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Hyphomycetes－*Beltrania* and Allied Species from Taiwan

Jin-Liang Chen[(1)] and Shean-Shong Tzean[(2,3)]

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ABSTRACT: Six hyphomycetous fungi: *Beltrania concurvispora*; *Bispora betulina*; *Bispora novae-zelandiae*; *Blastophorum truncatum*; *Botryosporium pulchrum* and *Titaea volucriata* on decaying leaves or stems were newly recorded from several localities of Taiwan using single or mass spore isolation technique. The morphological traits were closely examined, diagnosed and illustrated, and their distinguished characters for identification and comparison with conspecies from varied geographic regions were also briefly discussed.

KEY WORDS: Hyphomycetes, Taiwan, taxonomy, biodiversity, mitosporic fungi.

INTRODUCTION

In traditional classification scheme, fungi without assessed sexual stage usually were being classified in the Sub-phylum Deuteromycotina. Saccardo and allied workers, mainly based on the macro- and micro-morphological characteristics, categorized the members of this group of fungi into four Classes: Hyphomycetes, Blastomycetes, Coelomycetes and Agonomycetes (mycelia sterile) (Saccardo, 1880, 1886; Talbot, 1971). Of the Hyphomycetes, Moniliales is the key order which encompassed anamorphic fungi with sporulating structures born on the discrete conidiophores or aggregated synematous or cushion-shaped sporodochia (Barnett and Hunter, 1998). The Moniliales was consisted of two families: Moniliacece and Dematiaceae, the latter was characterized with pigmented mycelium, conidiophore or conidium (Barnett and Hunter, 1998). Hughes (1958) firstly noticed that except conventional morphological traits in sporulating structure, conidiogenesis patterns were also distinct and stable, and used them to categorize the Hyphomycetes into 8 groups. The theme was followed up, redefined and implemented, i.e. the taxa of Hyphomycetes according to conidiogenesis were assigned to Alleuriosporae, Annelosporae, Blastosporae, Phialosporae Porosporae, Sympodulosporae, etc., by Subramanian (1962), Tubaki (1958) and Barron (1968), respectively. This system was later proved extremely valuable for more rapid and precise distinction and classification of Hyphomycetes. The concept later has been adopted by Sutton (1980), by in combination of macro-sporulating structure and conidiogenesis characteristics to create a classification scheme for the Coelomycetes. More recently, the phylogenetic relationships of these fungi imperfect with respect to their affiliated Ascomycetes or Basidiomycetes were gradually established via the molecular systematic approach (Loutozoni, et al., 2004; Schoch et al., 2006). Evidently, by the approach in combination of the molecular and phenotypic characters, the biological hierarchical relationship for each taxon in nature will be established eventually.

In our laboratory, the inventory of the anamorphic fungi originated from Taiwan to illustrate their biodiversity has been setup as one our long-term goals since the early 1980 onwards. A series of papers in this regard was published and documented in the more recently published “Fungal Flora of Taiwan” (Tzean et al., 2005). Our major approach for identification of the members of the mitosporic fungi were primarily based on the system proposed by the eminent mycologists mentioned aboved (Hughes, 1958; Subramanian, 1962; Tubaki, 1958; Barron, 1968).

In this communication, we reported six fungi: *Beltrania concurvispora* Matsushima; *Bispora betulina* (Corda) Hughes; *Bispora novae-zelandiae* Matsushima; *Blastophorum truncatum* Matsushima; *Botryosporium pulchrum* Corda and *Titaea volucriata* K. Matsushima et T. Matsushima, which previously were not recorded, from the decayed leaves and stems in several various localities of Taiwan, using the single or mass spore techniques.

1. Department of Hospital and Health Care Administration, Chia-Nan University of Pharmacy and Science, 60, Sec.1, Erh-Jen Rd., Jen-Te Conty, Tainan 717, Taiwan.
2. Department of Plant Pathology and Microbiology, National Taiwan University, 1, Sec. 4, Roosevelt Rd., Taipei 106, Taiwan.
3. Corresponding author. Tel: 886-2-3366-4595; Fax: 886-2-2362-0639; Email: sst@ntu.edu.tw

The collection, identification and preservation of the anamorphic fungi may not only enrich and enlighten our understanding of their biodiversity, but also provide the precious microbial resources for potential application for the betterment of human welfare.

MATERIALS AND METHODS

Samples collected from various rotten vegetations from several locations in Taiwan were incubated in moist chambers (plastic boxes, 30 x 20 x 12 cm, with three layers of moistened papers) to facilitate the sporulation of the fungal habitants. Pure culture was established by single or mass spore isolation techniques on 3% water agar using a sterile glass micro-needle under stereomicroscope. A piece of agar containing the well separated individual spore or spore mass was transferred to oat meal agar (OMA), V8 juice agar or corn meal agar (CMA) slants or plates depending on their nutrient preference, to establish axenic culture for identification. Details of morphological characteristics and conidiogenesis were illustrated and photographed with an Olympus light microscope (BH-2) built with a drawing tube. The taxonomic systems of Barron (1968), Hughes (1958) and Ellis (1971) were followed for identification. Dried voucher specimens were deposited in the Department of Plant Pathology and Microbiology, National Taiwan University, Taipei, Taiwan, ROC., for further comparative study.

TAXONOMIC TREATMENTS

Beltrania concurvispora Matsushima, 1975. Matsushima Icones Microfungorum a Matsushima Lectorum. p. 15. Figs. 1 & 3A-C

Colonies diameter on corn meal agar larger than 90 mm in 30 days at 25°C, effuse, velvety, occasionally with sporadically spotted sub-colonies, olive brown; reverse uncolored to olive brown. Mycelium mostly immersed, composed of branched, septate, smooth, pale brown to dark brown hyphae. Conidiophores macronematous, mononematous, straight to flexuous, proliferation, simple, septate, smooth to finely roughened or varicose, brown, paler towards the apex, 68.3-635.0 x 5.0-7.5 µm, with conspicuous scar. Conidiogenous cells sympodial, polyblastic, terminal or lateral. Conidia rhomboid, truncate at the base, with a minute apiculate at the apex, 0-septate, smooth, pale brown to dark reddish brown, with a distinctly hyaline transverse band at the widest part, 25.0-40.0 x 14.2-17.1 µm, truncate

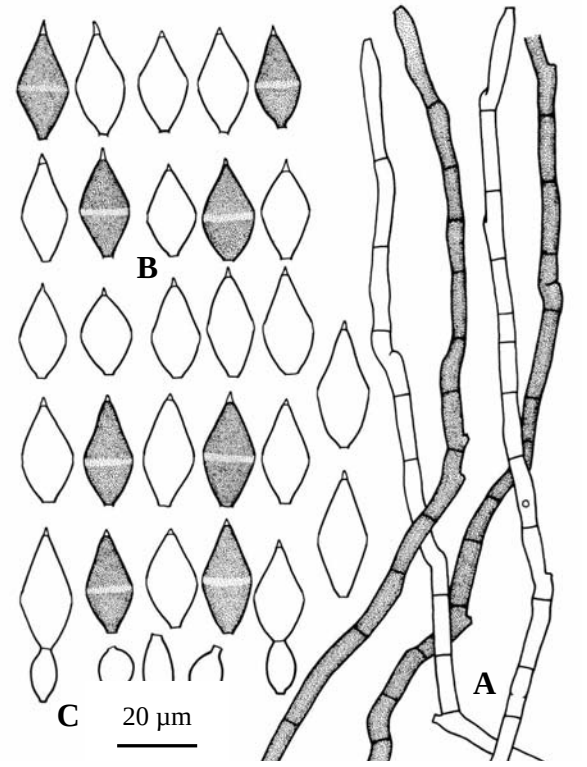

Fig. 1. *Beltrania concurvispora*. A: Conidiophores. B: Conidia. C: Separating cells. Bar = 20 µm

2.5-4.6 µm wide at the base; separating cells oval, doliform, smooth to finely roughened, paler brown, truncate at the both ends, 15.0-17.5 x 7.8-8.3 µm.

Specimens examined: Taiwan, Tayuan Mountain, Yilan County, on a rotten leaf, Apr. 14, 1986. *leg.* J.L. Chen. TNTU 619.

Distribution: Taiwan, Australia, Japan.

Notes: The genus *Beltrania* was established by Penzig (1882) to accommodate a single species, *B. rhombica* Penzig. Thereafter fourteen allied species have been described (CABI Bioscience Databases, 2008). *B. concurvispora* was originally recorded by Matsushima (1975) from rotten leaf in Iriomote Island, Okinawa, Japan. It was characterized by producing sympodial, polyblastic, terminal or lateral conidiogenous cells with conspicuous scar, and rhomboid conidia with a hyaline transverse band at the widest part. Our isolate from Taiwan resembles the type species of *B. concurvispora* in the shape, size and pigmentation in conidia, but somewhat deviated while grown on corn meal agar, i.e. the conidiophores were longer (up to 635.0 µm) compared to the isolate of Matsushima, on b/c-culture (up to 160.0 µm). This species was with rare occurrence.

Bispora betulina (Corda) Hughes, 1958. Can. J. Bot., 36: 740. Figs. 2 & 3D-E

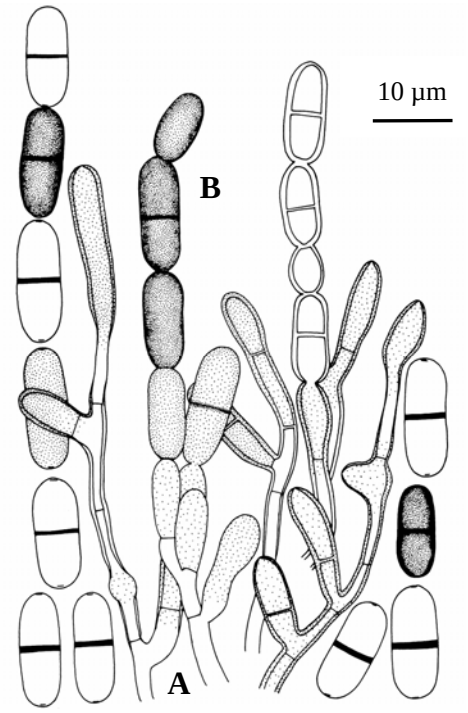

Fig. 2. *Bispora betulina*. A: Conidiophores. B: conidia.

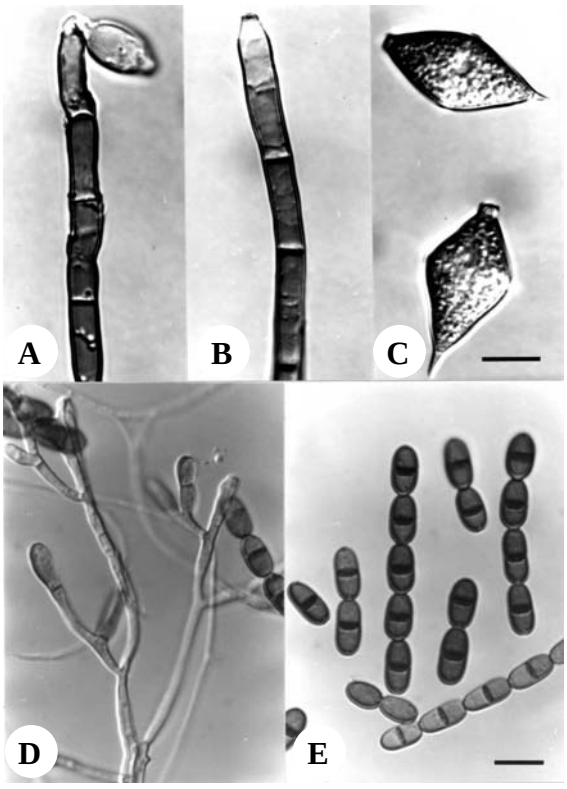

Fig. 3. *Beltrania concurvispora*(A-C). A & B: The upper part of Conidiophores. C: Rhomboid conidia with distinctly truncate at the base and a minute apiculate at the apex. *Bispora betulina* (D & E). D: Conidiophores with monoblastic conidiogenous cells. E: Elongated-ellipsoidal conidia with a dark brown band at the septum. Bars A-E = 10 µm.

Colonies diameter on corn meal agar 80 mm in 169 days at 25°C, effuse, velvety, somewhat powdery, grayish brown, brown to dark brown; reverse grayish brown to dark brown. Mycelium mostly immersed, partly superficial, composed of branched, septate, smooth or very finely roughened, hyaline to pale brown, 1.2-3.3 µm wide hphae. Conidiophores macronematous, mononematous, simple or rarely branched, straight or slightly flexuous, smooth or very finely roughened, brown or paler towards the base, 7.5-41.7 x 3.3-4.6 µm. Conidiogenous cells monobasic. Conidia catenate, cylindrical rounded at the both end, usually 1-septate, rarely 0-septate, smooth, pale brown, brown or dark brown, often with a dark brown band at the septum (5.5)8.3-15.8 x (3.8)4.2-5.8 µm.

Specimens examine: Taiwan, Shihpachien Mountain, Hsinchu City, on rotten leaf, Apr. 25, 1986. *leg.* J.L. Chen. TNTU 523.

Distribution: Taiwan, Canada, Europe, Great Britain, Japan, Russia, USSR, USA.

Notes: Since the erection of the genus *Bispora* by Corda (1837), thereafter about thirty eight allied species have been described (CABI Bioscience Databases, 2008). *Bispora betulina* was first recorded by Hughes (1958), who treated *Dioccum betulinum* as a basionym, and transferred it to the genus *Bispora* Corda as *B. betulina* (Corda) S. Hughes. *Bispora betulina* is easily distinguished by its monoblastic conidiogenous cells and catenulate conidia with a dark brown band at the septum. Our isolate is similar to the type species of this fungus in conidial morphology, size and ontogeny, but differs in having longer conidiophores. It is a common species.

Bispora novae-zelandiae Matsushima, 1985. Mats. Mycol. Mem. No. 4: 9. Figs. 4 & 6A-B

Colonies diameter on corn meal agar 18 mm in 52 days at 25°C, slowly growing, olive brown to yellowish brown; reverse olive brown to dark brown. Mycelium mostly immersed, composed of branched, septate, smooth to roughened, pale brown to brown, 1.4-3.2 µm wide hyphae. Conidiophores micronematous, semimacronematous, mononematous, smooth to roughened, pale brown, 8.7-71.4 x 4.4-6.4 µm. Conidiogenous cells blastic, acropetal. Conidia borne in catenulate chain, simple or branched, doliiform to elongated-doliiform, 0-2-septate, truncated at the both end, smooth, pale brown, 5.2-18.7 x 2.8-5.6 µm, often constricted at the septate.

Specimens examined: Taiwan, Taipei City, National Taiwan University campus, on rotten stem, Feb. 28, 1991. *leg.* J.L. Chen. TNTU 969.

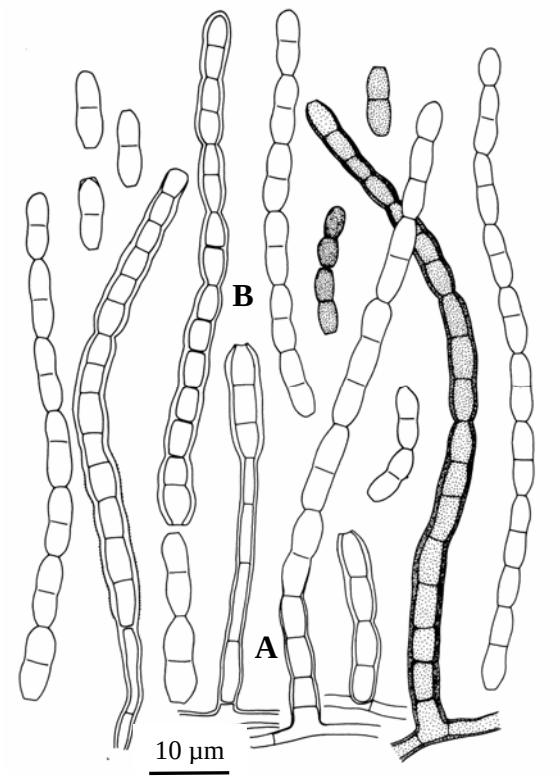

Fig. 4. *Bispora novae-zelandiae*. A: Conidiophores. B: Conidia.

Distribution: Taiwan, New Zealand.

Notes: This fungus was originally recorded from New Zealand by Matsushima (1985). It was easily recognized by its doliiform, pale brown conidia, which were born in catenulate chain, with truncated at the both end and constricted at the septate. The Taiwanese's isolate was comparable to those of New Zealand's collection in global shape and pigmentation of its conidia, and monoblastic conidiogenous cells. However, the former conidia (up to 18.7 µm) were longer than in the latter (up to 14.0 µm). This is a rare species.

Blastophorum truncatum Matsushima, 1971. Microfungi of the Solomon Islands and Papua-New Guinea. pp. 8-9. Figs. 5 & 6C-D

Colonies diameter on oat meal agar 45-48 mm in 35 days at 25°C, effuse, velvety, brownish grey to grayish brown; reverse grayish brown, brown. Mycelium immersed, partly superficial, composed of branched, hyaline to brown, smooth, hyphae. Conidiophores single or clustered, simple, straight or flexuous, septate, smooth, thick-walled, dark brown at the base, paler and thinner towards the apex, 18.3-132.6 x 2.7-4.8 µm. Conidiogenous cells polyblastic, sympodial; conidia produced from

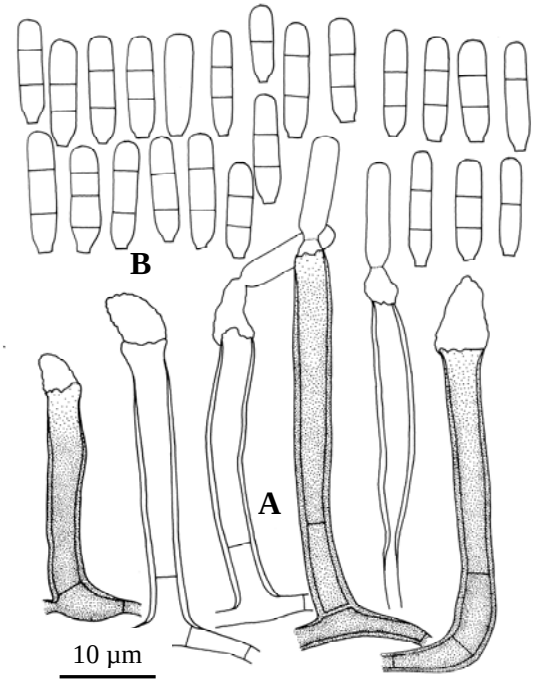

Fig. 5. *Blastophorum truncatum*. A: Conidiophores. B: Conidia.

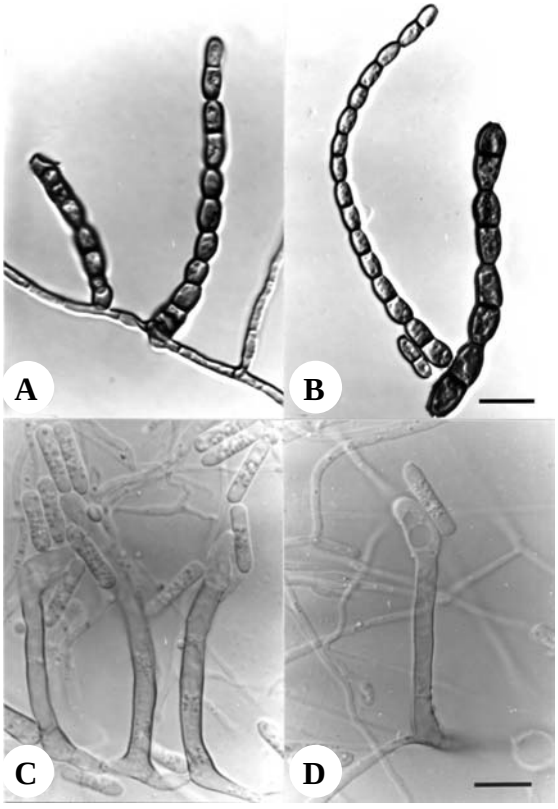

Fig. 6. *Bispora novae-zelandiae*. A: Micronematous conidiophores arising from hyphae. B: Doliiform to elongated-doliiform, catenate conidia, constricted at the septate. *Blastophorum truncatum*. C & D: Simple conidiophores borne with polyblstic conidiogenous cells and cylindrical, hyaline, smooth conidia. Bars A-D = 10 µm.

irregularly inflated, hyaline apical part of conidiogenous cells. Conidia cylindrical, truncate at the base, rounded at the end, 1-2-septate, hyaline, smooth, guttulate, 8.7-17.0 x 2.6-4.3 µm.

Specimens examined: Taiwan, Tayuan Mountain, Yilan County, on rotten leaf, Mar. 29, 1986. *leg.* J.L. Chen. TNTU 513.

Distribution: Taiwan, Japan, Papua-New Guinea.

Notes: The genus *Blastophorum* was established by Matsushima in 1971 to accommodate a single species, *B. truncatum* Matsushima, on rotten leaves of *Castanopsis cuspidate* var. *sieboldii* from Japan. Currently, there were four additional species being described (CABI Bioscience Databases, 2008). *Blastophorum truncatum* was characterized by polyblastic conidiogenous cells and cylindrical, hyaline, septate, smooth conidia. Our collection was very similar to the type species in shape and pigmentation of its conidiophores and conidia, but differed in having shorter conidiophores. This species was rare, with low prevalence.

Botryosporium pulchrum Corda, 1840. Flora Ill. De Muced. d' Europe: 39. Figs. 7 & 9A-B

Colonies diameter on V8-juice agar 64 mm in 45 days 25°C, effuse, floccose, white; reverse white toyellowish white. Mycelium superficial, immersed, composed of branched, septate, hyaline to subhyaline, smooth, 2.4-7.5 µm wide hyphae. Conidiophores macronematous, mononematous, simple, erect, septate, smooth or near so, hyaline, up to 1468.0 µm long, 7.5-14.2 µm wide; lateral stalks often swollen on the apex, with several lobed vesicles. Conidiogenous cells polyblastic. Conidia abundant, produced from the lobed vesicle, ellipsoidal, fusiform, subglobose, with a small hilum at the base, hyaline, roughened, 3.7-10.0 x 3.0-5.3 µm.

Specimens examined: Taiwan, Chiayi City, on decaying leaf of sugarcane, Nov. 2, 1986. *leg.* J.L. Chen. TNTU 625.

Distribution: Taiwan, China, Australia, USA, Europe.

Notes: This species was first described by Corda (1840). It is easily distinguished by its distinct simple, erect, hyaline, long conidiophores with lateral stalks and lobed vesicles, polyblastic conidiogenous cells and ellipsoidal to subglobose, hyaline conidia. Both *B. pulchrum* and *B. longibrachiatum* (Oudem.) Maire were frequently recorded, but the latter species contrasted to the former in having simple conidiophores without dichotomous branch (Subramanian, 1971).

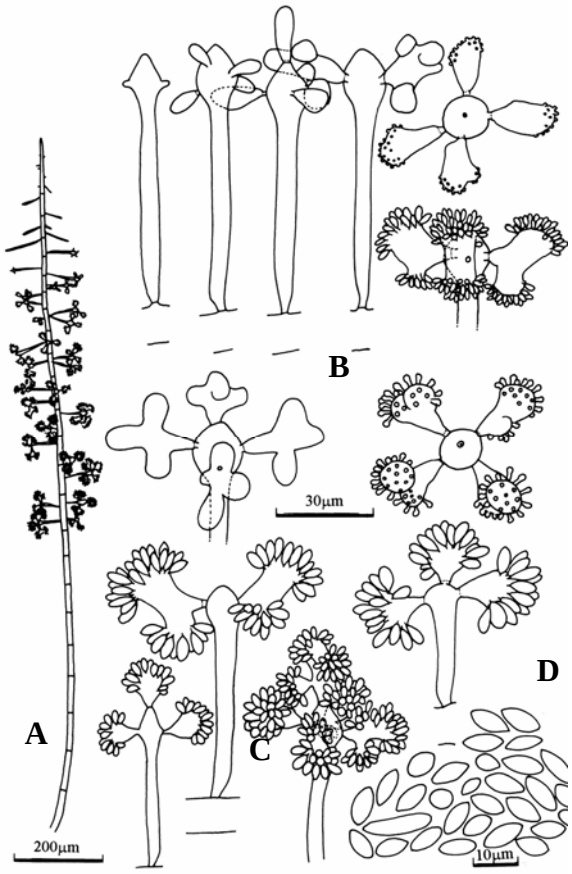

Fig. 7. *Botryosporium pulchrum*. A: Conidiophores. B: Lateral stalks with developing lobed vesicles. C: Lateral stalks with several lobed vesicles and conidia. D: Conidia. Bars A = 200 µm, B-C = 30 µm, D = 10 µm.

Titaea volucriata K. Matsushima et T. Matsushima, 1996. Mats. Mycol. Mem. No. 9: 39. Figs. 8 & 9C-E

Colonies on oat meal agar growing slowly, 2-3 mm diameter in 14 days at 25°C, dense, velvety, white, orange white to pale orange or greyish orange; reverse orange white. Mycelium immersed, composed of branched, septate, smooth, hyaline, 0.8-6.4 µm wide hyphae. Conidiophores micronematous, mononematous, smooth, hyaline, 1.6-3.7 µm wide. Conidiogenous cells denticle, sympodial, terminal to lateral or intercalary. Conidia consisting of a main axis and two lateral arms, smooth, hyaline; main axis: 6.1-11.0 µm long, 2-celled, constricted at the septum, the basal cell larger, the upper cell smaller, rounded at the apex, 2.2-4.0 µm wide; arms lateral, slender, tapering upwards and hooked or curved, wing-shaped, 12.0-32.8 µm long, 1.8-3.6 µm wide at the base, 0.6-0.8 µm wide at the apex. Chlamydospores catenulate, globose or ellipsoidal, smooth, hyaline, up to 8.8 µm wide.

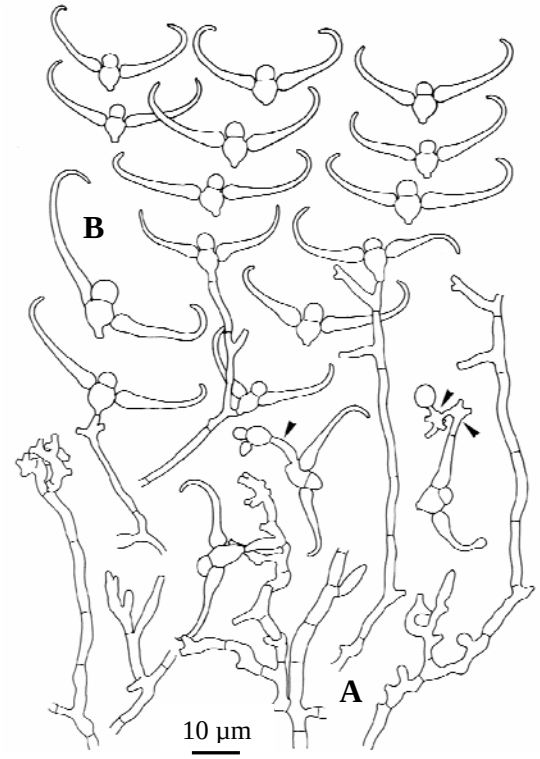

Fig. 8. *Tieae volucriata*. A: Conidiophores with sympodial, denticle Conidiogenous cells (arrows). B: Conidia.

Specimens examined: Taiwan, Nantou County, on herbaceous rotten stem, Feb. 10, 1993. *leg.* J.L. Chen. TNTU 1055.

Distribution: Taiwan, Japan.

Notes: The genus *Titaea* was established by Saccardo (1876) to accomodate a single species, *T. callispora* Sacc. Subsequently nineteen species have been described (CABI Bioscience Databases, 2008). *Titaea. volucriata* was originally recorded from decaying leaf and dead bark of broad-leaved tree in Japan by Matsushima (1996). It was easily distinguished by its micronematous, hyaline conidiophores with sympodial, denticle conidiogenous cells, and smooth, hyaline, flying bird-shaped conidia, with a main cylindrical axis and 2-wing-shaped-arms. The present Formosan's collection is similar to the type species of *T. volucriata* in shape and pigmentation of conidia and conidiophores, but the lateral arms of conidia in the former (up to 32.8 µm) were much longer than those in the latter (up to 21 µm). This is a rare species.

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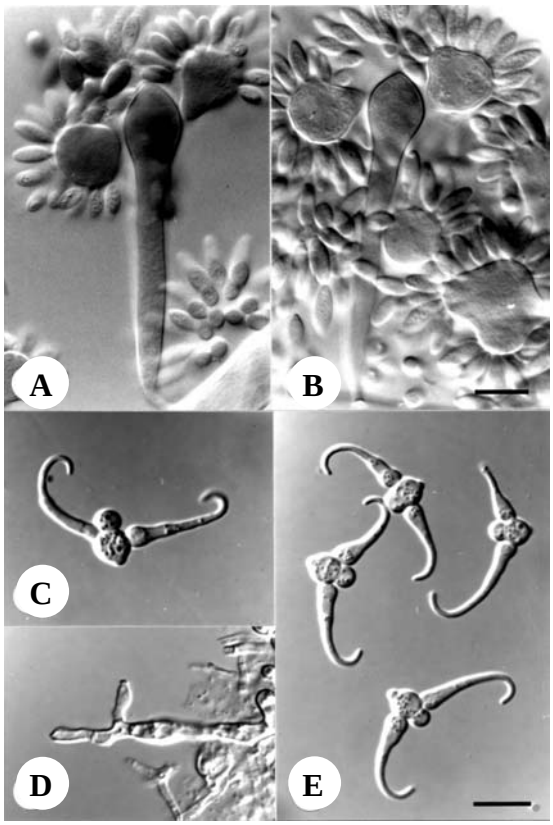

Fig. 9. *Botryosporium pulchrum* (A & B). A: Lateral stalks arising from Conidiophores with several lobes polyblastic conidiogenous cells at the apex. B: Ellipsoidal or fusiform conidia. *Tieae volucriata* (C-E). D: Micronematous conidiophore. C & E: Bird-liked, smooth, hyaline conidia with a main axis and 2-arms. Bars A-E = 10 µm.

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臺灣產絲孢綱不完全菌 *Beltrania* 和近似種之探討

陳珹篠[1]、曾顯雄[2,3]

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摘　　要

本文詳細繪圖、描述六種臺灣產隸屬於不完全菌絲孢綱 (Hyphomycetes) 之新紀錄種真菌：*Beltrania concurvispora*、*Bispora betulina*、*Bispora novae-zelandiae*、*Blastophorum truncatum*、*Botryosporium pulchrum* 以及 *Titaea volucriata*，並簡扼比較討論此類真菌之鑑定特徵，以及和分布於其它不同地域之同種真菌之異同。

關鍵詞：絲孢綱、不完全菌、分類學、生物多樣性、臺灣。

1. 嘉南藥理科技大學醫務管理系，717 台南縣仁德鄉二仁路 1 段 60 號，臺灣。
2. 國立臺灣大學植物病理學與微生物學系，106 台北市羅斯福路 4 段 1 號，臺灣。
3. 通信作者。Tel: 886-2-3366-4595; Fax: 886-2-2362-0639; Email: sst@ntu.edu.tw