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Two additional new species of *Carbacanthographis* from India

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Abstract: Two new species of the lichen genus *Carbacanthographis*, namely *C. albolirellata* and *C. indica*, are reported from India. The two species are distinguished by their exciple character, ascospore septation and chemistry. *Carbacanthographis albolirellata* has a completely carbonized exciple, submuriform ascospores and no lichen substances. *Carbacanthographis indica* is characterized by a laterally carbonized exciple, trans-septate ascospores and by the presence of salazinic acid.

Key words: lichenized Ascomycota, *Graphidaceae*, taxonomy

Introduction

The lichen genus *Carbacanthographis* Staiger & Kalb comprises 21 species world wide (Staiger 2002; Kalb 2004; Archer 2006, 2007, 2009; Lücking *et al*. 2009; Bungartz *et al*. 2010; Sharma *et al*. 2010; Tripp *et al*. 2010). The genus is characterized by a convergent, carbonized exciple, labia covered with a distinct white pruinose layer in the upper part, warty periphysoids, and I− or weakly I+, muriform or trans-septate ascospores.

The closely allied genus *Acanthothecis* Clem. also has warty periphysoids, but can easily be distinguished from *Carbacanthographis* by a non-carbonized exciple. *Carbacanthographis* is morphologically similar to *Graphis* Adans., in having a well-developed, carbonized, convergent exciple; however, *Graphis* differs from *Carbacanthographis* in lacking periphysoids and in the strongly I+ ascospores.

In our earlier paper on this genus (Sharma *et al*. 2010), we recognized two species from India, *C. marcescens* from Tamil Nadu, Kerala and the Andanman Islands and a sorediate species *C. sorediata* B. O. Sharma, Makhija & Khadilkar from Tamil Nadu. Further investigation of the lichen family *Graphidaceae* from India has revealed the occurrence of two new *Carbacanthographis* species, namely *C. albolirellata* and *C. indica*, which are described in the present paper. A table comparing the characters of all accepted species of *Carbacanthographis* is also given.

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Materials and Methods

The study is based on the examination of herbarium specimens lodged at the Ajrekar Mycological Herbarium (AMH). Sections of thalli and ascomata were mounted in water, 10% KOH (K), Lugol's solution (I), and lactophenol cotton-blue (LPCB). All measurements were made on material mounted in water. Secondary products were identified by thin-layer chromatography using standardized methods (Culberson & Kristinsson 1970; Culberson 1972; White & James 1985) and the solvent systems toluene-dioxane-acetic acid (180:45:5) and toluene-ethyl acetate-formic acid (139:83:8). The specimens were examined under UV light (365 nm).

The Species

Carbacanthographis albolirellata B. O. Sharma & Khadilkar sp. nov.

MycoBank No.: MB 561007

Sicut *Carbacanthographis coccospora* sed ascosporis majoribus differt.

Typus: India, Tamil Nadu, near Daisy Bank, Kodaikanal, 25 January 1975, *P. G. Patwardhan & A. V. Prabhu*, 75.365 (AMH—holotypus).

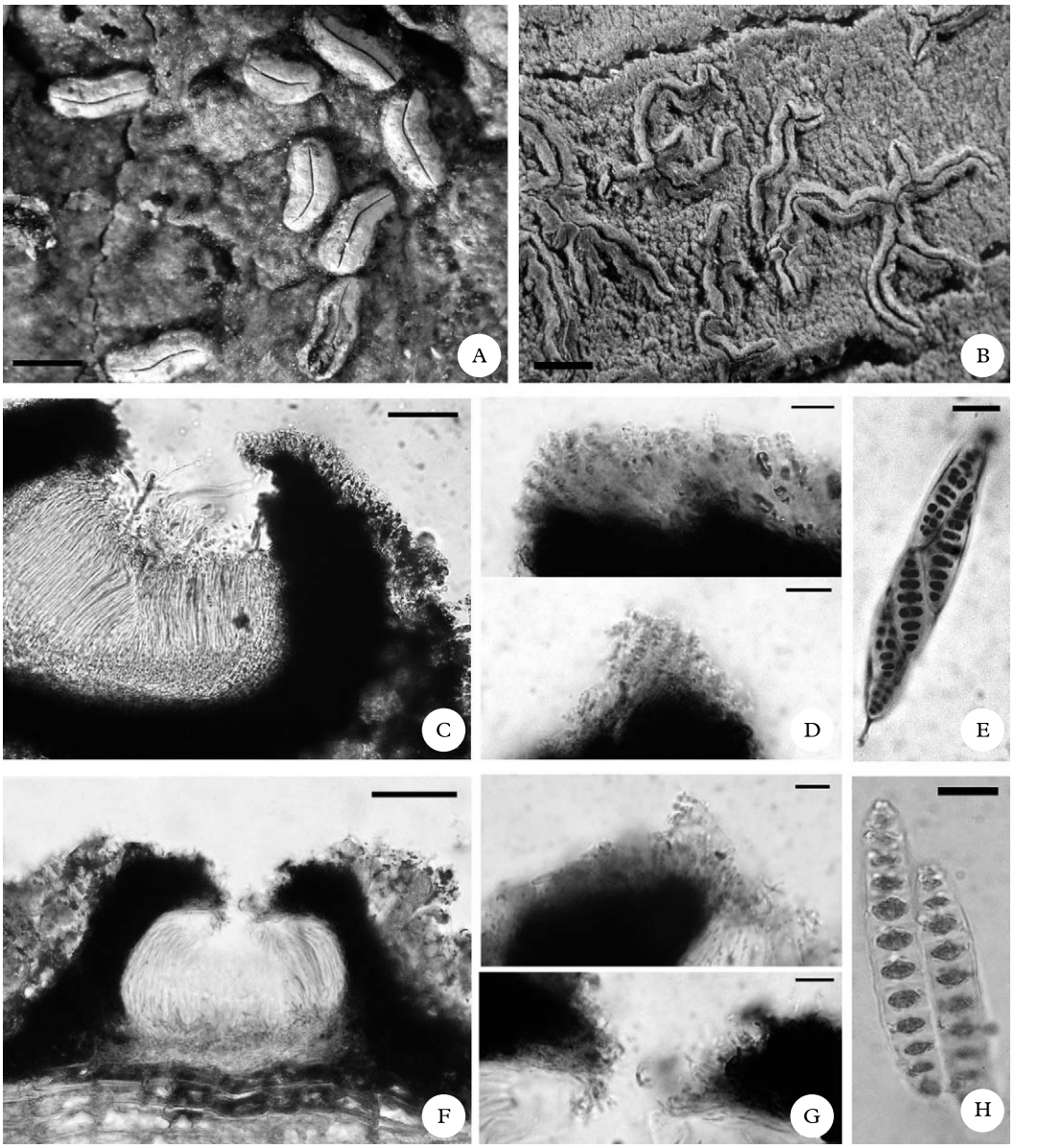

FIG. 1. *Carbacanthographis* species. A, C–E, *C. albolirellata* (holotype AMH); A, habitus; C, vertical section of the ascocarp; D, warty periphysoids; E, ascospores. B, F–H, *C. indica* (holotype AMH); B, habitus; F, vertical section of the ascocarp; G, warty periphysoids; H, ascocarps. Scales: A & B = 1 mm; C & F = 50 μm; D & E, G & H = 10 μm.

(Fig. 1A, C–E)

Thallus crustose, corticolous, epiphloeodal, yellowish brown, dull, rough, verrucose, cracked, delimited by a thin, black hypothallus.

Ascocarps lirellate, black, white-pruinose, black underneath, prominent to sessile, simple, straight to slightly curved, 1–4 mm long with rounded ends. *Disc* slit-like, epruinose. *Proper exciple* convergent, completely carbonized including the base. *Epithecium*

absent. *Hymenium* hyaline, not inspersed, I−, 75–150 μm high. *Paraphyses* simple. *Periphysoids* short, distinctly warty. *Asci* 8-spored; *ascospores* hyaline, submuriform, with 6–8 transverse and 1–2 longitudinal septa per segment, 16–20 × 6–8 μm, I+ blue violet.

Chemistry. No lichen substances detected.

Remarks. *Carbacanthographis albolirellata* is comparable to *C. coccospora* (Aptroot) Aptroot & Lücking, having similar morphological features, but *C. coccospora* has small, (6–) 9–12 × 7–10 μm long, ascospores.

Other species of *Carbacanthographis* which share similar morphological characters are *C. amicta* (Nyl.) Staiger & Kalb, *C. crassa* (Müll. Arg.) Staiger & Kalb, *C. hilli* (A. W. Archer) A. W. Archer, *C. inspersa* Staiger, *C. muriformis* E. A. Tripp & Lendemer, *C. salazinica* (A. W. Archer) A. W. Archer and *C. subalbotecta* Staiger & Kalb, but all of them differ in their chemistry.

Carbacanthographis albolirellata is differentiated from *C. indica* described below in having a completely carbonized exciple, submuriform ascospores and no lichen substances in the thallus.

The new species *Carbacanthographis albolirellata* has been collected only twice from Tamil Nadu in the Western Ghats of India. These mountains play a special role in the botany of the Indian subcontinent for their interesting flora and they are one of the richest lichen sites in India.

Additional specimen examined. **India:** *Tamil Nadu*: near Daisy Bank, Kodaikanal, 1975, *P. G. Patwardhan & A. V. Prabhu*, 75.367 (AMH).

Carbacanthographis indica B. O. Sharma & Khadilkar sp. nov.

MycoBank No.: MB 561008

Sicut *Carbacanthographis marscescens* sed ascosporis trans-septatis differt.

Typus: India, Meghalaya, Garo hills, *Lagerstroemia* forest, 5 November 1977, *P. G. Patwardhan & M. B. Nagarkar*, 77.1340 (AMH—holotypus).

(Fig. 1B, F–H)

Thallus crustose, corticolous, epiphloeodal, greyish white, flat, smooth to rough, cracked, delimited by a black hypothallus.

Ascocarps lirellate, conspicuous, concolorous with the thallus, with a conspicuous, raised thalline margin, rarely simple, mostly irregularly branched, erumpent, 1–5 mm long, ends acute. *Disc* slit-like, epruinose. *Proper exciple* convergent, entire, laterally carbonized, base distinctly orange-brown. *Epithecium* absent. *Hymenium* hyaline, not inspersed, I−, 87–137 μm high. *Paraphyses* simple. *Periphysoids* short, indistinctly warty. *Asci* 8-spored; *ascospores* hyaline, trans-septate, with 10–15 transverse septa, 25–70 × 7·5–10 μm, I+ colour reaction weak.

Chemistry. Salazinic acid present.

Remarks. The only species so far known to have salazinic acid and a laterally carbonized exciple, *Carbacanthographis marcescens* (Fée) Staiger & Kalb, differs from the new species in having smaller, muriform ascospores. Similarly *C. cleitops* (Fée) Lücking and *C. triphoroides* (M. Wirth & Hale) Lücking have stictic acid and muriform ascospores.

Carbacanthographis indica is differentiated from species of *Carbacanthographis* with laterally carbonized exciples and trans-septate ascospores by the presence of salazinic acid. *Carbacanthographis induta* (Müll. Arg.) Lücking from Vietnam and *C. iriomotensis* (M. Nakan.) M. Nakan. & Kashiw. from Japan, have similar morphological characters but differ in their chemistry; C. *induta* has norstictic acid and *C. iriomotensis* has stictic acid.

Graphis garoana Nagarkar & Patw., a species from Meghalaya, India, clearly belongs to *Carbacanthographis* [holotype—India, Meghalaya, Garo hills, Darugiri reserve forest; 6 Dec, 1978, *M. B. Nagarkar*, 78.387–AMH (!)], and appears to be somewhat close to *C. indica*, sharing some characters such as a laterally carbonized exciple and trans-septate ascospores. However, *G. garoana* has simple, emergent, long lirellae up to 8 mm long, and has norstictic acid in addition to salazinic acid in the thallus.

Carbacanthographis indica can also be distinguished from the species of *Carbacanthographis* with completely carbonized exciples and trans-septate ascospores by the presence

TABLE 1. Comparison of characters of the accepted species of *Carbacanthographis*

Species	Exciple carbonization	Hymenium	Ascospore			Chemistry	Soredia
			Septation	No./asus	Dimensions		
C. alloafzelii	lateral	clear	trans-septate	8	18–20 × 8–10 µm	psoromic	absent
C. iriomotensis	lateral	clear	trans-sepate	8	15–45 µm long	stictic	absent
C. induta	lateral	clear	trans-septate	8	65–70 × 9–12 µm	norstictic	absent
C. indica	lateral	clear	trans-septate	8	25–70 × 7·5–10 µm	salazinic	absent
C. marcescens	lateral	clear	muriform	8	12–17 × 5–7 µm	salazinic, protocetraic	absent
C. sorediata	lateral	clear	muriform	8	17–27 × 7–10 µm	salazinic	present
C. saxiseda	apical	clear	muriform	8	24–27 (–30) × 16–18 µm	norstictic	absent
C. triphoroides	lateral	clear	muriform	2–6	47–75 × 18–30 µm	stictic	absent
C. cleitops	lateral	clear	muriform	single	80 –100 × 20–25 µm µm	stictic	absent
C. saxorum	lateral to complete	clear	trans-septate	8	21–28 × 8–11 µm	norstictic	absent
C. stictica	complete	inspersed	trans-septate	8	23–35 × 6–7 µm	stictic	absent
C. inspersa	complete	inspersed	muriform	8	14–8 × 6–7 µm	protocetraric	absent
C. hertelii	complete	clear	trans-septate	(4–) 6–8	15–45 µm long	protocetraric	absent
C. chionophora	complete	clear	trans-septate	8	20–25 × 6–8 µm	protocetraric, lichexanthone	absent
C. candidata	complete	clear	trans-septate	4–8	55–100 × 7–9 µm	protocetraric, lichexanthone	absent
C. coccospora	complete	clear	muriform	8	(6–) 9–12 × 7–10 µm	no lichen substances	absent
C. albolirellata	complete	clear	muriform	8	16–20 × 6–8 µm	no lichen substances	absent
C. hillii	complete	clear	muriform	8	22–26 × 10–12 µm	psoromic	absent
C. amicta	complete	clear	muriform	8	14–18 × 6–7 µm	salazinic	absent
C. salazinica	complete	clear	muriform	8	19–23 × 7–8 µm	salazinic, norstictic, protocetraric	absent
C. crassa	complete	clear	muriform	single	120–180 × 25–30 µm	stictic	absent
C. subalbotecta	complete	clear	muriform	8	55–90 × 11–18 µm	protocetraric, lichexanthone	absent
C. muriformis	complete	clear	muriform	4	114–162 × 9–15 µm	protocetraric	absent

of salazinic acid and ascospore size. *Carbacanthographis alloafzelii* (A. W. Archer) A. W. Archer has psoromic acid and ascospores 18–20 × 8–10 µm. *Carbacanthographis candidata* (Nyl.) Staiger and *C. chionophora* (Redinger) Staiger & Kalb have protocetraric and lichexanthone in the thallus, while *C. stictica* Staiger & Kalb has the stictic acid complex.

Carbacanthographis indica has been collected from Meghalaya in North-East India, which is extremely rich in floral and faunal biodiversity, with several endemic species of lichens.

Additional specimens examined. **India:** *North-East India*: Meghalaya, Garo hills, *Lagerstroemia* forest, 1977, *P. G. Patwardhan & M. B. Nagarkar*, 77.2094, 77.2093 (AMH).

A comparison of the characters of the accepted species of *Carbacanthographis* is provided in Table 1.

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