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## Microfungi on the *Pandanaceae*: Two new species of *Camposporium* and key to the genus

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During an investigation into the microfungi that inhabit the *Pandanaceae*, two new species of *Camposporium* were found. *Camposporium fusisporum* sp. nov. and *C. ramosum* sp. nov. are described, illustrated and compared with accepted species. *Camposporium cambrense*, *C. japonicum* and *C. ontariense* are also reported from the *Pandanaceae*. A key to *Camposporium* species, and a comparative synopsis table are provided.

**Key words:** anamorphic fungi, *Freycinetia*, hyphomycetes, *Pandanus*, systematics, taxonomy.

### Introduction

*Camposporium* was introduced by Harkness (1884) with the single species *C. antennatum* Harkn. The genus is characterised by dematiaceous, simple conidiophores that have terminal, integrated, denticulate conidiogenous cells. The conidia are typically cylindrical and elongate, multi-septate, rounded at both or either end, the apex is either simple or has one or more cylindrical appendages, the base typically has a persistent portion of the denticle attached. Conidia are generally smooth, and often the cells at each end are significantly paler in pigmentation than the central cells (Hughes, 1951; Ellis, 1971; Ichinoe, 1971). Species of *Camposporium* are separated mainly on conidial characters, especially size, septation, pigmentation patterns, and presence and type of apical appendage/s. Although no recent review of *Camposporium* has been published, Hughes (1951) accepted four species, Rao and Rao (1964) treated three new species from India, and Ichinoe (1971) treated six species from Japan, two being new to science. To facilitate in the identification of taxa in this genus, a dichotomous key and comparative synopsis of all currently accepted species is presented (Table 1).

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Deighton and Pirozynski (1972) introduced the genus *Paratrichoconis* with *P. chinensis* (Hansf.) Deighton & Piroz. for species that are morphologically similar to *Camposporium* but have hyaline conidia. Castañeda *et al.* (1997) transferred *C. antillana* R.F. Castañeda and *Scolecobasidium fusarioides* Matsush. to *Paratrichoconis* as *P. antillana* (R.F. Castañeda) R.F. Castañeda and *P. fusarioidea* (Matsush.) R.F. Castañeda, respectively. Other species of *Camposporium* with hyaline conidia (e.g. *C. hyalinum* Abdullah, *C. marylandicum* Shearer, *C. scolecosporum* Matsush.) may also be more appropriately treated in *Paratrichoconis* (Matsushima, 1971; Shearer, 1974; Abdullah, 1980). *Camposporium aquaticum* Dudka was transferred first to *Vargamyces* Tóth (Tóth, 1979) and then to *Xylomyces* as *X. aquaticus* (Dudka) K.D. Hyde & Goh (Dudka, 1966; Hyde and Goh, 1999). The genus *Camposporidium* Nawawi & Kuthub. was introduced to accommodate species with conidia morphologically similar to those of *Camposporium*, but produced terminally on percurrently proliferating conidiogenous cells (Nawawi and Kuthubutheen, 1988).

The present work originates from an ongoing study of the saprobic microfungi that inhabit members of the monocotyledon family *Pandanaceae* (e.g. McKenzie, 1995; McKenzie and Hyde, 1996; Hyde, 1997; Whitton *et al.*, 1999, 2000).

***Camposporium cambrense*** S. Hughes, Mycological Papers 36: 11 (1951).

Conidia 84.5-91.5 µm long, 11.2-14.5 µm wide at widest point, 0-1 appendage, 9-11-septate.

*Specimen examined:* NEW ZEALAND, Waikato, Mt Pirongia, on decaying leaves of *Freycinetia banksii*, 21 May 1988, E.H.C. McKenzie (PDD 56717).

*Habitat:* Known to inhabit leaf litter, decaying leaves of *Freycinetia banksii* and *Laurus nobilis*, decaying capsules of *Fagus sylvatica*, decaying bark of *Fagus sylvatica* and decaying wood of *Ulmus* sp. and *Quercus* sp.

*Distribution:* Japan (Ichinoe, 1971), New Zealand (current specimen), Taiwan (Matsushima, 1987), U.K. (Hughes, 1951; Ellis, 1971; Kirk, 1981).

*Notes:* Conidia of *C. cambrense* were described as being 15-septate, smooth, 62-115 × 8-10 µm, with a rounded apex and a distinct basal scar. The apical appendage (if present) is singular, hyaline, septate, simple and 32-126 × 1.5-2 µm (Hughes, 1951). In the current specimen about half of the conidia had evidence of a single apical appendage. In all of these conidia the appendage was damaged or incomplete so length measurements were unable to be made. Conidial morphology and dimensions are consistent with *C. cambrense*. The slightly wider conidia in the current specimen are interpreted as being due to natural variation.

**Table 1.** Synopsis of *Camposporium* species.\*

	Conidiophores		Conidia			Appendage		
	Size	Septation	Size	Septation	Colour	Morphology	Septation	Length
<i>C. antennatum</i>	76-166 × 6 (32-166 × 5-6)	Up to 12	42-78 × 7.5-8.8 (42-90 × 6-10)	7-14 (4-14)	Pale-brown, paler end cells	1-3 (simple)	Aseptate	Up to 40
<i>C. cambrense</i>	22-84 × 6-7 (22-95 × 5-7)	3-10	62-115 × 8-10 (62-115 × 7.5-14.5)	Up to 15 (9-13)	Pale-brown, paler end cells	1 (simple)	Septate	32-126
<i>C. fusisporum</i>	100-145 × 6.5-10	10-15	86-115 × 13.5-19	8-11	Brown, paler end cells	2-3 (simple)	Aseptate	17-40
<i>C. hyalinum</i>	10-40 × 4-6	0-1	20-75 × 3-5	2-6	Hyaline, concolourous	1 (simple)	Aseptate	16-55
<i>C. hyderabadense</i>	25.2-39.6 × 3.6-5.4	1-3	32.4-54 × 3.6-7.2	5-9	Dark-brown, concolourous	1-4 (simple)	Aseptate	Up to 43.2
<i>C. indicum</i>	28.5-50.4 × 3.6-7.2	2-5	21.6-72 × 3.6-7.2	3-14	Dark-brown, paler end cells	0	—	—
<i>C. japonicum</i>	37.5-77.5 × 5-6.5	5	42.5-70 × 5-7.5	7-10	Pale-brown, concolourous	0-1(2-4-branched)	Aseptate	Up to 36
<i>C. laundonii</i>	Up to 40 × 5-8	0-2	50-150 × 13-17	4-9	Brown, paler end cells	1-2 (simple)	Septate	Up to 60
<i>C. marylandicum</i>	41-127 × 2-3	0-5	24.7-44 × 4.5-6.5	5-10	Hyaline, concolourous	1 (simple)	?	33.5-80
<i>C. microsporum</i>	Up to 72 × 3.6-7.2	1-5	25.8-36 × 7.2-9	2-6	Pale-brown to brown, concolourous	1-2 (simple)	Aseptate	10.8-28.8
<i>C. ontariense</i>	45-200 × 5-7	6-8	20-35 (20-53) × 8-12 (6.5-12)	3-7 (3-9)	Pale-brown, concolourous	0	—	—
<i>C. pellucidum</i>	30 to 150 × 5-8	Up to 10	78-140 × 7.5-12	Up to 16 (7-16)	Pale-brown, paler end cells	1 (simple)	Septate	30-145
<i>C. quercicola</i>	15-60 × 3.5-4	1-3	28-45 × 3.5-4.5	5-9	Pale-brown, paler end cells	0-3 (simple)	Aseptate	Up to 30
<i>C. ramosum</i>	70-138 × 5.2-6	4-10	80-112 × 6.4-9.6	8-15	Brown, paler end cells	1 (1-3-branched)	1-2 septate	20-60
<i>C. scolecosporum</i>	10-20 × 2.5-4.5	0-3	48-108 × 3-4	6-12	Hyaline, concolourous	0	—	—

\* All measurements in  $\mu\text{m}$ . Measurements in brackets refer to composite dimensions from additional published specimens. Some information was ascertained from accompanying illustrations.

***Camposporium fusisporum* Whitton, McKenzie & K.D. Hyde, sp. nov.**

(Figs. 1-5)

*Etymology:* *fusisporum*, refers to the fusoid shape of the conidia.

*Coloniae* effusae, brunneae. *Mycelium* immersum et superficiale, pallide brunneae, septata, cylindrica. *Conidiophora* 100-145 × 6.5-10 µm, macronemata, mononemata, irregulariter cylindrica, recta vel flexuosa, brunneae, ad apicem pallidiora, laevia, non ramosa vel ramosa, 10-15-septata. *Cellulae conidiogenae* holoblastica, mono- vel polyblastica, in conidiophoris incorporatae, denticulatae, ca. 2 µm diam. *Conidia* 86-115 × 13.5-19 µm, solitaria, sicca, fusoida, elongata, brunneae vel pallide brunneae, cellulis extremis pallidioribus, laevia, 8-11-septata, 2-3 apicem appendiculata, hyalinis, aseptata, sicca, 17-40 × 1.5-2.8 µm.

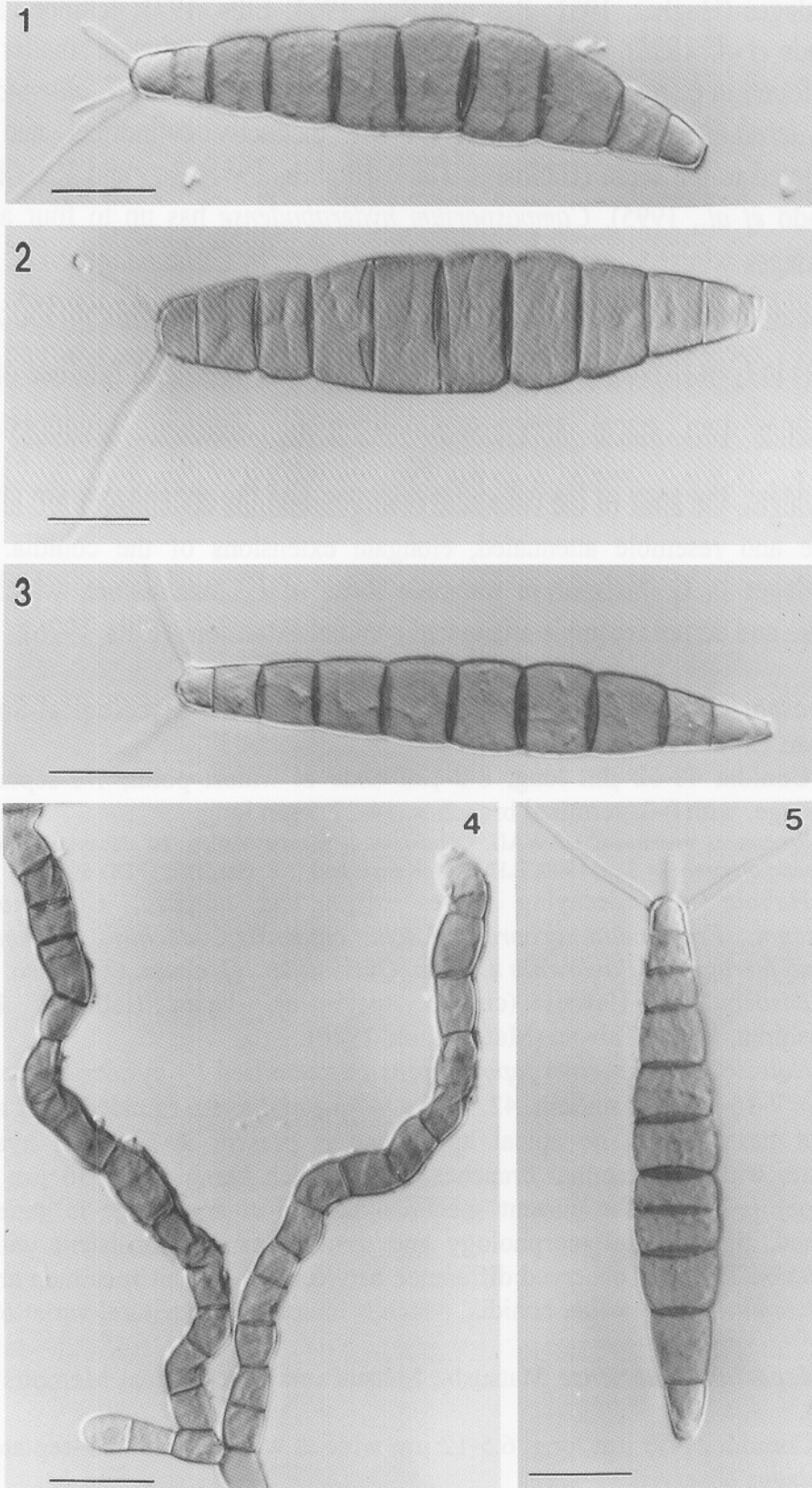
*Colonies* on natural substrate effuse, consisting of individual conidiophores scattered over the substrate surface, brown. *Mycelium* immersed and superficial, superficial hyphae pale brown, septate, cylindrical. *Stroma* none. *Hyphopodia* absent. *Setae* absent. *Conidiophores* 100-145 µm long, 6.5-10 µm wide at the base, macronematous, mononematous, irregularly cylindrical, strongly flexuous to twisted, erect, brown, sometimes fading slightly towards the apex, smooth, simple or infrequently branching towards the base, thickened walls and septa, 10-15-septate, often slightly constricted at the septa, each cell is connected via a small, circular pore at the centre of each septum, individual cells short, 7-17 µm long. *Conidiogenous cells* holoblastic, mono- or polyblastic, integrated into the apical region of the conidiophore, denticulate; denticles cylindrical, sometimes curved, pale brown, smooth, sometimes remaining attached to the conidia following detachment, acting as a separating cell, ca. 2 µm diam. *Conidia* 86-115 µm long, 13.5-19 µm wide at widest point, solitary, dry, fusoid, elongate, brown or pale brown, typically the two end cells are slightly paler in pigmentation than the rest of the conidium, smooth, thickened walls and slightly thickened septa, each septum has a single, central, circular pore, 8-11 (typically 9-)septate, often slightly constricted at the septa, basal cell conical with a truncate and strongly thickened end, apical cell rounded with 2-3, independent, simple, cellular, aseptate, hyaline, smooth, straight, curved or flexuous appendages, 17-40 µm long, 1.5-2.8 µm wide towards the base.

*Habitat:* Known to inhabit decaying leaves of *Pandanus* sp.

*Distribution:* Brunei Darussalam.

*Holotype* here designated: BRUNEI DARUSSALAM, Bandar Seri Begawan, amongst the mangroves of the Brunei Sungai (river) delta, on *Pandanus* sp. (mangrove associate), 28 Oct. 1995, S.R. Whitton [HKU(M)12925].

*Notes:* *Camposporium fusisporum* is characterised by conidia that are 8-11-septate, 86-115 × 13.5-19 µm, elongate fusoid, with 2-3 independent apical appendages. *Camposporium antennatum*, *C. hyderabadense* P.Rag. Rao & D. Rao, *C. microsporum* P.Rag. Rao & D. Rao and *C. quercicola* Mercado *et al.*, are the only species of *Camposporium* that have independent apical



**Figs. 1-5.** *Camposporium fusisporum*. 1-3, 5. Conidia. Note the 2-3 independent apical appendages. 4. Conidiophores. Bars = 20  $\mu$ m.

appendages (Hughes, 1951; Rao and Rao, 1964; Ellis, 1971; Ichinoe, 1971; Mercado *et al.*, 1995). However, in all four species the conidia are smaller than those found in *C. fusisporium* (Table 1). In addition, conidia of *C. antennatum*, *C. hyderabadense* and *C. querciola* are distinctly cylindrical and not constricted at the septa (Harkness, 1884; Hughes, 1951; Rao and Rao, 1964; Mercado *et al.*, 1995). *Camposporium hyderabadense* has up to four apical appendages whilst *C. microsporum* has only two. In *C. laundonii* M.B. Ellis the conidia are more or less fusoid in shape and of a similar size (50-150 × 13-17 µm) to *C. fusisporium*, however, the conidia of *C. laundonii* produce one or sometimes two apical appendages. When *C. laundonii* produces two appendages, the apex of the conidium diverges, and the appendages are always septate and resemble attenuated, elongate extensions of the conidia. The appendages in *C. fusisporium* resemble those of *C. antennatum*, which are aseptate and do not resemble attenuated conidial extensions (Ellis, 1976).

***Camposporium japonicum*** Ichinoe, Transactions of the Mycological Society of Japan 12: 83 (1971).

Conidia 48-62 µm long, 8-9 µm wide at widest point, 7-9-septate; 1 appendage, with 0-3 terminal branches, 14-27.5 µm long.

*Specimens examined:* HAWAII, Oahu Island, Manoa Valley, on decaying leaves of *Freycinetia arborea*, 24 Sep. 1990, E.H.C. McKenzie and D.E. Gardener (PDD 69211).

*Habitat:* On decaying leaves of *Acacia confusa*, *Cinnamomum japonicum*, *Freycinetia arborea*, *Litchi chinensis*, *Machilus thunbergii*, *Mucuna ferruginea*, *Paulownia kawaka*, *Quercus* sp., *Q. acuta*, *Q. glauca*.

*Distribution:* Hawaii (current specimen), Japan (Ichinoe, 1971; Matsushima, 1975), Taiwan (Matsushima, 1980).

*Notes:* *Camposporium japonicum* is characterised by cylindrical conidia that are 7-10-septate, smooth, 42.5-70 × 5-7.5 µm, have a rounded apex and a distinct basal scar. The apical appendage if present is singular, hyaline, aseptate, with 2-4 terminal branches, each branch being up to 36 µm long (Ichinoe, 1971). In the current specimen the apical appendage is generally branched, the conidial morphology and dimensions are consistent with *C. japonicum*. The only observed difference between the current specimen and *C. japonicum* is slightly wider conidia, which is interpreted as natural variation.

***Camposporium ontariense*** Matsush., Matsushima Mycological Memoirs 3: 3 (1981).

Conidia 27-53 µm long, 6.5-12 µm wide at widest point, 5-9-septate, no appendages observed.

*Specimen examined:* HAWAII, Oahu Island, Manoa Valley, on decaying leaves of *Freycinetia arborea*, 24 Sep. 1990, E.H.C. McKenzie and D.E. Gardener (PDD 72322).

*Habitat*: On decaying leaves of *Freycinetia arborea*, decaying wood of *Acer saccharum*.

*Distribution*: Canada (Matsushima, 1981), Hawaii (current specimen).

*Notes*: *Camposporium ontariense* is characterised by cylindrical to ellipsoid conidia that are 3-7-septate, smooth,  $20-35 \times 8-12 \mu\text{m}$ , have a rounded apex and a distinct basal scar. No apical appendages are present (Matsushima, 1981). The current specimens are morphologically and dimensionally consistent with *C. ontariense*, differing only in having slightly longer conidia.

***Camposporium ramosum* Whitton, McKenzie & K.D. Hyde, sp. nov.**

(Figs. 6-14)

*Etymology*: *ramosum*, branched, referring to the branched apical appendage.

*Coloniae* effusae, brunneae. *Mycelium* immersum et superficiale. *Conidiophora* 70-138  $\times$  5.2-6  $\mu\text{m}$ , macronemata, mononemata, solitaria, non ramosa, irregulariter cylindrica, recta vel flexuosa, atrobrunneae, ad apicem pallidiora, laevia, 4-10-septata. *Cellulae conidiogenae* holoblastica, polyblastica, in conidiophoris incorporatae, pallide brunneae, laevia, denticulatae. *Conidia* 80-112  $\times$  6.4-9.6  $\mu\text{m}$ , solitaria, sicca, cylindrica, elongata, brunneae vel pallide brunneae, concolor vel cellulis extremis pallidioribus, laevia vel subverrucosa, 8-15-septata, apicem appendiculata, fere 3-ramosa, hyalinis, 1-2 septata, 20-60  $\mu\text{m}$  longa.

*Colonies* on natural substrate, effuse, consisting of individual conidiophores scattered over the substrate surface, brown. *Mycelium* immersed and superficial. *Stroma* none. *Hyphopodia* absent. *Setae* absent. *Conidiophores* 70-138  $\mu\text{m}$  long, 5.2-6  $\mu\text{m}$  wide towards the base, macronematous, mononematous, solitary, unbranched, erect, irregularly cylindrical, flexuous, dark brown towards the base, fading to pale brown towards the apex, smooth, 4-10-septate, thickened walls and septa. *Conidiogenous cells* holoblastic, polyblastic, integrated into the apical region of the conidiophores, pale brown, smooth, denticulate; cylindrical denticles act as separating cells, 1-3 denticles per conidiophore. *Conidia* 80-112  $\mu\text{m}$  long, 6.4-9.6  $\mu\text{m}$  wide at the widest point, solitary, dry, cylindrical, elongate, brown or pale brown, concolorous or with 1-2 cells at each end paler in pigmentation, with a minute, rounded, roughened surface especially towards the ends, slightly thickened walls and septa, 8-15-septate, apex rounded, basal cell truncate, often with a persistent portion of the denticle attached, the apical cell gives rise to a single, simple or branched appendage; appendage hyaline, 1-2-septate, smooth, tapering from the base to the apex, close to the base the appendage typically divides into 3 (sometimes 2) terminal branches, individual branches 20-60  $\mu\text{m}$  long.

*Habitat*: Known to inhabit decaying stems of *Freycinetia scandens* and *F. arborea*.

*Distribution*: Australia, Hawaii.

*Holotype* here designated: AUSTRALIA, north Queensland, in forest surrounding Lake Barrine, on decaying stems of *Freycinetia scandens*, 18 June 1996, S.R. Whitton [HKU(M)12924].

*Additional specimen*: HAWAII, Oahu Island, Manoa Valley, on decaying leaves of *Freycinetia arborea*, 24 Sep. 1990, E.H.C. McKenzie and D.E. Gardener (PDD 72323).

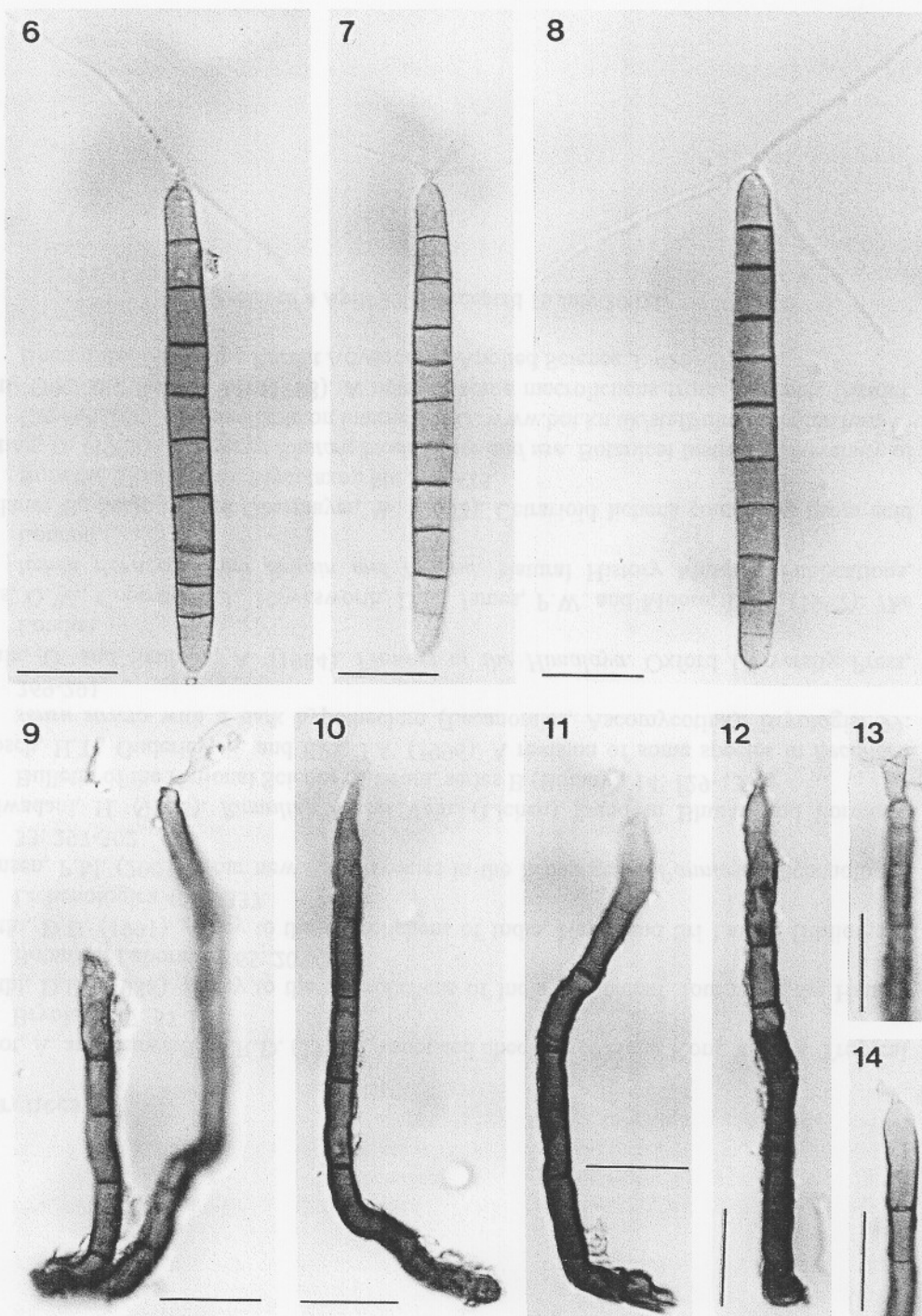
*Notes*: In all other species of *Camposporium* the conidia are described as being smooth-walled, whilst the current specimen has a slightly roughened surface especially towards the ends. *Camposporium ramosum* is morphologically similar to *C. japonicum*, which has a similar number of cells, and a single branched appendage at the apex. However, the conidia of *C. japonicum* are shorter ( $42.5\text{--}70 \times 5\text{--}7.5 \mu\text{m}$ ), and the appendage is aseptate and shorter (up to  $36 \mu\text{m}$  long) (Ichinoe, 1971).

#### Key to species of *Camposporium*

In some cases, measurements differ from the described specimens due to information from additional published specimens, including current specimens. Some information was ascertained from accompanying illustrations.

1. Conidia without apical appendages .....2
1. Conidia typically with apical appendages .....4
2. Conidia  $< 7 \mu\text{m}$  wide .....3
2. Conidia  $> 7 \mu\text{m}$  wide; 3-9-septate,  $20\text{--}53 \times 6.5\text{--}12 \mu\text{m}$ , cylindrical, pale brown .....*C. ontariense*
3. Conidia 6-12-septate,  $48\text{--}108 \times 3\text{--}4 \mu\text{m}$ , attenuated towards the apex, hyaline.....*C. scolecosporum*
3. Conidia 3-14-septate,  $21.6\text{--}72 \times 3.6\text{--}7.2 \mu\text{m}$ , cylindrical, dark brown .....*C. indicum*
4. Conidia with a single apical appendage, branched or simple .....5
4. Conidia with more than one apical appendage, always simple .....10
5. Single appendage branched .....6
5. Single appendage unbranched .....7
6. Conidial appendage 2-4-branched, aseptate, up to  $36 \mu\text{m}$  long; conidia 7-10-septate,  $42.5\text{--}70 \times 5\text{--}7.5 \mu\text{m}$  .....*C. japonicum*
6. Conidial appendage 0-3-branched, 1-2 septate, up to  $60 \mu\text{m}$  long; conidia 8-15-septate,  $80\text{--}112 \times 6.4\text{--}9.6 \mu\text{m}$  .....*C. ramosum*
7. Single apical appendage septate .....8
7. Single apical appendage aseptate,  $16\text{--}55 \times 0.5\text{--}1.5 \mu\text{m}$ ; conidia hyaline, 2-6-septate,  $20\text{--}75 \times 3\text{--}5 \mu\text{m}$  .....*C. hyalinum*
8. Conidia hyaline,  $24.7\text{--}44 \times 4.5\text{--}6.5 \mu\text{m}$ , 5-10-septate; appendage  $33.5\text{--}80 \times 0.5\text{--}1 \mu\text{m}$ .....*C. marylandicum*
8. Conidia pale-brown to brown.....9





**Figs. 6-14.** *Camposporium ramosum*. 6-8. Conidia. Note the branched apical appendage. 9-12. Conidiophores. 13, 14. Denticulate conidiogenous cells. Bars = 20  $\mu\text{m}$ .

9. Conidia 7-16-septate, 78-140 × 7.5-12 μm; appendage when present 30-145 × 1.5-2 μm ..... *C. pellucidum*
9. Conidia 9-15-septate, 62-115 × 7.5-14.5 μm; appendage when present 32-126 × 1.5-2.5 μm ..... *C. cambrense*
10. Conidia elongate fusoid..... 11
10. Conidia cylindrical ..... 12
11. Conidia 8-11-septate, 86-115 × 13.5-19 μm; 2-3 divergent apical appendages, aseptate, 17-40 × 1.5-2.8 μm ..... *C. fusisporum*
11. Conidia 4-9-septate, 50-150 × 13-17 μm; 0-2 appendages, septate, up to 60 μm long ..... *C. laundonii*
12. Conidia 5-9-septate, 28-45 × 3.5-4.5 μm; with (0-)1-3 divergent, apical, aseptate appendages ..... *C. quercicola*
12. Conidia > 6 μm wide..... 13
13. Conidia 42-90 × 6-10 μm, 4-14-septate; with 1-3 divergent, apical, aseptate appendages ..... *C. antennatum*
13. Conidia < 45 μm long..... 14
14. Conidia 2-6-septate, 26-36 × 7-9 μm; with 1-2 divergent, apical, aseptate appendages ..... *C. microsporum*
14. Conidia 5-9-septate, 32.4-54 × 3.6-7.2 μm,; with 1-4 divergent, apical, aseptate appendage .. *C. hyderabadense*

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