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SHORT COMMUNICATION

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Two new species of *Lirula* on *Abies* from Japan

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Abstract Two new species of *Lirula* (*L. japonica* and *L. exigua*) on *Abies mariesii* collected in subalpine areas of northern Japan are described as members of Rhytismatales, Discomycetes. *Lirula japonica* causes needle cast in fir, but *L. exigua* seems to occur on the needles of physically damaged twigs. Morphological characteristics of both species are discussed.

Key words *Lirula exigua* · *Lirula japonica* · Needle cast · New species · Rhytismatales

The genus *Lirula* Darker (Rhytismatales, Discomycetes) was established by Darker (1967) based on *L. nervisequia* (DC.: Fr.) Darker on *Abies alba* Mill. The genus is characterized by mostly elongate-linear, dark ascocarps (hysterothecia) arranged along the length of needles, subcylindrical to clavate asci whose apical pores are not stained blue by iodine, and filiform clavate ascospores surrounded by a gelatinous sheath.

Darker (1967) recognized six species and one variety in the genus; all are parasitic on *Abies* or *Picea*. Those taxa had been included in *Hypodermella* Tubeuf or *Lophodermium* Chevall. (Darker 1932). Kaneko (1993) added a new species, *L. pakistanense*, found in the Pakistan Himalayas on *Abies pindrow* Royle.

In recent studies of diseases of Japanese *Abies* in subalpine areas, some *Lirula* species have been found on the trees. In comparisons with related species of *Lirula* and allied genera, the specimens collected by the author were found to be undescribed species of *Lirula*. This article describes these as two new species.

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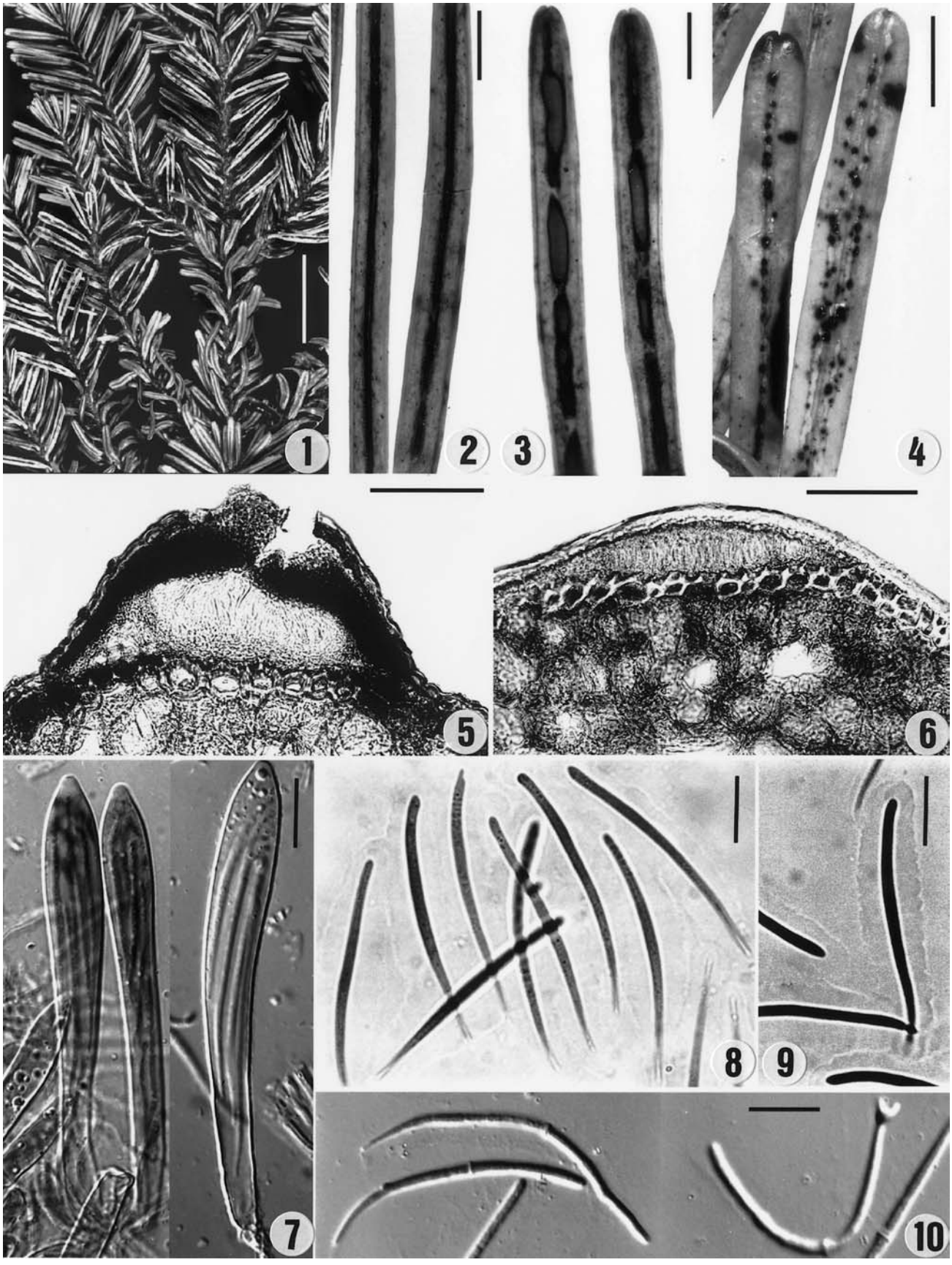
Lirula japonica S. Kaneko, sp. nov. Figs. 1–10
Hysterotheciis hypophyllis, nervisequis, continuis, 2–15 mm longis, 0.5 mm latis, atronitidis, incisura longitudinali anguste aperientibus, intraepidermalibus, 400–550 μm latis, 170–330 μm altis; plectenchymate basilari achromo, 12–20 μm crasso, hyalino; tegmine atro, pseudoparenchymatico, cum epidermide 50–95 μm crasso; hymenio plano vel concavo, 70–130 μm crasso; ascis cylindricis usque clavatis, apice rostriformibus, 135–170 × 16–21 μm; paraphysibus filiformibus, simplicibus, hyalinis, usque 130 μm longis, 2–2.5 μm crassis; ascosporis filiformibus clavatisque, hyalinis, 53–86 × 2.5–3.5 μm, muco 3–6 μm crasso involutis. Spermogoniis fere epiphyllis, in uno vel duobus ordinibus conspersis, atronitidis, intraepidermalibus, 200–380 μm latis, 75–120 μm altis; spermatiis bacillaribus, 3–4 × 1 μm.

Holotype: On *Abies mariesii* Mast. (*ohshirabiso*): Mt. Mokko, Hachimantai, Iwate Pref., Japan, July 11, 1986, collected by S. Kaneko, TFM:FPH 7523 (Herbarium of Forest Mycology and Pathology, Forestry and Forest Products Research Institute, Japan).

Etymology: *japonica* = Japanese, referring to the distribution area of the present species.

Hysterothecia hypophyllous, nervisequious, continuous, on brown, 3-year-old needles, occasionally interrupted, 2–15 mm long, 0.5 mm wide, black, opening by a longitudinal slit, lips inconspicuous, hysterothecia in cross section intraepidermal, 400–550 μm wide, 170–330 μm deep; prosenchymatous basal layer 12–20 μm thick, colorless, covering layer of epidermal wall and dark pseudoparenchyma 50–95 μm thick; hymenium flat or concave, 70–130 μm thick; asci 8-spored, cylindrical to clavate, rostriform at tip, 135–170 × 16–21 μm; paraphyses filiform, simple, hyaline, up to 130 μm long, 2–2.5 μm thick; ascospores filiform clavate, hyaline, 53–86 × 2.5–3.5 μm, surrounded by a gelatinous sheath about 3–6 μm thick. Spermogonia, mostly epiphyllous, in one or two scattered rows, black, intraepidermal, 200–380 μm wide, 75–120 μm deep; spermatia bacillar, 3–4 × 1 μm.

Other specimens examined: On *Abies mariesii*: Mt. Mokko, Hachimantai, Iwate Pref., June 19, 1989, S. Kaneko



Figs. 1–10. *Lirula japonica* (holotype). **1** Diseased needles of *Abies mariesii* with hysterothecia. **2** Hysterothecia formed along the midrib of lower surface of needles. **3** Opened hysterothecia in humid condition. **4** Spermogonia on the upper surface of needles. **5** Cross section of a hysterothecium. **6** Cross section of a spermogonium. **7** Asci. **8** Ascospores, stained with lacto-fuchsine. **9** Ascospores surrounded by a gelatinous sheath. **10** Germinating ascospores forming a septum. *Bars* **1** 2 cm; **2–4** 2 mm; **5**, **6** 100 μm; **7–10** 20 μm

Table 1. Morphological comparisons of some related species of *Lirula* on *Abies*

Species	Asci (μm)	Ascospores (μm)	Paraphyses	Spermogonia	Reference
L. japonica	135–170 × 16–21	53–86 × 2.5–3.5	Simple	In 1 or 2 scattered rows	Present study
L. exigua	85–140 × 10–15	36–68 × 2–3	Recurved at tip	Scattered	Present study
L. abietis-concoloris	150–180 × 16–20	70–104 × 4–5	Simple	Continuous or frequently interrupted	Darker (1932)
	120–170 × 20–23	68–128 × 4–5	Simple	Continuous or frequently interrupted	Present study (3 specimens from NY)
L. nervisequia	150–200 × 24–30	75–90 × 3–4	Simple	Continuous	Darker (1932)
L. punctata	105–150 × 22–24	78–100 × 3–4.5	Simple	In 1 or 2 scattered rows	Darker (1932)
	78–130 × 18–23	43–95 × 3–4.5	Simple	In 1 or 2 scattered rows	Present study (BPI 650970:holotype)
	77–125 × 19–22	48–88 × 3–4	Simple	In 1 or 2 scattered rows	Present study (BPI 650969)

NY, New York Botanical Garden

& T. Kubono, TFM:FPH 7529 & 7532; June 16, 1987, S. Kaneko, TFM:FPH 7530; May 3, 1986, S. Kaneko, TFM:FPH 7531; Mt. Shirane, Nikko, Gunma Pref., Aug. 26, 1991, S. Kaneko, TFM:FPH 7533.

Lirula japonica morphologically resembles *L. abietis-concoloris* (Mayr ex Dearn.) Darker, *L. nervisequia* (DC: Fr.) Darker, and *L. punctata* (Darker) Darker to some extent (Table 1). In Japan, *L. nervisequia* was recorded as the cause of needle cast in *Abies* under the old names, *Lophodermium nervisequia* DC. or *Hypodermella nervisequia* (Fr.) Lagerberg (Kitajima 1933; Sawada 1952; Kamei 1959). However, they did not describe the precise morphology of the fungus. *Lirula nervisequia* can be distinguished from *L. japonica* by the former's continuously formed spermogonia on the upper surface of its needles and its larger asci (Table 1).

For comparisons with *L. abietis-concoloris* and *L. punctata*, the author examined several specimens of the two *Lirula* species on loan from the New York Botanical Garden (NY) and the U.S. National Fungus Collections (BPI), including the type specimen of *L. punctata* (BPI 650970) (Table 1). *Lirula japonica* differs from *L. abietis-concoloris* in the characteristics of the spermogonia and smaller ascospores. Furthermore, the position of the hysterothecia of *L. japonica* is intraepidermal (Fig. 5), whereas that of the latter species is intraepidermal in the center but subepidermal at the edges. The scattered spermogonia of *L. japonica* (Fig. 4) and *L. punctata* are similar to each other. However, *L. japonica* is distinguished from the latter species by slender asci (Fig. 7) and thinner ascospores (Fig. 8). Moreover, it became clear by examining the specimens from North America that the color of the spermogonium surface of *L. punctata* is yellowish-brown in contrast to the black color of *L. japonica*.

The mature hysterothecia of the fungus are produced on 3-year-old needles. Observations of the disease cycle of the fungus in the field indicate that the pathogenicity of the fungus is strong, as in the case of *L. abietis-concoloris* (Scharpf 1986, 1988).

Lirula exigua S. Kaneko, sp. nov. Figs. 11–16

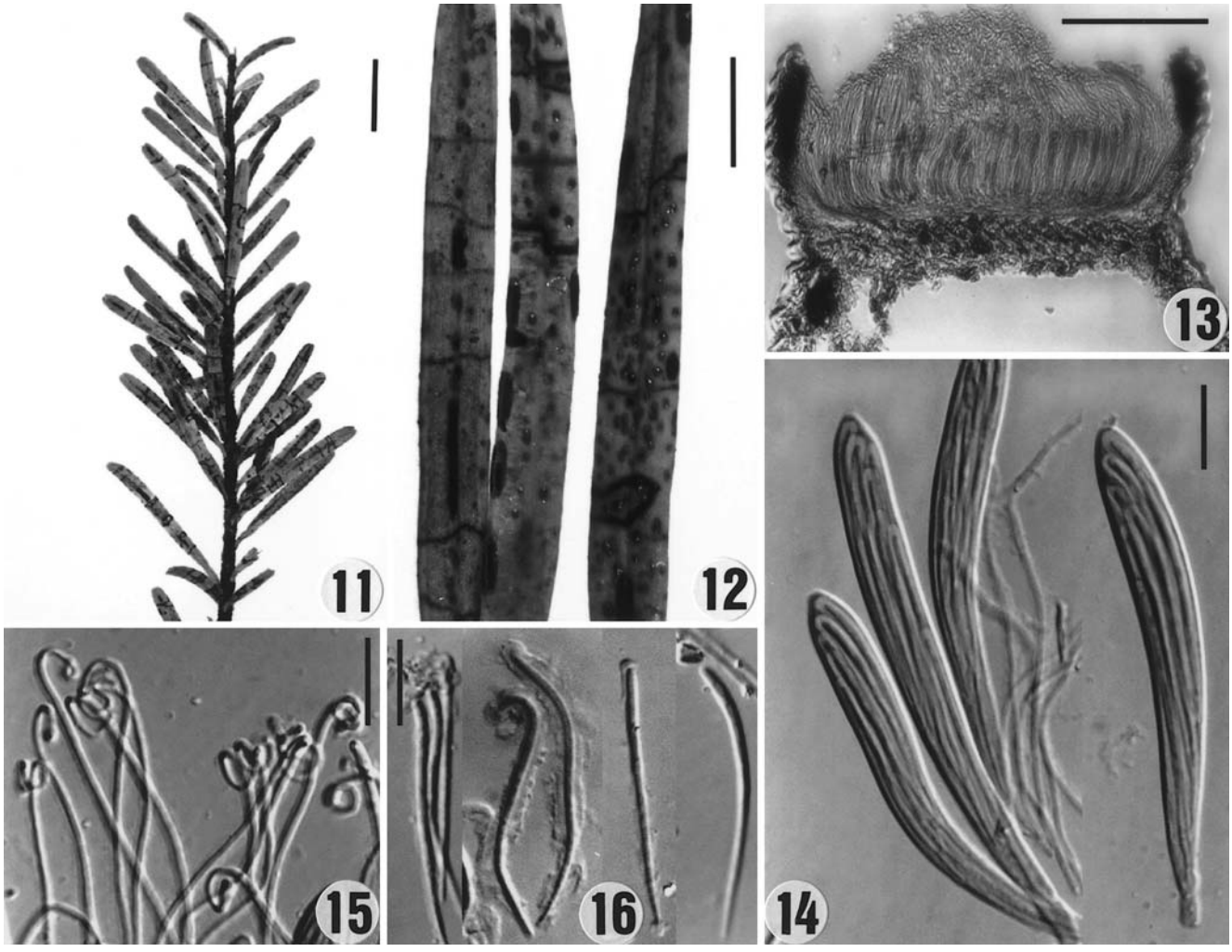
Hysterotheciis amphigenis in foliis emortuis, in pagina inferiore nervisequis interdum superiore sparsis, 0.5–4 mm longis, 0.5 mm latis, atronitidis, incisura longitudinali anguste aperientibus, intraepidermalibus, 330–390 μm latis, 150–290 μm altis; plectenchymate basilari achromo 17–23 μm crasso, hyalino; tegmine atro, pseudoparenchymatico, cum epidermide 40–46 μm crasso; hymenio plano; ascis cylindricis usque clavatis, apice rostriformibus, 85–140 × 10–15 μm; paraphysibus filiformibus, maturitate apice uncinatis, hyalinis, usque 115–160 μm longis, 1.8–2.0 μm crassis; ascosporis filiformibus clavatisque, hyalinis, 36–68 × 2.0–3.0 μm, muco 3–4 μm crasso involutis. Spermogoniis fere epiphyllis, conspersis, brunneis, intraepidermalibus, 90–200 μm latis, 30–80 μm altis; spermatiis non visis.

Holotype: On *Abies mariesii* Mast.: Iozawa, Hakkoda Mts., Aomori Pref., Japan, June 29, 1988, collected by S. Kaneko, TFM:FPH 7522.

Etymology: *exigua* = small, referring to the comparatively small ascospores of the present species.

Hysterothecia amphigenous, nervisequious at the lower surface, scattered at the upper surface, on dead needles, 0.5–4 mm long, 0.5 mm wide, black, opening by a longitudinal slit, surrounded frequently by a black line, lips inconspicuous, hysterothecia in cross section intraepidermal, 330–390 μm wide, 150–290 μm deep; prosenchymatous basal layer 17–23 μm thick, colorless, covering layer of epidermal wall and dark pseudoparenchyma 40–46 μm thick; hymenium flat; asci 8-spored, cylindrical to clavate, rostriform at tip, 85–140 × 10–15 μm; paraphyses filiform, at maturity recurved at tip, hyaline, 115–160 μm long, 1.8–2.0 μm thick; ascospores filiform clavate, hyaline, 36–68 × 2.0–3.0 μm, surrounded by a gelatinous sheath about 3–4 μm thick. Spermogonia, mostly epiphyllous, scattered, brown, intraepidermal, 90–200 μm wide, 30–80 μm deep; spermatia not seen.

Lirula species usually occur on blighted needles of living twigs having strong pathogenicity. The fruit bodies (hysterothecia and spermogonia) of the present species, however, were observed on the needles of dead twigs that had been damaged physically. Furthermore, the fruit bodies were frequently surrounded by black lines (Figs. 11, 12). These characteristics of *L. exigua* differ from those of other *Lirula* species. A similar example is known in the genus *Lophodermium* (Minter 1981), which is closely related taxonomically to *Lirula*, i.e., fruit bodies of some



Figs. 11–16. *Lirula exigua* (holotype). **11** Affected needles of *Abies mariesii.* **12** Hysterothecia and spermogonia surrounded by *black lines*. **13** Cross section of a hysterothecium. **14** Asci. **15** Paraphyses with a recurved tip. **16** Ascospores. *Bars* **11** 1 cm; **12** 2 mm; **13** 100 μm; **14–16** 20 μm

Lophodermium species with weak pathogenicity are surrounded by black lines. The distinctions between *Lirula* and *Lophodermium* are the shape of hysterothecia and ascospores, i.e., linear hysterothecia and clavate to clavate-cylindrical ascospores of *Lirula* are distinguished from elliptical hysterothecia and filiform ascospores of *Lophodermium* (Darker 1967). The hysterothecia (Fig. 12) of *L. exigua* is shorter than in other *Lirula* species, but distinct from *Lophodermium* species. The shape of the ascospores (Fig. 16) of this species is also typical of *Lirula* species. *Lirula exigua* can be easily distinguished from other *Lirula* species (Table 1) by its smaller ascospores (Fig. 16), characteristic paraphyses with a recurved tip (Fig. 15), and scattered spermogonia on the surface of its needles (Fig. 12).

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