

## Noteworthy Species of the Genus *Ramalina* (Ascomycotina: Ramalinaceae) in China

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**Abstract** *Ramalina almqvistii*, *R. hokkaidensis*, *R. intermedia*, *R. obtusata*, *R. pentecostii*, *R. pertusa* and *R. sekika* are reported from China for the first time. *R. pentecostii* and *R. sekika* are the second report for the species. *R. pseudosekia* was reduced to a synonym of *R. pollinaria*.

**Key words:** *Ramalina almqvistii*, *R. hokkaidensis*, *R. intermedia*, *R. obtusata*, *R. pentecostii*, *R. sekika*, lichens.

In the course of our taxonomic study of the genus *Ramalina* basing on herbarium specimens kept in the Institute of Microbiology, Academia Sinica (HMAS), the Institute of Applied Ecology, Academia Sinica (IFP) and the National Science Museum, Tokyo (TNS), we found following seven species to be new to China; *R. almqvistii*, *R. hokkaidensis*, *R. intermedia*, *R. obtusata* and *R. pertusa*. In addition, *R. pentecostii* and *R. sekika* were found and they are the second report for the species in China. The present paper presents characteristic features for each species, including chemical variations, based on Chinese specimens.

### Materials and Methods

The specimens used for the present study were primarily based on the herbarium specimens kept in HMAS, IFP and TNS. Specimens collected by Kashiwadani and Moon in China in 1995 and 1999 were also studied. The secondary products

of the specimens examined were determined by thin layer chromatography (TLC) using the amended procedures of Culberson & Johnson (1982). To evaluate anatomical variation within the thallus and apothecia, sections were cut by hand with a razor blade. These were mounted in GAW solution and the anatomy and spores were examined with standard light microscopic procedures.

### Notes on Species

***Ramalina almqvistii*** Vain., Ark. Bot. 8: 17 (1909).

*Ramalina almqvistii* is a fistulose species characterized by saxicolous habit, discontinuous medullary hyphae, absence of soredia or isidia, short fusiform ascospores and by the presence of sekikaic or divaricatic acids.

Although this species is widely distributed in East Asia, it has never been recorded from China. Three specimens collected on rocks at Prov.

Liaoning were now identified with the divaricatic acid race of this species. New to China.

Specimens examined. China. Prov. Lianing: Laotieshan, on rock, elevation 250 m, October 7, 1981, X. Chen et al. 5762 (IFP); the same locality, September 1, 1931, Y. Kobayashi 13 (TNS); Kuandian, Baishilazi Reserve, on rock, 1245 m alt, X. Chen 6844 (IFP).

**Ramalina hokkaidensis** Kashiw., Bull. Natn. Sci. Mus. Ser. B, 12: 89 (1986).

This species was well studied by Kashiwadani (1986) for Japanese specimens. It very much resembles *Ramalina conduplicans* Vain., a species widely distributed in East Asia, in having similar laciniae with punctiform pseudocypbellae. However, it can be distinguished from the latter by the canaliculate laciniae tapering towards the apices and by the presence of stenosporic acid. *R. conduplicans* has dorsiventral laciniae even in the distal branches and produces homosekikaic, sekikaic or divaricatic acids as major chemical substances. New to China.

Specimen examined. China. Prov. Heilongjiang: Liangshui forest centre, Dailing, 300 m, October 6, 1975, X. Chen 3863 & 3907-1 (IFP). Prov. Sichuan, Liangshan Co.: N slope of Mt. Luoji, Xichang City (27°45'N, 102°20'E), on twigs of *Rhododendron* sp., elevation 2205–2245 m, September 21, 1999, H. Kashiwadani 42376 (TNS).

**Ramalina intermedia** (Del. ex Nyl.) Nyl., Flora 56: 66 (1873). (Fig. 1a & 1b)

Thallus saxicolous, up to 3 cm long. Laciniae discrete or forming swards, sparingly and irregularly branched, growing from a delimited or more or less expanded holdfast. Laciniae greenish yellow, solid, 0.3–1.5(–3) mm wide, flattened towards the basal parts, terete and more or less cylindrical in distal parts, often ending in nodular or granular soredia. Pseudocypbellae sparse, elliptical, flat. Soralia present, laminal or subterminal to terminal, soredia granular, covered by outer layers. Laciniae 150–400  $\mu\text{m}$  thick; upper cortex indistinct, 3–5  $\mu\text{m}$  thick; chondroid tissue

weakly cracked, continuous; medulla loose. Apothecia very rare, laminal or submarginal, up to 0.7 mm in diam.; disc flat to more or less convex, without white margin; thalline exciple entire or sorediate; hymenium 35–40  $\mu\text{m}$  high; subhymenium 15–20  $\mu\text{m}$  thick, proper exciple 30–40  $\mu\text{m}$  thick; ascospores shortly fusiform, 11–12  $\times$  4–4.5  $\mu\text{m}$ . Pycnidia not seen.

Chemistry: (Race 1) usnic, homosekikaic, sekikaic and 4'-*O*-methylnorhomosekikaic acids. (Race 2) usnic, divaricatic and 4'-*O*-demethyldivaricatic acids.

*Ramalina intermedia* includes a series of forms ranging from discrete and shrubby thalli growing from a delimited holdfast up to 3 cm high with irregularly or dichotomously branched and dorsiventral laciniae near the base (Fig. 1a), to small tufted thalli growing from more or less expanded holdfast up to 1 cm high with more or less terete and weakly branched laciniae (Fig. 1b). Similar morphological variations were also reported for *R. polymorpha* (Ach.) Ach. by Acharius (1797) and Krog and James (1977).

When Kashiwadani (1987) revised Japanese species of *R. intermedia*, he reported the presence of homosekikaic and sekikaic acids as major chemical substance. In addition to the race 1 containing homosekikaic acid agg., divaricatic acid containing specimens (race 2) were also found for this species. The two chemical races were inseparable morphologically and this chemical difference seems to have no taxonomic value.

*Ramalina intermedia* resembles *R. pollinaria* (Westr. ex Ach.) Ach., a saxicolous species widely distributed in the world, in having granular soredia covered by outer layers (Kashiwadani and Moon 2003). However, it can be readily distinguished from the latter by the narrower laciniae and by the absence of evernic and obtusatic acids which are constant components for *R. pollinaria*. It might be confused with *R. polymorpha* (Ach.) Ach., a species widely distributed in the Northern Hemisphere, which differs in having no chemical substances.

During the present study, we found this species

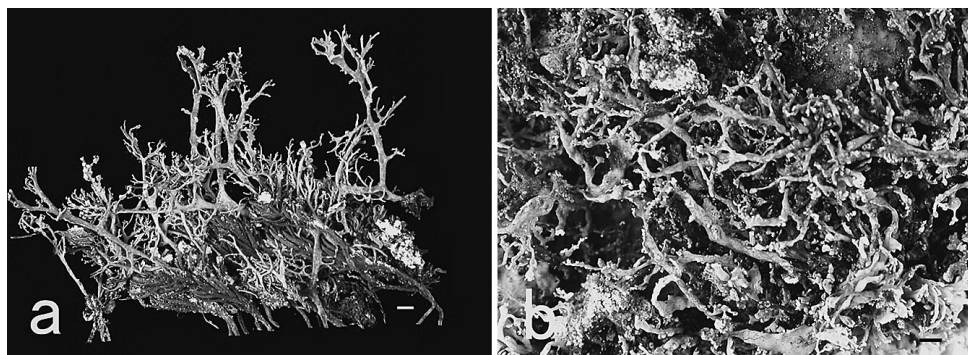


Fig. 1. *Ramalina intermedia* (Del. Ex Nyl.) Nyl., a) a plant growing among mosses (Z. Congfu 3487, IFP, bar=1 mm), b) plants growing on exposed rock (H. Kashiwadani 39240, TNS, bar=5 mm).

from three localities in China. They coincide well with the exsiccate specimens of this species preserved in TNS both in morphology and chemistry. The specimen from Mt. Changbai, Jilin Province, was collected among mosses on rocks and determined as the race 1. The specimens from Ping Shui Shan, Jiansi Province were collected on exposed rocks along river and determined as the race 2. This is a new report for this species from China.

Specimens examined. (Race 1) China. Prov. Liaoning: Laotie-shan, on rock, X. Chen et al. 5772 (IFP). Prov. Jilin. Mt. Changbai, among mosses on ground, around the lake near the summit, elevation about 2150 m, August 30, 1983 m, C. Zhao 3487 (IFP).

(Race 2) China. Liaoning Prov.: Snake Island, Dalian, on rock around the summit, May 13, 1973, Zhang Lizhu 016-1 (IFP). Jiang Ci Sang: Ping Shui Shan, Jing Gang Shan Nature Reserve, on rocks, elevation 900 m, July 12, 1995, H. Kashiwadani 39240 & 39323 (TNS).

Exsiccata examined. M.E. Hale: Lich. Amer. Exs. 171 (race 1, TNS). V. Räsänen: Lich. Fenn. Exs. 28 (race 1, H). W.A. Weber: Lich. Exs. Colol. 605 (race 1, TNS).

***Ramalina obtusata*** (Arnold) Bitt., Pringsheim Jahrb. Wiss. Bot. 36: 435 (1901). (Fig. 2)

*Ramalina obtusata* is characterized by corticolous habit, shrubby and fistulose thallus growing from a narrow holdfast, inflated and more or

less pellucid thalli without side branches, sparse and small fenestrations, continuous medullary hyphae without isolated clumps of hyphae and the presence of evernic and obtusatic acids as major chemical substances.

Historical review for this species has been provided by Krog and James (1977). Although fertile specimens for this species has not been reported, one specimen (Fig. 2) from Mt. Chanbai, Prov. Jilin has characteristic features written above, which coincide well with those of the lectotype of *R. obtusata* (Arnold: Lich. Exs. 577b—isolectotype in BM!). New to China.

Specimen examined. China. Prov. Jilin: 14 km from Baishan Station, Mt. Changbai, on bark of *Picea yezoensis*, elevation 1270 m, June 19, 1980, C. Zhao 0320 (IFP).

***Ramalina pentecostii*** Krog & Swinscow, Norw. J. Bot. 23: 167 (1976). (Fig. 3a, 3b, 3c)

*Ramalina pentecostii* is characterized by its corticolous or saxicolous habit (Krog & Swinscow 1976), weakly branched subpendulous laciniae showing bilateral appearance (Fig. 3a), marginal soralia (Fig. 3b) and shortly linear pseudocypbellae, smooth chondroid layer without cracks (Fig. 3c) and by the absence of medullary chemical substance. Apothecial laminar, 0.8–1.5 mm in diameter; disc with white margin; ascospores shortly fusiform, 11–12×5–6 μm in size.

*Ramalina pentecostii* is a poorly known lichen

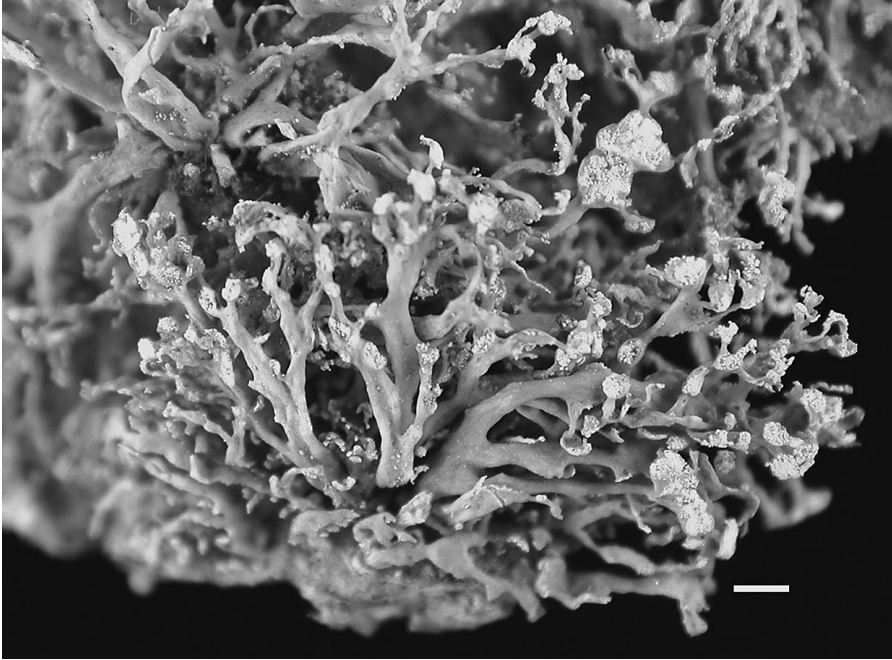


Fig. 2. *Ramalina obtusata* (Arnold) Bitt., showing a habit (C. Zhao 0320, IFP). Bar=1 mm.

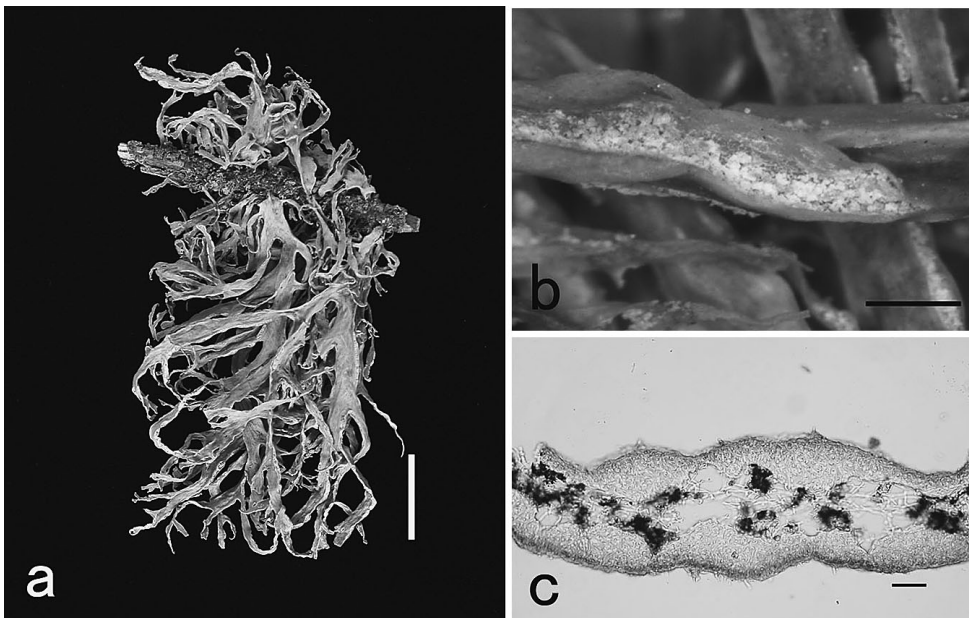


Fig. 3. *Ramalina pentecostii* Krog & Swinscow (Z. Congfu 2501, IFP). a) habit (bar=1 cm), b) laciniae showing bilateral appearance by marginal soralia (bar=0.5 mm), c) cross section of branches, showing smooth chondroid tissue (bar=100  $\mu$ m).



and it has been so far known only from Uganda, East Africa (Type collection: Uganda, Toro, Ruwenzori, R.E. Pentecost 115—holotype in BM!). In the course of the present study, we found several specimens comparable to the species collected in Mt. Tianshan, Xinjiang Prov., northwest China. These specimens are quite identical morphologically as well as chemically with the type specimen. One of them (Z. Congfu 25019 is fertile and the description of apothecia is given above, though Krog and Swinscow (1976) reported only sterile specimens.

This species is unique in having dorsiventral laciniae with marginal continuous soralia and in producing no chemical substances. This characteristic lichen is not easily mistaken for any other species of *Ramalina* found in Asia. Specimens of subpendulous thalli of *R. farinacea* (Pers.) Ach., a corticolous widespread species in temperate regions in the world, might be confused with this species, but it differs in having repeatedly branched laciniae with discrete soralia and in producing depsidones such as protocetraric, norstictic or salazinic acids as major chemical substances.

This is the second record for *R. pentecostii* in China. All specimens from China were collected on branches of *Picea* sp., at elevations between 1900 to 2260 m.

Specimens examined. China. Prov. Xinjiang, Mt. Tianshan, Bayi forest centre, *Picea* sp., 2260 m alt, August 31, 1982, C. Zhao 2242 (IFP); the same locality, on dead wood, 1900 m alt, September 1, 1982 (IFP); Takesi forest centre, on *Picea* sp., 1950 m alt., September 24, 1982, C. Zhao 2501 (IFP); Zhaosu forest centre, on *Picea* sp., 2260 m alt, September 26, 1982, C. Zhao 2480 (IFP); Gongliu forest center, September 29, 1982, on *Picea* sp., 1900 m alt., September 29, 1982, C. Zhao 2629 (IFP).

***Ramalina pertusa*** Kashiw., Mem. Natn. Sci. Mus. 18: 102. (1985)

Although *Ramalina pertusa* has been reported widely distributed in Japan and Taiwan (Kashiwadani 1985, Kashiwadani et al. 2006), it has

never been reported from mainland China. One specimen collected at Huanre, Prov. Liaoning, is now identified as this species. New to China.

Specimen examined. China. Prov. Liaoning: Huanren County, on dead twigs, 800 m, September 11, 1986, X. Chen & S. Liu 6702 (IFP).

***Ramalina pollinaria*** (Westr. ex Ach.) Ach., Lich. Univ.: 608 (1810).

Basionym. *Lichen pollinarius* Westr., Kgl. Vitensk. Acad. Nya Handl. 16: 56 (1795). Type collection: Suesia (H-Ach. 1831D!).

*Ramalina pseudosekika* Asahina, J. Jpn. Bot. 16: 139 (1940). Type collection: North Korea, Prov. Pyongannam-do, Gija-rim, Pyongyang, 1930, H. Den s.n. (herb. Asahina 334—holotype in TNS), syn. nov., *tlc*: usnic, evernic and obtusatic acids.

*Ramalina pollinaria* is a well-known species of the genus characterized by the saxicolous habit, solid and sparingly branched laciniae with granular soredia, narrowly fusiform ascospores (12.5–14×3.5–4.5 μm in size) and by the presence of evernic and obtusatic acids as major medullary substances.

Asahina (1940) described *Ramalina pseudosekika* Asahina from North Korea. The holotype specimen, however, is quite identical morphologically and chemically with the holotype of *R. pollinaria* and can be simply reduced to a synonym of the latter species.

*R. pollinaria* seems to be widely distributed in China.

Representative specimens examined. China. Prov. Hebei, Weixian Co: Mt. Xiaowutai, on rock, 1700 m alt., August 15, 1982 Liu Shun 79 (IFP). Prov. Heilongjiang: Laotudingzi hill Da-hailin, on rock, August 28, 1973, Gao Qian 9218-1 (IFP); Laoli hill, Wudalianchi, on rock, 300 m alt., X. Chen 3518 (IFP). Prov. Jilin, Heilong Co: Shiliping, on rock 700 m alt., September 12, 1983, C. Zhao 3958 (IFP); north hill, Ji'an town, on rock 120 m alt., September 13, 1963, X. Chen 2469 (IFP); Ice field, Mt. Changbai, on rock, 1750 m alt., August 25, 1977, X. Chen 4996 (IFP). Prov. Liaoning: Fengcheng

Co.: Pheonix Hill, July 22, 1984, Gao De'en & Liu Shun 0252 (IFP); Kuandian Co.: Fotanggou, Baishilazi Reserve, on rock, 1000 m alt., November 18, 1988, X. Chen 7058 (IFP). Prov. Shandong: Mt. Laoshan, October 16, 1985, on rock, X. Chen & Liu Shun 226 (IFP).

**Ramalina sekika** Asahina, J. Jpn. Bot. 16: 138 (1941)

*Ramalina sekika* is a saxicolous species similar to *R. pollinaria*, which differs in having evernic and obtusatic acids as chemical substances. It is apparently one of a rare species of the genus, having been so far known only from the type collection in China (Type collection: Laotie-shan, Port Arthur, Prov. Liaoning, China, July 19, 1940, Y. Asahina 333—holotype in TNS!, *tlc*: sekikaic, 4'-*O*-demethyl sekikaic and salazinic ( $\pm$ ) acids). In the present study, we found additional localities for this species in Provinces Lianing and Jilin, China as cited below. This is the second report for the species.

Representative specimens examined. China. Prov. Liaoning: Xianrendong, Zhuanghe City, on rock in *Pinus densiflora* forest, X. Chen et al. 5801 (IFP); Laotieshan, Lushun, on rock, September 1, 1931, Y. Kobayasi 14 (TNS); Huangnichuan, Lushan, on rock, March 19, 1963, X. Chen 1191 (IFP); Huishan Hill, Shenyang, April 5, 1973, X. Chen s.n. (IFP). Prov. Jilin: Badaogou, Changbai Co., on rock, 450 m alt., Septem-

ber 5, 1963, X. Chen 2340 (IFP).

### Acknowledgements

We are most grateful to Dr. S. Kurokawa, Botanic Gardens of Toyama for his critical reading of the manuscript. This study was supported in part by JSPS KAKENHI to H. Kashiwadani (no. 17570089) and MEXT KAKENHI to H. Koyama (no. 07041151).

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