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# A genus *Schizotrema* (Graphidaceae) new to China, with a world-wide key

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**Abstract:** Based on the specimens collected from Yunnan Province, the lichen genus *Schizotrema* Mangold & Lumbsch is reported as new to China, with the species *Schizotrema guadeloupense* (Hale) Mangold & Lumbsch. Among Graphidaceae, the genus is characterized by its ascomata with concentrically layered margins composed of carbonized excipular remnants of older hymenia; the proper exciple is fused to indistinctly free, periphysoids are usually present, and the ascospores are transversely septate to muriform. The species *S. guadeloupense* is also new to Asia. In addition, notes of other five species in the genus are also given, with ecology and distribution, and world-wide key to species of *Schizotrema* is described in the present paper. All these results provide basic data information for the taxonomy of the family Graphidaceae.

**Key words:** taxonomy, lichenized fungi, Ostropales, new record

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## 中国地衣新记录属——裂孔衣属

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**摘要:** 该文报道了中国文字衣科地衣一新记录属——裂孔衣属 (*Schizotrema* Mangold & Lumbsch) 及其 1 个新记录种, 即瓜岛裂孔衣 [*Schizotrema guadeloupense* (Hale) Mangold & Lumbsch], 标本来自云南。该属主要特征为地衣体壳状, 树皮生, 具子囊盘类或色盘衣类的子囊果, 子囊果具再生层状边缘, 固有盘被融合或不明显, 具侧生侧丝, 子囊孢子横隔透镜或砖壁型。瓜岛裂孔衣也是亚洲新记录种。此外, 该文还对裂孔衣属其他 5 种的生态分布特征进行了描述, 并提供了该属世界范围检索表。以上结果为文字衣科地衣的分类学研究提供了基础资料。

**关键词:** 分类学, 地衣型真菌, 厚顶盘目, 新记录

The genus *Schizotrema* Mangold & Lumbsch belonging to Graphidaceae, Ostropales Ostropomycetidae, Lecanoromycetes, Pezizomycotina, Ascomycota, only

comprises six species in thelotremoid-Graphidaceae (Kalb, 2009; Mangold et al., 2009; Lumbsch et al., 2010; Rivas Plata et al., 2010, 2012, 2013; Lücking et

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al., 2016). It was rather recently established to accommodate species with rounded ascomata and a layered margin formed by concentrically arranged remnants of carbonized excipular tissue from older hymenia. In recent years, some small genera of graphidaceae have been reported in China, such as thelotremoid genera *Chapsa* (Xu & Jia, 2015) and *Myriotrema* (Xu et al., 2016), and graphioid genera *Carbacarthographis* (Jia et al., 2017; Liu et al., 2018), *Fissurina* (Jia et al., 2018) and *Leiorreuma* (Wang et al., 2015). Based on specimens collected from Yunnan Province, this genus is here newly reported from China, with a single species, *Schizotrema guadeloupense*.

## 1 Materials and Methods

The specimens are deposited in Fungarium of the College of Life Sciences, Liaocheng University, China (LCUF). OLYMPUS SZX16 and TECH XTS-30D dissecting microscopes, and OLYMPUS BX53 compound microscope were used for the morphological and anatomical studies, and the lichen substances were detected using standardized thin layer chromatography (TLC). These were conducted as described in Jia & Wei (2016).

## 2 Descriptions

*Schizotrema* Mangold & Lumbsch, in Mangold, Elix & Lumbsch, Fl. Australia 57: 657 (2009).

Type species: *Schizotrema zebrinum* Mangold.

Thallus corticolous, crustose, pale grey to yellowish-green, smooth to rough. Photobiont trentepohlioid. Apothecia erumpent to prominent,  $\pm$  rounded, apothecioid but usually with a narrow pore, regenerating with concentrically layered excipula and laterally covered by thalline layer, concolorous with the thallus; excipula more or less carbonized, periphysoids usually present; new hymenia formed from below the previous hymenia; ascospores transversely septate or muriform, non-amyloid.

Chemistry:  $\beta$ -orcinol depsidones, or no lichen substances present.

Notes: *Schizotrema* is characterized by erumpent to prominent, apothecioid ascomata with regenerating hy-

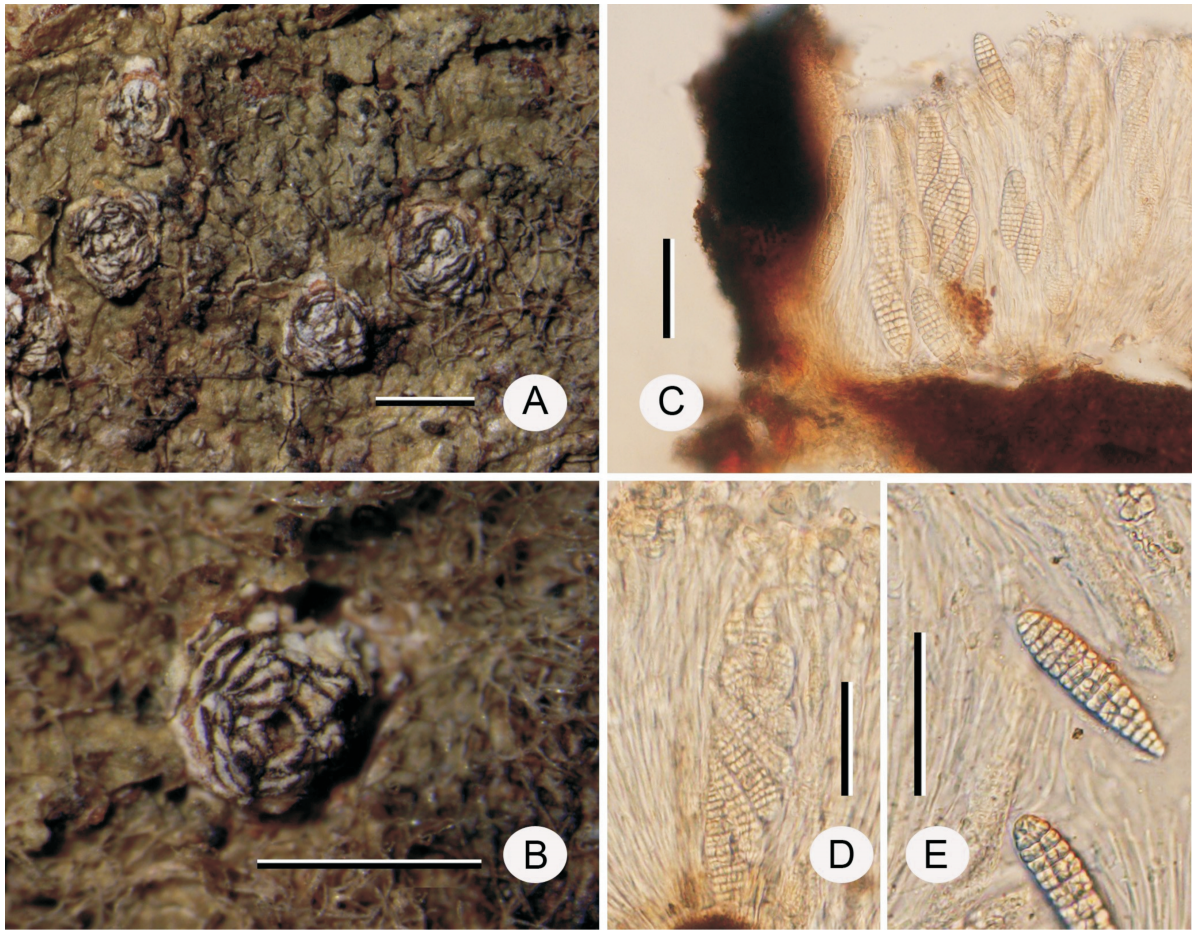
menia resulting in a  $\pm$  distinctly layered margin, with an apically free proper exciple that is dark brown to carbonized, a strongly conglutinated hymenium, distinct lateral paraphyses, ascospores transversely septate to muriform, hyaline to yellowish or brownish at late maturity. The genus grows on bark and wood and is found world-wide, with a concentration of species in Australia, mainly in cool-temperate and warm-temperate rainforests, less commonly in subtropical and tropical habitats. *Schizotrema* is most similar to *Topeliopsis* Kantvilas & Vězda, but differs in the carbonized excipula. Several other genera of thelotremoid Graphidaceae form lateral paraphyses, viz. *Acanthotrema* Frisch, *Chapsa* A. Massal., *Melanotopelia* Lumbsch & Mangold, *Pseudoramonia* Kantvilas & Vězda, *Schizotrema* Mangold & Lumbsch, *Thelotrema* Ach., and *Topeliopsis* Kantvilas & Vězda. except for *Melanotopelia* and *Schizotrema*, have a non-carbonized excipulum, and *Melanotrema* differs from *Schizotrema* in the simple, non-layered excipulum. *Crutarndina* Parmen, Lücking & Lumbsch agrees with *Schizotrema* in the layered excipulum but only has the apical portion carbonized and both genera are phylogenetically unrelated.

*Schizotrema guadeloupense* (Hale) Mangold & Lumbsch, in Mangold, Elix & Lumbsch, Fl. Australia 57: 657 (2009). —*Thelotrema guadeloupense* Hale, *Phytologia* 26: 416 (1973); type: Guadeloupe, Parc National de Guadeloupe, *M. E. Hale* 31633; holotype: US!

### Fig. 1

Thallus partially endoperidermal, pale greyish green to pale olive, dull to glossy, smooth to rough, corticate; cortex 15–20  $\mu\text{m}$  thick; photobiont layer continuous.

Ascomata rounded to somewhat irregular, erumpent, 0.5–0.8 mm diam., regenerating with layered margins. Disc usually hidden by excipular material, pore 0.2–0.4 mm diam., rounded to angular, formed by the apices of the innermost excipular tissue. Proper exciple usually apically free, dark brown to carbonized and usually containing periderm cells. Hymenium 150–200  $\mu\text{m}$  high; periphysoids conspicuous. Epithecium indistinct. Asci 8-spored. Ascospores richly muriform,



A, B. Thallus (Scales = 1 mm); C. Asci with ascospores (Scale = 50  $\mu\text{m}$ ); D, E. Asci with ascospores (Scale = 20  $\mu\text{m}$ ).

Fig. 1 *Schizotrema guadeloupense* (specimen: Z. F. Jia 11-488).

ellipsoid to fusiform, with rounded to subacute ends, hyaline to brownish at late maturity, non-amyloid,  $40 - 70 \mu\text{m} \times 15 - 20 \mu\text{m}$ , locules rounded to angular; ascospore wall thin, non-halonate, I-.

Chemistry: Stictic acid (major) and constictic acid (minor).

Notes: *Schizotrema guadeloupense* is similar to *S. schizolomum* (Müll. Arg.) Mangold & Lumbsch, but the latter species has larger ascospores ( $60 - 180 \mu\text{m} \times 20 - 40 \mu\text{m}$ ) and produces salazinic acid. *S. cryptotrema* (Nyl.) Rivas Plata & Mangold is also somewhat similar, but differs in the rather cryptic ascomata and the psoromic acid chemistry.

Ecology and Distribution: In China, the species grows on bark, known from tropical primeval forest of Mountain Daweishan in Yunnan Province, Southwest China. Associated lichens include species of *Graphis*. It

was previously reported from the Antilles (Guadeloupe), Argentina, Australia (including Tasmania), and New Zealand (Mangold et al., 2009; Lumbsch et al., 2010), and is new to China and to both continental and tropical Asia.

Specimens examined: China. **Yunnan** Gejiu City, Manhao Town, Malongdi, 1 280 m, 23 November 2011, Z. F. Jia 11-488, 11-493 (LCU).

**Notes on other five species of *Schizotrema* in the world**

*Schizotrema cryptotrema* (Nyl.) Rivas Plata & Mangold, in Rivas Plata, Lücking, Sipman, Mangold, Kalb & Lumbsch, *Lichenologist* 42 (2): 184 (2010). —*Thelotrema cryptotrema* Nyl., *Annls Sci. Nat., Bot.*, sér. 57: 319 (1867).

*Schizotrema cryptotrema* is characterized by ascomata morphological cryptic, with indistinctly layered;

ascospores muriform; presence of psoromic acid.

Ecology and Distribution: On bark. French Guiana, Brazil, Costa Rica (Nylander, 1867; Redinger, 1936), Venezuela (Kalb, 2009).

*Schizotrema flavolucens* (Sipman) Lücking, in Lücking, Mangold & Lumbsch, *Herzogia* 29: 506 (2016). — *Myriotrema flavolucens* Sipman, *Trop. Bryol.* 6: 5 (1992).

*Schizotrema flavolucens* is characterized by conspicuous, layered ascomata with carbonized proper exciple; asci 8-spored; ascospores hyaline, non-amyloid, 18–25  $\mu\text{m} \times 7\text{--}11 \mu\text{m}$ , transversely septate, with (3–) 5 (–6) locules; presence of lichexanthone.

Ecology and Distribution: On twigs in humid savannah vegetation on sandstone flats at tableland. Venezuela (Sipman, 1992).

*Schizotrema schizolomum* (Müll. Arg.) Mangold & Lumbsch, in Mangold, Elix & Lumbsch, *Fl. Australia* 57: 657 (2009). — *Leptotrema schizoloma* Müll. Arg., *Nuov. Giorn. Botan. Ital.* 21: 49 (1889).

*Schizotrema schizolomum* is characterized by regenerating, distinctly layered and carbonized ascomata; 1–4 (–6) spored asci; large, thin walled, mainly non-amyloid, muriform ascospores sized 60–180  $\mu\text{m} \times 20\text{--}40 \mu\text{m}$ ; presence of salazinic acid or no lichen substances.

Ecology and Distribution: On bark and wood in

cool-temperate to warm-temperate rainforests. Tasmania, New Zealand, Argentina, Australia (Mangold et al., 2009; Lumbsch et al., 2010).

*Schizotrema subzebrinum* Mangold, in Mangold, Elix & Lumbsch, *Fl. Australia* 57: 657 (2009).

*Schizotrema subzebrinum* is characterized by inconspicuous, erumpent, distinctly layered and distinctly carbonized ascomata; asci 8-spored; ascospores hyaline, non-amyloid, 20–35  $\mu\text{m} \times 7\text{--}10 \mu\text{m}$ , submuriform, with 10–14  $\times 1\text{--}2$  (–3) locules; absence of lichen substances.

Ecology and Distribution: On bark in warm-temperate rainforest. NSW (Mangold et al., 2009).

*Schizotrema zebrinum* Mangold, in Mangold, Elix & Lumbsch, *Fl. Australia* 57: 657 (2009).

*Schizotrema zebrinum* is characterized by conspicuous, layered ascomata with carbonized thick proper exciple; asci 6–8-spored; ascospores hyaline, non-amyloid, 30–80  $\mu\text{m} \times 6\text{--}11 \mu\text{m}$ , transversely septate, with 12–22 locules; presence of variable chemistry containing stictic acid, constictic acid, conprotocetraric acid, protocetraric acid, and so on (major to absent).

Ecology and Distribution: On bark in cool-temperate to warm-temperate and tropical montane rainforests. Australia (Mangold et al., 2009), New Zealand (Lumbsch et al., 2010).

### World-wide key to species of *Schizotrema*

- 1a. Ascospores transversely septate ..... 2  
 1b. Ascospores (sub-) muriform ..... 3  
 2a. Ascospores 30–80  $\mu\text{m} \times 6\text{--}11 \mu\text{m}$ , with 12–22 locules; stictic or fumarprotocetraric acids present .....  
 ..... *Schizotrema zebrinum* Mangold  
 2b. Ascospores 18–25  $\mu\text{m} \times 7\text{--}11 \mu\text{m}$ , with (3–)5(–6) locules; lichexanthone present .....  
 ..... *S. flavolucens* (Sipman) Lücking  
 3a. Ascospores submuriform, 20–35  $\mu\text{m} \times 7\text{--}10 \mu\text{m}$ ; no lichen substances ..... *S. subzebrinum* Mangold  
 3b. Ascospores muriform, 35–180  $\mu\text{m} \times 15\text{--}40 \mu\text{m}$ ; chemistry variable ..... 4  
 4a. Ascospores 60–180  $\mu\text{m} \times 20\text{--}40 \mu\text{m}$ ; salazinic acid or no lichen substances .....  
 ..... *S. schizolomum* (Müll. Arg.) Mangold & Lumbsch  
 4b. Ascospores 35–80  $\mu\text{m} \times 15\text{--}30 \mu\text{m}$ ; psoromic or stictic acid or cinchonarum unknowns ..... 5  
 5a. Stictic acid (major) and constictic acid (trace); apothecia with distinctly layered margins .....  
 ..... *S. guadeloupense* (Hale) Mangold & Lumbsch  
 5b. Psoromic acid present; apothecia morphologically cryptic, with indistinctly layered margins .....  
 ..... *S. cryptotrema* (Nyl.) Rivas Plata & Mangold

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