 12\text{--}20$	S	DV	DV	18–23
<i>G. miyabei</i> Yamada et Miyake	LV	1–1.5	18–24	S	DV	DV	60–90
<i>G. nipponicum</i> Yamada	—	2–3	$23\text{--}31 \times 20\text{--}26$	—	—	—	40–86
<i>G. nootkatense</i> Arth.	N	3–4	$27\text{--}42 \times 23\text{--}30$	S	DV	CP	30–45
<i>G. torminali-juniperinum</i> Ed. Fisch.	MC	1.5–2.5	$24\text{--}27 \times 18\text{--}24$	S	—	SP	65–100
<i>G. tremelloides</i> Hartig	E	3–5	$30\text{--}45 \times 28\text{--}35$	S	R	S, R	60–90
<i>G. turkestanicum</i> Tranz.	SC	3–4	$29\text{--}39 \times 24\text{--}32$	S	DV	SP	64–87

1) LA: type LA (large annulate); E: type E (echinulate); SA: type SA (small annulate); MC: type MC (minutely coronate); RV: type RV (verrucose with refractive body); N: type N (nail-headed); SC: type SC (small coronate) (Lee and Kakishima, 1999a).

2) Kern (1973).

3) OW: outer wall; SW: side wall; IW: inner wall; S: type S (smooth); R: type R (rugose); SE: type SE (sparsely echinulate); T: type T (tuberculate); SP: type SP (small papillae); DV: type DV (densely verrucose); CP: type CP (coralloid projection), —: not determined (Lee and Kakishima, 1999b).

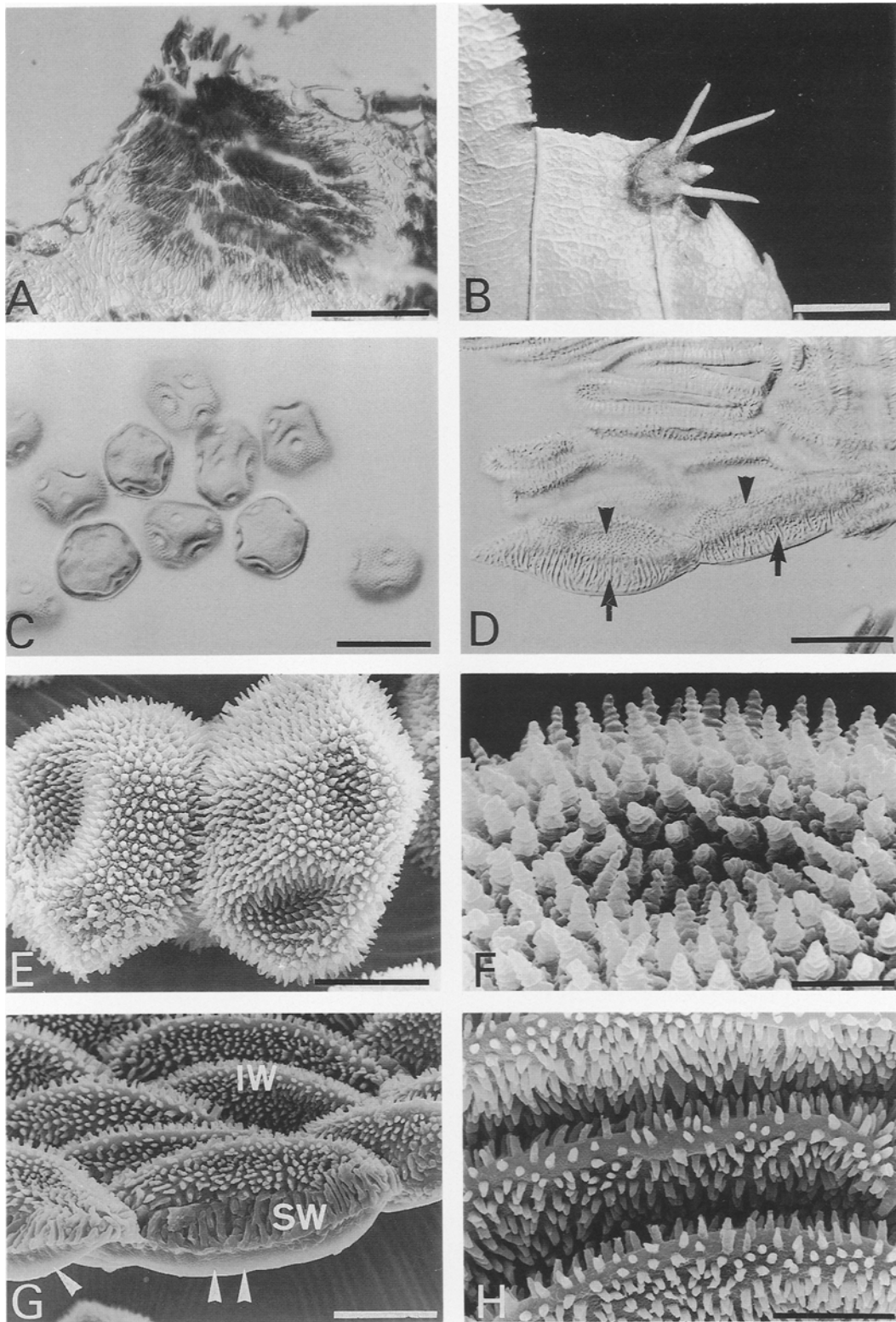


Fig. 1. *Roestelia echinulata*. Light (A–D) and scanning electron micrographs (E–H). A. Vertical section spermogonium on *Sorbus globosa*. B. Aecia on *S. globosa*. C. Aeciospores. D. Peridial cells; arrowheads indicate process on the inner wall, and arrows indicate the rugose side wall. E. Surface structure of aeciospores. F. Large annulate processes on the aeciospore surface. G. Surface structures of peridial cells; inner wall (IW): type SE (sparsely echinulate); side wall (SW): type R (rugose); outer wall (arrowheads): type S (smooth). H. Echinulate process on the inner wall. Scale bars: A: 40 μm ; B: 2 mm; C: 30 μm ; D: 40 μm ; E, H = 10 μm ; F = 2 μm ; G = 20 μm .

lata, we suspect the possible genetic connection between *R. echinulata* and one of these species.

All specimens examined have been deposited in the Mycological Herbarium, the Institute of Microbiology, Academia Sinica, China (HMAS).

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