STUDIES OF CANADIAN THELEPHORACEAE

V. TWO NEW SPECIES OF *ALEURODISCUS* ON CONIFERS[1]

By H. S. Jackson

Abstract

Two species of *Aleurodiscus* occurring on conifers, which have been under observation for several years, are described as new. Both are related to *Aleurodiscus roseus* (Pers. ex Fr.) Höhn. & Litsch. The first, described as *A. Minnsiae* sp. nov., occurs most commonly on *Tsuga canadensis* and is noteworthy because of an associated sclerotial disseminating phase of characteristic morphology, which has been known under the herbarium name *Minnsia carnea* E. & E. ined. The history of our knowledge of this phase is given in some detail. The second species occurs on *Pinus Strobus* and is described as *A. Pini* sp. nov. The known collections of both species are listed. Comparative culture work was conducted which showed that the two species are heterothallic, have a different growth rate, and are incompatible. They are also different from a form of *A. roseus* occurring on *Populus* which proved to be homothallic.

Introduction

Among the interesting forms encountered in connection with a general study of the Thelephoraceae of northeastern North America, considered with special reference to those found in Ontario, Canada, two species of *Aleurodiscus* which occur on coniferous hosts have been under observation for several years.

These species, one of which occurs most commonly on *Tsuga canadensis* and the other, so far exclusively on *Pinus Strobus*, both show relationship with *Aleurodiscus roseus* (Pers. ex Fr.) Höhn. & Litsch. (= *Corticium roseum* (Pers. ex Fr.) Fr.). The latter species, as ordinarily considered, is quite certainly a collective one as is clearly indicated when a large series of specimens having the general morphological features of the species are compared. Only the one species has so far been recognized in North America. In Europe, Bourdot & Galzin (1), Pilat (8), and Litschauer (6) recognize a second species, *Aleurodiscus polygonioides* (Karst.) Pilat (= *Corticium polygonioides* Karst.). Burt (4, p. 224) included the latter as a synonym of *Corticium roseum*. Bourdot & Galzin place the two species in a special section, Aleurodiscoideae, of *Corticium*. Pilat includes them in a subgenus Lyomyces, of *Aleurodiscus*, based on the emended genus of that name proposed by Karsten.

There would seem to be little question that the relationship of these forms is with *Aleurodiscus* because of the large flexuous basidia and the characteristic branched paraphyses. In *Aleurodiscus* or in *Corticium*, however, they form a sharply delimited group as was clearly recognized by Pilat and Bourdot.

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This group, we venture to predict, will ultimately contain several recognizable species and when better understood it may be found logical to include them in a genus separate from *Aleurodiscus*.

A serious difficulty in resolving the collective species, *A. roseus*, into the different biological entities of which it is quite obviously composed, lies in the paucity of clear-cut morphological characters. The general characters are distinctive enough and there is little difficulty in recognizing the group. The variations in the basic microscopic characters in the apparently different forms are, however, usually not of a magnitude that makes for clear-cut distinctions. Spore size, shades of color in some cases, and the general character of the fructification and of the substratum, are of assistance in indicating the existence of different species within the complex. An extensive comparative study of cultures in the dikaryophase, together with interfertility studies from series of monospore cultures of the suspected segregates, will need to be made before the picture is at all clear.

The two species which form the subject of the present contribution are obviously distinct from each other and, we believe, sufficiently characteristic to justify separation from the two species already recognized in the group.

Aleurodiscus Minnsiae

The species to be described under the above name is of special interest because of a unique sclerotial disseminating phase which precedes the basidial fructification and occurs on the upper side of the twigs of the host in mid-summer or early fall (Figs. 5, 6, 7). This phase when mature consists of a brightly colored, open, cup-shaped structure about 1 mm. in diameter which has in the center, loosely attached at the base, a flattened sphaeroid body about 1/2 mm. in diameter which finally becomes free and apparently functions as a sclerotial propagating body. The structure might be described as like a tiny "nest" with a single "egg". It shows a superficial resemblance to *Sphaerobolus* but is sessile on the substratum and has a more open, less lacerated peridium, with no suggestion of a median gelatinous layer.

Historically it is this phase of the fungus to be described which has previously attracted the attention of mycologists because of its unique structure and because it proved to be one of those mycological puzzles, the solution of which is so often long delayed.

My own interest in this species began when, in company with Dr. L. O. Overholts, the sclerotial phase was collected on the twigs of *Tsuga canadensis* during the 1934 foray of the Mycological Society held at Inlet, N.Y. (Aug. 21–23). At that time no one at the foray who saw the material had any suggestions as to its identity or relationship though it was noted that a sterile *Corticium*-like fungus was associated. Unfortunately the collection was not shown to Dr. C. L. Shear who was in attendance at the foray and who, as was later revealed, could have given it a name. In October of that year I collected the same fungus in the vicinity of Toronto on larger branches of *Tsuga*,

accompanied on the under side by a conspicuous pink, sterile fructification which showed the general morphological characters of *Corticium roseum.* During that fall, tissue cultures were made from the peridium and from the "egg" as well as from the accompanying corticioid fructification. All grew rapidly and produced a characteristic clamp-bearing mycelium. No difference in the character of the hyphae or the growth of the colonies could be detected. Fig. 9 shows colonies from the three sources planted side by side on the same plate. The species has been under observation more or less regularly since 1934 and there seems no question that the sclerotial structure is a phase in the life history of the *Aleurodiscus.* The association is constant, though the sclerotial phase begins to develop early in the season, usually during July and August, while the basidial fructification is not usually prominent till in September or October.

In the summer of 1935 I learned from Dr. J. R. Hansbrough that he had collected a similar fungus in Oregon on the branches of *Pinus contorta* which he had sent to Dr. Shear who had identified it as *Minnsia carnea* E. & E. ined. I then wrote to Dr. Shear telling him of my interest and preliminary work on the fungus. After some correspondence, Dr. Shear very graciously turned over to me, in February of 1936, certain notes he had accumulated and at one time had intended to publish. I am greatly indebted to Dr. Shear for this cooperation.

From these notes I learned that there are, in the herbarium of the Bureau of Plant Industry at Washington, from the residue of the J. B. Ellis herbarium which Dr. Shear had purchased from the executors after the death of Ellis's daughter, two parts of a collection (Ellis's *4031*) made by S. A. Beach and D. G. Fairchild, July 2, 1892, on twigs of *Tsuga canadensis* on the south bank of Watkins Glen, New York. These specimens are labeled *Minnsia carnea* E. & E. nov. gen. & sp. On one of the packets in Ellis's handwriting, is a note which reads as follows: "This was sent me by Miss Minns* 8 or 10 years ago from the Lake Superior region and has lain in my herbarium under the name *Minnsia carnea* E. & E. but has not been published, as the fructification is uncertain. I tried M. C. Cooke but he was unwilling to give it a name. It is apparently a nov. gen. near *Sphaerobolus.*" J.B.E.

The collection by Miss Minns referred to by Ellis in the note quoted above has recently been located by Dr. D. P. Rogers in the Ellis Herbarium at the New York Botanical Garden. The outside packet bears the following data: "*Minnsia carnea* Ell. (nov. gen. allied to *Tubercularia*), on dead branches, Keweenaw Point, Michigan, August 1882, Miss S. Minns (in package numbered 28)". The packet bears the number *3703*, evidently Ellis's herb. no. Inside is a note in Ellis's hand: "Cooke says of this *3703*: 'I have not been able to

* *It is evident from the proposed generic name that it was Ellis's intention to name the fungus in honor of Miss Minns. To perpetuate this intention, as seems fitting, I have selected the specific name "Minnsiae" for the Aleurodiscus. It is now quite certain that the person Ellis intended to honor was Miss Susan Minns (1838–1938), an enthusiastic amateur botanist, resident in Boston. She was for many years a member of the Gray Herbarium Visiting Committee and during her active years corresponded with many American botanists.*

make anything satisfactory of this. This can be better done on the spot in watching its development. It is at any rate curious and I suppose somewhat allied to *Michenera artocreas*' ". Inside the packet is another label marked "*Minnsia carnea* E. & E., collected in the Lake Superior region by Miss S. Minns". The collection consists of two twigs, evidently of hemlock, with an abundance of the sclerotial phase in an excellent state of preservation. There is no evidence of an associated basidial fructification.

Dr. Shear mentions having collected this many years ago on hemlock at Alcove, New York. This collection has not been located. There are in the Bureau of Plant Industry several other collections (see "Specimens examined"), including a part of the collection made by Overholts and myself at Inlet, New York, which is apparently the first seen by Dr. Shear which showed an associated immature corticioid fructification. He also noted the resemblance of this to *Corticium roseum.*

From Dr. Shear's notes I also learned that Dr. W. W. Diehl had seen a collection of this fungus in the herbarium of the State Museum at Albany, New York, which I later borrowed through the courtesy of Dr. H. D. House. This specimen is labeled *Illosporium cupulatum* Peck ined. and was collected in July (year ?) on *Tsuga canadensis* at Sylvan Beach (Oneida Lake), New York by C. H. Peck. This collection on examination proves without doubt to be the *Minnsia carnea.* It had been examined at one time by Dr. John Dearness, and a note made by him accompanying the specimen reads as follows: "This is a curious thing. One form seems to be parasitic on the other but on dissection they seem to have the same hyphal structure. I do not get the nature or position of the spores". The "forms" referred to are evidently the peridium and the "egg". My own examination failed to reveal spores of any sort.

Dr. Roland Thaxter also knew of this fungus in the sclerotial phase as is evidenced by collections in the residue of his herbarium at Harvard University, labeled *Minnsia carnea* E. & E. There are two parts of a collection made by Thaxter at Intervale, New Hampshire, and another made at Lewes, New York, by A. H. W. Povah. One of the Intervale packets bears the following note in Thaxter's hand: "Burt, May 1920, says he never saw anything like it". An earlier collection made by Thaxter in 1887 at Cranberry, N.C. has recently been discovered by Dr. D. P. Rogers among unidentified material at the Farlow Herbarium which bears the note "apparently *Sphaerobolus*".

More recently, Dr. J. R. Hansbrough and associates at the New Haven Laboratory of Forest Pathology, following the identification of the collection on *Pinus contorta* from Oregon by Dr. Shear in 1932, have repeatedly collected this species on *Tsuga canadensis* in New England, notably in Maine, New Hampshire, and Vermont. A set of these collections was recently sent to me by Dr. Hansbrough and are listed below under "Specimens examined".

As nearly as I can determine, the name *Minnsia carnea* E. & E. ined. has appeared in the literature only once. A reference to this form was made

by Spaulding and Hansbrough (9) in connection with a study of decay of logging slash in the northeast. They say of this fungus (p. 10): "*Minnsia carnea* is so little known that it never has been scientifically described, yet it is plentiful on hemlock twigs and weakens them so that they break at the infected places". The name also appears in tables on pp. 8 and 10 of their publication.

Aleurodiscus Minnsiae sp. nov. (Figs. 1 to 7, 9, 11)

Fructificatio late effusa vel in irregularibus areolis, primo vivide roseo-alutacea, dein cremeo-alutacea vel alba, tenuiter membranacea, separabilis, margine abrupto vel attenuato; subiculum crasse tunicatis hyphis 3–4μ diam. nodoso-septatis compositum; paraphyses multae, nodulosae, ramis irregularibus brevibusque praeditae; basidia longo-cylindracea vel subclavata, 80–110 × 8–10μ, flexuosa, 4 subulatis arcuatis 7–8.5μ longis sterigmatibus praedita; basidiosporae ovoideae 12–16 × 8.5–11μ, tunicis tenuibus, hyalinis, non-amyloideis.

Fructification when mature widely effused or in irregular patches, bright pinkish buff to shell pink or pale flesh color when fresh, fading to cream buff or white, 125–200μ thick, surface at first continuous, becoming rimose in age exposing the subiculum, soft membranous, separable, margin irregular, abrupt or thinning out; subiculum made up of thick-walled hyphae, 3–4μ in diam., with capillary lumen, arranged more or less horizontally below, interwoven in the subhymenium, with regular clamps; paraphyses abundant in the hymenium, thin-walled, 1.5–2μ in diam., nodulose, with irregular peglike branches; basidia arising from deep in the subiculum, long cylindrical or subclavate 80–100 × 8–10μ, more or less flexuous, bearing four subulate, arcuate sterigmata, 7–8.5μ long; basidiospores ovoid 12–16 × 8.5–11μ, slightly flattened on one side with conspicuous apiculus, walls thin, smooth, colorless, non-amyloid.

Basidial fructification preceded or accompanied by a characteristic sclerotial disseminating phase described in the text.

Specimens examined:*

Ontario: On *Tsuga canadensis*, N. Bathurst St., Toronto, Oct. 1934, with R. F. Cain, TRT *8231*, NY; Bell's Lake, N. of Parry Sound, Sept. 22, 1935, TRT *8233*, NY, FH, BPI, OTB, IA; East of Maple, Nov. 9, 1935, TRT *8232*, NY, FH, BPI, OTB; May 5, 1936, TRT *9835*, NY, FH; June 1, 1936, with R. F. Cain, TRT *10474*; Holland River Marsh, Oct. 2, 1936, with R. F. Cain, TRT *11116*, NY, FH; June 3, 1937, TRT *11131* **type**, NY, FH, BPI, OTB, UPS; TRT *11697*; Oct. 1937, TRT *12176*, NY, FH, OTB, BPI; South of Aurora, June 1, 1936, TRT *10471*; East of Hatchley, Oct. 13, 1936, R. F. Cain, TRT *10164*; near Sutton, Sept. 23, 1936, TRT *9836*, NY, FH, BPI, OTB, IA; "Glengert", Terra Cotta, May 23, 1937, TRT *11698*; N.E. of Sharon, Oct. 17,

* *Unless otherwise noted, Ontario collections were made by the writer. The herbarium abbreviations, indicating where specimens are deposited, are as proposed in the report on the standardization of herbarium abbreviations, Chronica Botanica, 5 : 142-150. 1939.*

1937, TRT *11624*; West of Maple, June 11, 1937, TRT *11700*, NY, FH, BPI, OTB, IA, UPS; Sept. 27, 1937, TRT *11699*; East of Snelgrove, May 21, 1937, TRT *12644*; West of Aurora, June 1, 1938, TRT *13240*, NY; near Killarney Lodge, Algonquin Park, Sept. 14, 1938, TRT *13445*; Pinetree Lake, Algonquin Park, Aug. 19, 1940, R. F. Cain, TRT *22458*, IA; Petawawa Forest Reserve, Chalk River, Sept. 1, 1941, TRT *17493*, NY; Sept. 5, 1941, TRT *17411*; Oxbow Lake, W. of Algonquin Park, Aug. 16, 1941, R. F. Cain, TRT *17915*, UPS.

Quebec: On *Tsuga canadensis*, Mt. Burnet, J. W. Groves, Aug. 2, 1933, OTB F*6150*, F*6409*, F*6549*, TRT; May 20, 1936, H. S. Jackson *et al.*, TRT *22948*, OTB F*6726*, F*6593*, F*6727*, NY; June 3, 1936, F. L. Drayton, OTB F*6605*, TRT; July 17, 1938, F. L. D., OTB *8326*, TRT.

British Columbia: On *Tsuga heterophylla*, Royston, July 29, 1938, I. Mounce, OTB F*8962*, TRT; on *Pinus ponderosa*, D'Arcy, June 16, 1930, J. R. Hansbrough *174*, NY; (as *Minnsia carnea* E. & E.); on *Pseudotsuga taxifolia*, Cinema, July 23, 1949, W. G. Ziller, V*5000*, TRT, NY; on *Abies lasiocarpa*, Cinema, July 25, 1949, W. G. Ziller V*5003*, TRT.

Maine: Freeport, Dec. 31, 1903, O. O. Stover (herb. Burt, ex herb. P. L. Ricker, as *Corticium roseum*) FH, TRT; on *Tsuga canadensis*, Elliotsville, Sept. 12, 1905, P. L. Ricker *1622*, BPI *71255*, TRT; Orient, July 8, 1935, H. G. Eno and J. R. Hansbrough, BPI FP*68986*, TRT; Skowhegan, July 8, 1935, H.G.E., BPI FP*88980*, TRT; Cornville, July 8, 1935, J.R.H. and H.G.E., BPI FP*88981*, TRT; Dover-Foxcroft, July 8, 1935, J.R.H. and H.G.E., BPI FP*88982*, TRT; Danforth, July 9, 1935, H.G.E. and J.R.H., BPI FP*88978*, TRT; Brookton, July 9, 1935, H.G.E., BPI FP*88979*, TRT; Milo, July 8, 1935, H.G.E., BPI FP*88985*, TRT; Otis, Aug. 24, 1943, J.R.H., BPI FP*93276*, TRT; Bar Harbor, Sept. 10, 1945, J.R.H., BPI FP*93577*, TRT.

New Hampshire: On *Tsuga canadensis*, Intervale, Sept. 1901, R. Thaxter, FH; Thornton, July 16, 1933, H. G. Eno and J. R. Hansbrough 177, BPI FP*63678*, NY, TRT; Waterville, July 16, 1933, J.R.H. *176*, NY; Marlow, Aug. 9, 1933, P. Spaulding and H.G.E., BPI FP*63026*, TRT; Plainfield, June 18, 1936, H.G.E., BPI FP*69972*, TRT; Bottomless Pit, Hanover, Aug. 27, 1937, L. O. Overholts, *20462*, TRT.

Vermont: *On Tsuga canadensis*, North Hero, Sept. 13, 1935, H. G. Eno, BPI FP*69173*, TRT; Poultney, Sept. 27, 1935, J. R. Hansbrough, BPI FP*69371*, TRT; Shoreham, Sept. 27, 1935, H.G.E. and J.R.H., BPI FP*69826*, TRT; Mt. Tabor, May 6, 1936, H.G.E., BPI FP*70136*, TRT; Bethel, May 7, 1942, P. Spaulding, BPI FP*93265*, TRT.

New York: On *Tsuga canadensis*, Sylvan Beach (Oneida Lake), July, C. H. Peck, NYS (as *Illosporium cupulatum* Pk. ined.); South bank of Watkins Glen, July 2, 1892, S. A. Beach and D. G. Fairchild, Ellis's *4031* (as *Minnsia carnea* E. & E.), BPI; New Salem, June 2, 1924, H. D. House *235*, NYS, TRT; Vaughans, N. of Hudson Falls, Dec. 1914, MO *44009*, TRT; Feb. 13, 1915, MO

44194, CU PP*27793*, W. L. White Herb. *3346*, FH, TRT; March 27, 1914, CU PP*27797*, W. L. White Herb. *2351*, FH, TRT; Feb. 20, 1915, CU PP*27792*, W. L. White Herb. *3347*, FH, TRT, IA, (all as *Eichleriella Leveilliana* (B. & C.) Burt, collected by S. H. Burnham); Lewis, Aug. 1920, A. H. W. Povah *899*, FH, NY, TRT (as *Minnsia carnea* E. & E. ined.); Newcomb, Sept. 29, 1932, P. Spaulding and H. G. Eno, BPI FP*82333*, TRT; Eagle's Nest, Inlet, Aug. 23, 1934, L. O. Overholts *18946*, and H. S. Jackson, TRT *22949*, BPI; N. Hudson, July 25, 1935, H. G. E., BPI FP*69023*, TRT; Moriah Center, July 25, 1935, H.G.E., BPI FP*69037*, TRT; Alexandria Bay, Sept. 12, 1935, H.G.E. and J. R. Hansbrough, BPI FP*69825*, TRT; Churubusco, Sept. 13, 1935, H.G.E., BPI FP*69185*, TRT; King's Ravines, N. of Frontenac Point, Cayuga Lake, May 2, 1937, TRT, NY, FH, IA; July 8, 1937, TRT, CU PP, NY, FH, IA; Oct 13, 1946, TRT *21338*, NY (all collected by the author).

Pennsylvania: On *Tsuga canadensis*, Ross Run, Huntingdon Co., April 29, 1934, L. O. Overholts *16885*; April 11, 1936, L.O.O. *19249*, TRT; July 5, 1936, L. O. O. *18707*, TRT; Alan Seeger Monument, Huntingdon CO., 4/3/37, G. L. Zundel, CU PP*25776*, TRT; Stone Creek, Huntingdon Co., June 27, 1936, L.O.O. *18734*, TRT; Laurel Run, Huntingdon Co., April 11, 1937, L.O.O. *20207*; Lamar Gap, Clinton Co., July 27, 1940, L.O.O. *22921*, TRT.

Michigan: On *Tsuga canadensis*, Keweenaw Point, Aug. 1882, Miss S. Minns, Ellis Herb. *3703*, NY (as *Minnsia carnea* E. & E. nov. gen.).

Tennessee: On *Tsuga canadensis*, Cades Cove, June 2, 1946, L. R. Hesler, TENN *17473*, TRT.

North Carolina: On *Tsuga canadensis*, Cranberry, July–Aug. 1887, R. Thaxter, (as "apparently *Sphaerobolus*") FH, NY, TRT.

California: On *Pseudotsuga taxifolia*, Darlingtonia, Jan. 3, 1947, H. E. Parks *6947*, TRT, NY, FH.

Oregon: On *Pinus contorta*, Rhododendron, Clackamas Co., Mar. 21, 1931, J. R. Hansbrough *173*, BPI, NY, TRT; on *Pseudotsuga taxifolia* (same locality) Nov. 5, 1930, J.R.H. *175*, NY.

By far the majority of the collections listed above are of the sclerotial or "Minnsia" phase as that is the stage that has attracted the attention of collectors. No attempt has been made to indicate, in the list of specimens examined, those which are primarily of the basidial fructification. No doubt such fructifications have been more frequently collected than the specimens available would indicate but have been discarded since collections made in the fall are sterile. It is probable also that collections may have been filed in herbaria as *Corticium roseum*. It has been possible to check only a few herbaria for such collections. Most of the Ontario collections listed are of the basidial fructification.

The flaring cup-shaped structure of the "Minnsia" stage, occurring as it does on the upper side of twigs and small branches, is suggestive that a

"splash-cup" mechanism may operate in the dissemination of the sclerotia, similar to the method briefly described by Dr. G. W. Martin (7, p. 244) for the dissemination of the peridiola in *Crucibulum*. During the early period of my interest in the "Minnsia" the late Dr. A. H. R. Buller had lectured at Toronto concerning his experimental studies of this mechanism as applied to the dissemination of the peridiola of the Nidulariaceae, and of the gemmae of the liverworts and mosses. Specimens of the "Minnsia" were shown to Dr. Buller and later to Dr. H. J. Brodie, who had been associated with Dr. Buller in this study. Both agreed that the structure was such that, in all probability, the sclerotia may be disseminated by drops of rain or drippings from branches above, splashing into the cups. No experimental tests have as yet been conducted with the "Minnsia". Dr. Buller's studies of this mechanism, so far as I am aware, remain unpublished except for an abstract (2) of a paper presented to the Royal Society of Canada in 1942.

There is ample evidence, supported by field observations, that the sclerotia are disseminated and serve as propagating bodies. The "Minnsia" stage is usually at its best with fully developed sclerotia in August and early September though collections have been made in July. Later in the fall the peridia are found to be empty. These gradually shrivel and dry after the sclerotia have been disseminated but may persist to the degree that they are recognizable during the winter months and well into early spring.

The sclerotia when planted on nutrient agar develop a rapidly growing mycelium from all sides and pure cultures are easily obtained from the marginal hyphae of such colonies. In nature, if a sclerotium comes to rest on the side of a twig or branch, it develops toward the under side a felt of mycelium which ultimately becomes a basidial fructification. There is some evidence that such colonies are at first rather superficial with very little development of mycelium in the bark though no detailed histological study has been made. Occasionally, where a fruiting body of the "Minnsia" stage is developed toward the side of a twig, mycelium may grow out from the base of the peridium.

In the development of the "Minnsia" stage the structure is at first a small, more or less sphaerical body which appears to break out from the superficial layers of the bark (Fig. 7). As it enlarges, a cleavage zone develops which results in the separation of an outer layer which becomes the flaring peridium, and an inner core which is left as the egglike sclerotium. The latter, when fully mature, is loosely attached at the base and easily removed. While there is no evidence of any specialized outer layer to the sclerotia, the hyphae have thick walls which presumably gelatinize, in the presence of moisture, sufficiently that the sclerotia adhere to any surface on which they come to rest. They are bright salmon in color when fresh.

Aleurodiscus Minnsiae, as is evident from the hosts listed above, has so far been collected most commonly on *Tsuga canadensis* in northeastern North America and probably occurs throughout the range of that host. No collections have yet been made on other coniferous hosts in that region. In the

west, however, collections have been made on two species of *Pinus*, *Tsuga heterophylla*, *Pseudotsuga taxifolia*, and *Abies lasiocarpa* bearing a fungus which appears to be morphologically identical with the "Minnsia carnea" stage of

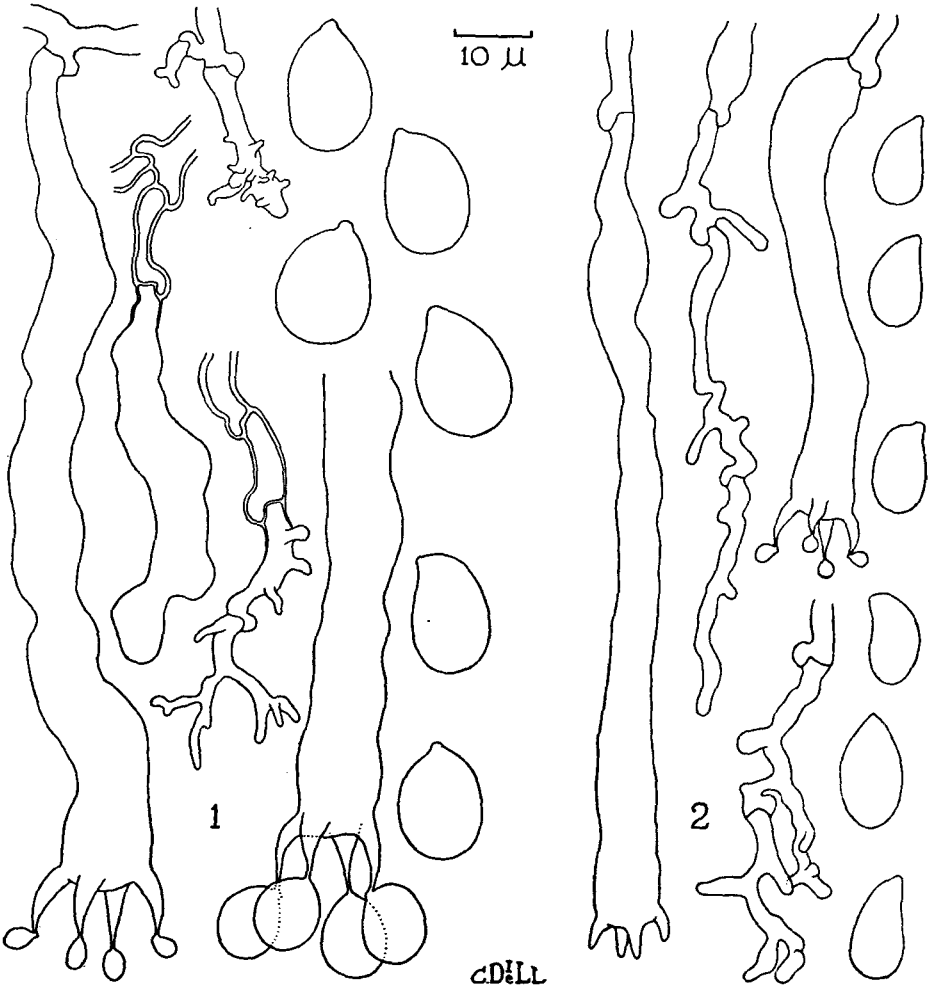

FIG. 1. *Aleurodiscus Minnsiae, basidia, spores, and paraphyses.*

FIG. 2. *Aleurodiscus Pini, basidia, spores, and paraphyses.* (*Reproduced at approximately ×1000.*)

the eastern species. Dr. D. P. Rogers informs me that he, also, had collected the "Minnsia" in Oregon on *Pseudotsuga* but no specimens are available and were perhaps not preserved. Unfortunately no basidial fructification is associated with any of these western collections except the ones from California and British Columbia on *Pseudotsuga taxifolia* and the one on *Abies lasiocarpa* from the latter province. The fructifications are immature. It is not possible, therefore, to state with finality that the western collections are *A. Minnsiae.* They are included in the above list with some hesitation.

While it seems probable that the basidial fructifications on these hosts, when available in good sporulating condition, will prove to be inseparable from *A. Minnsiae*, it must be recognized that biologically distinct forms or races may exist which might be indistinguishable morphologically. Quite recently preliminary evidence has been obtained that the western forms may show differences. During the summer of 1949 Dr. Mildred K. Nobles made cultures from the sclerotia of the two collections from British Columbia listed above on *Pseudotsuga taxifolia* and *Abies lasiocarpa* which she was kind enough to send me. Comparison of these with a culture of the eastern form on *Tsuga canadensis*, isolated in October 1949 from sclerotia, indicates a decidedly different growth rate of the mycelium. Since no detailed study of the growth rate of collections made of the eastern form from different collections or localities is available, the full significance of the observation recorded above cannot be properly evaluated at present. It is obvious that a further study of western collections on different hosts in comparison with the eastern form is desirable.

A notable feature of *A. Minnsiae* is the fact that the basidia mature in the spring, commonly in late May or June. Ontario collections of the basidial fructifications made in the fall, winter, or early spring are sterile but show immature basidia in various stages of development depending on the date of collection. This is true also of the form on *Pinus Strobus* to be described later in this paper and of a form of *A. roseus* on *Populus* discussed on p. 74. It is not, however, true for all collections commonly labeled *Corticium roseum* or *Aleurodiscus roseus* as found in herbaria. Collections from Ontario on *Acer* and on undetermined wood, for example, are fruiting in September and October. Of 33 collections in the University of Toronto herbarium made in various parts of the United States on broad-leaved hosts, 14 are sterile, 11 are producing basidia in the fall or winter, and 8 are fruiting in the spring. The related European species, *A. polygonoides*, evidently is in fruiting condition in the fall, judging from the few collections available.

In 1915 Burt (3) recorded *Eichleriella Leveilliana* (B. & C.) Burt as occurring in New York State on the basis of three collections made by S. H. Burnham at Hudson Falls and one by G. W. Clinton at Buffalo labeled *Stereum Leveillianum* B. & C. House (5, pp. 22, 32) also records the species from New York based on another collection made by Burnham, the identification of which is credited to Burt. These records are decidedly out of range for this species, which is said to be common only in the southern states and in tropical America. The Burnham collections, cited by Burt, are on twigs of *Tsuga canadensis*

Aleurodiscus Minnsiae. FIG. 3. *Under side of twigs of Tsuga canadensis showing immature basidial fructifications as they appear in September. Natural size.* FIG. 4. *Basidial fructification when in fruiting condition in late May or early June.* FIG. 5. *Upper side of two of the twigs from Fig. 3, showing the "Minnsia" stage. Natural size.* FIG. 6. *A portion of one of the twigs on Fig. 5 enlarged to twice the diameter.* FIG. 7. *The "Minnsia" stage still further enlarged. Note some empty peridia and a few small undifferentiated structures before the separation into peridium and sclerotium has occurred.*


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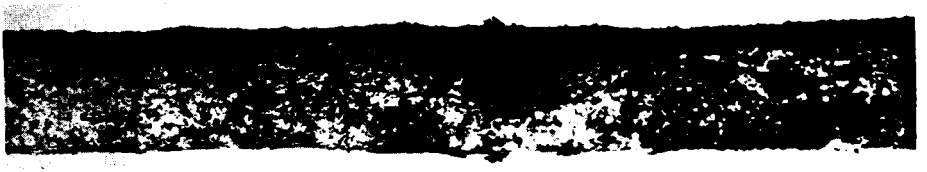

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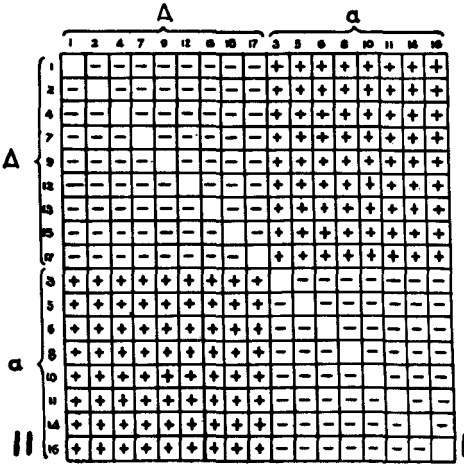

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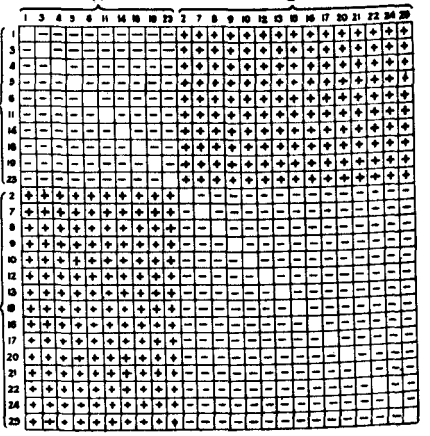

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with the exception of one which is on *Populus tremuloides*. The collections on *Tsuga*, together with two additional ones on that host made at other dates during the same year by Burnham at Hudson Falls, all prove to be *Aleurodiscus Minnsiae* and are listed above. The one on *Populus* (MO *44170*, CU PP*27556*) is a form of *Aleurodiscus roseus* occurring not uncommonly on the under side of dead branches of *Populus* and *Salix* in the tree. The Burnham collections were all made in the winter between December and March and consist of sterile basidial fructifications. At this season of the year and later the associated "Minnsia" stage on the *Tsuga* collections, which is at its best in the preceding summer and early fall, has often largely disappeared. Recognizable remnants are, however, present on some of the twigs which assist in making the identification positive. The collection labeled as having been made by G. W. Clinton at Buffalo, N.Y. is something quite different. It is on the bark of some deciduous leaved host and is sterile. It has been examined recently at my request by Dr. G. W. Martin who reports that it is in all probability a young phase of *E. Leveilliana*. The out-of-range records from New York for this species are therefore reduced to one.

Comparative Culture Studies

During the early period when *Aleurodiscus Minnsiae* was under observation, another form occurring on the under side of dead branches of living *Pinus Strobus* was frequently collected. This also was obviously related, but quite different in general appearance from *A. Minnsiae* and from the usually collected form of *A. roseus*. There is never any evidence of an associated "Minnsia" stage.

As noted above *A. Minnsiae* produces its spores in the late spring; fall and winter collections are sterile, but show immature basidia. This is true also of the form on *Pinus*. A set of single-spore cultures was obtained from the forms on both hosts in the spring of 1937. The only form of *A. roseus* available at the time was one which occurs commonly on the under side of dead branches in trees of *Populus tremuloides*. This also produces its basidiospores in late May or early June. A set of monospores was obtained from this form also.

A comparison of polysporous cultures was first made as an indication of comparative growth rate. Fig. 10 shows colonies from the three sources planted side by side on the same plate. The smallest colony is from *Populus*, the largest one from *Pinus*, and the medium one is of *A. Minnsiae* from *Tsuga*. The comparative growth rates were therefore indicative of different entities though no detailed study was attempted.

FIG. 8. *Aleurodiscus Pini showing mature basidial fructifications. Natural size.* FIG. 9. *Aleurodiscus Minnsiae. Comparison of colonies from tissue cultures secured from developing basidial fructifications, from the peridium of the "Minnsia" stage and from the sclerotium.* FIG. 10. *Comparison of polysporous cultures, upper left colony of a form of Aleurodiscus roseus from Populus; upper right, Aleurodiscus Minnsiae; lower colony of Aleurodiscus Pini.* FIG. 11. *Interfertility table for Aleurodiscus Minnsiae.* FIG. 12. *Same for Aleurodiscus Pini.*

An examination of the monospore cultures derived from the form of *A. roseus* on *Populus* showed that all the hyphae developed clamps at the septa, which was not true of monospore cultures derived from fructifications on *Tsuga* or *Pinus*. This fact, together with the decided difference in growth rate, clearly indicates that the form on *Populus* is biologically distinct from the forms occurring on *Tsuga* and *Pinus*. It is presumably "homothallic". Since no other form of more typical *A. roseus* was available for comparison in culture, it cannot be determined from the evidence available whether or not this form on *Populus* is distinct from the more commonly recognized form. As stated above, this form matures its basidiospores in late spring or early summer while some collections assigned to *A. roseus* from farther south are known to produce their basidiospores in late summer or early fall. It is quite possible that the form under discussion may prove worthy of segregation when a comparative study of cultures from more sources is available. This form on *Populus* is apparently the same as the sterile form collected in February by S. H. Burnham, mentioned on p. 72, which was assigned by Burt to *Eichleriella Leveilliana*.

The hyphae of monosporous cultures secured from fertile fructifications of *A. Minnsiae* and from the form on *Pinus Strobus* remained clampless. Each set was paired in all possible combinations and the usual type of interfertility tables were prepared and are reproduced on Plate II. Fig. 11 is of *Aleurodiscus Minnsiae*, while Fig. 12 is the table for the form on *Pinus*. Both are heterothallic, in the sense that the term is usually used in the higher basidiomycetes, and apparently of the bipolar type of interfertility, though perhaps an insufficient number of cultures was available to rule out the possibility of tetrapolarity, especially in the case of *A. Minnsiae*. Cultures 2, 3, 4, and 5 of *A. Minnsiae* were paired with Cultures 1, 2, 3, and 7 of the form on *Pinus*. No clamps resulted in any of these pairings, showing that the two forms are incompatible and therefore biologically distinct. I am indebted to Dr. A. J. Skolko for having isolated the sets of monospore cultures and for conducting the interfertility tests and preparing the tables.

Aleurodiscus Pini

Because of the evidence furnished by the comparative culture studies reviewed above and the existence of certain morphological differences which are considered significant, together with the evidence that *A. roseus* is to be interpreted as a collective species, it has been decided to describe the form on *Pinus Strobus* as a new species.

Aleurodiscus Pini sp. nov. (Figs. 2, 8, 12)

Fructificatio primo parum roseo-alutacea, deinde cremeo-alutacea, 90–110μ crassa, infrequenter continue effusa, saepe in parvis interruptis areolis sparsa, tenuiter membranacea, margine attenuato; subiculum angustum, hyphis

tenuiter tunicatis 3–3.5μ diam., nodoso-septatis; paraphyses multae, supra ramosae, 2.5–3μ diam., tenuiter tunicatae; basidia longo-cylindracea vel subclavata, 65–90 × 5–9 μ, 4 subulata, arcuata, 6–8μ longa sterigmata gerentia; basidiosporae ellipsoideae, 10–12 × 6.5–7.5μ, tunicis tenuibus, hyalinis, non-amyloideis.

Fructification pinkish buff when fresh, fading to cream buff, 90–110μ thick, rarely continuously effused, more commonly in small discontinuous patches, soft membranous, margin thinning out; subiculum poorly developed, hyphae with walls only slightly or not at all thickened, 3–3.5μ in diam., with clamps; paraphyses abundant, flexuous, branching above, 2.5–3μ in diam., walls thin; basidia long cylindrical or subclavate, sometimes subventricose below, 65–90 × 5–9μ, arising from near the base of the subiculum, bearing 4 subulate slightly arcuate sterigmata, 6–8μ long; basidiospores ellipsoid, 10–12 × 6.5–7.5μ, slightly flattened below on one side, with prominent apiculus, walls thin, smooth, colorless, nonamyloid.

Specimens examined:

Ontario: On *Pinus Strobus*, woods E. of Maple, Nov. 2, 1935, TRT *8230*, FH, NY, BPI, OTB, IA, UPS; June 1, 1936, R. F. Cain, TRT *10472*; N. o Summit Golf Club, N. of Richmond Hill, Oct. 31, 1936, TRT *10828;* May 20, 1937, TRT *11702*, FH, NY, OTB; June 3, 1937, TRT *11703* **type,** FH, NY, OTB, BPI, IA, UPS; June 1, 1939, TRT *13241*, FH, NY, BPI, IA; woods W. of Maple; June 11, 1937, TRT *11701*; Oct. 6, 1937, TRT *11640*, FH, NY, BPI, OTB; June 4, 1938, TRT *13325*; Bear Island, Lake Timagami, Aug. 19, 1937, TRT *11611*; N. of Holland River Marsh, May 29, 1937, TRT *12688*; N. of Cathcart, Brandt Co., May 6, 1938, R. F. Cain *13009*; Oakland Swamp, Brandt Co., June 12, 1939, R. F. Cain, TRT 16494, FH, NY, BPI, OTB, IA, UPS; Oct. 9, 1939, TRT *15094*, *15095*; Constance Bay, N.W. of Ottawa, June 30, 1938, TRT *13561*, FH, NY, BPI, OTB, IA; Lake of Two Rivers, Algonquin Park, Sept. 15, 1938, TRT *13438*; June 13, 1942, TRT *17631*, FH, NY, BPI, OTB, IA, UPS; Pt. Alexander, N. of Chalk River, Aug. 31, 1941, TRT *17428*, UPS; Petawawa Forest Reserve, Chalk River, Sept. 2, 1941, TRT *17357*.

Quebec: On *Pinus Strobus*, Morgan's woods, near Ste. Anne de Bellevue, Aug. 25, 1941, H. S. Jackson, TRT.

Pennsylvania: On *Pinus Strobus*, Ross Run, Huntingdon Co., Oct. 27, 1931, L. O. Overholts *13785*, TRT; Apr. 17, 1932, L.O.O. *22401*, TRT; Feb. 19, 1932, L.O.O. *16729* and R. W. Davidson, TRT; June 4, 1936, L.O.O. *19297*, TRT; English Center, Lycoming Co., May 8, 1936, L.O.O. *19271*, TRT; Shaver's Creek, Huntingdon Co., Feb. 2, 1936, L.O.O. *19221*, TRT; McAlvey's Fort, Huntingdon Co., Aug. 15, 1934, L.O.O. *17642*, TRT. (These specimens labeled *Corticium roseum* or *C. roseum* var. *Strobi* n. var. (ined.).)

New Hampshire: On *Pinus Strobus*, Jaffrey, July 23, 1939, G. D. Darker, *6822*, TRT; Waterville, July 21, 1932, J. R. Hansbrough, BPI FP*81233*, TRT.

Massachusetts: On *Pinus Strobus*, Shirley, Nov. 11, 1935, D. H. Linder, F.H., Herb. D. P. Rogers *3179*, TRT; Harvard Forest, Hamilton, July 18, 1937, H. S. Jackson, TRT; Oct. 1940, D. P. Rogers *3178*, TRT; Tapsfield, Aug. 18, 1928, J. R. Hansbrough, BPI FP*81231*, TRT.

Michigan: On *Pinus Strobus*, Cheboygan, June 15, 1948, R. F. Cain, TRT *22882*.

Connecticut: On *Pinus Strobus*, East Granby, Apr. 11, 1939, H. G. Eno, BPI FP*84260*, TRT.

New York: On *Pinus Strobus*, Ringwood Preserve, near Ithaca, Apr. 22, 1935, W. L. White *1651*, and H. Brandriff, FH, TRT; May 24, 1935, W.L.W. *1697* and H.B. CU PP*24738*, FH, TRT; Ithaca, Mar. 2, 1935, W.L.W. *1677*, CU PP*24722*, FH, TRT; Lyons Falls, Oct. 18, 1936, W.L.W. *2709* and H. J. Miller, FH, TRT; Old Forge, Adirondack Mts., Oct. 19, 1936, W.L.W. *2633* and A. P. Viegas CU PP*25524*, FH, TRT.

Aleurodiscus Pini differs from *A. Minnsiae* in a number of essential features. There is no evidence of a sclerotial disseminating phase. Cultures, as noted above, show a different growth rate and when monospore cultures of the two species are paired, no clamps are formed. The basidial fructifications when fresh show an appreciable difference in shade of color. The *A. Pini* fructifications are less extensive, thinner, and do not form as continuous a fruiting surface. The subiculum of fructifications of *A. Pini* is less well developed than in *A. Minnsiae* and the hyphae have much thinner walls. In *A. Minnsiae* the spores are ovoid while in *A. Pini* they are ellipsoid and appreciably smaller.

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