

Staurothele Norman
(VERRUCARIALES: VERRUCARIACEAE s. lato: STAUROTHELACEAE)

Thallus crustose, immersed or superficial, often inconspicuous, usually dark brown to blackish, smooth to uneven, continuous to rimose, areolate, or verrucose, rarely subsquamulose. Photobiont Stichococcus or Pleurococcus, also present in hymenium as numerous globose-cuboid or cylindrical cells between the asci.

Perithecia superficial or immersed in thalline warts, forming pits when on limestone. Involucrellum present or absent. True exciple complete black, or pale below. Periphyses present, conglutinate; paraphyses absent. Asci verrucarioid, without a distinct ocular chamber but sometimes with an apical "plug" staining red with Congo Red. Spores 2, 4 or 8, muriform, colorless to deep brown.

Pycnidia immersed; conidiogenous cells short-ampulliform, acrogenous; conidia bacilliform, simple, colorless. No substances. On calcareous or siliceous rocks, often in and by streams or lakes.

The hymenial algal cells, though considerably smaller than those in the vegetative part of the thallus, are the same species. Care is required in determining the presence and shape of hymenial algal cells and the number of ascospores per ascus.

After Thomson, 1991

Rev. Dec. 1993

[Note: Thomson does not accept the shape of the hymenial algae as a taxonomic criterion; info. on the shapes of the algae is mostly from a preliminary edition of his key and should be taken with a grain of salt].

I. Subgenus Sphaeromphale (Spores 1-2 per ascus)

1. Thallus with radiate areoles at margins. 2

1. Thallus without radiate areoles. 3

2. Marginal areoles narrow and highly convex. Lobes ± contiguous. Hymenial algae spherical. Hymenial gelatin I+ blue (or + red-brown?). Thallus brown or blackish brown, shining or matt, thin or thick, the central areoles thicker and larger than the peripheral, the marginal areoles (on fine-grained substrates) contiguous and appearing radiate or (on coarse-grained and eroding substrates) becoming separate and dispersed-radiate ("S. perradiata"), sometimes (particularly on quartz substrates) preceded by a blackish cobwebby prothallus. Perithecia entirely within the central thallus verrucules, 0.4-0.6 mm diam., only the mouth visible, simple; exciple hyaline, surrounded by a dark thalloid layer between it and the involucrellum;

involucrellum prominent and black, curving around most of the exciple. Spores brown, to 9-septate transversely and 3-septate longitudinally, ellipsoid or elongate ellipsoid, 24-50 x 11-21 μ m. Hymenial algae ellipsoid. Growing on (usually?) acidic rocks in irrigated depressions, often in cold running water as in snowmelt areas. Alaska to Greenland, south in the mountains to the southwestern U.S. (southern California to Texas and Oklahoma), and to southeast Canada, New York in the east. Extremely variable in vegetative morphology and appearance. Report of S. succedens is based on misidentification of this species. S. drummondii (Tuck.) Tuck. (synonyms: S. fuscocuprea, S. septentrionalis, S. perradiata, Endocarpon wilmsoides)

2. Marginal areoles flattened, squamule-like, to 2 mm long and 1 mm broad, black below. Thallus gray, areolate; areoles 0.3-1.0 mm broad. Perithecia within the central areoles, only the mouth visible as an inconspicuous small projection of the areole; exciple dark; hymenial algae predominantly short, 3-4 μ m long; spores pale, to 7-septate transversely, 3-septate longitudinally, 40-45 x 15-20 μ m. On siliceous rocks, Arizona and Mexico (Sonora). S. effigurata Thomson

3. Perithecia within the rock, leaving a cavity when falling out. Spores 30-52 x 15-22 μ m, 2-4, ellipsoid, very soon dark brown, with 10-12 transverse and 3-5 longitudinal septae. Perithecia about 0.2 mm wide, \pm completely immersed in the rock, covered by the thallus, only the tip showing; involucrellum lacking; exciple dark all around, simple but the upper edges a little thicker than the sides; hymenial gelatin I+ wine red. Thallus endolithic, sometimes making a powdery layer over the surface, sooty gray-white to brownish. Hymenial algae subglobose or cuboid, 2-3(-4.5) mm diam. On hard limestones in exposed situations, British Columbia, NW Territories, Utah. S. rupifraga (Massal.) Arnold

3. Perithecia surficial on the rock or \pm embedded in thallus. 4

4. Perithecia surficial on the rock. Thallus lacking or nearly so. 5

4. Perithecia within thallus areoles. 6

5. Spores 27-62 x 18-30 μ m. Thallus, if visible, confined to scant tiny black verrucules, or appearing as a whitish discoloration of the substrate. Spores to 8-septate transversely, 3-septate longitudinally, dark brown. Perithecial warts subspherical with the base constricted, to 0.7 mm broad. Perithecia single in the verrucule, to 0.5 mm broad; involucrellum carbonaceous and constricted below, with algae visible in the lower portion, subcompound in the sense of Swinscow, dark reddish brown; hymenium I+ blue. On calcareous rocks, shales, or sandstones, 2750-9400 ft, on dry rocks, often in steppe-like areas. Arizona to Oklahoma, north to Washington, Minnesota and Saskatchewan, with disjuncts in the northernmost parts of the

Northwest Territories. Report of S. rufa from Washington was based on misidentification of this species. S. elenkinii Oksn.

5. Spores narrower, 32-65 x 12-18 um. Thallus, if visible, consisting of traces or brown or ashy brown thin areoles less than 0.1 mm broad, scattered around the perithecia. Spores slanting in ascus, ellipsoid, muriform, many celled, becoming dark brown. Perithecia sessile on thallus traces or substrate; involucrellum dark brownish black, nearly surrounding the pale brown exciple, hyaline above, dark below; hymenium I+ blue. Greenland and Ellesmere Island. Possibly only a severely depauperate extreme of S. drummondii. [Also, the distinctions from S. elenkinii as given by Thomson do not seem that great, but the information given by him is difficult to use in comparisons]. S. arctica Lynge

6. Thallus with a continuous zone toward periphery; interior either smooth, chinky, or becoming areolate.

7

6. Thallus entirely areolate or chinky-areolate. 8

7. Perithecia within humps raised above the general thallus level.

Thallus dark brown to brown-black, sometimes with paler marginal rings, continuous towards margin, becoming finely chinky to angular chinky-areolate in the interior (less distinctly areolate than S. clopimoides), usually with a broad smooth outer zone, often shining, paraplectenchymatous, the upper cells strongly browned; algae distributed through the thallus. Perithecia hemispherical or flattened, immersed in 0.3-0.5 mm broad warts with broadening bases; mouth projecting; black when dry, brown when wet; exciple 0.27-0.36 mm thick, pale; involucrellum brown to black-brown; hymenium I+ blue then violet. Hymenial algae globose-cuboid, 2-3 um diam. Spores (25-)30-38(-50) x (10-)15-20(-22) um, many-celled. On moist, hard, acidic rocks in streams and seepage. Montane, subarctic-boreal, Alaska to Greenland, south to Connecticut and Ohio in the east (down to near sea-level), to Colorado, Arizona and California in the west (2100-13500 ft). S. fissa (Taylor in Mack.) Zw. (synonyms: S. hazslinskyi, S. umbrina (nomen confusum), S. circinata, S. lithina sensu Zahlbr., S. glacialis)

7. Perithecia immersed, not projecting above the general level.

Thallus coppery brown, thin, smooth and continuous to deeply rimose-areolate, or scattered and reduced to small verrucules or patches around the perithecia. Perithecia entirely embedded within thallus, only the flattened mouth showing as a low convex protrusion in the areolae of the thallus; involucrellum pale brown; exciple pale brown, darker above and merging with the involucrellum for about 1/3 of the upper part; hymenial gelatin I+ blue then violet. Hymenial algae elongate. Spores 2 per ascus, many celled, finally dark brown, ellipsoid or elongate, 38-50 x 14-21 um. On siliceous rocks (granites and gneiss), submerged in brooks and on lake shores. Alaska south to California and Colorado in the west and south to the Great Lakes area and Maryland in the east. S. clopimoides (Anzi ex Arnold) Stein.

in Penther & Zederbauer

8. Areoles \pm narrowed at base, appearing somewhat spherical; sterile and fertile areoles of same size; ostioles surrounded by conspicuous black involucrellum or else pruinose. 9

8. Areoles rimose, not narrowed at base; perithecial mouth dark but not ring-like or pruinose. 10

9. Perithecia with black involucrellum showing conspicuously, ring-like, around ostiole. Widespread. Thallus deeply cracked-areolate to subsquamulose, thick (300-700 μ m), contiguous to dispersed; fertile and sterile areoles similar, out to the margin of the thallus. Perithecia within the larger areoles, only the mouth showing with part of the involucrellum; involucrellum thickened only near the mouth (subcompound in the sense of Swinscow), black or dark brown, merging with the thallus tissue; exciple hyaline to pale brown, blackening toward the mouth; spores 2 per ascus, dark brown, muriform with many cells, ellipsoid or ovate, 20-50 x 15-25 μ m. Hymenial algae cylindrical, 6-10 x 3-4 μ m. On acid rocks, often near but not in the water. Arctic-boreal-temperate, Alaska to Greenland, south to New England and the Great Lakes states in the east and to California and Mexico (Hidalgo) in the west. S. areolata (Ach.) Lett. (synonyms: S. clopima sensu Th. Fr. non (Wahlenb.) Th. Fr., S. catalepta sensu Malme and sensu Zschacke)

9. Perithecia with conspicuous pruinose tip around the ostiole on areoles; actual mouth not visible and perithecia deep within areoles. Southwestern (Utah and Nevada). Thallus brownish black, areolate; areoles tiny (0.2-0.5 mm diam.), rounded, hemispherical. Involucrellum dark, wrapping around the exciple; hymenial algae from spherical, ca. 5 μ m diam., to more commonly elongate, to 6-8 μ m long. Spores brown, 2-5-septate longitudinally, to 9-septate transversely, 38-55 x 18-25 μ m. On arid sandstones. S. orispruinosa Thomson

10. Thallus dark brown, smooth, often with radiate-lobed appearance, the "lobes" contiguous or widely separate; areoles rounded above; fertile ones larger than sterile peripheral ones. Marginal areoles narrow and highly convex. Lobes \pm contiguous. Hymenial algae spherical. Hymenial gelatin I+ blue or + red-brown. (see S. drummondii, above)

10. Thallus black or dark-brown (then slightly rough above), or greenish yellow to olive-gray or ashy, chinky-areolate; areoles rounded or flat. 11

11. Thallus ashy or bluish-ashy. 12

11. Thallus greenish yellow, olive or brown, with surface smooth or only slightly rough, or dark brown to black, with surface epruinose

and only slightly rough. 13

12. Thallus surface very rough (roughening raised, almost vermiculate), ashy, pruinose; areoles very angular and chinky; spores 57-70 x 35-37 μ m. Areoles flat, 0.2-0.7 mm broad; pruinosity angularly patterned; sides vertical and black. Perithecia embedded in the areoles with only the mouth showing; involucrellum lacking; upper part of exciple dark, lower part pale. Spores partly 1 per ascus, brown. On sandstone, Colorado and Utah, ca. 5500-6000 ft. S. rugosa Thomson

12. Thallus surface slightly rough (mealy appearing), bluish gray; areoles very flattened (tile-like); spores 29-38 x 12-18(-28) μ m. Perithecia pruinose. Thallus bluish-ashy, quite thin, chinky-areolate. Perithecia minute, immersed, apex flat. Hymenial algae globose. Thallus bluish ashy, quite thin, chinky-areolate; areoles minute, angular, flat, confluent; hypothallus lacking. Perithecia single in areoles, tiny (0.2 mm); apex flat, pruinose; exciple black, entire; hymenium I+ blue turning red. Spores hyaline, many celled, short- to elongate-ellipsoid. On siliceous rocks, New Mexico, known only from the lectotype. [The lectotypification changed the concept of the species, which was originally described as having 2 spores per ascus]. S. lecideoides B. de Lesd. [emend. Thomson]

13. Thallus dark brown (slightly more olive-brown when moist), chinky-areolate; areoles angular, tiny, 0.1-0.2 mm broad; perithecia completely immersed and only broadened black tip of involucrellum visible; hymenial gelatin I-; spores 23-39(-50) x 10-18(-20) μ m. On dry non-calcareous rocks. Hymenial algae spherical. Medulla and hypothallus dark. Thallus surface minutely rough; marginal areoles sometimes slightly tending to become radiate. Perithecia 0.6-1.0 mm diam., single in the areoles; ostiole not noticeable. Involucrellum wrapping around the dark exciple; asci saccate; spores partly 1 per ascus, oval, pale, to 6-11-septate transversely, 1-2-septate longitudinally. Areoles flat; surface matt. [Thomson also compares this species to S. drummondii, which has convex areoles, and to S. tenuissima, which has spores 6-8 per ascus]. Mexico (Morelia), north to California, Utah, New Mexico and Texas. S. polygonia B. de Lesd.

13. Thallus (overall appearance in the mass) greenish yellow to olive-gray; areoles 0.1-0.3 mm broad; perithecia with involucrellum projecting conspicuously above thallus level and perithecia only partly embedded in thallus; hymenial gelatin I+ blue; spores 37-52 x 13-20 μ m. On calcareous rocks. Thallus of close angular areoles 0.1-0.3 mm broad, dull greenish brown to orange brown; areoles usually only slightly convex, the sides vertical and not shiny. Exciple black. Asci broadly clavate. Spores soon darkening, 7-8(-12)-septate transversely, 2-3-septate longitudinally. Growing at 2200-12500 ft elevation. Arizona and southern

California, northeast to Minnesota and North Dakota, and north to NW Nevada. [Thomson also compares this species to S. areolata, which differs in having strongly convex, shiny brown areoles and involucrellum within the areoles]. S. monicae (Zahlbr.) Wetm.

II. Subg. Polyblastioides (Spores 4-8 per ascus).

1. Perithecia within the rock, leaving a cavity when falling out. Spores 30-52 x 15-22 um, 2-4 per ascus. On limestone, British Columbia, NW Territories, Utah. (see S. rupifraga)

1. Perithecia within the thallus, not leaving a cavity. Spores 4-8 per ascus. 2

2. Perithecia within globular verrucae covered with angular crystals; exciple subcompound and also at times subduplicate; spores hyaline to pale brownish, 37-45 x 15-23 um. Thallus consisting of scattered dark gray-green to blackish areoles or granules at least partly covered with calcareous nodules giving it a gray appearance. Perithecia adnate on the rock, subcompound (with only a dark thickening around the ostiole), black at apex, embedded in Pertusaria-like globular thalline verrucae which are constricted at base and covered with angular crystals; exciple appearing subduplicate with a black basal portion varying from a flange-like extension to cupping the main exciple, 100 um thick, dark brown; hymenial gel I+ blue; spores 8/ascus, hyaline then pale brownish, muriform, 1-3(-4) septate longitudinally, 5-8-septate transversely, 37-45 x 15-23 um. Hymenial algae spherical or cuboid to twice as long as broad, 3 x 3-6 um. On **calcareous** rocks near waterfalls and in seepages, and on rock fragments on frost boils, northern Alaska and NW Territories. Report of S. hymenegonia is based on misidentification of this species. S. discedens (Nyl.) Zahlbr.

2. Perithecia embedded within flat-areolate thallus. 3

3. Thallus of tiny granulose verrucules combined into areolate-appearing units, greenish gray or ashy gray; perithecia with dimidiate involucrellum; spores hyaline, 4(-8) per ascus. Verrucules subsidiose. Perithecia black, bare (i.e., epruinose?), ca. 0.3-0.5 mm broad, with the basal 1/3-1/2 embedded in the verrucules; excipulum dark red, ca. 50 um thick; surrounded only to the base by a dark red to reddish black involucrellum 125-150 um thick; ostiole scarcely visible. Spores 5-7-septate transversely, 1-2-septate longitudinally, 18-32 x 10-25 um. On conglomerate, 5700 ft, Arizona. S. verruculosa Thomson

3. Thallus of smooth-surfaced definite areoles; areoles gray to coppery brown or bluish ashy; perithecium not dimidiate; spores usually 8 per ascus, hyaline to brownish. 4

4. Thallus coppery brown, chinky-areolate; areoles flat, angular, tiny, 0.15-0.30 mm; involucrellum compound; spores 20-32 x 10-15 um. Perithecia immersed, then \pm prominent with square or concave tips, solitary in the areoles, with the mouth and part of the involucrellum protruding, compound; involucrellum dark,

reaching the base of the exciple and wrapped inward; exciple dark brown, paler within; hymenial gelatin I+ blue turning red; asci broadly clavate; spore 6-8 per ascus, oblong or ellipsoid, hyaline. Hymenial algae globose. Thallus thin (0.1 mm), matt; surface smooth. On non-calcareous rocks in deciduous forests, Tennessee and Alabama. S. tenuissima Degel.

4. Thallus ashy to pale brownish; areoles slightly convex, angular, larger, 0.5-1.0 mm; involucrellum subcompound; spores small, 15-22 x 9-12 μ m, 8 per ascus, hyaline, 5-7-septate transversely, 1-2-septate longitudinally. Perithecia distinctly immersed in the areoles, dark; ostiole raised and prominent; involucrellum dark, around the mouth and flaring outward; exciple hyaline; hymenial gelatin I+ blue turning wine red. Hymenial algae globose to somewhat oblong. Hymenium I+ green-gold. Thallus continuous or partly dispersed; some areoles chinky-split, the fertile ones with the black ostiolar mouth prominent and slightly raised; thallus containing vertical rows of hyphal cells with algae in intercalated rows. On **calcareous rocks in moist habitats, such as ravines which occasionally carry water in heavy downpours. Eastern (New England to Alabama, west to Minnesota, Iowa and Missouri). S. diffractella (Nyl.) Tuck.**

Literature

Thomson, J. W. 1991. The lichen genus Staurothele in North America. The Bryologist 94(4): 351-367.

In: Purvis, et al., Lichen Flora of Great Britain and Ireland. Galloway, D. 1985. Flora of New Zealand Lichens.