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# A Note on the Genus *Pertusaria* (Ascomycotina, Pertusariaceae) Collected in the Cheju Island, Korea

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**Abstract** Eight species of the genus *Pertusaria* in the family Pertusariaceae are reported from the Cheju Island in Korea. Among them four species are newly recorded for the Korean lichen flora. *P. coreana* Räsänen is reduced to a synonym of *P. astomoides* Nyl. The presence of pseudocyphellae is reported in *P. laeviganda* and *P. sublaevigand*. An artificial key for all species of the genus known to occur in Korea is provided.

**Key words:** *Pertusaria*, lichen, Korea, pseudocyphellae

The first report of the genus *Pertusaria* from Korea was made by Räsänen (1940) who described *P. coreana* Räsänen basing on a specimen collected in Korea. Huneck *et al* (1994) added three species, *P. commutata* Müll.Arg., *P. multipuncta* (Turner) Nyl. and *P. velata* (Turner) Nyl. Recently Moon (1999) added following 15 species to the lichen flora of Korea, *P. amara* (Ach.) Nyl., *P. composita* Zahlbr., *P. glauca* Zahlbr., *P. lactea* (L.) Arnold, *P. laeviganda* Nyl., *P. nakamurae* (Räsänen) Dibben, *P. pertusa* (L.) Tuck., *P. pseudamara* K.H.Moon & Shibuichi, *P. pustulata* (Ach.) Duby, *P. quartans* Nyl., *P. radiata* Oshio, *P. stenostoma* Nyl., *P. subfallens* Vain., *P. submultipuncta* Nyl. and *P. subobductans* Nyl. Consequently 19 species of *Pertusaria* are known in Korea at present.

During the lichenological investigation in the Cheju Island, Korea under the Collection Building and Natural History Studies in Asia and the Pacific Rim Project supported by the National Science Museum, Tokyo, Moon and Kashiwadani made an extensive collection of *Pertusaria*. As a result of taxonomic studies on them, nine species of *Pertusaria*, including four species newly found in Korea, will be reported in this paper.

## Material and Method

The present study is based on 50 specimens of the genus *Pertusaria* collected by Moon and Kashiwadani during their field survey for lichens in the Cheju Island in 2001. Details of collection site of this survey are shown in Kashiwadani *et al.* (2002). Specimens reported in the present paper are kept in the herbarium of the National Science Museum, Tokyo (TNS). Chemical substances were studied by means of thin-layer chromatography (Culberson & Johnson 1982) and HPLC. Sections of apothecia and thalli were cut by hand-razor and observed in GAW or lactophenol cotton-blue solutions.

## Species

**Pertusaria astomoides** Nyl., Lich. Jap. 51. 1890. (Figs. 1A & 1B)

Type collection: Japan, Takashima, E. Almquist s.n., 1879, on rock (H-NYL 22968!). TLC:

norstictic acid.

*Pertusaria coreana* Räsänen, Bot. Mag. Tokyo, 32: 96. 1940. Type collection: Korea, Prov. Pyongannam-do, Kangdong-gun, Yongdae-ri, on rock, [holotype in H (not seen), isotype in TNS (A. Yasuda 638!)], syn. nov. TLC: norstictic acid.

*Pertusaria astomoides* is characterized by the moderately thick and areolate thallus with tubercles containing pycnidia and verrucae producing 2–3 apothecia, the asci with two spores (140–165×50–55 μm in size), the common occurrence of pycnidia with black ostioles, the bacillar pycnoconidia (6–8 μm in length), the saxicolous habit along the coast and by the presence of atranorin and norstictic acid.

Räsänen (1940) described *Pertusaria coreana* based on a specimen collected on rocks at Yongdae-ri (near by Pyongyang) in Korean Peninsula. Even though the type specimen has no apothecia, it has conspicuously areolate and moderately thick thallus (Fig. 1B) and pycnidia in tuberculate verrucae that produce bacillar pycnoconidia, 7–8 μm in length. In addition, it produces norstictic acid as a chemical substance. Thus, it is reduced as a synonym of *P. astomoides*.

This species might be confused with *Pertusaria subobductans* Nyl., from which it can be distinguished by the areolate thallus, the verrucae with 2–3 apothecia, the common occurrence of pycnidia with black ostioles and by the saxicolous and maritime habit.

This species has been recorded only from southwestern Japan where it mainly grows on seaside rocks (Oshio 1981). However, we found it on sunny lava which is splashed with seawater in the Cheju Islands.

The specimen reported from Shodo-shima Island in Japan under *P. mendax* Müll.Arg. by Kashiwadani *et al.* (2000) is now identified with *P. astomoides*.

Specimens examined. Prov. Cheju: En route from Sehwa to Shihung-ri, Hado-ri, Pukcheju-gun, Cheju Island, on rocks (lava) along the coast, elevation 1–2 m, June 1, 2001, H. Kashiwadani 43838 & 43848a (TNS); Andok Valley, Andok-myon, Namcheju-gun, Cheju Island, on rocks along stream, elevation about 85 m. May 27, 2001, H. Kashiwadani 43608; Songsanlichubong, Sonsan-up, Namcheju-gun, Cheju Island, on rocks, elevation 80–182 m, May 29, 2001, H. Kashiwadani 43758.

Other specimen examined. Japan. Shikoku. Prov. Awa: Mt. Hoshigajo, Shodo-gun, on exposed rocks, elevation 780–700 m. December 15, 1998, H. Kashiwadani 41541 (TNS).

**Pertusaria laeviganda** Nyl., Lich. Jap. 53. 1890. (Fig. 1C & Fig. 2)

The diagnostic features for this species are, the subglobose verrucae with 6–8 apothecia, the presence of pseudocyphellae (Fig. 2A & 2B) on the thallus and verrucae, the 8-spored asci and the presence of stictic acid and 4,5-dichlorolichexanthone. It should be noted that this species forms pseudocyphellae on the thallus as well as on verrucae, which have never been reported from *Pertusaria*. However, pseudocyphellae in this species are often very rare or almost lucking as in the case of the holotype of *P. laeviganda* (Japan, Mt. Fuji, Umagaeshi, E. Almquist, 1879, H-NYL 23230!). Similar pseudocyphellae are formed also in *P. sublaeviganda*, though they are not so conspicuous.

The occurrence of this species from Korea was reported made by Moon (1999) and this is the second report for the species. It is common on tree barks such as *Abies*, *Acer*, *Carpinus* and *Quercus* at elevations higher than 900 m in the Cheju Island as in other areas of Korea (Moon 1999).

Specimens examined. Prov. Cheju: En route from Youngshil Rest Area to Witsae Oreum Shelter, Mt. Halla, Cheju Island, on bark of *Abies koreana*, elevation 1650–1700 m, May 24, 2001, H. Kashiwadani 43472; En route from Witsae Oreum Shelter to Eorimok, Mt. Halla, Cheju Island, on bark of *Carpinus* sp., elevation 1600–1000 m. May 24, 2001, H. Kashiwadani 43537; Along trail of Songpanak route to the summit, Mt. Halla, Namwon-up, Namcheju-gun, Cheju Island, on bark of *Carpinus* sp., elevation 750–900 m. May 28, 2001, H. Kashiwadani 43660 &

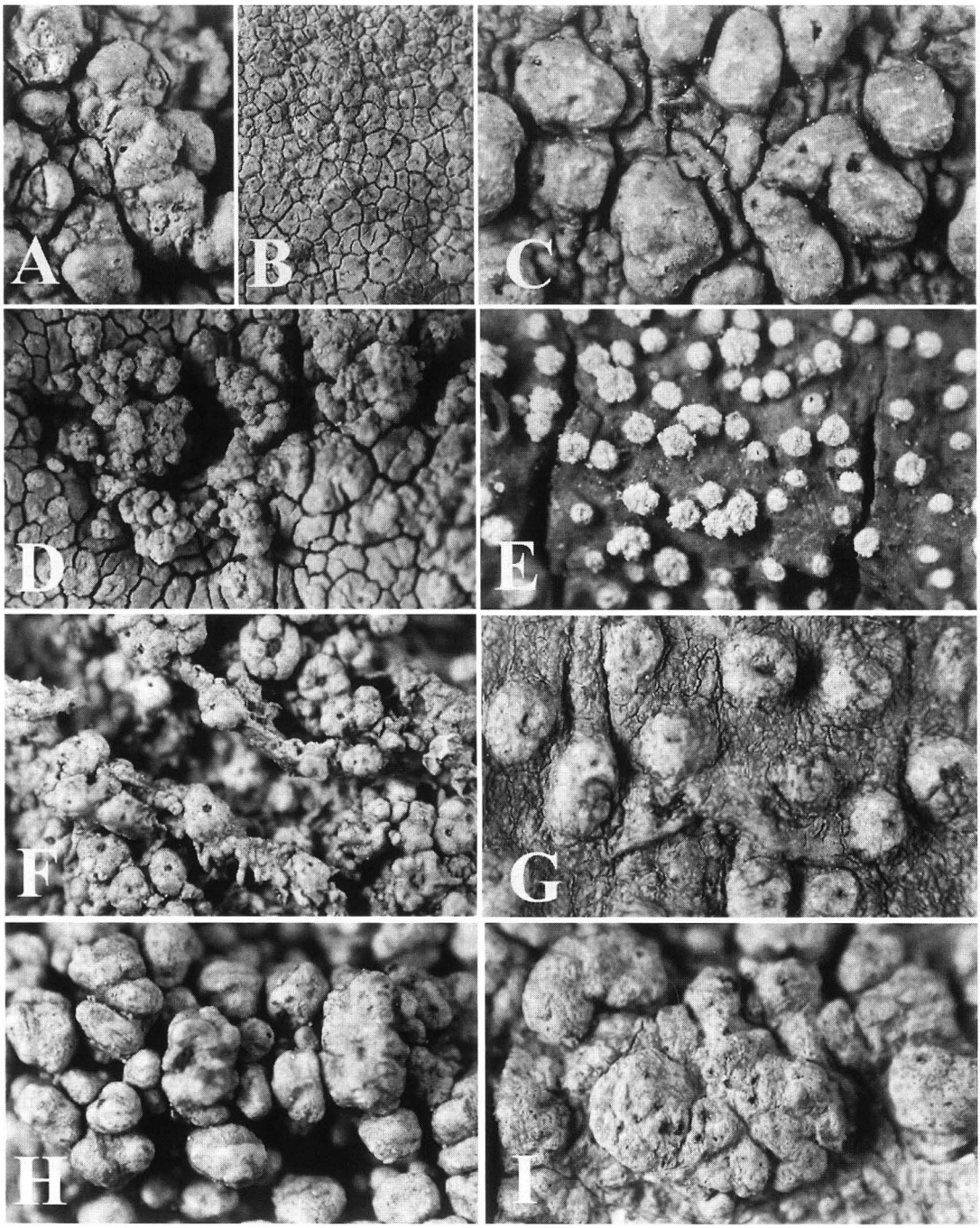


Fig. 1. *Peretusaria*. A, *P. astomoides* (H. Kashiwadani 43848a). B, *P. coreana* (A. Yasuda 638-isotype). C. *P. laeviganda* (K.H. Moon 5987). D, *P. leucosora* (H. Kashiwadani 43819). E, *P. multipuncta* (H. Kashiwadani 43738). F, *P. quartans* (K.H. Moon 5943). G, *P. subfallens* (H. Kashiwadani 43485). H, *P. sublaeviganda* (H. Kashiwadani 43449). I, *P. subonductans* (K.H. Moon 5939). Bar=2 mm.

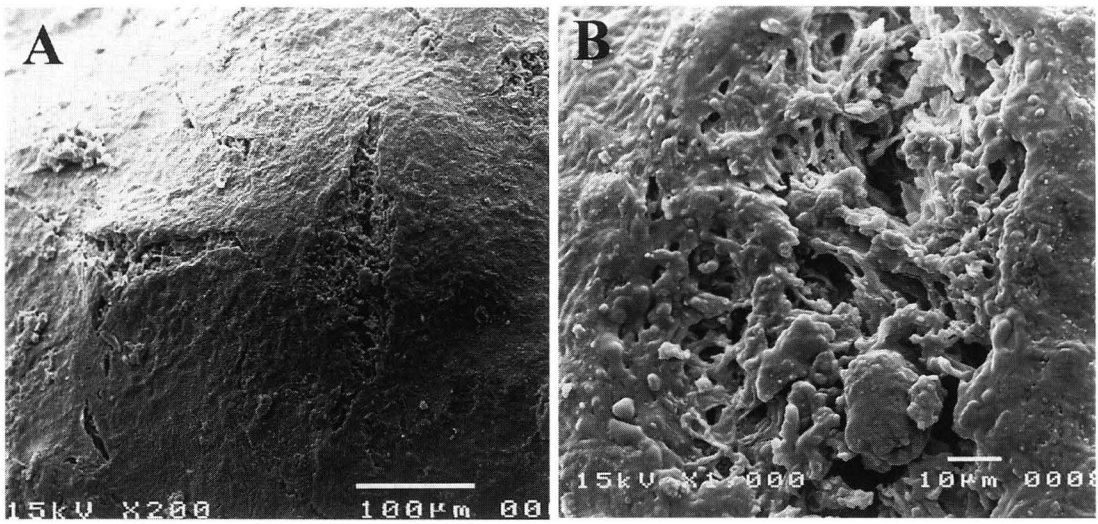


Fig. 2. A, Pseudocyphellae of *P. laeviganda* (K.H. Moon 5996). B, Magnification of a part of a pseudocyphellae (K.H. Moon 5996).

K.H. Moon 5914; the same locality, on bark of Quercus sp., elevation about 900 m, May 28, 2001, H. Kashiwadani 43682 & 43696; the same locality, on bark of *Carpinus* sp., elevation about 1260 m. May 31, 2001, K.H. Moon 5817; Youngshil Rest Area, Sogwip'o-shi, Cheju Island, on bark of *Quercus mongolica*, elevation about 1260 m, May 31, 2001, K.H. Moon 5996.

**Pertusaria leucosora** Nyl., Flora 60: 223. 1877. (Fig. 1D)

This species is easily distinguished from saxicolous species of *Pertusaria* by the sterile and areolate thallus with granular to postulate soredia and by the production of fumarprotocetraric and protocetraric acids as chemical substances.

Although *Pertusaria leucosora* has been known to occur widely from Honshu to Kyushu in Japan (Kashiwadani *et al* 1996, 2000; Kashiwadani & Inoue 1993; Oshio 1968), it has never been reported before from Korea. In the Cheju Island, it was found at one locality where it grows on rock (lava) in exposed condition at elevation about 1100 m.

Specimen examined. Prov. Cheju: 1100 m alt. Rest area along Rd. 99, Sogwip'o-shi, Cheju Island. On rock (lava); elevation about 1100 m. May 31, 2001, H. Kashiwadani 43819.

**Pertusaria multipuncta** (Turner) Nyl., Lich. Scand. 179. 1861. (Fig. 1E)

The diagnostic characters for *Pertusaria multipuncta* are the greenish gray to yellowish green thallus that is usually thin, smooth and poorly areolate, the marginally lacerate small apothecia (0.3–0.6 mm in diameter) with open and pale discs, the 1-spored asci and the production of fatty acids and hypothamnolic(±) acid.

Although this is one of the most common species of *Pertusaria* in Japan, it has been reported only from two localities in the Korean Peninsula, Mt, Sorak (Moon 1999) and Mt. Okryu (Huneck *et al.* 1994). In the Cheju Island, it is commonly found on barks from lowland up to 900 m high.

Specimens examined. Prov. Cheju: Supsum Island, Serguipo-shi, on bark of *Castanopsis sieboldii*, elevation 3–130 m, May 23, 2001, H. Kashiwadani 43462; Mt. Dansan, Sagye-ri, Andok-myon, Namcheju-gun, Cheju Island, on bark of Carpinus sp., elevation about 50 m. May 27, 2001, H. Kashiwadani 43659; Along trail of Songpanak route to the summit, Mt. Halla, Namwon-up, Namcheju-gun, Cheju Island, on bark of

*Carpinus* sp., elevation about 900 m, May 28, 2001, H. Kashiwadani 43678; the same locality, on bark, elevation 750–900 m, K.H. Moon 5888; Kwanumsa, Odung-dong, Cheju-shi, Cheju Island, on bark of *Castanea crenata*; elevation about 580 m, May 29, 2001, H. Kashiwadani 43738 & K.H. Moon 5923; Youngshil Rest Area, Sogwip'o-shi, Cheju Island, on bark of *Carpinus* sp., elevation about 1260 m. May 31, 2001, K.H. Moon 6040.

**Pertusaria quartans** Nyl., Lich. Jap. 54. 1890. (Fig. 1F)

*Pertusaria quartan* is peculiar in having muscicolous habit among species of *Pertusaria*. The hemiglobose apothecia with 4-spored spores and production of stictic acid and 4-5-dichlorolichexanthones are the diagnostic feature for this species.

This species has been reported only from Mt. Sorak (Moon 1999) in Korea and this is the second locality for the species. It grows over the mosses on barks in the Cheju Island as in the cases in Japan (Oshio 1968; Kashiwadani *et al.* 1996).

Specimens examined. Prov. Cheju: En route from Witsae Oreum Shelter to the summit of Mt. Halla, Cheju Island, on bark, elevation 1700–1750 m, May 24, 2001, H. Kashiwadani 43523; Along trail of Songpanak route to the summit, Mt. Halla, Namwon-up, Namcheju-gun, Cheju Island, on bark with mosses, elevation 750-900 m, May 28, 2001, K.H. Moon 5896; Kwanumsa, Odung-dong, Cheju-shi, Cheju Island, on bark of *Castanea crenata*, elevation about 580 m, May 29, 2001, K.H. Moon 5943.

**Pertusaria subfallens** Vain., Bot. Mag., Tokyo, 35: 55. 1921. (Fig. 1G)

As in the case of Japanese material, the Korean specimens contain fumarprotocetraric, protocetraric and succinprotocetraric(±) acids. The occurrence of this species in Korea was reported by Moon (1999). In the Cheju Island, it mainly grows on barks of *Abies* at elevation above 100 m.

Prov. Cheju: En route from Youngshil Rest Area to Witsae Oreum Shelter, Mt. Halla, Cheju Island, on bark of *Abies koreana*; elevation 1650–1700 m, May 24, 2001, H. Kashiwadani 43473 & K.H. Moon 5764; the same locality, on bark of *Betula* sp., elevation 1650–1700 m, May 24, 2001, H. Kashiwadani 43485; 1100 m alt. Rest area along Rd. 99, Sogwip'o-shi, Cheju Island, on twigs of *Maackia amurensis* subsp. *buergeri*, elevation about 1100 m, May 31, 2001, H. Kashiwadani 43766; En route from Eorimok to Mt. Eosungsang-ak, Cheju-shi, Mt. Halla, Cheju Island, on twigs of *Maackia amurensis* subsp. *buergeri*, elevation 900–1000 m, June 2, 2001, H. Kashiwadani 43792 & 43800; En route from Witsae Oreum Shelter to the summit of Mt. Halla, Cheju Island, on bark of *Abies koreana*, elevation 1700–1750 m, May 24, 2001, K.H. Moon 5773.

**Pertusaria sublaeviganda** Vain., Bot. Mag., Tokyo 35: 58. 1921. (Fig. 1H)

The characteristic features for this species are the more or less thick thallus with uneven surface with inconspicuous pseudocyphellae, the hemiglobose verrucae with 5–6 apothecia, the 8-spored asci, the ostioles without dark pigments (K−) and the production of confluentic acid and xanthones. The specimens collected in the present area coincide very well with the Japanese material.

This species has been reported only from Japan and the distribution range is extended to Korea. In the Cheju Island, it was found at only one locality where it grows on bark of *Carpinus*. It is interesting that the Korean specimen was collected at low altitude (130 m high) contrary to the fact that this species is known from montane to subalpine areas in Japan (Oshio 1968).

Specimen examined. Prov. Cheju: Supsum Island, Serguipo-shi, on bark of *Carpinus* sp., elevation 130 m, May 23, 2001, H. Kashiwadani 43449; En route from Youngshil Rest Area to Witsae Oreum Shelter, Mt. Halla, Cheju Island, on rock, elevation 1650–1700 m, May 24, 2001, H. Kashiwadani 43474.

**Pertusaria subobductans** Nyl., Lich. Jap. 52. 1890. (Fig. 1I)

This species was once reported from Mt. Sorak by Moon (1999). This is the second report from Korea. In the present area, it is rather common on barks or twigs of deciduous broad-leaved trees such as *Carpinus* and *Castanea*.

Specimens examined. Prov. Cheju: En route from Witsae Oreum Shelter to Eorimok, Mt. Halla, Cheju Island. On bark of *Carpinus* sp.; elevation 1600–1000 m. May 24, 2001, H. Kashiwadani 43550; Mt. Sanbangsan, Andok-myon, Namcheju-gun, Cheju Island, on twigs of tree, elevation 70–380 m, May 26, 2001, H. Kashiwadani 43578; Kwanumsa, Odung-dong, Cheju-shi, Cheju Island, on bark of *Castanea crenata*, elevation about 580 m, May 29, 2001, K.H. Moon 5939.

## Key to the Species of *Pertusaria* in Korea

1. Apothecia disciform, ascospores with a single wall ..... 2
1. Apothecia verruciform, ascospores with a double wall ..... 10
2. Generaly fertile, ascospores 1 or 2 per ascus ..... 3
2. Generaly sterile ..... 8
3. Ascospores 1 per ascus ..... 4
3. Ascospores 2 per ascus ..... *P. composita*
4. Picrolichenic acid present ..... *P. amara*
4. Picrolichenic acid absent ..... 5
5. Thallus P+ orange red, depsidone (protocetraric acid or norstictic acid) present ..... 6
5. Thallus P−, depsidones absent (fatty acids or lecanoric acid present) ..... 7
6. Protocetraric acid present .... *P. subfallens*
6. Norstictic acid present .. *P. submultipuncta*
7. Fatty acids present ..... *P. multipuncta*
7. Lecanoric acid present ..... *P. velata*
8. Thallus P+ orange red, protocetraric acid present ..... *P. leucosora*
8. Thallus P−, protocetraric acid absent .... 9
9. Thallus C+ red, lecanoric acid present .... ..... *P. lactea*
9. Thallus C−, picrolichenic acid present .... ..... *P. pseudamara*
10. Ascospores 8 per ascus ..... 11
10. Ascospores 2 or 4 per ascus ..... 13
11. Verruca larger (up to 3.5 mm in diameter), ascospores 110–130 μm in length ..... 12
11. Verruca smaller (less than 1.5 mm in diameter), not constricted at the base, ascospores smaller (less than 100 μm in length) ..... ..... *P. stenostoma*
12. Stictic acid present ..... *P. laeviganda*
12. Conflentic acid present ... *P. sublaeviganda*
13. Ascospores 4 per ascus ..... 14
13. Ascospores 1–2 per ascus ..... 17
14. Thallus UV+ brick red, xanthones present ..... 15
14. Thallus UV−, xanthones absent ..... ..... *P. nakamurae*
15. Inner wall of ascospore smooth ..... ..... *P. quartans*
15. Inner wall of ascospore rough ..... 16
16. Verrucae constricted at base, spores 130–180 μm in length ..... *P. glauca*
16. Verrucae not constricted at base, spores small, 100–130 μm in length .... *P. radiata*
17. Thallus UV+, xanthone and stictic acid present ..... 18
17. Thallus UV−, xanthone absent, norstictic acid present ..... 19
18. 4,5-dichlorolichexathone present, inner wall of ascospores smooth ..... *P. pertusa*
18. 2-chloro-6-*O*-methylnorlichexanthone present, inner wall of ascospores rough ..... ..... *P. pustulata*
19. Plant saxicolous, spores broadly ellipsoid, pycnidia common; norstictic acid present .. ..... *P. astomoides*
19. Plant mainly corticolous, spores oblong-ellipsoid, pycnidia usually absent; norstictic and perlatoric acids present ..... ..... *P. subobductans*

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