Taxonomy of *Dactylella* complex and *Vermispora*. III. A new genus *Brachyphoris* and revision of *Vermispora*

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According to morphology and phylogenetic analyses of the ITS region, a new genus *Brachyphoris* is established for the very short conidiophore species previously included in the genus *Dactylella*, viz. *D. helminthodes*, *D. stenomeces*, *D. oviparasitica*, *D. tenuifusaria* and *D. brevistipitata*. A detailed delimitation of the genus *Vermispora* is also proposed. Five species are accepted in *Vermispora* including *Vermispora leguminacea* sp. nov. and one new combination, *Vermispora spermatophaga*. *Vermispora obclavata* is excluded from the genus.

Keywords: *Brachyphoris*, key, *Vermispora*.

Introduction

In studies on the *Dactylella* complex and *Vermispora*, three major clades were distinguished based on analysis of ITS sequences data (Fig. 1, Chen *et al.*., 2007). Species with very short conidiophores constitute a distinct group adjacent to the Dactylella and Vermispora clades (Chen *et al.*, 2007). Considering the molecular and morphological analysis, we introduced a new genus, *Brachyphoris* gen. nov.

The genus *Vermispora* was established by Deighton and Pirozynski (1972) with the type species *V. grandispora*, a parasite of the leaf-inhabiting *Irenopsis aciculosae* (Meliolaceae) in Sierra Leone. *Vermispora grandispora* was described with micronematous, septate, colourless, simple, and almost straight conidiophores which are slightly geniculate above the old conidial scars. Conidia are colourless, long cylindric-fusiform, slightly curved and usually slightly sigmoid, mostly 5-8-septate without constrictions at the septa.

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Since the genus was proposed without a clear delimitation, the limits of *Vermispora* have been increasingly widened by various workers to accommodate species resembling the type species. Four species have been assigned to *Vermispora* including *V. grandispora* Deighton & Pirozynski (1972), *V. obclavata* V. Rao & de Hoog (1986), *V. fusarina* Burghouts & W. Gams (1989) and *V. cauveriana* Rajashekhara, Bhat & Kaveriappa (1991). Gams (1989) compared *V. fusarina* with *Dactylella oviparasitica* G.R. Stirling & R. Mankau. Liu et al. (2005) provided further insight into the relationship of *Vermispora fusarina*, *Dactylella oviparasitica* and *D. brevistipitata* B. Liu, Xing Z. Liu & W.Y. Zhuang through phylogenetic analyses of ITS sequences. The complicated relationship revealed that this whole complex requires further revision.

**Materials and methods**

Strains examined in this study were tabulated in Chen et al. (2007). The materials and methods are the same as those used by Chen et al. (2007).

*Brachyphoris* J. Chen, L.L. Xu, B. Liu & X.Z. Liu, **gen. nov.**
MycoBank: 510641

*Etymology:* The epithet refers to the very short conidiophores.

*Conidiophora* inconspicua, conidio vix longiora, simplicia vel interdum ramosa, vulgo solitaria vel pauce aggregata. Conidium unum vel interdum duo gerentia. Conidia hyaline, fusiformia vel filiformia, recta vel leviter curvata.

*Conidiophores* simple or occasionally branched, hyaline, very short, scarcely longer than conidia. Conidiophore mostly produces a single conidium, sometimes with two conidia. *Conidia* hyaline, smooth-walled, spindle-shaped, filiform or elongate fusoid, straight or slightly curved.

*Teleomorph: Hyalorbilia.*


*Brachyphoris brevistipitata* (B. Liu, Xing Z. Liu & W.Y. Zhuang) J. Chen, L.L. Xu, B. Liu & Xing Z. Liu, **comb. nov.**
MycoBank: 510642


*Colonies* reaching 3.5 cm diam. after incubation at 25°C for 10 days on PDA, white, with irregular edge and aerial mycelium, reverse whitish; colonies reaching up to 4 cm diam. within 10 days on CMA, with sparser aerial mycelium than on PDA. *Hyphae* hyaline, septate, branched, 2.5-3 μm wide. *Conidiophores* simple or occasionally branched, hyaline, very short, 1.5-5 μm.
Fig. 1. *Brachyphoris brevistipitata*. A. Colony on PDA. B-G. Conidiophores and conidia, conidia borne on short conidiophores. H. Conidia with 3 and 5 septa. Bars: A=5 cm, B-F = 20 µm, G-H = 10 µm.

long, 2-4 µm wide at the base and 1.5-3 µm at the apex. Conidiophores mostly producing a single conidium, sometimes with two conidia. *Conidia* occasionally aggregated, narrowly spindle-shaped, tapering evenly towards the
blunt apex and base, usually straight, occasionally slightly curved, especially at the apex, hyaline, smooth-walled, 3-5-septate, 23-(39)-52 × 3-(3.5)-4 µm.

**Habitat:** Decaying twigs of broad-leaved tree, rotten bamboo.

**Distribution:** China (Liu et al., 2005).

**Material examined:** China, Beijing Province, Fragrance Mountain, 450 m altitude, on decaying twigs of broad-leaved tree, 24 June 2002, B. Liu 6167 (HMAS 86810, holotype).

**Notes:** *Brachyphoris brevistipitata* is similar to *B. oviparasitica* (G.R. Stirling & Mankau) J. Chen, L.L. Xu, B. Liu & Xing Z. Liu, comb. nov. and *B. helminthodes* (Drechsler) J. Chen, L.L. Xu, B. Liu & Xing Z. Liu, comb. nov., while *B. oviparasitica* produces 5-9-septate conidia measuring 40-(56)-65.5 × 3.5-(4.5)-5 µm (Stirling and Mankau, 1978), *B. helminthodes* bears 7-septate and occasionally 8-septate conidia (Drechsler, 1952). Furthermore both *B. oviparastica* and *B. helminthodes* are parasites, the former parasitizes eggs of *Mcloidogyne*, and the latter subsists parasitically on oospores of *Pythium debaryanum* and zygospores of *Cochlonema megalosomum*. *Brachyphoris brevistipitata* did not show any capability of infecting nematode eggs or oospores. *Vermispora fusarina* is also similar to *Brachyphoris brevistipitata* in conidial shape, but its conidiophores are longer and conidia are more curved and slightly broader (Burghouts and Gams, 1989).

**Brachyphoris oviparasitica** (G.R. Stirling & Mankau) J. Chen, L.L. Xu, B. Liu & Xing Z. Liu, **comb. nov.**

MycoBank: 510644


**Colonies** compact, fluffy or thickly cottony, reaching 2-2.5 cm diam. after incubation at 25ºC for 15 days on PDA. Colonies on CMA produce sparser aerial mycelium than on PDA with the diam. of 5.5-6 cm. *Hyphae* hyaline, septate, flexuous and frequently branched, varying from 1.5-3.5 µm in diam. *Conidiophores* hyaline, solitary, short, nonseptate, so that a single sporogenous cell functions as the conidiophore, 3-28 µm long, 2.5-3 µm wide at the base, tapering upwards to a width of 1-2 µm. *Conidia* thin-walled, hyaline, fusiform, 5-9-septate, 40-(56)-65.5 × 3.5-(4.5)-5 µm.

**Habitat:** Eggs of *Mcloidogyne*, eggs of *Globodera rostochiensis*.

**Distribution:** Netherlands, USA (Stirling and Mankau, 1978).

**Material examined:** Netherlands, Wageningen, Mierenbos, from eggs of *Globodera rostochiensis*, 9 June 1985, D. Hugo, CBS 347.85, CBS 348.85, CBS 349.85, USA, California, from nematode eggs, June 1984, R. Mankau, (BPI 418236, 418237, 418238); extype living culture in CBS 379.84.
**Fig. 2.** *Brachyphoris oviparasitica.* A. Colony on PDA. B. Conidia with 7 septa. C-G. Conidiophores and conidia, conidia borne on short conidiophores. Bars: A = 2 cm, B-G = 10 µm.

*Notes:* Stirling and Mankau (1978) ascribed this species to *Dactylella* because *Dactylella* contained many species capable of utilizing nematodes as a food source. They considered however that the taxon lacked many characteristics of this group. According to our molecular analysis, species with
short conidiophores are quite different from other species in *Dactylella*, so we proposed a new genus *Brachyphoris* to accommodate them. It is interesting that species with parasitic ability interspersed among *Dactylella* and *Brachyphoris*, which partly accounts for the less taxonomic value of parasitic ability than trapping events.

Due to the rather special habitat, *Brachyphoris oviparasitica* requires relatively complex media for growth and sporulation. Stirling and Mankau (1978) tried a number of media including Czapek-Dox, Potato-dextrose, Soil-extract, Corn-meal, Glucose-peptone, YPSS and enriched YPSS for the culture of *B. oviparasitica*. Sporulation only occurred on Corn-meal and Enriched YPSS and on YPSS under the treatment of light. During our study, the fungus sporulated on Potato-dextrose agar after two weeks, and the CBS 347.85 culture sporulated better than others. May be the fungus has adapted to the saprotrophic life style after several transfers.

*Brachyphoris oviparasitica* resembles *Dactylella attenuata* R.H. Gao, Xing Z. Liu, L.P. Lei & T.F. Li, *B. helminthodes* and *B. brevistipitata*, however it differs from the former by its rather short conidiophores (Stirling and Mankau, 1978), the latter two species are more similar to *Brachyphoris oviparasitica* in conidial and conidiophore morphology, while conidia of *B. helminthodes* are longer and narrower (Drechsler, 1952). *Brachyphoris brevistipitata* produces conidia with less septum (Liu *et al.*, 2005).

*Brachyphoris tenuifusaria* (Xing Z. Liu, R.H. Gao, K.Q. Zhang & L. Cao) J. Chen, L.L. Xu, B. Liu & Xing Z. Liu, *comb. nov.* (Fig. 3)

MycoBank: 510643  
= *Dactylella tenuifusaria* Xing Z. Liu, R. H. Gao, K.Q. Zhang & L. Cao, Mycological Research 100: 236, 1996.

*Colonies* on PDA buff to hazel, very slow-growing, extending to a diam. of 2 cm within 1 month at 25°C, producing sparse aerial mycelium. *Hyphae* hyaline, septate, creeping, rather scantily branched. *Conidiophores* usually in small groups or borne singly, hyaline, erect, branched, septate, 8-(35)-67 µm in length, 1-(2)-4 µm wide at the base, frequently with several branches, 4-34.5 × 1.5-3 µm. *Conidia* hyaline, elongate-fusoid, tapering toward the tail-like apex, 88-(102)-113 × 4-(5.5)-6 µm, frequently 10-13-septate.

*Habitat*: Soil. Capture and consume testaceous rhizopods.

*Distribution*: China (Liu *et al.*, 1996).

*Material examined*: China, Guizhou Province, Fanjing Mountain, 1770 m altitude, from forest soil, 25 June 1994, X.Z. Liu, (HMAS 70427, holotype); extype living culture in CBS 617.95.
Fig. 3. *Brachyphoris tenuifusaria* (HMAS 70427). A, C. Conidia. B. Hyphae with captured rhizopods. Bars: A-C = 20 µm.

Notes: *Brachyphoris tenuifusaria* is a special species that can capture and consume rhizopods through outgrowth from the hyphae (Liu et al., 1996). Regretfully isolate CBS617.95 could not sporulate. So we can only get limited information through specimen. *Brachyphoris tenuifusaria* is similar to *B. helminthodes* and *B. oviparasitica* in conidial morphology, while *B.*
helminthodes and B. oviparasitica have shorter conidia, 40-(56)-65.5 × 3.5-(4.5)-5 µm (Drechsler, 1952) and 53-(67)-84 × 2.5-(3)-4 µm (Stirling and Mankau, 1978) respectively.

**Key to Brachyphoris species**

1. Conidia less than 15-septate................................................................................................ .....2
2. Conidia up to 22-septate ........................................................................... \textit{Brachyphoris stenomeces}

1. Conidia no more than 5-septate................................................................. \textit{Brachyphoris brevistipitata}
2. Conidia 5-15-septate ........................................................................................3

3. Conidia foot-like at the base, capture and consume rhizopod........ \textit{Brachyphoris tenuifusaria}
3. Conidia rounded at both end ........................................................................4

4. Conidia 4-9-septate, 40-(56)-65.5 × 3.5-(4.5)-5 µm ......................... \textit{Brachyphoris oviparasitica}
4. Conidia mainly 7-septate, 53-(67)-84 × 2.5-(3)-4 µm.................. \textit{Brachyphoris helminthodes}


\textit{Colonies} white to salmon. \textit{Hyphae} colourless, septate, branched. \textit{Conidiophores} borne as lateral branches of the mycelial hyphae, colourless, simple, smooth, thin-walled, slightly geniculate above the old conidial scars. Conidial scars inconspicuous, truncate, unthickened. \textit{Conidia} colourless, long cylindric to fusiform, obclavate or elongate fusoid, smooth, thin-walled, slightly curved and usually slightly sigmoid.

\textit{Type species: Vermispora grandispora} Deighton & Pirozynski

**Vermispora fusarina** Burghouts & W. Gams, Memoirs of The New York Botanical Garden 49: 58, 1989 (Fig. 4)

\textit{Colonies} on PDA white to light yellow with abundant aerial mycelium, growing slowly, reaching 2.4 cm diam. after incubation at 25°C for 15 days. \textit{Vegetative hyphae} hyaline, branched, 2-3 µm wide. \textit{Conidiophores} not differentiated from the vegetative hyphae, arising mostly as lateral branches, proliferating repeatedly at some distance from the apex in a sympodial manner, 17-80 µm long, 2.5-3 µm wide near the base, ending in a broadly truncate scar 1.5-2.5 µm diam. \textit{Conidia} hyaline, fusiform, curved and slightly beaked at the apex, 2-4 (mainly 3)-septate, 31-(41)-45 × 4-(4.5)-5 µm. \textit{Chlamydospores} absent.

\textit{Habitat:} Egg of \textit{Globodera pallida}.

\textit{Distribution:} Netherlands (Burghouts and Gams, 1989).

\textit{Material examined:} Netherlands, Assen, from egg of \textit{Globodera pallida}, January 1984, Th. Burghouts, CBS 382.84, CBS 383.84A, CBS 383.84B.

\textit{Notes:} \textit{Vermispora fusarina} resembles \textit{Vermispora grandispora} Deighton & Pirozynski in its slightly curved, elongate fusiform conidia, while
Fig. 4. *Vermispora fusarina*. A. Colony on PDA. B. Conidia. C-H. Conidiophores and conidia.
Bars: A = 2 cm, B-H = 10 µm.
the conidia of *V. fusarina* appear shorter than those of *V. grandispora* (Deighton and Pirozynski, 1972).

**Vermispora grandispora** Deighton & Pirozynski, Mycological Papers 128: 87, 1972  
*Conidiophores* borne as lateral branches of the mycelial hyphae, almost colourless, simple, smooth, thin-walled, substraight, slightly geniculate above at the old conidial scars, 22-55 µm long, 3.5-4 µm wide near the base diminishing gradually to about 2.5 µm wide towards the apex, septate and with a basal septum. Conidial scars about 1.5 µm diam., unthickened. *Conidia* almost colourless, long cylindric-fusiform, smooth, thin-walled, slightly curved and usually slightly sigmoid, with an acute curved apex and a truncate unthickened hilum about 1.5 µm diam., when mature 5-8-septate, not constricted, 73-96 × 4.5-5 µm.

*Habitat*: Overgrowing *Irenopsis aciculosa* on *Sida urens*.

*Distribution*: Sierra Leone (Deighton and Pirozynski, 1972).

*Specimen examined*: Sierra Leone, Bumpe, overgrowing *Irenopsis aciculosa* on *Sida urens*, 30 October 1949, F.C. Deighton, IMI 40258b.

*Notes*: As type species of *Vermispora*, *V. grandispora* can be distinguished from other species in *Vermispora* through its much longer conidia (Deighton and Pirozynski, 1972).

**Vermispora leguminacea** J. Chen, L.L. Xu, B. Liu & Xing Z. Liu, sp. nov.  
MycoBank: 510346  
*Coloniae* lente crescentes, albae, copiose sporulantes, hyphae hyalinae, septatae, ramosae. *Conidiophora* erecta, flexuosa, ramosa vel non ramosa, hyalina, sursum geniculata, 26-(52)-104 µm longa, basi 1.5-3 µm crassa, apice 1-1.5 µm crassa. *Conidia* cylindrico-fusiformia, leniter curvata, 1-5-septata, plerumque 3-septata, 20-(17.5)-34 × 4-(4.5)-5 µm.

*Colonies* on PDA growing slowly, reaching 1.2-1.5 cm diam. after incubation at 25ºC for 10 days, white, finely powdery due to conidium formation. After about 20 days, the colony slight brown, felty with sparse aerial mycelium. *Vegetative hyphae* hyaline, branched, 1.5-3 µm wide. *Conidiophores* simple, smooth, substraight, slightly geniculate, proliferate successively from the apex, 26-(52)-104 µm long, 1.5-3 µm wide near the base diminishing gradually to 1-1.5 µm wide towards the apex. *Conidia* hyaline, cylindrical-fusiform, pod-shaped, slightly curved, 1-5 (mainly 3)-septate, 20-(17.5)-34 × 4-(4.5)-5 µm.

*Habitat*: Soil.

*Distribution*: China.

Fig. 5. *Vermispora grandispora*. A-D. Conidia. E. Conidiophore with a conidium. Bars: A-E = 15 µm.


*Notes*: *Vermispora leguminacea* is characterized by its pod-shaped conidia. This species resembles *V. grandispora* (Deighton and Pirozynski, 1972), *V. fusarina* (Burghouts and Gams, 1989) and *V. spermatophaga* (Drechsler) J. Chen, L.L. Xu, B. Liu & Xing Z. Liu, comb. nov. (Drechsler, 1938) in conidial shape and septate, but can be distinguished via the smaller
Fig. 6. *Vermispora leguminacea* sp. nov. A-F. Conidiophores and conidia. Bars: A-F = 10 µm.

Conidia 20-(17.5)-34 × 4-(4.5)-5 µm. The ITS region phylogeny also proved its difference with similar species (Fig. 1 Chen *et al.*, 2007).

*Vermispora spermatophaga* (Drechsler) J. Chen, L.L. Xu, B. Liu & Xing Z. Liu, *comb. nov.* (Fig. 7)

MycoBank: 510645

= *Dactylella spermatophaga* Drechsler, Phytopathology 28: 91, 1938.

*Colonies* white to grey, compact with irregular edge, slow growing, reaching 1.5-2 cm in diam. after incubation at 25°C for 15 days. *Mycelium* abundantly branched. *Vegetative hyphae* hyaline, weak, 1-2 µm wide, flexuous,
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Fig. 7. *Vermispora spermatophaga* comb. nov. A. Colony on PDA. C. Conidia. B, D-F. Conidiophores and conidia. Bars: A = 2 cm, B-F = 15 μm.

 septate. *Conidiophores* hyaline, septate, simple or somewhat branched, slightly geniculate, commonly 27-64 μm high, 3-4 μm wide at the base, tapering upwards to a width of 1-1.5 μm at the apex. *Conidia* hyaline, elongate spindle-shaped, roundly truncate at the base, narrowly rounded at the apex, straight or slightly curved in the apex, 2-4 (mainly 3)-septate, 25-(45)-50 × 3.5-(5)-5.5 μm.

*Habitat:* Decaying plant remains, Soil.

*Distribution:* USA (Drechsler, 1938).
Material examined: USA, Michigan, East Lansing, from oospore of *Phytophthora megasperma* var. *sojae*, 1976, B. Sneh, CBS 255.76.

Notes: *Dactylella spermatophaga* accommodate *Vermispora* well in elongate spindle-shaped, slightly curved conidia as well as geniculate conidiophores (Drechsler, 1938) so we included this fungus in *Vermispora* as *Vermispora spermatophaga*. *Vermispora spermatophaga* resembles *V. fusarina* in conidial morphology while conidia of *V. fusarina* slightly broaden at the hilum and gradually tapering to the beaked apex (Burghouts and Gams, 1989).

**Excluded species**

*Vermispora obclavata* V. Rao & de Hoog, Studies in Mycology 28: 53, 1985. (Fig. 8)

The subhyaline, usually irregularly verruose conidiophores as well as conidia with rather firm walls do not agree with this genus.

**Key to Vermispora species**

1. Conidia more than 5-septate................................................................. 2
2. Conidia mainly 3-septate........................................................................ 3

2. Microconidia absent, conidia 5-8-septate................................. *Vermispora grandispora*

3. Conidia pod-shaped, 20-(17.5)-34 × 4-(4.5)-5 µm........................... *Vermispora leguminacea*

4. Conidia slightly broaden at the hilum and gradually tapering to the beaked apex................................. *Vermispora fusarina*

4. Conidia roundly truncate at the base, ........................................ *Vermispora spermatophaga*

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**References**


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