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On the taxonomy of *"Catapyrenium" plumbeum* (lichenized Ascomycetes, Verrucariaceae)

O. Breuß*

Abstract

"Catapyrenium" plumbeum is shown to comprise three species, two of which belong to *Verrucaria*, and one to *Placopyrenium*. *Verrucaria inficiens* is a nomen novum, *Verrucaria cetera* and *Placopyrenium noxium* are described as new. They differ in spore size, presence or absence of an involucrellum and other anatomical characters. At least when young they live as parasites on thalli of *Staurothele areolata*. The pycnidial type is regarded as a main character for distinguishing *Verrucaria* from *Placopyrenium*.

Key Words: Lichenized Ascomycetes, Verrucariaceae, *Catapyrenium plumbeum*, *Verrucaria inficiens* nom.n., *Verrucaria cetera* sp.n., *Placopyrenium noxium* sp.n., mycoflora of North America.

Zusammenfassung

Es wird aufgezeigt, daß *"Catapyrenium" plumbeum* im bisherigen Umfang drei Arten umfaßt, wovon zwei zu *Verrucaria* und eine zu *Placopyrenium* zu zählen sind. *Verrucaria inficiens* wird als nomen novum eingeführt. *Verrucaria cetera* und *Placopyrenium noxium* werden neu beschrieben. Die Arten unterscheiden sich in Sporengröße, Ausbildung oder Fehlen eines Involucrellums und weitere anatomische Merkmale. Zumindest jung leben sie als Parasiten auf Lagern von *Staurothele areolata*. Der Bau der Pycniden wird als Hauptunterscheidungsmerkmal zwischen *Verrucaria* und *Placopyrenium* angesehen.

Introduction

In the latest checklist of North American lichens (ESSLINGER & EGAN 1995) the generic name *Catapyrenium* is used in a very broad circumscription, mainly basing on the treatment by THOMSON (1987, 1989), who included within his concept of *Catapyrenium* squamulose as well as areolate and placodiate species. A more restricted circumscription was used by BREUSS (1990) in his revision of European species. Areolate species were excluded as belonging to *Verrucaria* since ontogenetic differences between *Catapyrenium* and *Verrucaria* were recognized: The thallus elements in *Catapyrenium*, the so-called "squamules" or "squamae", develop individually from the prothallus, whereas *Verrucaria* has a crustose thallus which develops into areolae by cracking. However, subsequent studies have shown that *Catapyrenium* still was heterogeneous, consisting of several discrete entities that deserve recognition at generic level. Strong support for the heterogenity of *Catapyrenium sensu lato* was the observation of two different pycnidial types (HARADA 1993): The *Xanthoria*-type (more properly named *Dermatocarpon*-type) pycnidium is a plurilocular type with several to many small cavities within paraplectenchymatous tissue; the conidiogenous cells surrounding each cavity are of the same size and shape as the tissue cells. The *Staurothele*-type pycnidium consists of a single central

* Dr. Othmar Breuß, Naturhistorisches Museum, Botanische Abteilung, Burgring 7, A-1040 Wien, Austria.

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cavity which is lined by a layer of flask-shaped conidiogenous cells. On base of pycnidial types in combination with perithecial and anatomical features BREUSS (1996) established or resurrected six segregates from *Catapyrenium*.

Morphologically similar to *Verrucaria* is the genus *Placopyrenium*. Its areolae have a lower cortex and are fastened to the substratum by corticated stipes, whereas the thallus of *Verrucaria* (if well developed at all) is not corticated below and fully appressed to the substratum. However, some *Verrucaria* species have better developed thalli with stipe-like attachment organs (see below). In these cases the type of pycnidia is distinctive: *Staurothele*-type in *Verrucaria*, *Dermatocarpon*-type in *Placopyrenium* (MÉNARD & ROUX 1995). *Placopyrenium* was described by BREUSS (1987); a detailed treatment is currently in preparation.

Results and discussion

One of the species treated below was originally described from New Mexico by DE LESDAIN (1932) as *Endopyrenium plumbeum* and transferred to *Catapyrenium* by THOMSON (1987). The thallus consists of small angular areolae with greyish, rather roughly pruinose upper surfaces. Its range was given from Alberta to Mexico along the Rocky Mountains on different kinds of siliceous and calcareous rocks in dry open sites. The chinky-areolate thallus of this species and its pycnidia of the *Staurothele*-type clearly shows that it is a member of the genus *Verrucaria*.

A critical revision of material labelled as *Catapyrenium plumbeum* revealed that this taxon is heterogeneous comprising two different *Verrucaria* species, one of which seems to be rather common in arid areas of the southwestern United States. These taxa may easily be confused with another hitherto undescribed species that, on account of anatomy and pycnidial type, has to be assigned to the genus *Placopyrenium*. Besides their morphological similarity these three spesies have in common their parasitic behavior: At least when young they live on thalli of *Staurothele* species, especially *S. areolata*, and may later become independent. Almost all herbarium samples contain certain amounts of these hosts in more or less close contact with the *Verrucaria* specimens, and partially parasitic behavior may be observed in most of them. For determination of these species, careful microscopical examination is necessary. The species are clearly distinguishable by spore size, presence or absence of an involucrellum and other anatomical characters.

***Verrucaria inficiens* BREUSS, nom.n.**

≡ *Endopyrenium plumbeum* DE LESD., Ann. Cryptog. Exot. 5: 100 (1932), non *Verrucaria plumbea* ACH., Lichenogr. Univ.: 285 (1810).
≡ *Catapyrenium plumbeum* (DE LESD.) THOMSON, Bryologist 90: 36 (1987).

Neotypus (hic designatus - original material probably destroyed at Dunkerque during World War II. like most of de Lesdain´s type material): Rio Arriba Co., San Juan River near Bancos Canyon, 5 mi S of Rosa, on dry exposed sandstone, 5860 ft, 18.7.1960, S. Flowers 1042 [COLO].

Annotation: In NY is a second specimen with same collecting data, except for different altitude.

Thallus areolate, whitish or bluish grey, dull, ± roughly pruinose. Areoles (0.5 -) 1 - 2 (- 2.5) mm, close together or becoming separate, flat to slightly convex, angular to

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somewhat rounded, rarer slightly incised (especially those at thallus margin), basally ± constricted, fastened to the substratum by a central hyphal bunch, free marginal parts of lower side pale brown to blackish, no hypothallus visible.

Areoles 200 - 400 µm thick (up to 1 mm including the "stipe"), upper cortex 15 - 20 µm thick, of small roundish-angular cells (4 - 6 µm diam.), outer cell layer brownish, overlain by a thickish amorphous layer (20 - 40 µm). The cortical paraplectenchyma continues laterally down to the free lower sides of the areoles. Algal layer continuous, algal cells 7 - 10 µm diam., alga-free medullary tissue ± cellular or with filamentous parts, especially near the attachment organ which is formed largely by longitudinally arranged hyphae with substratum particles in between.

Perithecia within the areolae, 1 to several per areole, entirely sunken into the areoles or with slightly protruding tips. Exciple pale at first and black around the ostiole, then darkening throughout, subglobose or pyriform, up to 350 (- 500) µm broad, without involucrellum. Periphyses 25 - 35 µm long and 2.5 - 3 µm thick. Asci clavate, 60 - 75 × 15 - 23 µm. Spores biseriately arranged, broadly ellipsoidal, 12 - 16 × 7.5 - 10 µm.

Pycnidia of *Staurothele*-type, small (up to 80 µm diam.), visible as small black irregular dots often in small depressions of the areoles. Pycnospores cylindrical, 5 - 7.5 × 1 µm.

The host species is mostly *Staurothele areolata*; one sample was found with *S. elenkinii*.

Verrucaria inficiens is somewhat atypical for *Verrucaria* as its areolae are corticated below and anchored by short central hyphal bunches similar to the stipes characteristic for *Placopyrenium*. But its pycnidial type clearly puts this species in closer affinity with *Verrucaria* and is here regarded as a species of *Verrucaria*.

Additional specimens examined: **Arizona:** Coconino Co, 5 mi E of Page, on rock, 14.10.1972, T.H. Nash III 5450 [ASU]. - Gila Co., Washington Park, trail 290 (Col. Devin trail), 11.7.1997, O. Breuß 13.189 [Herb. Breuß].

Colorado: Boulder Co., Lykins formation 0.5 mi S of Red Hill summit, between Altona and Lyons, 6000 ft, 14.11.1954, S. Shushan & W.A. Weber [COLO]. - Boulder Co., south base of Steamboat Mt., arid slope with *Cercocarpus montanus*, 1.5 mi N of Lyons, on Lyons sandstone, 5500 ft, 10.3.1959, S. Shushan & W.A. Weber [COLO]; on sandstone rimrock, Steamboat Mt., west slope, 2 mi NW of Lyons, 6000 ft, 7.4.1965, W.A. Weber [COLO]; calc. sandstone ledges, west slope of Steamboat Mt., 2 mi NW of Lyons, 5300 ft, 30.4.1966, W.A. Weber, R. Santesson & R.A. Anderson [COLO]; Steamboat Mt., 2 mi NW of Lyons, 6000 ft, 1.4.1967, Weber & Anderson [COLO]. - Boulder Co., Morrison limestone, just W and NW of Boulder, ca. 5900-6000 ft, 1.4.1962, R. Anderson [COLO]. - Boulder Co., Bear Creek road, S of Boulder, W of Devil's Thumb subdivision, on thin bedded shale, Niobrara formation, just E of Dakota Ridge, 31.1.1992, W.A. Weber [COLO]. - Larimer Co., *Pinus edulis* stand on limestone outcrops of Ingleside formation, Owl Canyon, 9.7 mi N of Teds Place (junction of Hwy. 287 and 14), ca. 6000 ft, 6.4.1955, W.A. Weber & S. Shushan [COLO, WIS]. - Larimer Co., Owl Canyon, 29 km NW of Fort Collins, Ingleside Formation, on calcareous sandstone of limestone-capped cuesta, 1800 m, Livermore Quadrangle, 12.4.1972, W.A. Weber, Lich. exs. 391 sub *Dermatocarpon plumbeum* [ASU, COLO, UBC, WIS]. - Larimer Co., sandstone and conglomerate of the Lytle Formation, Dakota Ridge, 22 mi N of Ft. Collins, 2 mi SE of Table Mt., 6300 - 6500 ft, 26.6.1960, R.A. Anderson [COLO]; Dakota Ridge, 4.5 mi SW of Ft. Collins, just above Horsetooth Reservoir, 5450-5900 ft, 17.7.1960, R.A. Anderson [COLO]. - Mesa Co., north end of Colorado National Monument, ca. 3 mi S of Fruita, *Pinus edulis-Juniperus osteosperma* community, on sandstone mesatop above Coke Ovens Overlook, 6200 ft, 12.5.1955, S. Shushan & W.A. Weber [COLO]; ibid., sandstone hogbacks at mouth of Fruita Canyon, 4600 ft, 12.5.1955, S. Shushan & W.A. Weber [COLO]. - Mesa Co., Colorado National Monument, Fruita (west) entrance highway not far below the rim below the Headquarters area, on sandstone ledges, 5600 ft., 23.11.1983, W.A. Weber [COLO]. - Montezuma Co., N-facing slope, Beaver Creek, 6 mi N of McPhee, 7500 ft, 12.6.1958,

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S. Shushan [COLO]. - San Miguel Co., Gypsum Gap, east end of Big Gypsum Valley, on massive sandstone blocks and ledges on summit of hill, on lip of small horizontal ledges, 20.3.1990, W.A. Weber & J.-C. Wei [COLO, NY]. - Weld Co., Wildcat Point, 2 mi N of Grover, 5.12.1965, Lanham [COLO]. - Yuma Co., 6 mi E of Wray, on N-facing, dry outcrops of limestone and chert conglomerate, ca. 3600 ft, 22.8.1960, S. Shushan & R. Anderson [COLO].

New Mexico: Grant Co., Little Hatchet Mts., Howell´s Ridge, 5000 - 5500 ft, NE limestone slopes, 11.&14.5.1992, R.D. Worthington 20863, 20855 [COLO]. - Harding Co., mesa SW of Bueyeros, 4500 ft, 17.9.1957, S. Shushan [COLO]. - Rio Arriba Co., San Juan River near Bancos Canyon, 5 mi S of Rosa, on dry exposed sandstone, 5700 ft, 18.7.1960, S. Flowers 1042 [NY]. - San Juan Co., west slope of mesa 5400 ft, 2 mi S of state line, US Hwy 666, N of Shiprock, 6.1957, S. Shushan [COLO]. - San Juan Co., Chaco Canyon National Monument, Charca Mesa S of Wijiji ruins, 36° 01´ N, 107° 52´ W, on Cliff House sandstone, 6400 ft, 6.8.1979, L. Sigal & T.H. Nash III 16411 [WIS].

South Dakota: Custer Co., Black Hills, 0.5 mi S of Lame Johnny Creek on S.D.79 (15 mi NE of Hot Springs), in open stunted ponderosa pines, 3500 ft, 5.7.1961, C.M. Wetmore 10650 [Hb. Vezda]. - Lawrence Co., vicinity of Timon Camp Ground, 4 mi WSW of Savoy, 11 mi W of Lead, in Limestone Plateau Region, near Little Spearfish Creek, 5.600 - 5.900 ft, 4.6.1960, R.A. Anderson [COLO].

Utah: Emery Co., San Rafael Swell, 0.4 km N of Wedge Overlook, 39°06´N, 110°46´W, Colorado Plateau, pinyon-juniper com., elev. 1380 m, on calc. sandstone, 3.9.1993, St. & S. Sharnoff 1181.15 [CANL]. - Millard Co., Desert Range Experiment Station, 50 mi W of Milford, 4500 ft, on rock in Rabbitbrush and *Kochia*, 7.1975, D.C. Anderson 112 [NY]. - San Juan Co., Devil´s Canyon, 6300 ft, on sandstone, 21.6.1952, S. Flowers 495 [COLO]. - Tooele Co., Stansbury Mts., N end, on dry exposed limestone, 4300 ft, 11.5.1952, S. Flowers 447 [COLO]. - Uintah Co., Mesa Verde sandstone formation, just back of Doug Chew cabin, Dinosaur National Monument, 7500 ft, 3.6.1956, W.A. Weber [COLO, NY, WIS]. - Uintah Co., below Split Mt., above camp, 4679 ft, 22.7.1962, S. Flowers [COLO]. - Wasatch Co., Currant Creek, 5300 ft, on sandstone, 3.8.1952, S. Flowers 867 [COLO].

Wyoming: Campbell Co., Rochelle Hills, head of Wildcat and S Fork Keyton Creeks, 1500 - 1550 m, Fort Union formation, *Pinus ponderosa-Juniperus*-sagebrush association, 5.-8.6.1975, W.A. Weber [COLO]. - Sweetwater Co., Green River at Paria Bottom, on dry exposed sandstone, 6120 ft, 3.7.1959, S. Flowers 945 [COLO); ibid., 6300 ft, 3.7.1959, S. Flowers 935, 936 [COLO, NY]. - Sweetwater Co., Green River, Brinegar Ranch, 18.7.1959, S. Flowers [COLO].

Verrucaria cetera BREUSS, sp.n.

Species habitu *Verrucariae inficienti* persimilis, a qua praesertim sporis maioribus et involucrello conspicuo differt.
Type: Colorado: Archuleta Co., north slope, *Quercus-Pseudotsuga* woods, Simms Ranch, 2 mi N of Chromo, ca. 8000 ft, 14. 6. 1955, S. Shushan [COLO, holotype; Hb. Vezda, isotype].

Additional specimens examined: **Colorado:** Archuleta Co., south slope, juniper hillside, Simms Ranch, 2 mi N of Chromo, ca. 8000 ft, 14.6.1955, S. Shushan S9915 right specimen [COLO]. - Garfield Co., 5 mi N of Rifle, sandstone ridge on west side of Rifle Creek along south edge of grand Hogback 2 mi SW of Rifle Gap, 1800 m, on talus blocks on steep east-facing slope, 12.6.1974, W.A. Weber, G. Kunkel & J. Munger [COLO].

New Mexico: San Juan Co., Pinos River at Benito Canyon, on dry exposed sandstone, 5700 ft, 16.7.1960, S. Flowers no. 951 [COLO, NY]. - San Juan Co., Chaco Canyon National Monument, Charca Mesa S of Wijiji ruins, 36°01´N, 107°52´W, on Cliff House sandstone, 6400 ft, 6.8.1979, L. Sigal & T.H. Nash III 16411 [NY]. - San Juan Co., Chaco Canyon National Monument, south side of Gallo Wash across from campground, 36°02´N, 107°53´W, on Cliff House sandstone, elev. 6300 ft, 5.8.1979, L. Sigal & T.H. Nash 16.171 [COLO]. - San Juan Co., Chaco Canyon National Monument, south side of Chaco Wash across from Hungo Pavie ruins, 36°02´N, 107°56´W, on sandstone, 6200 ft, 7.8.1979, L. Sigal & T.H. Nash [SFSU].

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Fig. 1: Distribution (maps based on cited specimens only): a) *Verrucaria inficiens*, b) *Verrucaria cetera* (dots) and *Placopyrenium noxium* (asterisks).

Morphologically, the species is very similar to *Verrucaria inficiens*. The most obvious differences are the larger spores and the presence of a well-developed involucrellum, which circles at least around the upper part of the perithecium, later extending to base of perithecium and sometimes enveloping the whole ascoma. Further differences include the longer periphyses, an oily hymenial inspersion, the lack of paraplectenchymatous lateral and lower cortices, and longer, often slightly bent pycnospores (see key).

The host species is *Staurothele areolata*.

Placopyrenium noxium BREUSS, sp.n.

Parasitica in *Staurothele areolata*. Anatomia areolarum ut in *Verrucaria inficiens*, sed pycnidia typo *Dermatocarpi*. Thallus crassior. Areolae stipitibus corticatibus in substrato affixae. Sporae 14 -18 × 7 - 9 µm.
Type: Canada, Alberta, summit of Plateau Mt., 50 mi N of Coleman, alpine area with patterned ground, elev. 8000 ft, 15. 8. 1969, C.M. Wetmore 18651 [WIS, holotype].

Morphologicaly *Placopyrenium noxium* is very similar to both previous species, from which it differs mainly in its somewhat thicker areoles with broader parts of their undersurface naked and distinctly corticated stipes. The generic difference is mainly in its pycnidial type. The species grows on *Staurothele areolata*.

Additional specimens examined: U.S.A.: **Colorado:** Larimer Co., sandstone and conglomerate of the Lytle Formation, Dakota Ridge, 22 mi N of Ft. Collins, 2 mi SE of Table Mt., ca. 6.300 - 6.500 ft, 26.6.1960, R.A. Anderson [COLO]. - **Utah:** Wasatch Co., Currant Creek, on dry exposed sandstone, 6700 ft, 6.8.1952, S. Flowers 592 [COLO]. - **Wyoming:** Carbon Co., vicinity of Silver Lake, 7 mi W of Snowy Range Pass, Medicine Bow Nat. Forest, ca. 10.000 ft, 12.8.1956, S. Shushan [COLO].

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Key to *Verrucaria* and *Placopyrenium* species parasitic/epiphytic on *Staurothele*

1 Pycnidia of *Dermatocarpon*-type, thallus up to 1 mm thick, areoles fastened to the substratum by distinct corticated stipes, spores 14 -18 × 7 - 9 µm .... ***Placopyrenium noxium***

1* Pycnidia of *Staurothele*-type, areolae fastened to the substratum by central hyphal fascicles, thallus thinner 2

2 Ascospores 12 - 15 (- 16) × 7 - 9 (- 10) µm. Perithecia without involucrellum, periphyses - 35 µm long, hymenium always without oil droplets. Areolae with lateral and lower cortices. Pycnospores 5 - 7.5 µm long, straight ..... ***Verrucaria inficiens***

2* Ascospores (18 -) 20 - 25 (- 27) × (8 -) 9 - 12 µm. Perithecia with involucrellum which envelops at least the upper half of the perithecium. Periphyses - 50 µm long, hymenium often inspersed with oil droplets (especially in the area of the ostiolum). Areolae without lateral and lower cortices. Pycospores 7.5 - 10 µm, often slightly curved ..... ***Verrucaria cetera***

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