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FULL PAPER

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Fusarium matuoi sp. nov. and its teleomorph *Cosmospora matuoi* sp. nov.

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Abstract A group of *Fusarium* isolates from slime flux similar to *F. aquaeductuum* produced unique, strongly curved, aseptate, C-shaped conidia. They were found to be identical to *F. splendens* nom. nud. Dried specimens from which *F. splendens* was originally isolated were reexamined and characterized as a new species of *Cosmospora*. *Cosmospora matuoi* sp. nov. is proposed for the teleomorph, and *Fusarium matuoi* sp. nov. is proposed for its anamorph.

Key words *Cosmospora matuoi* · *Fusarium matuoi* · *Fusarium splendens* · *Hypocrea splendens* · Taxonomy

Introduction

Slime flux of wounded trees is an interesting substrate that has been little explored for fungal diversity. During our investigation of fungal flora on slime flux, a species of *Fusarium* Link that has characteristic morphology was frequently isolated. These *Fusarium* isolates from slime flux grew slowly and formed slimy orange colonies with few aerial hyphae. They were morphologically similar to *F. aquaeductuum* (Radlk. & Rabenh.) Lagerh. and its allies. However, they clearly differed from *F. aquaeductuum* by having small, aseptate, strongly curved, almost C-shaped conidia. Abundant production of such conidia has been reported in *F. splendens* Matuo & Tak. Kobay., and the present isolates were considered conspecific to this fungus. However, *F. splendens* was published without a Latin diagnosis; hence, the name has been treated as "nomen nudum" and nomenclaturally invalid. *Fusarium splendens* has been mostly ignored by *Fusairum* taxonomists (Booth 1971; Gerlach and Nirenberg 1982; Nelson et al. 1983), so reassessment of this species is necessary.

Fusarium splendens was originally described as an anamorph of *Hypocrea splendens* W. Phillips & Plowr. from twigs of *Albizia julibrissin* Durazz. (Matuo and Kobayashi 1960). Doi (1968), however, pointed out that Matuo and Kobayashi's specimen of *H. splendens* was a misidentified species of an undescribed *Nectria* (Fr.) Fr. Because he did not assign any specific name to it, the teleomorph of *F. splendens* needs to be reinvestigated. Moreover, Rossman et al. (1999) made a global rearrangement of Nectriaceae, in which members of the genus *Nectria* were distributed among 20 genera. Therefore, the taxonomic identity of the teleomorph of *F. splendens* needs to be examined to correctly place it taxonomically.

In the present article, we reexamined the original cultures of *F. splendens* and its teleomorph specimens described by Matuo and Kobayashi, together with our isolates obtained from slime flux. The appropriate taxonomic position of the species is discussed together with its teleomorph.

Materials and methods

Fungal materials

Cultures of *F. splendens* (SUF 222 = ATCC 18695 and SUF 484 = ATCC 18694, both isolated from *Albizia julibrissin*), were supplied from SUF (Shinshu University, Faculty of Textile Science and Technology, Ueda, Nagano, Japan). Dried specimens (TFM: FPH 653, 1040, and 1182) of the teleomorph of *F. splendens* (as *Hypocrea splendens*) and a culture (FB-37) were supplied from FFPRI (Forestry and Forest Products Research Institute, Tsukuba, Japan). *Fusarium* isolates forming aseptate, C-shaped conidia were obtained from slime flux exuding from various deciduous trees and bamboos in central Japan. Single conidia were isolated using a micromanipulator (Skerman 1968). A

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search for the teleomorph of this fungus in neighboring sites was also conducted. Additional isolates obtained in the present study were deposited at the MAFF Genebank System (National Institute of Agrobiological Sciences, Tsukuba, Ibaraki Japan).

Observation of morphological characteristics

To observe colony morphology, potato dextrose agar (PDA) cultures were inoculated with a single conidium and incubated under 12L:12D light condition at 25°C for 2 weeks. Colors are according to Kornerup and Wanscher (1978).

Observations of microscopic features under culture were done on synthetic low-nutrient agar (SNA: 1 g KH_2PO_4, 1 g KNO_3, 0.5 g $MgSO_4 \cdot 7H_2O$, 0.5 g KCl, 0.2 g glucose, 0.2 g sucrose, 0.6 ml 1N NaOH, 23 g agar, 1 l distilled water, with a piece of sterile filter paper ~1 × 2 cm placed on the cooled agar surface; Nirenberg 1976). Measurments were done using an ocular micrometer.

Dried specimens (TFM: FPH 653, 1040, and 1182) were rehydrated and sectioned using a freeze microtome. Ascospores were observed via SEM by mounting perithecia from dried specimens intact or crushed on the stubs without fixation and then gold-coated in an Eiko IB3 Ion Coater.

Results and discussion

Descriptions

Based on precise morphological analyses and comparison, the original three isolates of *F. splendens* preserved at FFPRI, SUF, and our new wild isolates appeared to be conspecific with an undescribed teleomorph as discussed in the following text. Because the anamorphic name, *F. splendens* nom. nud., is nomenclaturally invalid and its teleomorph was also erroneously connected to the anamorph based on an apparent misidentification, we redescribe the fungus as follows.

Cosmospora matuoi Hosoya & Tubaki, sp. nov.

Figs. 1–3

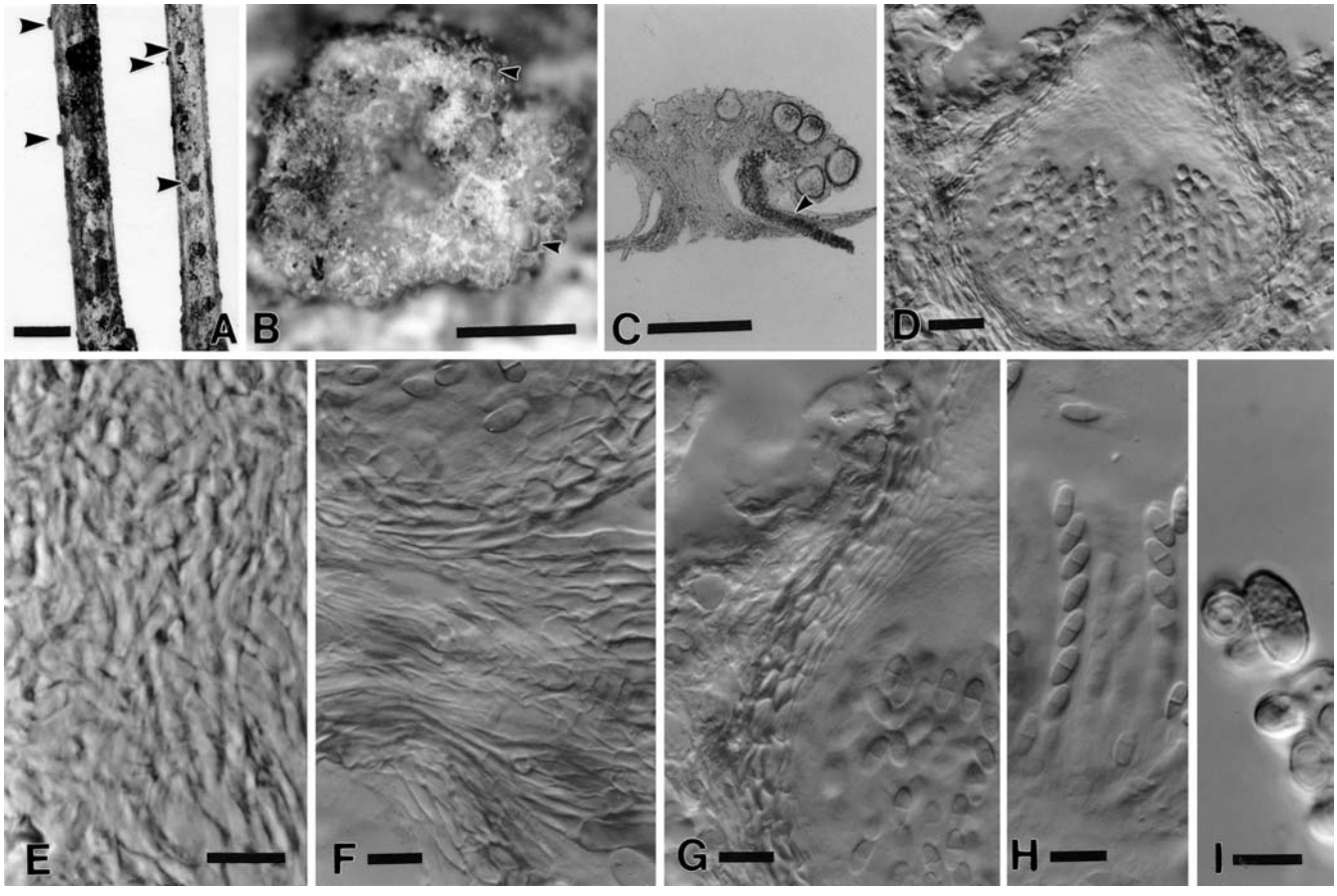

Fig. 1. *Cosmospora matuoi* (TNS-F-11126). **A** Clustered perithecia (*arrowheads*) on twigs of *Albizia julibrissin*. **B** Close-up of clustered perithecia when dry; most perithecia are submerged in stroma. Some perithecia showing lateral collapse (*arrowheads*). **C** Section of perithecial cluster showing stroma developing from the inside of the plant tissue and filling the area between and beneath the perithecia. *Arrowhead* shows the host epidermis. **D** Vertical section of a perithecium. **E** Close-up of hyphae of the stroma intertwined with each other, observed under phase-contrast microscopy. **F** Prosenchymatous stroma developed between the perithecial wall (appearing in the *upper* and the *lower* side of the photo). **G** Close-up of a vertical section of the perithecial wall. Note perithecial wall consists of several layers of moderately thick-walled elongate cells. **H** Asci. **I** Highly magnified ascospore with verrucose surface. *Bars* **A** 5 mm; **B**, **C** 0.5 mm; **D–H** 10 μm; **I** 5 μm

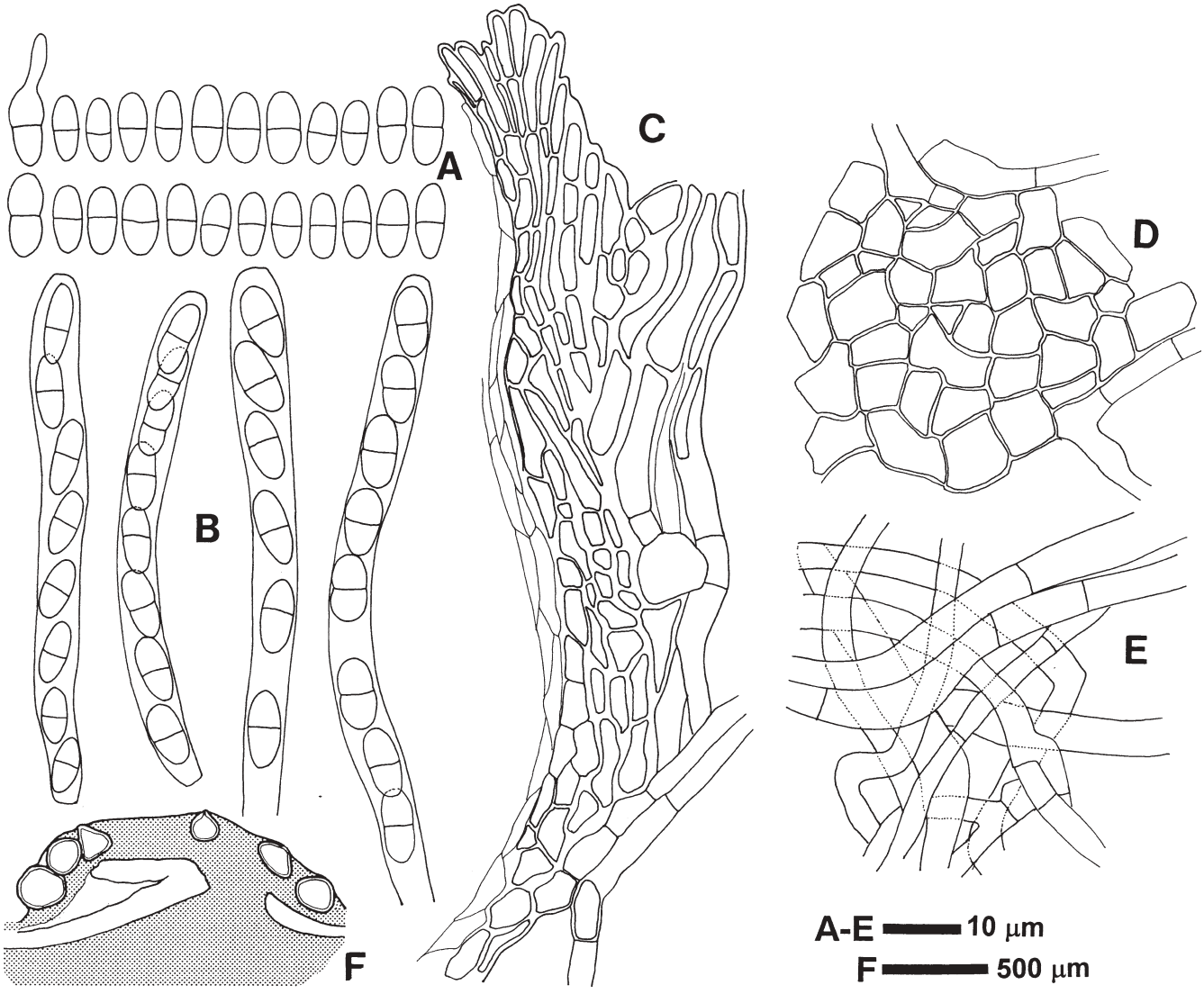

Fig. 2. *Cosmospora matuoi* (TNS-F-11126). **A** Ascospores. One at the *upper left* germinating. Warts on the surface are not shown. **B** Cylindrical asci with eight oblique monoseriate ascospores. Only upper portions are drawn for the two at the *right*. **C** Vertical section through ostiole. Note thin perithecial wall extending from the outer layer into the stroma. **D** Surface view of perithecial wall, showing the external layer and part of the stroma. **E** Close-up of a hyphae in the stroma. **F** Schematic section of a perithecial cluster, erumpent from host epidermis. *Dotted region* shows prosenchymatous stroma

Stromata in ramis, subepidermalia, dein erumpentia, 1.5 mm diametro, prosenchymatica, mollia ex hyphis tenuivel mediocriter crassi-tunicatis 2–3 μm crassis laxe vel arcte implicate composita. Perithecia ampulliformia vel globosa, 100–200 μm diametro, in sicco 2/3 eorum in stromate infossa et a latere impressa, Greyish Orange (5B4). Paries peritheciorum 7.5–20 μm crassus, ad medianum ex cellulis 3–4 stratosis elongatis visis compositus, 8–17 × 2–4 μm compositus; ad apicem ex cellulis "textura angularis" 5–10 μm diametro a superficie. Asci 55–82 × 4–7 μm, cylindrici, octospori, cum annulo apicali manifeste praedita. Ascosporae 8–11 × 3–5 μm, oblongae vel ellipsoideae, 1-septatae, minute verrucosae, pallide brunneae ad maturitatem. Status anamorphosis: *Fusarium matuoi*.

Holotypus: Japan. Honshu: TNS-F-11126, Mamurogawa-machi, Mogami-gun, Yamagata Pref. on *Albizia julibrissin* (Nemunoki), Oct. 1958, col. T. Kobayashi., National Science Museum, Tokyo.

Isotypus: TFM: FPH 1040, Forestry and Forest Products Research Institute, Tsukuba.

Etymology: Dedicated in honor of the late Dr. Takken Matuo who first reported this fungus.

Stromata 1.5 mm in diameter, erumpent through the host epidermis, prosenchymatous, composed of thin- to medium thick-walled hyphae 2–3 μm thick, hyaline, loosely to tightly entangled, running parallel to and around the perithecia, agglutinated near the outermost perithecial layer; context soft. Perithecia gregarious, occurring in an aggregation of several to several tens in stroma, ampulliform to globose, 100–200 μm in diameter; when dry, 2/3 of lower perithecia buried in the stroma, showing papilla with indistinct apical disc (25 μm in diameter), laterally collapsed, Greyish

Orange (5B4); when rehydrated, perithecia immersed almost completely in the stroma, Pale Orange (5A3); KOH−, paler in lactic acid. Perithecial wall 7.5–20 μm thick, composed of 3–4 layers of elongate cells; cells in the middle perithecial wall layer 8–17 × 2–4 μm, thin-walled to membranaceous, becoming thicker walled toward the outside; cells near the ostiole thicker walled; *textura angularis* in surface view, composed of angular cells 5–10 μm across. Asci 55–82 × 4–7 μm, cylindrical, containing 8 uniseriate ascospores arranged vertically to obliquely, with a clear apical ring. Ascospores 8–11 × 3–5 μm (8.94 ± 0.71 × 3.82 ± 0.41 μm, average ± SD, $Q = 2.36 \pm 0.29$; $n = 25$), oblong to ellipsoidal, 1-septate, minutely verrucose, slightly brownish when mature; smooth and hyaline when young; inflated and constricted at the septum, cells rarely separated before germination.

Additional specimens examined: TFM: FPH 653, Mamuro-gawa-machi, Mogami-gun, Yamagata Pref., on *Albizia julibrissin*, 4-X-1962, col. T. Kobayashi; TFM: FPH 1182, Asagawa-machi, Hachioji City, Tokyo, on *Albizia julibrissin*, 28-V-1959, col. T. Kobayashi.

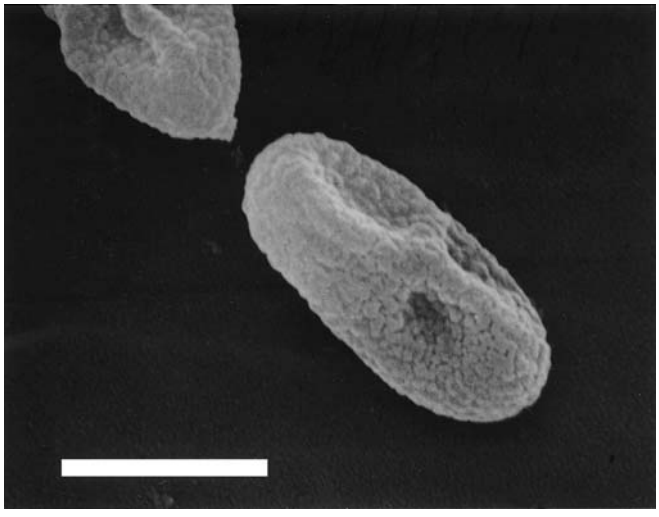

Fig. 3. Scanning electron microscope (SEM) photograph of an ascospore of *Cosmospora matuoi* (TNS-F-11126). Note verrucose surface. *Bar* 5 μm

Anamorph: ***Fusarium matuoi*** Hosoya & Tubaki, sp. nov. Figs. 4–6

Synonyms invalid:

Fusarium splendens Matuo & Tak. Kobay., nom. nud. Trans. Mycol. Soc. Japan 2(4): 13, 1960.

Fusarium aquaeductuum Lagerh. var. *medium* Wollenw. aggr. *sensu* Booth, *pro parte*, Booth, "The Genus *Fusarium*," CMI, Kew, Surrey, p. 60, 1971.

Coloniae in PDA lentissime crescentes, 3.5–4 cm diametro in 14 dies ad 25°C, Light Yellow (3A4) vel Deep Orange (5A8), merismoideae, rugosae vel mucosae; hyphae aeriae absentes vel minime evolutae. Phialides plerumque adelophialidicae cum processu hyphae brevi vel longo (usque 20 μm longo), 1–2 μm crasso, plus infrequenter aphanophialidicae et monophialidicae, subulatae, 10–25 × 2–3 μm, plerumque singulatae in conidiophoras simplices, plus infrequenter gregatiae in conidiophoras ramosae. Conidia plerumque in hyphis superficialibus, plus infrequenter in hyphis submersis vel in hyphis aeriis efferentia, aseptata vel 6-septata (vulgo 0–3-septata); conidia aseptata, (5–)7–22(–30) × (1–)1.5–2(–3) μm, valde curvata et fere C-formia, raro parum curvata, tenui-tunicata, aliquando sursum attenuata; conidia 1–2-septata rariora, 17–31(–36) × (1.5–)2–2.5(–3) μm; conidia 3-septata (25–)33–56 × (1.5–)2–3 μm, generaliter lunata vel filamentosa cum cellula apicali aculeata et cellula basali obscure vel non pedicellata, obscure septata; conidia >3-septata 40–55 × 2.5–3. Chlamydosporae absentiae vel terminales vel intercalares, solitariae vel catenulatae, globosae, 4–7 μm diametro, leaves vel verrucosae.

Holotypus: Japan. Honshu: TNS-F-11127 (isolate MAFF 410976, ex type, deposited in National Institute of Agrobiological Sciences = FB-37, deposited in FFPRI).

Etymology: Dedicated in honor of the late Dr. Takken Matuo who first reported "*F. splendens.*"

Colonies on PDA slow growing, attaining a diameter of 3.5–4 cm after 14 days at 25°C, Light Yellow (3A4) to Deep Orange (5A8), strongly pigmented at the center; surface

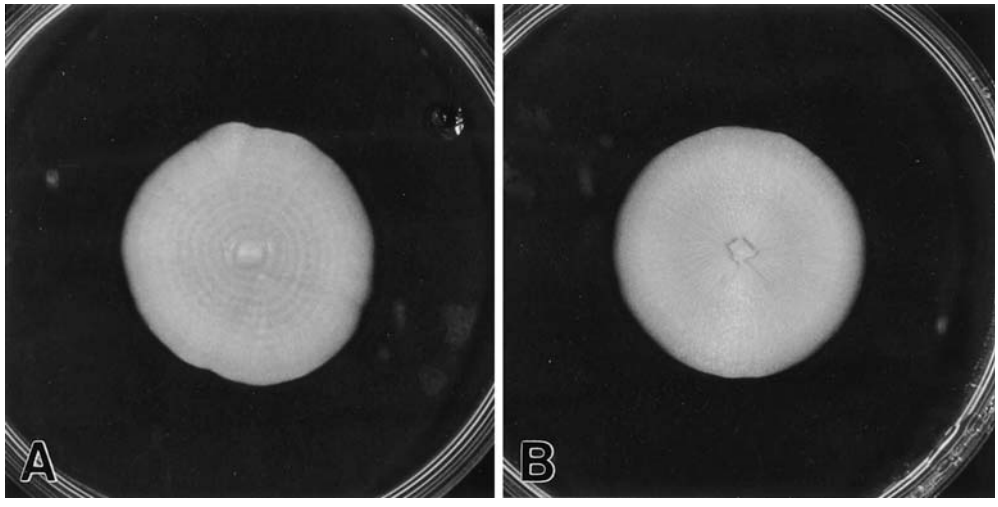

Fig. 4. *Fusarium matuoi*. Comparison of colony morphology of teleomorphic and anamorphic isolates of *Fusarium matuoi* on potato dextrose agar (PDA). **A** Teleomorphic isolate (MAFF 410976). **B** Anamorphic isolate (D8701)

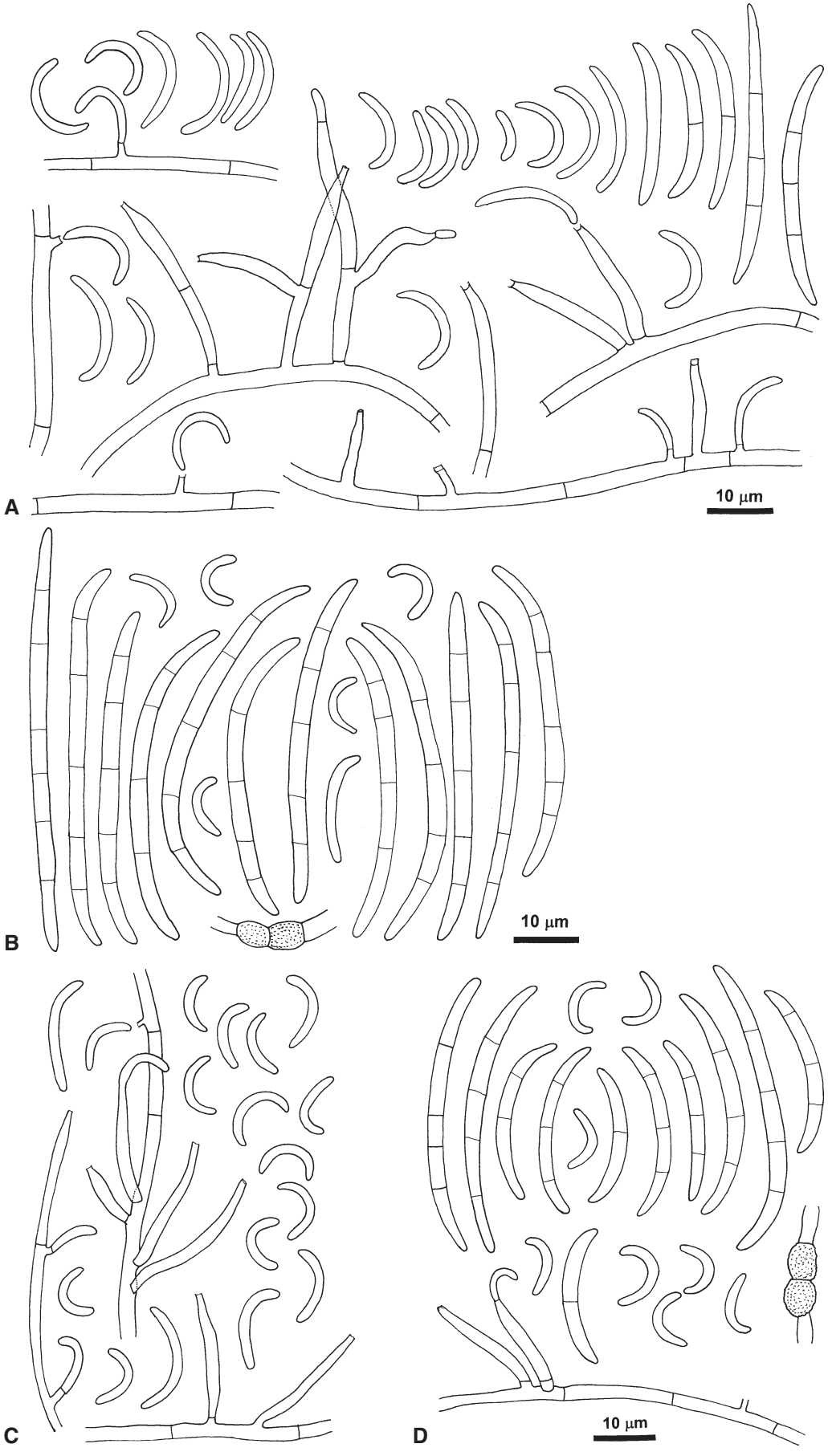

Fig. 5. *Fusarium matuoi.* Conidia, conidiophores, conidiogenous cells, and chlamydospores. Note continuous variation from strongly curved, aseptate C-shaped conidia to multiseptate, falcate conidia. **A** Isolate FB-37 (MAFF 410976, ex type). **B** Isolate D1301. **C** Isolate D10102. **D** Isolate D8701

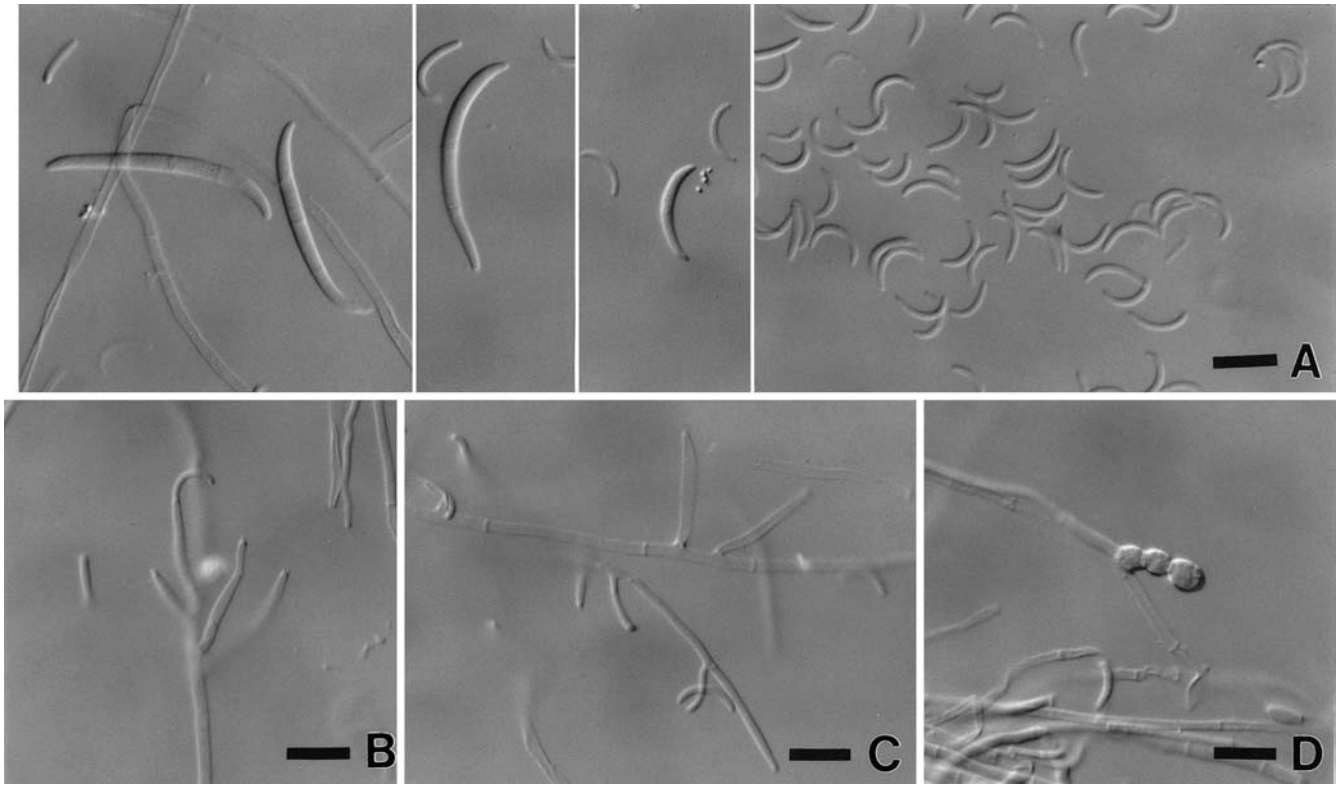

Fig. 6. Microscopic morphology of *Fusarium matuoi* on synthetic low-nutrient agar (SNA). **A** Conidia showing continuous variation from aseptate, strongly curved C-shaped to multiseptate, falcate (D12507). **B** Conidiophores (D10102). **C** Conidiophores (D10102). **D** Chlamydospores (D8701). *Bar* 10 μm

variable, merismoid, wrinkled, or slimy; aerial hyphae absent to spare; hyphae on the surface often forming mycelial ropes. Phialides mostly reduced to adelophialides with short to long (up to 20 μm) hyphal protrusions, 1–2 μm thick, narrowed at the apex; less frequently inconspicuous as denticles on hyphae (aphanophialides) or distinct monophialides of 10–25 × 2–3 μm, subulate, mostly borne singly on simple conidiophores, or less frequently in groups on branched conidiophores. Conidia mostly produced on superficial hyphae, less frequently on submerged hyphae, but also on aerial hyphae; 0–6-septate, mostly aseptate or 3-septate; aseptate conidia (5–)7–22(–30) × (1–)1.5–2(–3) μm, 11.5 ± 3.36 × 1.55 ± 0.20 μm (average ± SD, n = 105), strongly curved and almost C-shaped, rarely weakly curved, thin-walled, occasionally with attenuate ends; 1–2-septate conidia 17–31(–36) × (1.5–)2–2.5(–3) μm (n = 21), sometimes observed, intermediate shape of aseptate and 3-septate conidia; 3-septate conidia (25–)33–56 × (1.5–)2–3 μm, 41.1 ± 7.46 × 2.36 ± 0.43 μm (average ± SD, n = 36); generally crescent to threadlike with pointed apical cell and indistinctly pedicellate to apedicellate foot cell, indistinctly septate; borne in sporodochia or in pionnotes; >3-septate conidia 40–55 × 2.5–3 (n = 14), similar to 3-septate conidia in morphology. Chlamydospores absent or terminal or intercalary when present, formed singly or in chains, globose, 4–7 μm in diameter, smooth to verrucose.

Isolates examined: SUF 222 (= ATCC 18695 = MAFF 238446), site not recorded, from *Albizia julibrissin,* 1956-IV, col. K. Sato; SUF 484 (= ATCC 18694 = MAFF 238445) site not recorded, from *Albizia julibrissin*, 1959-X, col. T. Kobayashi; D1101 (= MAFF 238438), D1301, Kiso, Kiso-gun, Nagano Pref., from slime flux of a deciduous tree, July 31, 1986, col. T. Hosoya; D8701 (= MAFF 238439), Yuzawa-machi, Minami-Uwonumagun, Niigata Pref., from slime flux of a deciduous tree, July 1987, col. T. Hosoya; D10002 (= MAFF 238440), Nishine, Tsuchiura-shi, Ibaraki Pref., from slime flux of a bamboo, July, 3, 1986, col. T. Hosoya; D10102 (= MAFF 238441), D10105 (= MAFF 238442), Nishine, Tsuchiura-shi, Ibaraki Pref., from slime flux of a bamboo, December 7, 1986, col. T. Hosoya; D12507 (= MAFF 238443), D12508 (= MAFF 238444), Itatachibana, Maebashi-shi, Gunma Pref., from slime flux of a deciduous tree, April 1987, col. T. Hosoya.

Morphological comparison of *F. splendens* isolates and new isolates of *F. matuoi* from slime flux

All isolates of *F. matuoi* showed a similar colony morphology on PDA and SNA, and no significant difference was observed among three isolates of *F. splendens* preserved at FFPRI and SUF (isolates FB-37, SUF 222, and SUF 484) and the newly collected isolates from slime flux forming C-shaped conidia (D1101, D1301, D8701, D10002, D10102, D10105, D12507, and D12508) (representatives in Fig. 4).

On SNA, no significant difference in length and width of conidia was found among the isolates (representatives

shown in Fig. 5) as well. Matuo and Kobayashi (1960) considered aseptate, C-shaped conidia and multiseptate, falcate conidia to be distinct structures, and described the former as microconidia and the latter as macroconidia. A continuum of conidial shape from aseptate, strongly curved, C-shaped conidia at one extreme to multiseptate, falcate conidia at the other extreme (see Figs. 5, 6) was, however, observed among the isolates examined.

Matuo and Kobayashi (1960) did not mention characteristics of phialides in *F. splendens*. Most conidia of the isolates examined were produced from hyphae through small openings (Fig. 5) (corresponding to aphanophialides sensu Gams 1971). Distinct phialides (corresponding to ortho- and adelophialides sensu Gams 1971) were infrequently observed and were subulate. Morphology of the latter structure was essentially identical among the isolates (Fig. 5). Small, aseptate C-shaped conidia and multiseptate, falcate conidia were sometimes formed from the same phialides.

Based on these analyses, we conclude that the original three isolates of *F. splendens* preserved at FFPRI and SUF and the wild isolates from slime flux obtained in the present study were all identical. In addition, chlamydospores, which were not previously described, were found in some isolates (D1101, D1301, D8701, FB-37, and SUF 484) (representatives in Figs. 5, 6D). Attempts to find a teleomorph were unsuccessful, and no teleomorph was produced in culture from mating experiments.

Taxonomic comparison of *F. matuoi* and related species

Fusarium matuoi is similar to *F. aquaeductuum* in slow-growth, slimy orange colonies with very few or no aerial hyphae. In fact, *F. splendens* was cited as a possible synonym of *F. aquaeductuum* by Booth (1971: 215). Booth (1971) recognized three intraspecific taxa: *F. aquaeductuum* var. *aquaeductuum* [teleomorph: *Nectria purtonii* (Grev.) Berk. ≡*Cosmospora purtonii* (Grev.) Rossman & Samuels in the current taxonomy], characterized by aseptate to one-septate, falcate macroconidia without microconidia, although allantoid, aseptate conidia are reported at initial stage of culture derived from ascospores (Booth 1959), and *F. aquaeductuum* var. *medium* [teleomorph: *Nectria episphaeria* (Tode: Fr.) Fr. ≡*Cosmospora episphaeria* (Tode: Fr.) Rossman & Samuels in the current taxonomy], distinguished from the former by the presence of aseptate, elliptic microconidia and having macroconidia with more septa. Booth (1971) presented another group of isolates designated *F. aquaeductuum* var. *medium* aggregate (teleomorph unknown), which differed from *F. aquaeductuum* var. *medium* in the absence of microconidia. None of these taxa was reported to produce chlamydospores. *Fusarium matuoi* is also similar to *F. aquaeductuum* var. *medium* in the morphology of multiseptate conidia, but clearly differs in having small, aseptate, C-shaped conidia and chlamydospores. We do not accept the distinction between micro- and macroconidia in *F. matuoi*, because they form a continuum and they share a common phialide in some cases. Based on this interpretation, *F. matuoi* could encompass the concept of *F. aquaeductuum* var. *medium* aggregate sensu Booth (1971), but it is differentiated by the presence of small, aseptate, C-shaped conidia (Table 1).

It is also speculated that *F. matuoi* had been submerged in the concept of *F. aquaeductuum* var. *medium* in the system of Gerlach and Nirenberg (1982), because a C-shaped conidium is illustrated in their line drawing of *F. aquaeductuum* var. *medium* among its conidial variations. However, only one aseptate C-shaped conidium is shown in their line drawings as a variation among its wide range of conidia, and is seemingly exceptional in their concept of *F. aquaeductuum* var. *medium*.

As Matuo and Kobayashi (1960) provided no Latin diagnosis for *F. splendens*, the name had remained nom. nud. One possible treatment for the name is to validate it by adding a Latin diagnosis. However, the specific epithet is based on an incorrect identification of the teleomorph. Although names are not necessarily required for anamorphs, a name is desired for the anamorph of the present fungus to avoid a confusing name already been applied, and for convenience. The authors therefore provided a new anamorphic name.

In addition to the species previously discussed, *Fusarium merismoides* Corda is another species similar to *F. matuoi* in colony morphology, and the production of chlamydospores. *Fusarium merismoides* is also known to be isolated from slime flux. A representative of strongly curved, small conidia with one septum, similar in shape with those in *F. matuoi*, is drawn in Gerlach and Nirenberg (1982: 29). *Fusarium merismoides*, however, lacks the abundant production of small, aseptate, C-shaped conidia that characterize *F. matuoi*. The phialides of *F. merismoides* are more robust than *F. matuoi*, although overlapping to some extent (Booth 1971; Gerlach and Nirenberg 1982). It can also be differentiated from *F. matuoi* by "incipient" polyphialides (Booth 1971). Nevertheless, *F. merismoides* is morphologically most similar to *F. matuoi* as a holomorph, given that its teleomorph is *Cosmospora biasolettiana* (Briosi & Farneti) Rossman & Samuels, as discussed in the following text (Tables 1, 2).

Taxonomic comparison of *C. matuoi* and related species

Matuo and Kobayashi (1960) identified their perithecial material as *Hypocrea splendens*, describing (1) light-colored ("golden yellow, then reddish orange, with a brown tinge when old") perithecial stroma, (2) presence of part spores, eventually formed from didymosporous ascospores, and showed (3) prominent perithecia crowded in the periphery of stroma. Doi (1968), however, pointed out that the specimen had eight didymosporous ascospores and prominent perithecia, both of which are also produced by some *Nectria* species. He further suggested that the pigmentation was not like that of *Hypocrea* Fr., but similar to that of *Nectria* (Doi, personal communication). Consequently, he concluded that the Matuo and Kobayashi's specimen was a species of

Table 1. Comparison of *Fusarium matuoi* and its major allied anamorphs

Character	*Fusarium matuoi* (present study)	*Fusarium merismoides* (Booth 1971)	*Fusarium aquaeductuum* var. *aquaeductuum* (Booth 1959, 1971; Gerlach and Nirenberg 1982)	*Fusarium aquaeductuum* var. *medium* (Booth 1971)	*Fusarium aquaeductuum* var. *medium* aggr. (Booth 1971)
Smaller aseptate conidia	Strongly curved, (5–)7–22(–30) × (–)1.5–2(–3) µm	Absent	Absent (allantoid, 5–7 × 1.5–2 µm conidia initially produced)	Navicular to ellipsoidal, 4–10 × 2–3 µm	Absent
Larger falcate conidia	Generally crescent to threadlike, mostly 3-septate, (25–)33–56 × (1.5–)2–3 µm	Fusoid, straight to curved with a rounded apex and a marked foot cell, 3–4-septate, 30–45 × 3.5–5 µm	Curved fusoid with a single almost central septum, occasionally two more septa, 15–45 × 3–3.5 µm	Curved, cylindrical, but narrowing slightly toward each end and have a narrowed subulate apex, 1–3-septate, 10–45 × 2.5–3.5 µm; 4–5-septate, 40–65 × 3–4 µm (in *F. aquaeductuum* var. *medium* aggr., conidia more uniform in appearance, 45–65 × 3–4 µm)	
Phialides	Subulate, 10–15 × 2–3 µm	Irregularly cylindrical with a wide apical pore, 12–20 × 3–5 µm, polyphialides also present	Almost cylindrical, 12–35 × 2.0–3.5 µm	Lateral phialides subulate, 25–35 × 2–4 µm; Conidiophore phialides 17–28 × 2.5 µm	
Chlamydospores	Present	Present	Absent	Absent	Absent
Teleomorph	*C. matuoi*	*C. biasolettiana*	*C. purtonii*	*C. episphaeria*	Unknown

Nectria, although he did not provide a name for the specimen (Doi 1968).

Our reexamination confirmed that pigmentation of the perithecia was closer to those of nectriaceous fungi than to *Hypocrea*, and that Matuo and Kobayashi's specimens were quite different from *H. splendens* in stroma characteristics. We clarified that the two-celled ascospores are essentially didymosporous with inseparable cells (Figs. 1H,I, 2A,B), but may rarely become separated and look similar to part spores. We also confirmed that the perithecia were not completely immersed in the stroma, and found lateral collapse of the perithecia in the prominent portion (Fig. 1B). The stromatic tissue of our fungus was found to be prosenchymatous, composed of interwoven hyphae spreading between the perithecia. In addition, observation via light microscopy and scanning electron microscopy (SEM) showed that ascospores were verrucose (Fig. 1I, 3), although inconspicuous under low magnification in the light microscope (Fig. 1H). Hence, Doi's (1968) conclusion to reclassify Matuo and Kobayashi's specimen as *Nectria* was basically accepted. However, due to the change in generic concepts in ascomycete taxonomy since then, the current genus suitable for Matuo and Kobayashi's specimen should be *Cosmospora* Rabenh., the definition of which is briefly summarized as follows: ascoma solitary to gregarious, globose, obpyriform to broadly obpyriform, small sized (usually less than 300 µm in diameter), collapsing laterally or not when dry, orange to red or dark red, rarely pale yellow, usually KOH+, rarely KOH−, nonstromatic or seated on a thin basal stroma, with thin ascomatal wall (less than 20 µm thick), often translucent; asci cylindrical to narrowly clavate, apex simple or with a ring, short-stalked, 8-spored; ascospores ellipsoid to ellipsoid-fusiform, 1(–3)-septate, usually yellow-brown, also hyaline, usually spinulose to tuberculate; known anamorphs *Acremonium*-like, with colonies and microconidia similar to those of *Fusarium* sect. *Eupionnotes*, *Chaetopsina* Rambelli, *Cylindrocladiella* Boesew., *Stilbella* Lindau, and *Volutella* Fr.; on other fungi and scale insects, less frequently on decaying woody substrata (Rossman et al. 1999).

Members of *Cosmospora* are herbicolous, arboricolous, fungicolous, or insecticolous, and show strong host preference. No *Cosmospora* has been described from *Albizia*. Four members of *Cosmospora* are didymosporous with *Fusarium* anamorphs on nonfungal hosts or not associated with scale insects: *C. biasolettiana*, *C. dingleyae* Lowen, *C. obscura* Lowen, and *C. peponum* (Berk. & M. A. Curtis) Rossman & Samuels (Rossman et al. 1999).

The latter three species are differentiated from our fungus by the absence of a well-developed stroma. In addition, *C. dingleyae* has cylindrical, aseptate conidia and KOH+ perithecia (Rossman et al. 1999); *C. peponum* has a herbicolous habitat, KOH+ perithecia, and smooth ascospores (Samuels et al. 1991); and *C. obscura* has larger asci and wider ascospores with a more verrucose surface (Rossman et al, 1999).

Because of a prosenchymatous stroma, a KOH-perithecial wall and perithecial surface of *textura angularis*, *C. biasolettiana* most closely resembles our fungus. As

Table 2. Comparison of *Cosmospora biasolettiana* and its major allied teleomorphs

Character	*Cosmospora matuoi* (present study)	*Cosmospora biasolettiana* (Rossman et al. 1999)	*Cosmospora purtonii* (Booth 1959, 1971; Rossman et al. 1999)	*Cosmospora episphaeria* (Booth 1959, 1971; Rossman et al. 1999)
Ascoma				
Appearance	Gregarious, clustered	Solitary to gregarious, scattered	Densely crowded, on the surface of effete pyrenomycetes, and on bark of hardwood and conifers	Scattered to gregarious on the surface of effete pyrenomycetes
Stroma	Translucent mass of hyphae, loose to tight prosenchyma	Translucent sheet of hyphae, loose prosenchyma	Thin, stromatic layer formed over the host	Thin byssus, or cushion of pseudoparenchyma, generally formed over the ostiole of the host
Shape, size, and color	Globose, 100–200 μm diameter., laterally collapsed when dry, KOH−; Greyish Orange when dry	Globose, 125–180 μm in diameter, laterally pinched when dry, KOH−; pale yellow to pale buff when dry	Shortly ampulliform with a flat or concave top, 150–230 μm diameter, laterally collapsed at the lower half when dry, KOH+, yellow to red	Ampulliform with a short apical papilla, (110–)125–140(–200) μm diameter, laterally collapsed when dry, KOH+, bright red to carmine red
Surface	Angular cells 5–10 μm across, *textura angularis*	Large, thin-walled cells, 6–12 μm diameter, *textura angularis*.	N/D	N/D
Wall in section	7.5–20 μm thick, composed of elongate cells 8–17 × 2–4 μm, *textura prismatica*, becoming thicker toward the outside	15–25 μm thick, composed of elongate cells 6–12 × 3–4.5 μm, *textura prismatica*.	38–42 μm thick, composed of elongate cells 10–12 × 3–4 μm with much thinner walls with outer layer of thick-walled globose cells 6–7 μm diameter	18–22 μm thick, composed of 3–4 layers of hyaline and very thin-walled cells, 16–24 × 1–1.5 μm, showing a gradation to the outer very thick-walled globose cells, 3–5 μm diameter
Ascus	Cylindrical, 55–82 × 4–7 μm, containing 8 uniseriate ascospores arranged vertically to obliquely	Narrowly clavate, 36–45 × 8–10 μm, containing 8 obliquely uniseriate ascospores	Cylindrical to narrowly clavate with a round apex, 55–70 × 6–9 μm, containing 8 obliquely uniseriate becoming biseriate ascospores	Cylindrical to clavate, 56–70 × 5–6 μm, containing 8 obliquely uniseriate becoming biseriate ascospores
Ascospore	Oblong to ellipsoid, 8–11 × 3–5 μm, 1-septate, smooth and hyaline, becoming slightly brownish and verrucose	Ellipsoid, 9–9.5 × 4–5 μm, 1-septate, hyaline, smooth	Almost cylindrical with obtuse ends, 8–11 × 3.5–4.5 μm, 1-septate, becoming light brown	Smooth, oblong to ellipsoid, 7–11 × 3.5–5 μm, 1-septate, becoming light brown and verrucose
Anamorph	*F. matuoi*	*F. biasolettiana* (suggested to be a synonym of *F. merismoides*)	*F. aquaeductuum* var. *aquaeductuum*	*F. aquaeductuum* var. *medium*

N/D, not described or no data

previously discussed, the anamorph of *C. biasolettiana* is *F. biassolettianum* Corda, which corresponds to *F. merismoides* (Rossman et al. 1999) and shows a resemblance to *F. matuoi*. *Cosmospora biasolettiana* is similar to our fungus in other respects, but distinguished from it in the size, in particular the width, of the asci (see Table 2).

Six didymosporous members of *Cosmospora* are known with anamorphs on nonfungal hosts or not associated with scale insects: *C. chlorina* (P. Crouan & H. Crouan) Lowen, *C. digitalicola* (P. Crouan & H. Crouan) Lowen, *C. juncundula* (Sacc. & Speg.) Rossman & Samuels, *C. papilionacearum* (Seaver) Rossman & Samuels, *C. sansevieriae* (Bat., J.L. Bezerra & C.R. Almeida) Rossman & Samuels, and *C. thujana* (Samuels) Rossma & Samuels. All these species differ from our fungus in that they produce reddish perithecia. In addition, *C. chlorina*, *C. digitalicola*, and *C. thujana* have a KOH+ perithecial wall; *C. juncundula* has much narrower ascospores (Rossman et al. 1993); *C. papilionacearum* has larger ascospores; and *C. sansevierae* has longer ascospores and its perithecial morphology is quite different from our fungus (Samuels 1973).

The two species the anamorphs of which resembles *F. matuoi,* i.e., *C. purtonii* and *C. episphaeria*, can be clearly differentiated from *C. matuoi* in their fungicolous habitat, red and KOH+ perithecia, and having no distinct stroma.

From the foregoing analysis, our fungus differed from any of the taxa in *Cosmospora* hitherto described as a holomorph; hence, a new taxon was established.

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