

## Reclassification of *Cladosporium bantianum* in the Genus *Xylohypha*

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**It is proposed that the dematiaceous hyphomycete *Cladosporium bantianum* (Saccardo) Borelli be transferred to the genus *Xylohypha* (Fries) Mason as *Xylohypha bantiana* (Saccardo) McGinnis, Padhye, Borelli, et Ajello. This new combination is necessary because *X. bantiana* produces conidiophores that are indistinguishable from its vegetative hyphae and one-celled, smooth-walled conidia that are borne in long, infrequently branched chains. The blastoconidia do not possess darkly pigmented hila. In contrast, members of the genus *Cladosporium* Link produce erect, distinct conidiophores and one- to four-celled smooth-to-rough-walled conidia that occur in short, frequently branched, fragile chains. The blastoconidia have darkly pigmented hila. *Cladosporium trichoides* Emmons is a later synonym of *X. bantiana*.**

In our studies of the etiologic agents of phaeohyphomycosis, it became apparent that the taxonomy and nomenclature of the dematiaceous hyphomycete *Cladosporium bantianum* (Saccardo) Borelli is in a state of confusion. There is disagreement regarding the proper name for this hyphomycete and its relationship to *Cladosporium trichoides* Emmons (5, 8). The purpose of this report is to clarify the taxonomy and nomenclature of *C. bantianum* so that this fungus can be accurately identified in the clinical laboratory.

Living cultures originally identified as either *C. bantianum* or *C. trichoides* were studied on potato glucose agar after 2 weeks of incubation at 25°C in the dark.

**Living cultures.** The strains and sources of living cultures of *Xylohypha bantiana* studied were as follows: NCMH (North Carolina Memorial Hospital) 111 = CDC B-1937 = NIH 8595 = IP (Institut Pasteur) 509, from human brain abscess (sent to the National Institutes of Health by G. Segretain, Institut Pasteur, Paris, France); NCMH 112 = CDC B-1938 = NIH 8580, from human brain abscess (T. Collette, Sayre, Pa.); NCMH 113 = CDC B-1940 = NIH 8579 = ATCC 10958 = CBS 173.52, derived from original isolate of *C. trichoides*, from human brain abscess (C. Binford, Baltimore, Md.); NCMH 114 = CDC B-1941 = NIH 8598, from soil (P. Klite, Panama); NCMH 115 = CDC B-2003 = NIH 8504, from chronic human abdominal wall abscess (J. Pereira, Washington, D.C.); NCMH 117 = CDC A-980 = NIH 8590, from human brain abscess (J. Barnola Duxans, Caracas, Venezuela); NCMH = 121 = CDC B-1897, from cat brain abscess (M. Rinaldi, Davis, Calif.); NCMH 122 = CDC B-1898 = ATCC 22649, from human brain abscess (J. Bennett, Florida); NCMH 474 = CDC B-2525, from cat brain abscess (Biberstein, Davis, Calif.); NCMH 1145 = DMD-38, from sawdust mulch heap (D. M. Dixon, Williamsburg, Va.); NCMH 1146 = DMD-42, from sawdust mulch heap (D. Dixon, Williamsburg, Va.); NCMH 1147 = DMD-58, from stump of *Juniperus virginiana* (D. Dixon, Suffolk, Va.); NCMH 1148 = DMD-39, from sawdust mulch heap (D. Dixon, Williamsburg, Va.); NCMH 1151 =

ATCC 24928, from human brain abscess (P. F. Jurgensen); NCMH 1152 = ATCC 28255 = Crichlow 853, from human brain abscess (D. K. Crichlow); NCMH 1168 = CBS 328.65, from a dog (G. A. de Vries); NCMH 1181 = SM 1502, from human brain abscess (M. Hironaga, Otsu, Japan); NCMH 1182 = SM 1522, from human cutaneous abscess (M. Hironaga, Otsu, Japan); NCMH 1186 = FCM 7819, from

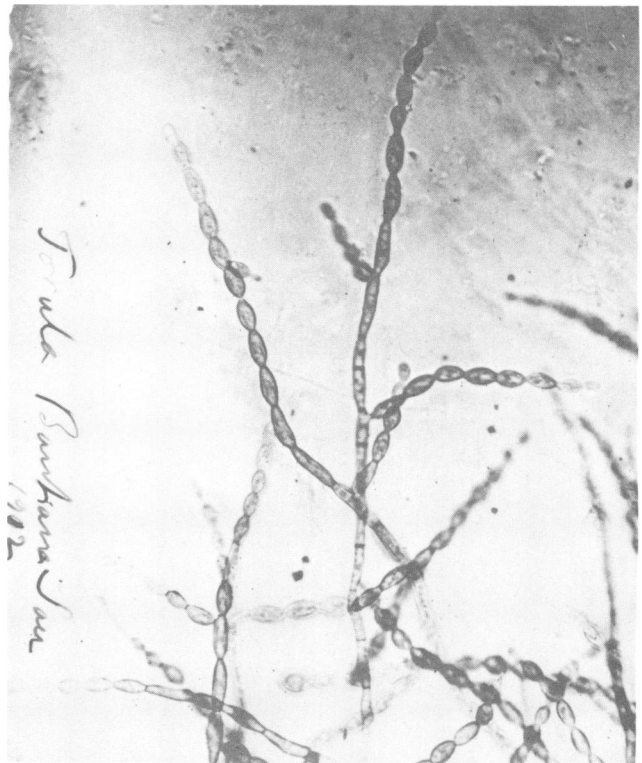


FIG. 1. Photograph of *Torula bantiana* dated 1912 that was taken and labeled by P. A. Saccardo. There is no magnification scale for this photograph.

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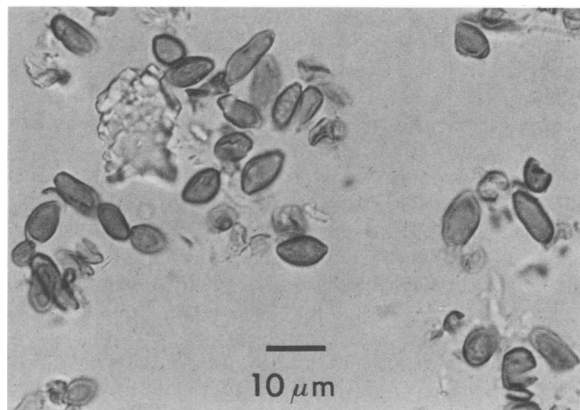


FIG. 2. Conidia contained in the exsiccatum labeled 499 for *T. bantiana* prepared by P. A. Saccardo.

human skin lesion (S. Amma, North Kerala, India); NCMH 1273 (derived from the original isolate of *C. trichoides* var. *chlamydosporum*) = CDC B-3955 = NIH 4018 = ATCC 46715, from human brain abscess (P. Zwadyk, Durham, N.C.); NCMH 1559, from human brain abscess (P. Zwadyk, Durham, N.C.); NCMH 1694, from human brain abscess (M. Ahern, New Haven, Conn.); NCMH 1796, from human brain abscess (C. Wilson, Brisbane, Australia); NCMH 1811 = ATCC 44217, from a human foot (S. Amma, North Kerala, India); NCMH 2226 = CDC B-3994, from human lung tissue (A. Padhye, Pensacola, Fla.); NCMH 2288, from human brain abscess (M. McGinnis, Chapel Hill, N.C.); NCMH 2417 = CDC B-4028, human isolate (M. Miyaji, Chiba City, Japan).

**Herbarium specimens.** In addition to living cultures, we examined the exsiccatum labeled 499, *Torula bantiana* Sacc., which is the holotype for *T. bantiana*, 22 herbarium

specimens of *Xylohypha nigrescens* (Pers. ex Fr.) Mason, and 9 specimens of *Xylohypha curta* (Corda) Hughes. *X. nigrescens* is the type species for the genus *Xylohypha* (Fr.) Mason.

The herbarium specimens of *Xylohypha* species examined and their sources were as follows: (i) Exsiccatum labeled 499, *Torula bantiana* Sacc. (Herbarium Mycol. Orto Botanico, Padova, Italy, by P. A. Saccardo); holotype for *T. bantiana*; the fungus was isolated from human brain tissue.

(ii) *X. nigrescens*: Herbarium IMI 372, on *Viburnum opulus* (E. W. Mason, United Kingdom); Herb. IMI 460, on *Ligustrum vulgare* (E. W. Mason, United Kingdom); Herb. IMI 1681, on *V. opulus* (E. W. Mason, United Kingdom); Herb. IMI 6523, on *Juglans* sp. (United Kingdom); Herb. IMI 6525, on *Cornus* sp. (Ranmore, United Kingdom); Herb. IMI 7283, on wood (Yorks, United Kingdom); Herb. IMI 14009, on dead branch (Yorks, United Kingdom); Herb. IMI 14021b, on *Fagus* sp. (12 April 1947, Yorks, United Kingdom); Herb. IMI 14469, on *Sambucus* sp. (7 April 1947, E. Yorks, United Kingdom); Herb. IMI 14502e, on dead wood (11 April 1947, M. B. Ellis); Herb. IMI 14518, on *Fraxinus* sp. (10 April 1947, Yorks, United Kingdom); Herb. 19244, on ash (November 1947, Yorks, United Kingdom); Herb. IMI 24989, on *Fraxinus excelsior* (14 September 1948, E. W. Mason, Northern Ireland); Herb. IMI 33718, on *Corylus avellana* (23 January 1949, S. J. Hughes, United Kingdom); Herb. IMI 47681, on *Tilia* sp. (K. W. G. Dennis, Scotland); Herb. IMI 58526, on *Fraxinus* sp. (28 January 1954, C. Booth, United Kingdom); Herb. IMI 73349, on *Fraxinus* sp. (United Kingdom); Herb. IMI 86685, on *Populus* sp. (15 April 1961, R. W. G. Dennis, Isle of Rhum); Herb. IMI 105714, on *Hedera helix* (11 April 1964, P. C. Holland, East Sussex, United Kingdom); Herb. IMI 156300, on *F. excelsior* (16 March 1971, R. W. G. Dennis, Isle of Mull); Herb. IMI 193818, on dead *Holcus* sp. (7 April 1975, R. W. G. Dennis); Herb. IMI 218638, on *Fraxinus* sp. (13 May 1934, Stroud, United Kingdom).

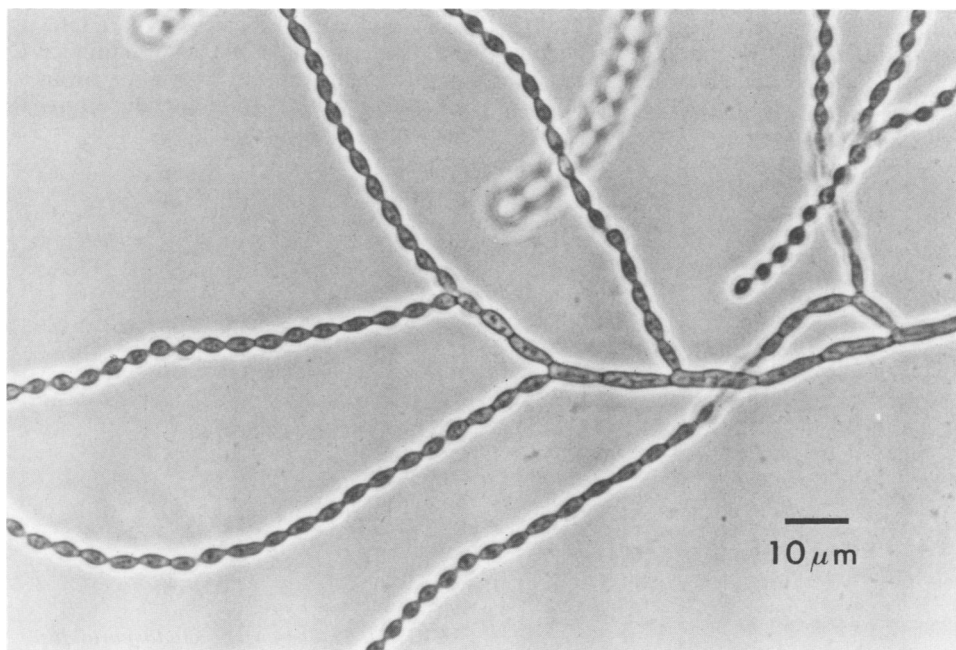


FIG. 3. *X. bantiana*. Conidiophore and long, sparsely branched chains of blastoconidia. NCMH 2288.

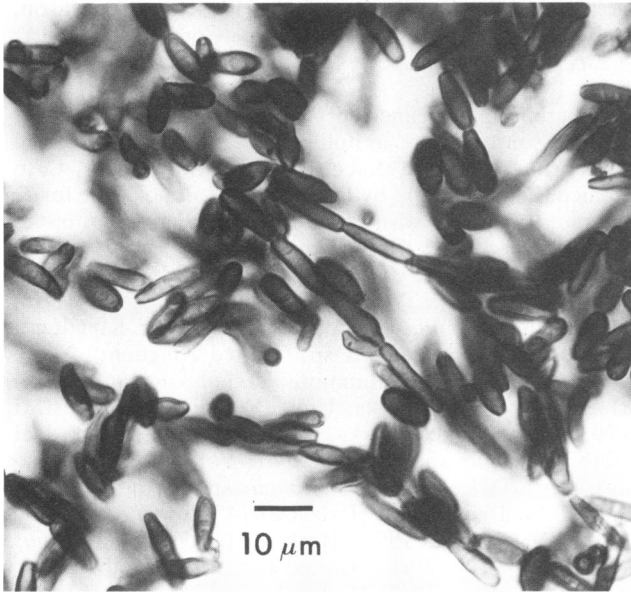


FIG. 4. *X. nigrescens*. Blastoconidia. Herb. IMI 6523.

(iii) *X. curta*: DAOM 41827, ex Herb. Karsten, Bot. Mus. Helsinki, ex type collection of *Torula olivacea* Corda, Mustiala, in ligno pini (31 October 1890); DAOM 49846, ex Herb. Corda, Nat. Mus. Prague, 155680, ex type collection of *Torula curta*; DAOM 71954, on rotten wood (25 November 1960, S. J. Hughes, Gatineau Park, Gatineau Cte, Quebec, Canada); DAOM 117486a, on *Weinmannia racemosa* (5 April 1963, S. J. Hughes, Lower Poesua River, Westland, New Zealand); DAOM 147218, on *Alnus rubra* (4 June 1966, C. D. Bird [15492], Vancouver Island, Vancouver, British Columbia, Canada); DAOM 154824, soil from burnt *Nothofagus* forest (28 January 1973, J. Wright, Tierra del Fuego, Ushuaia, Argentina); DAOM 160306, on *Gorselinia litoralis* wood (F. J. Morton [876], Tongariro National Park, Wellington, New Zealand); DAOM 160307, on *Nothofagus cliffortioides* wood (5 March 1963, J. Dingley [474], Tongariro National Park, Wellington, New Zealand);

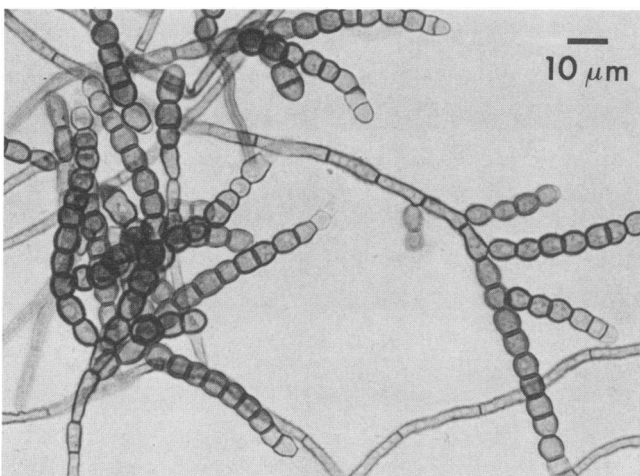


FIG. 5. *X. curta*. Conidiophores and sparsely branched chains of conidia. DAOM 71954.

DAOM 160308, on wood (7 March 1963, J. Dingley, Tongariro National Park, Wellington, New Zealand).

On the basis of the examination of these cultures and herbarium specimens, we propose the following.

*Xylohypha bantiana* (Saccardo) McGinnis, Padhye, Borelli, et Ajello, comb. nov. (Fig. 1 to 3).

Basionym: *Torula bantiana* Saccardo, Ann. Mycol. 10:320, 1912.

Synonyms: *Cladosporium bantianum* (Saccardo) Borelli, Riv. Anat. Patol. Oncol. 17:618, 1960; *C. trichoides* Emmons in Am. J. Clin. Pathol. 22:540-541, 1952; *C. trichoides* var. *chlamydosporum* Kwon-Chung, Mycologia 75:320, 1983 (invalid name, Arts. 9.5 and 37 [9]).

On potato glucose agar at 25°C, *X. bantiana* forms olivaceous-grey floccose colonies. *X. bantiana* isolates can grow at temperatures up to approximately 42 to 43°C, a characteristic useful for distinguishing the organism from *Cladosporium carrionii* Trejos, which has a maximum growth temperature of 35 to 37°C. The conidia occur as long, sparsely branched chains consisting of as many as 35 or more blastoconidia. The conidial chains, which are not fragile, arise from pale brown conidiophores that are poorly differentiated from the vegetative hyphae. The blastoconidia are one-celled (rarely two-celled), pale brown, smooth walled, ellipsoid to oblong-ellipsoid, and approximately 3 by 6.4 µm. The conidia may be either truncate or slightly constricted at their base. Obvious pigmented hila are always absent. These characteristics are compatible with the genus *Xylohypha* (3, 4; Fig. 4 and 5) rather than *Cladosporium* (6; Fig. 6). Members of the genus *Cladosporium* produce erect, distinct, pale brown conidiophores that are well differentiated from the vegetative hyphae. The blastoconidia occur in short, fragile, branched chains. They are one- to four-celled, pale brown, either smooth or rough walled, ellipsoid, fusiform to cylindrical, and variable in size. The conidia of the *Cladosporium* spp. have distinct, darkly pigmented hila. The ramoconidia formed near the apex of the conidiophores usually are shield shaped.

*X. bantiana* is an extremely important etiologic agent of cerebral phaeohyphomycosis (1, 2, 7). Appropriate management and early diagnosis of an infection caused by *X. bantiana* is vital. Even with antifungal chemotherapy and surgical management, mortality owing to this fungus is extremely high. It is therefore imperative that *X. bantiana* be accurately identified.

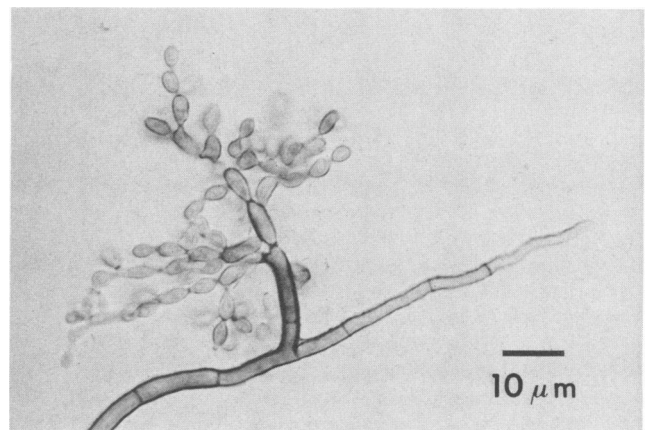


FIG. 6. *Cladosporium cladosporioides*. An erect, distinct conidiophore giving rise to fragile, short branched chains of blastoconidia. NCMH 1493.

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