

Taxonomic Notes on the Lichen Family Verrucariaceae in Japan (I)
Five Species of *Verrucaria* Previously Reported from Japan

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日本産アナイボゴケ科地衣類分類ノート (I)
かつて日本から報告のあったアナイボゴケ属5種

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Five species of *Verrucaria* (Lichenes, Verrucariaceae), *V. glaucinodes* Nyl., *V. halophila* (Nyl.) Nyl., *V. nipponica* Zahlbr., *V. praevia* Nyl., and *V. submicrospora* Nyl., are revised and detailed descriptions and illustrations are given in the present paper. Among these species, *V. glaucinodes* and *V. submicrospora* are still known only from the type localities and *V. nipponica* is common in Japan. *V. praevia* is lectotypified here.

The lichen genus *Verrucaria* Schrad. is characterized by having a crustose thallus and simple spores within the family Verrucariaceae. Twelve species of the genus have been recorded from Japan (Nylander 1890, Vainio 1918, Müller Argoviensis 1891, Yoshimura 1963). Most of the species have been recorded only once for Japan, usually with only a too brief descriptions and no figure. In the present paper, detailed descriptions and illustrations will be given to five species of *Verrucaria*, *V. glaucinodes*, *V. halophila*, *V. nipponica*, *V. praevia*, and *V. submicrospora*, which the author can clearly characterize at present. Among them *V. nipponica* is rather common in Japan.

Materials and methods

Specimens loaned from H and W were examined. For *Verrucaria nipponica*, specimens collected by the present author (all deposited in HIRO) were also used for the description and figures.

Morphological observations were made on air-dried specimens with the naked eye or under a dissecting microscope. Lactophenol cotton-blue (abbreviated as LPCB) preparations were used for anatomical observations, but descriptions of color were taken from GAW preparations.

Eumeration of the species

1. *Verrucaria glaucinodes* Nyl., Lich. Jap. 89. 1890. Type: Japan, Kyushu Takashima, saxicola

(on non-calcareous rocks), 1879, E. Almquist s. n. (H-NYL 3035 – holotype). (Figs. 1A, 2)

Thallus epilithic, areolate; areoles polygonal, with almost straight margins, pale brown with or without gray tint, but more or less black near the margins (not so prominent), dull, smooth, almost flat, thick. Perithecia common, immersed in the thallus at the lower half or more, 0.2–0.35 mm

across; the naked parts black, a little glossy, smooth. Pycnidia not found.

Thallus 60–150 μm thick, lacking distinct upper cortex, with hyaline epinecral layer (5–10 μm thick); medulla (including algal layer) up to 110 μm thick, sub- to euparaplectenchymatous, usually hyaline, lumina of hyphae 3–5 μm high and 3–4 μm wide in the upper part, 3–4 μm across in the

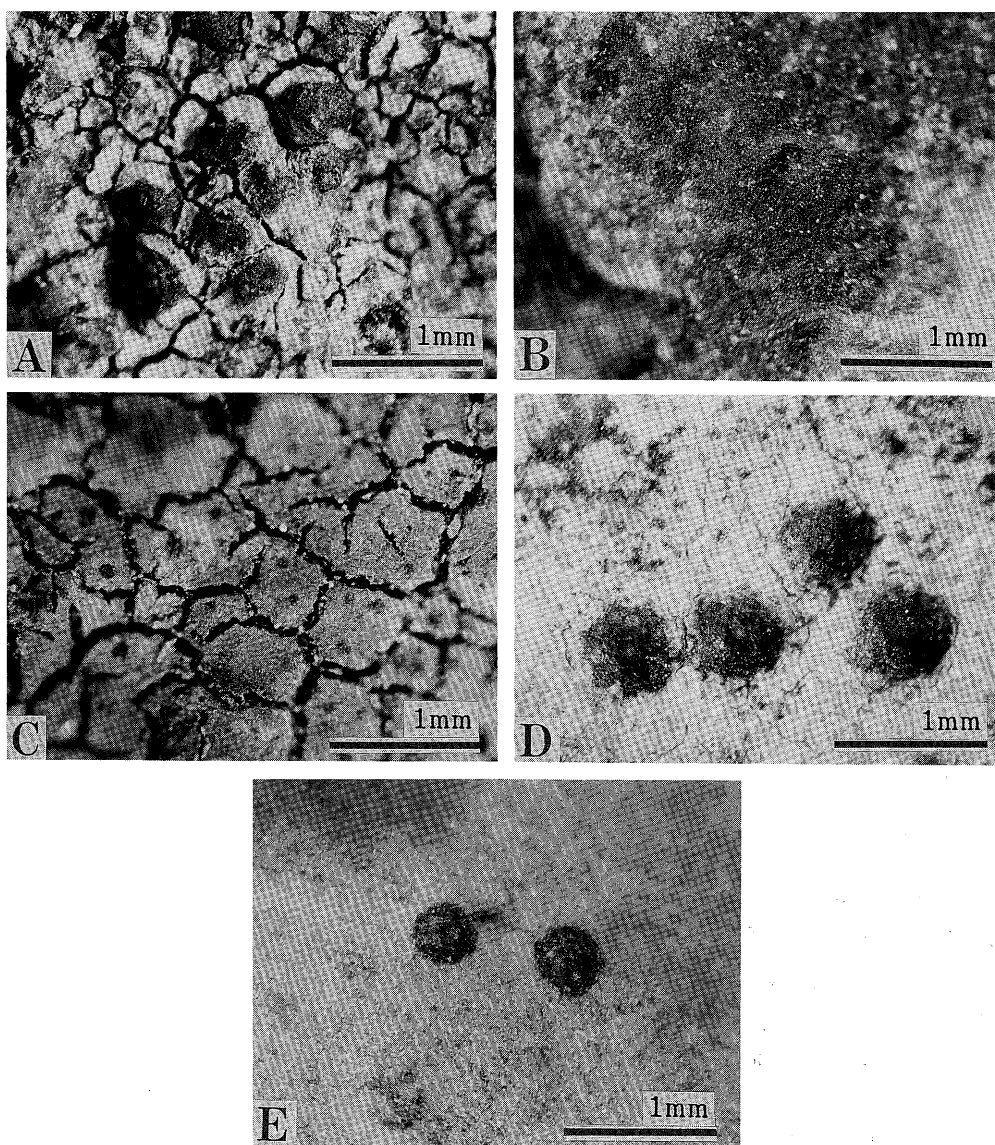


Fig. 1. *Verrucaria* in Japan. A, *V. glaucinodes* (holotype); B, *V. halophila* (H-NYL 3001); C, *V. nipponica* (holotype); D, *V. praevia* (lectotype); E, *V. submicrospora* (holotype).

lower part; phycobiont cells in small clusters, distributed more densely in the upper part; the basal layer sometimes present, up to $20\ \mu\text{m}$ thick, paraplectenchymatous, dark brown to almost black, composed of more or less thick-walled hyphae. Perithecia (excl. involucrellum) almost spherical, $330\ \mu\text{m}$ high \times $270\ \mu\text{m}$ wide; involucrellum dark brown, prominent in the upper side of perithecium, spreading downwards with a little extension into the deep layers of the medulla, more or less diverging from the exciple in the lower part, absent in the bottom, $70\text{--}80\ \mu\text{m}$ thick in the side of perithecia, lacking thalline cover in the upper part; exciple hyaline to more or less brown, $15\text{--}20\ \mu\text{m}$ thick in the sides and bottom; subhymenium $20\text{--}25\ \mu\text{m}$ thick; periphyses $20\text{--}40\ \mu\text{m}$ long; hymenium $220\ \mu\text{m}$ high \times $200\ \mu\text{m}$ wide; spores hyaline, simple, ellipsoidal, $21\text{--}23 \times 10\text{--}12\ \mu\text{m}$.

This species is characterized by an areolate thallus with prominent black margin, and well developed epinecral layer. This species resembles *Verrucaria glaucina* Ach. in having well developed thallus of black-margined areoles lacking prominent basal layer. It differs from the latter by larger spores ($11\text{--}18 \times 7\text{--}8\ \mu\text{m}$ in *V. glaucina* according to Zschacke 1934), usually exposed perithecia and less developed black margin.

This species is only known from the type locality.

2. *Verrucaria halophila* (Nyl.) Nyl. in Branth et Rostr., Bot. Tidsskr. **3**: 275. 1869 = *Verrucaria microspora* Nyl. f. *halophila* Nyl., Act. Soc. Linn. Bordeaux **21**: 431, 1857. Type: Gallia, ad rupes calcareas a mare saepe inumdatas prope Cancale Galliae occidentalis lecta a cel. de Brebisson (H ?, not seen). (Figs. 1B, 3)

Thallus crustose, epilithic, smooth, almost continuous, thin, very dark brown to almost black,

a little glossy, minutely and very slightly papillate. Perithecia scattered, protruding and exposing the greatest portion, not constricted at the base, $0.1\text{--}0.15\ \text{mm}$ across, usually slightly depressed around ostioles. Pycnidia not found.

Perithecia (excl. involucrellum) almost hemispherical, $120\ \mu\text{m}$ high \times $170\ \mu\text{m}$ wide; involucrellum prominent in the upper side of perithecia, spreading downwards, slightly diverging from exciple, absent in the bottom, ca. $20\ \mu\text{m}$ thick, almost black or very dark brown, with or without thin thalline cover in the lower part; exciple very dark brown in the upper part, indistinct below, up to $15\ \mu\text{m}$ thick; subhymenium ca. $15\ \mu\text{m}$ thick; periphyses short, $10\text{--}15\ \mu\text{m}$ long, almost simple; hymenium ca. $100\ \mu\text{m}$ high \times $150\ \mu\text{m}$ wide; asci clavate, $20\text{--}25 \times$ ca. $15\ \mu\text{m}$; spores 8 in each ascus, hyaline, simple, ellipsoidal, $8\text{--}9 \times 4\text{--}5\ \mu\text{m}$.

Specimen examined. Kyushu, Fukuoka-ken, Moji, "Mitso", on non-calcareous rocks, 20 April 1879, E. Almquist (H-NYL 3001).

The description above is based on the collection by E. Almquist (H-NYL 3001), which was reported by Nylander (1890) as *Verrucaria halophila* (Nyl.) Nyl. It agrees well with the original description of *V. microspora* Nyl. f. *halophila* Nyl.; the basionym of *V. halophila* (Nylander 1857). This species in Japan is characterized by a very thin and dark thallus, and small spores ($8\text{--}9 \times 4\text{--}5\ \mu\text{m}$).

It may be easily confused with *V. microspora* Nyl., but differs from the latter by having slightly smaller spores ($8\text{--}10 \times 5\text{--}7\ \mu\text{m}$ in *V. microspora* according to Nylander 1855).

3. *Verrucaria nipponica* Zahlbr., Ann. Mycol. **14: 45, 1916.** Type: Japan, Honshu, Mie-ken, Iga, Kami-tsuge (as "Komitsuge"), ad saxa granitica, U. Faurie 1958 (W – holotype). (Figs. 1C, 4)

Thallus epilithic, areolate. Areoles polygonal

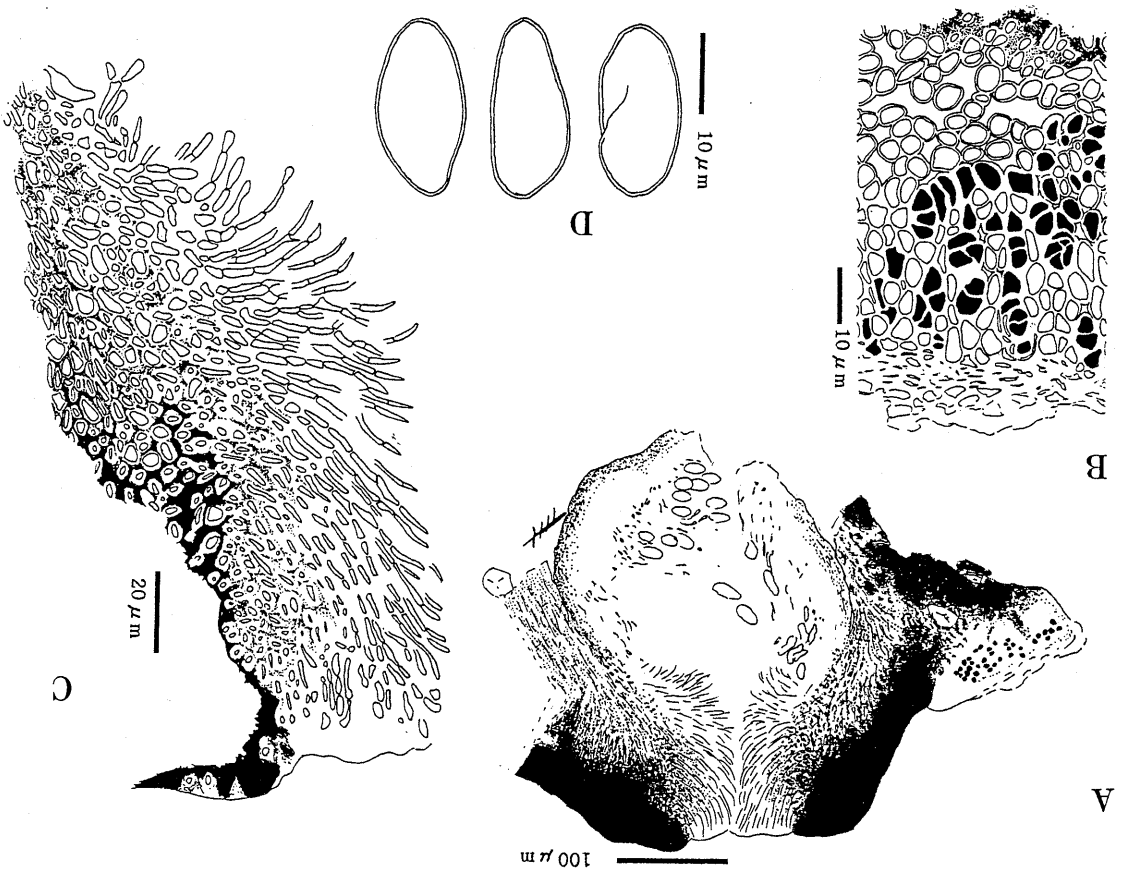


Fig. 2. Anatomy of *Verrucaria glaucnodes*. A, vertical section of perithecium; B, vertical section of thallus; C, part of perithecium in vertical section; D, spores. (LPCB preparations, holotype)

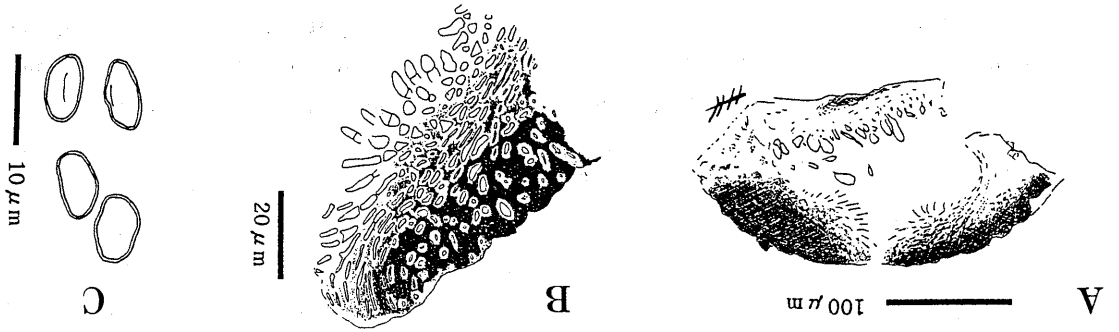


Fig. 3. Anatomy of *Verrucaria halophila*. A, vertical section of perithecium; B, part of perithecium in vertical section; C, spores. (LPCB preparations, H-NYL 3001)

with more or less straight margins, pale to somewhat dark brown, dull, smooth, almost even, or a little convex. Perithecia common, scattered over the thallus, usually single in areole, almost completely immersed in the thallus, usually protruding, frequently exposing the upper part of involucrellum. Pycnidia common, immersed in the thallus.

Thallus thick, sometimes exceeding 500 μm ; upper cortex up to 20 μm thick, weakly differentiated from medulla, eu- to subparaplectenchymatous, lumina of hyphae 2–3 μm across, walls of hyphae ca. 1 μm thick; medulla (including algal layer) 30–120 μm thick, sub- to euparaplectenchymatous, lumina of hyphae 2–6 μm high, 2–3 μm wide, generally larger in the lower part of the layer, walls of hyphae ca. 1 μm thick; phycobiont cells almost evenly distributed throughout medulla, solitary or in small clusters; the basal layer largely variable in thickness, sometimes exceeding 250 μm , eu- to subparaplectenchymatous, very dark brown; lumina of hyphae 4–8 μm across in the upper part, 3–6 μm across in the lower part; walls of hyphae ca. 0.5 μm thick, but frequently thicker (ca. 1 μm thick or more) in the lower part, Perithecia (excl. involucrellum) almost spheric, up to 480 μm high \times 350 μm wide; involucrellum relatively almost black, weakly developed in the upper side of perithecium, spreading below and merging with the basal layer of thallus; exciple almost hyaline or pale brown, almost black, ca. 10 μm thick in the sides and bottom; subhymenium 10–30 μm thick; periphyses 20–50 μm long; hymenium up to 380 μm high \times 270 μm wide; asci clavate, ca. 100 μm long \times 20 μm wide; spores 8 in each ascus, hyaline, simple, ellipsoidal (to oval), 24–29 \times 8–12 μm . Pycnidia of the *Staurothele*-type in the sense of Harada (in press); pycnoconidia bacilliform, 5–7 \times ca. 1 μm .

Additional specimens examined: HONSHU. Shizuoka-ken, Haibara-gun, Hon-kawane-chô, 360 m alt., H. Harada 3474 (HIRO); Iwata-gun, Tatsuyama-mura, 50 m alt., H. Harada 3490 (HIRO); Aichi-ken, Kita-shitara-gun, Tôel-chô, 200 m alt., H. Harada 3498 (HIRO); Gifu-ken, Gujô-gun, Minami-mura, 150 m alt., H. Harada 3514 (HIRO); Hiroshima-ken, Saiki-gun, Yoshiwamura, Mt. Kanmuri, 850–900 m alt., H. Harada 2653 (HIRO). SHIKOKU. Kochi-ken, Takaoka-gun, Kubokawa-chô, 200 m alt., H. Harada 3446 (HIRO).

This species is characterized by having a brown, thick and areolate thallus with black basal layer, the involucrellum which is poorly developed in the upper part and is not differentiated from well developed basal layer, and relatively large spores (24–29 \times 8–12 μm).

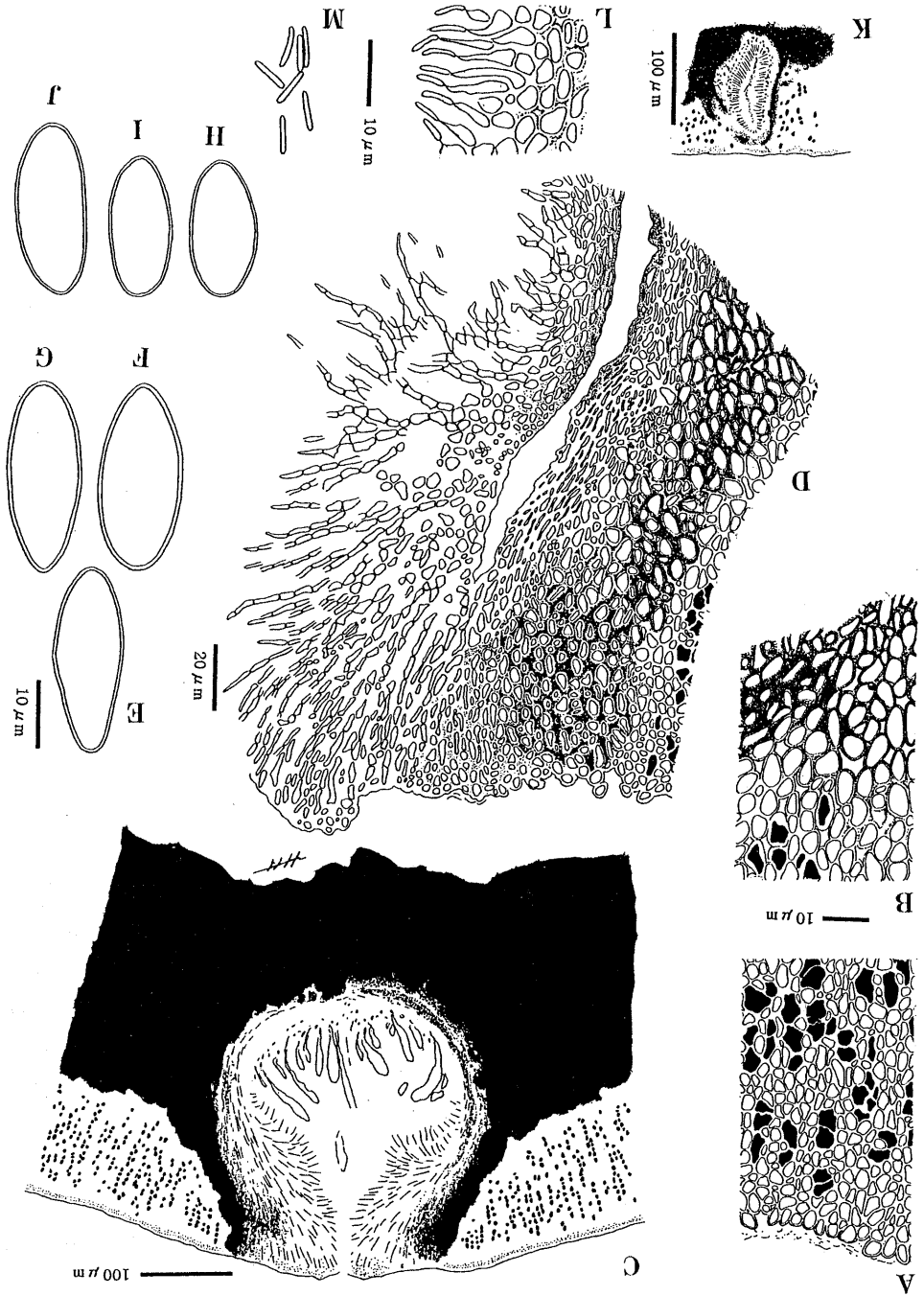
Verrucaria nipponica Zahlbr. resembles *V. glaucina* Ach. in having the thallus with prominent basal layer. However, it differs from the latter by having areoles without black margins.

This is the commonest species of aquatic *Verrucaria* in Japan. It usually grows on periodically submerged rocks at the edge of streams, frequently associated with *Dermatocarpon miniatum*.

4. *Verrucaria praevia* Nyl., Lich. Jap. 89. 1890. Type: Japan, Kyushu, Fukuoka-ken, "Mitso", 20 Oct. 1879, E. Almquist (H-NYL 2953 – lectotype) (Figs. 1D, 5)

Thallus epilithic, continuous to rimulose, pale brown or grayish to almost black, dull or a little glossy, almost flat, rather smooth. Perithecia scattered, protruding and exposing the greatest portion, almost hemispheric, 0.3–0.8 mm in diameter, with or without thin thalline cover (mottled), almost black, but paler in color and depressed around ostioles. Pycnidia not found.

Fig. 4. Anatomy of *Verrucaria nipponica*. A, upper part of thallus in vertical section; B, lower part of thallus in vertical section; C, vertical section of perithecium; D, part of perithecium in vertical section; E-J, spores; K, vertical section of pycnidium; L, part of pycnidium in vertical section; M, pycnoconidia. (LPCB preparations. A-D, K-M, holotype; E-G, Harada 3474; H-J, Harada 3490)



Perithecia (excl. involucrellum) pyriform, 220–250 μm high \times 230–300 μm wide; involucrellum very dark chestnut brown, prominent in the upper side of perithecium, well spreading laterally, absent in the bottom, containing scattered hyaline crystals, 70–110 μm thick, with a distinct hyaline tissue between the involucrellum (except for the upper part) and the side of the exciple, \pm covered with very thin thallus; exciple dark brown in the uppermost part, hyaline in the remainder, 15–20 μm thick in the sides; subhymenium 20–30 μm thick; periphyses ca. 25 μm long; hymenium 180–200 μm high \times 170–260 μm wide; asci clavate, ca. 60 μm long \times 20 μm wide; spores 8 in each ascus, hyaline, simple, ellipsoidal, 15–21 \times 8–11 μm .

Habitat: On non-calcareous rocks.

Additional specimen examined: Japan, no precise locality, E. Almquist? (H-NYL 2954 pro parte – syntype).

Four specimens of *Verrucaria praevia* are

preserved at the Nylander Herbarium of the Helsinki University. They are H-NYL 2953, 2954, 2955, and 3793. H-NYL 2953 contains a piece of rock glued on a card. On the herbarium envelope, the following data was recorded in black ink: “*Verrucaria praevia* Nyl.”, “E. Almquist”, “Japonia, Mitso”, “0,016-21, 8-10” with illustrations of two spores. In H-NYL 2954, two pieces of rocks are glued on a card, on which “Japonia” and “v. praevia” are indicated. H-NYL 2955 contains three species of rocks fixed on a card. On the original herbarium envelope of this specimen, is found the following information: “*Verrucaria praevia*”, “japonia, Mitso”, “E. Almquist 2, and “20/x 1879”. In H-NYL 2953, perithecia are 0.3–0.8 mm (0.3–0.8 mm in the protologue) in size, and spores are 15–21 \times 7–11 μm (14–21 \times 7–16 μm in the protologue). H-NYL 2953 agrees well with the original description given by Nylander in the size of perithecia as well as in the spore size. H-NYL 2954 comprise of two

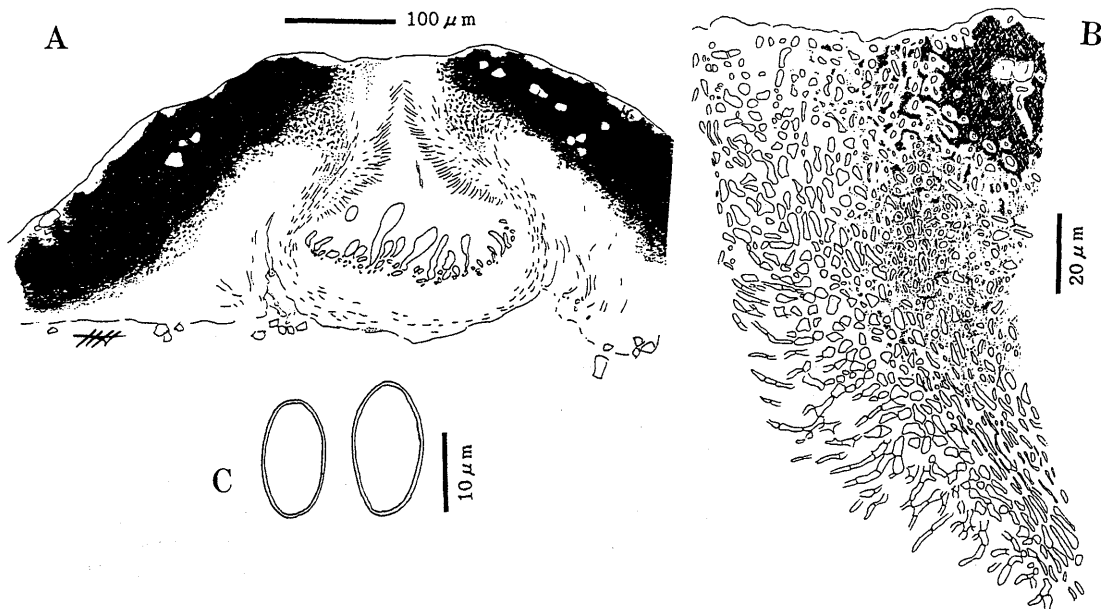


Fig. 5. Anatomy of *Verrucaria praevia*. A, vertical section of perithecium; B, part of perithecium in vertical section; C, spores. (LPCB preparations, lectotype)

species growing on different rocks. The specimen growing on the one rock well agrees with H-NYL 2953 not only in the external morphology but also in the size of perithecia and spores. In contrast, the specimen growing on the other rock differs from H-NYL 2953 in the size of perithecia (0.2–0.5 mm) and spores ($13\text{--}15 \times 7\text{--}8 \mu\text{m}$). H-NYL 2955 and H-NYL 3793 are also quite different from H-NYL 2953, since the perithecia are 0.2–0.5 mm and about 0.3 mm, and spores are $12\text{--}17 \times 6\text{--}8 \mu\text{m}$ and $15\text{--}20 \times 6\text{--}10 \mu\text{m}$, respectively. The author thus designates here H-NYL 2953 as the lectotype of *V. praevia* and regards H-NYL 2954 pr. p. (a syntype) to be identical with H-NYL 2953. Description shown above is based mainly on H-NYL 2953.

Verrucaria praevia is characterized by having large perithecia (0.3–0.8 mm in diameter), which are exposed for the most part, and well developed involucrellum with hyaline tissue between the lower half of the involucrellum and the side of the exciple. It resembles *V. dufourii* DC. in having almost completely exposed perithecia and medium-sized spores, but is clearly distinguished from the latter by having larger perithecia (up to 0.5 mm

wide in the latter according to Zachacke 1934) and growing on non-calcareous rock.

5. *Verrucaria submicrospora* Nyl., Lich. Jap. 90. 1890. Type: Japonia, Kyushu, Fukuoka-ken, Moji, "Mitsa", on non-calcareous rocks, 20 Oct. 1879, E. Almquist (H-NYL 2994 – holotype). (Figs. 1E, 6)

Thallus endolithic (on more or less decayed sandstone). Perithecia rather sparsely scattered, protruding and exposing the greatest portion, almost hemispherical, 0.2–0.3 mm across, black throughout, more or less depressed around ostioles, usually with very inconspicuous furrows on the upper surface (air-dried material). Pycnidia not found.

Hyphae of thallus spreading among inorganic particles of the substratum. Perithecia (excl. involucrellum) almost spherical, $160 \mu\text{m}$ high and wide; involucrellum very dark chestnut brown, prominent in the upper side of the perithecium, slightly spreading downwards, absent below, almost contiguous with the exciple, containing numerous inorganic particles probably derived from the substratum, $30\text{--}40 \mu\text{m}$ thick in the sides,

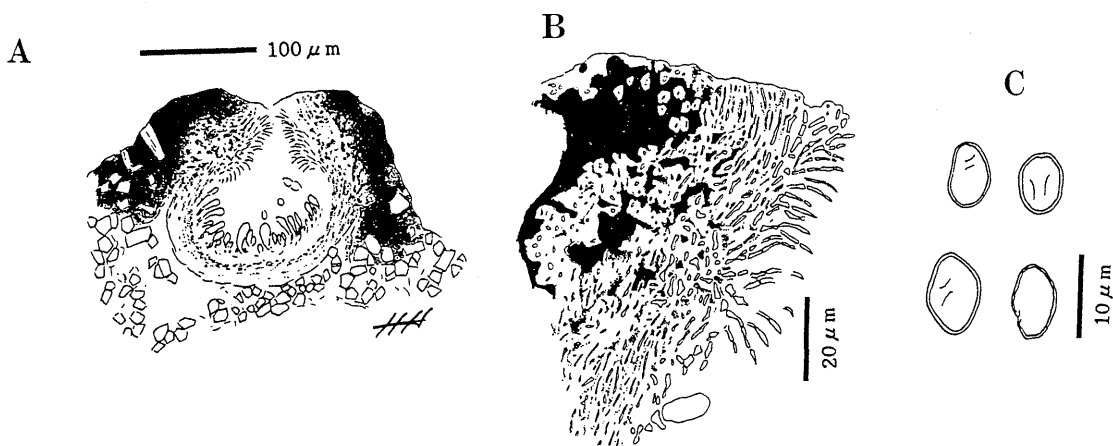


Fig. 6. Anatomy of *Verrucaria submicrospora*. A, vertical section of perithecium; B, part of perithecium in vertical section; C, spores. (LPCB preparations, holotype)

± with indistinct hyaline tissue between the lower part of involucrellum and the side of the exciple; exciple hyaline, but mottled with very dark brown granules (?), 15–20 μm thick, in the sides and bottom; subhymenium 5–10 μm thick; periphyses 10–15(–20) μm long, almost simple; asci clavate, ca. 25 μm \times 10 μm ; spores 8 in each ascus, hyaline, simple, ellipsoidal to broadly ellipsoidal, 8–10 \times 5–6.5 μm .

This species is characterized by the endolithic habit (on non calcareous rock) and small spores (8–10 \times 5–6.5 μm). It resembles *Verrucaria microspora* Nyl. in having small spores but differs from the latter by the endolithic habit.

I wish to express my sincere thanks to curators of the herbaria listed in the materials and methods for arranging loan specimens at my disposal. Deep thanks are extended to Dr. S. Kurokawa, Toyama Prefecture, and Dr. H. Kashiwadani of National Science Museum, Tokyo for critically reading the manuscript. I am also grateful to Prof. T. L. Esslinger of North Dakota State University for correcting the English text.

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要旨

アナイボゴケ属 (*Verrucaria*) は日本から12種が知られている。しかし、これらの殆どが一度しか報告されておらず、その多くは記載が非常に短く図も全く紹介していないので、実体は殆ど不明であった。これらの報告の基になった標本も殆ど再検討されていなかったが、最近になって著者が検討する機会を得た。その結果、次の5種を認めた：*Verrucaria glaucinodes* Nyl., *V. halophila* (Nyl.) Nyl., *V. nipponica* Zahlbr., *V. praevia* Nyl., *V. submicrospora* Nyl. 本論文ではこれら5種について詳細な記載と図を示し、分類学的考察を行った。*V. submicrospora* については選定基準標本を指定した。*V. nipponica* は河川の水辺の岩上に生育し、日本にかなり広く分布することが判った。