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NEW DISEASE REPORT

Melampsora ferrinii causing rust disease on *Corydalis incisa* in Korea

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Corydalis incisa (Papaveraceae), commonly known as incised fumewort, is an annual or biennial herb native to East Asia. In Korea, the plant is widely used for medicinal purposes but it has also been designated as a climate-sensitive biological indicator due to its high adaptability to global warming and resulting rapid spread (Park, 2016). Following a weed risk assessment, the United States designated *C. incisa* as an emerging invader with potential risks (Koop, 2017).

In April 2020, typical rust disease symptoms were found on *C. incisa* in a field in Jeongeup (35°35'15" N 127°00'30" E), Korea, with a disease incidence of 70%. Light green chlorotic spots on the upper surface



FIGURE 1 Rust disease caused by *Melampsora ferrinii* on *Corydalis incisa*. Aecia on the lower surface of infected leaves (a) and stem (b).

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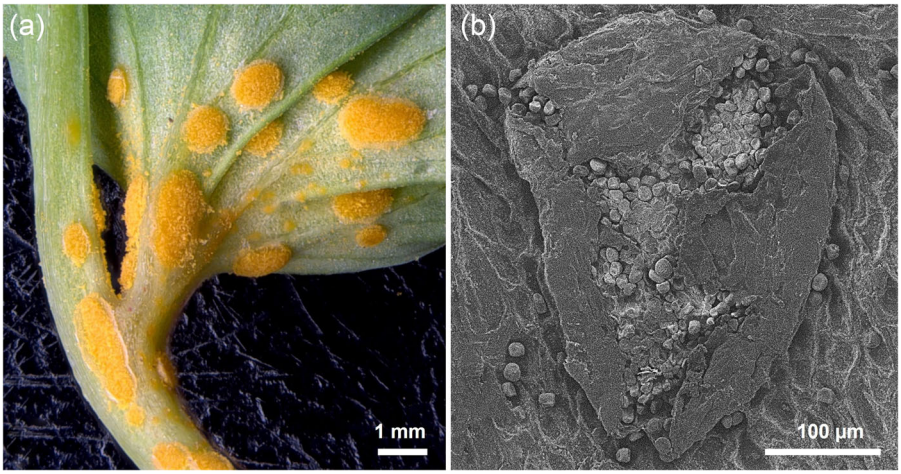


FIGURE 2 Aecia of *Melampsora ferrinii* on *Corydalis incisa* observed under a stereo microscope (a) and a scanning electron microscope (b).

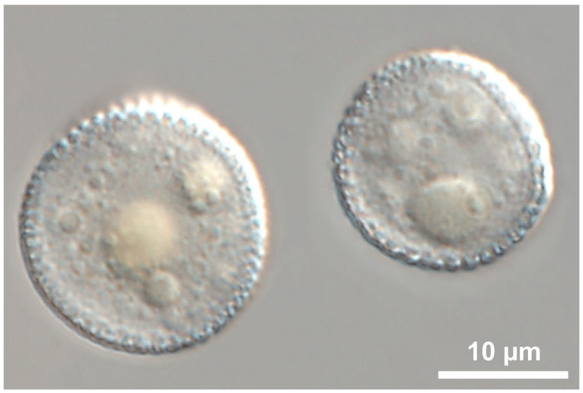


FIGURE 3 Aeciospores of *Melampsora ferrinii* observed under a DIC microscope.

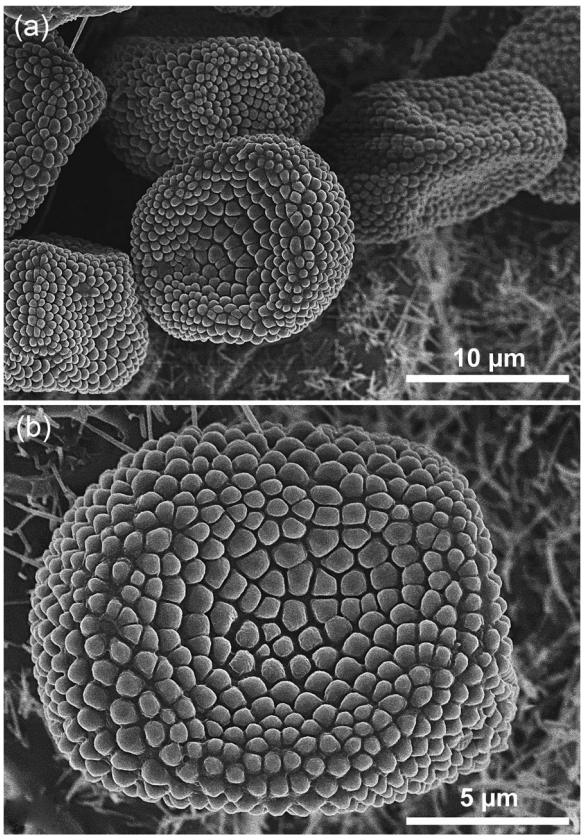


FIGURE 4 Aeciospores (a) and a closer view of the verrucose wall surface of an aeciospore (b) of *Melampsora ferrinii* observed under a scanning electron microscope.

of leaves were associated with yellow rust pustules on the corresponding lower surface and on stems (Fig. 1). A representative sample was deposited in the Kunsan National University Herbarium (Accession No. KSNUH766).

Infected leaves were examined under a stereo microscope (M205C; Leica, Germany), a DIC microscope (Axio Imager 2; Carl Zeiss, Germany), and a scanning electron microscope (S-4800+EDS; Hitachi, Japan). Aecia were subepidermal without peridia, yellow to orange, oval to ellipsoidal, mostly scattered, and 1–2 mm in diameter (Fig. 2). Aeciospores were yellow, globoid to broadly ellipsoid, and measured (15.1–)16.1–18.9(–20.5) × (11.5–)13.4–16.08(–17.8) µm (mean 17.5 × 14.7 µm) (Fig. 3). Aeciospore wall was hyaline, densely verrucose, and 1.0–2.0 µm in thickness (Fig. 4). The morphological characteristics were similar to those reported for *Melampsora ferrinii* (Peng et al., 2022).

To confirm the morphological identification, genomic DNA was extracted from a diseased leaf (KSNUH766) using a MagListo 5M Plant Genomic DNA Extraction Kit (Bioneer, Korea). The internal transcribed spacer (ITS) and large subunit (LSU) rDNA regions were amplified with primers ITS5-u and ITS4rust and primers LRust1R and LRust3, respectively (Beenken et al., 2012). Two resulting sequences were deposited in GenBank (Accession Nos. MZ836847 for ITS and MZ831512 for LSU). A BLASTn search showed that the Korean sample differs at one nucleotide with *M. ferrinii* from *Corydalis* and *Salix* spp. for ITS sequences (KJ136570, KY053852, KY764068, KY798349, KY798352, MW996576, MW996577, MW996578) but is identical for LSU sequences (MW99009, MW990092, MW990093, KY053853, KJ136562, KJ136563, NG060305). In maximum-likelihood trees of

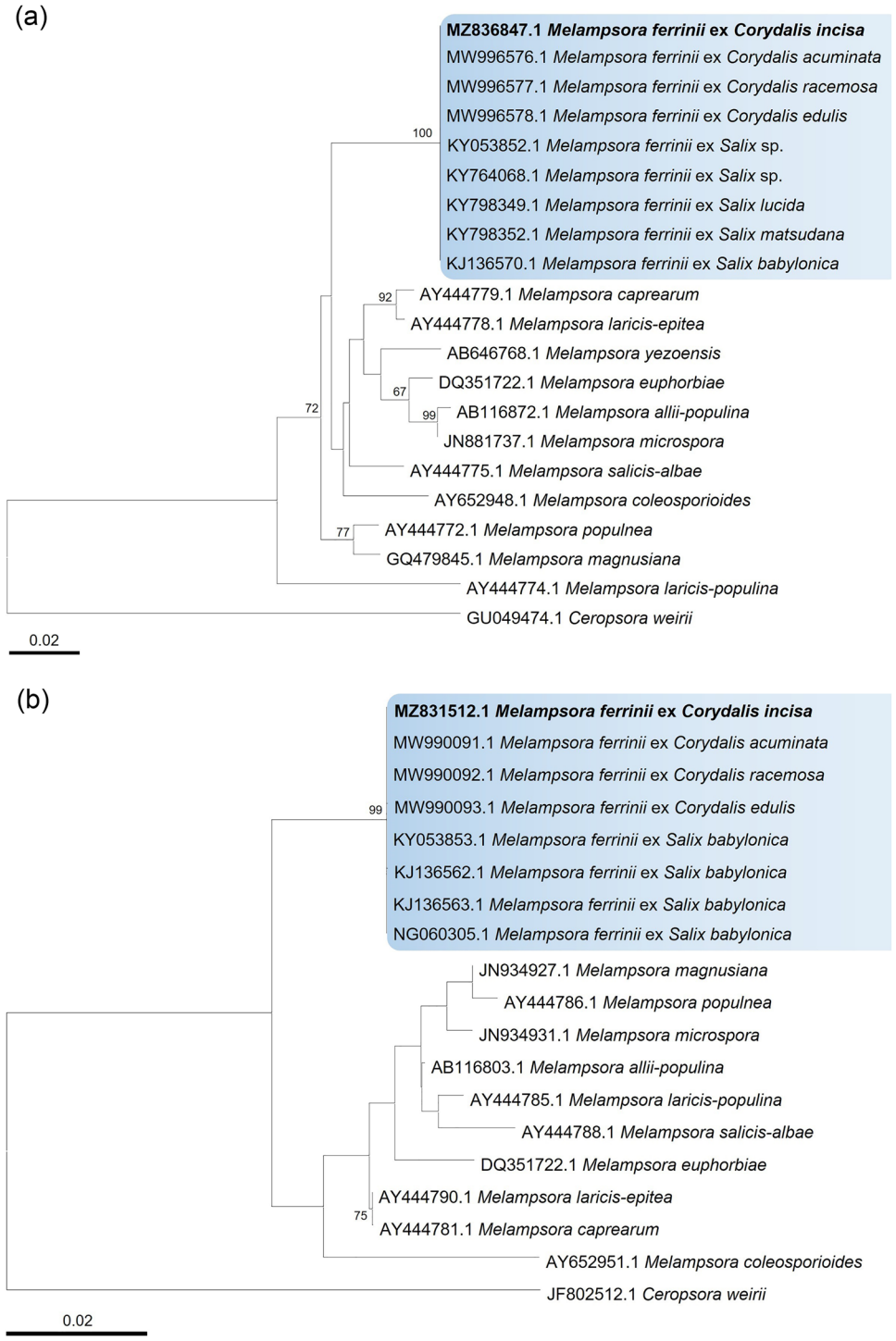


FIGURE 5 Maximum likelihood trees of *Melampsora* species based on ITS (a) and LSU (b) rDNA sequences. Bootstrapping support values >60% are given above branches. The coloured box represents *M. ferrinii*, and the Korean sample is shown in bold.

the ITS and LSU sequences (Fig. 5), the Korean sample formed a clade with reference sequences of *M. ferrinii*, with high bootstrapping values of 100% in ITS and 99% in LSU. Based on morphological characteristics and sequencing data, the Korean pathogen was identified as *M. ferrinii*.

Melampsora ferrinii is a heteroecious rust species, developing its uredinial and telial stages on *Salix* species and its aecial stage on *Corydalis*. It has been recorded from *C. acuminata*, *C. edulis* and *C. racemosa* in China (Peng et al., 2022) and *Salix* spp. in Argentina, Brazil, Chile, and the USA (Farr & Rossman, 2024). To our knowledge, this is the first report of rust disease caused by *M. ferrinii* in Korea. Although *M. ferrinii* has not yet been recorded on *Salix* species in Korea, the nationwide spread of *C. incisa* suggests that this rust pathogen could potentially affect *Salix* species. The spread of *C. incisa* driven by global climate change has been shown to increase the incidence of *Neophysopella*

kraunhiae, another rust fungus infecting *C. incisa* as an alternate host, on *Wisteria floribunda* in Korea (Lee et al., 2024). Therefore, the introduction and spread of *C. incisa* may facilitate the occurrence of *M. ferrinii* on *Salix* spp., potentially resulting in ecological and economic damage.

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