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Short Communication

New combinations and synonyms in *Graphidaceae* (lichenized Ascomycota) from India

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Graphidaceae, the largest crustose family within *Ostropales* comprising more than 2000 species (Lücking *et al.* 2016), is widely distributed in tropical and subtropical regions of the world. Since 2002, the taxonomy of the family has undergone major changes and, as a result, a large number of new genera have been established and several old genera resurrected based mainly on molecular studies (Staiger *et al.* 2006; Rivas Plata *et al.* 2012, 2013; Lücking *et al.* 2013; Lumbsch *et al.* 2014). *Graphidaceae* is now well circumscribed in terms of generic classification and species delimitation. In earlier publications, Singh & Swarnlatha (2009) and Singh & Singh (2017*a*) made several new combinations for Indian taxa. In the present paper a further five new combinations are proposed which are the result of our continuing study on Indian graphidioid *Graphidaceae* and examination of more type specimens preserved at Agarkar Research Institute, Pune, India (AMH), Botanical Survey of India, Allahabad (BSA), the Natural History Museum, London (BM), Conservatorie et Jardin botaniques de la Ville de Genève (G), Finnish Museum of Natural History, University of Helsinki, Finland (H-NYL), and National Botanical Research Institute, Lucknow (LWG). The new combinations include: *Carbacanthographis garoana*, *Diorygma occultum*, *Fissurina leucocarpoides*, *F. parvicarpa* and *Pallidogramme canarensis.* In addition, seven names are synonymized viz. *Diorygma indicum* under *D. aeolum*, *Fissurina shivamoggensis* under *F. leucocarpoides*, *Graphis andamanica*, *G. longissima* and *G. sitapurensis* to *G. flavovirens*, *G. kollaimalaiensis* under *G nigrocarpa*, and *Phaeographina nakanishii* under *Schistophoron tenue.*

Type specimens deposited in AMH, BM, BSA, G, H and LWG were examined morphologically, anatomically and chemically. Morphological characters of thalli (reproductive structures, colour, size and shape) were observed using a Nikon SMZ 1500 stereomicroscope. Thin hand-cut sections of thalli and ascomata were examined, mounted in an aqueous solution of KOH. All anatomical measurements were made in water mounts and examined using a Nikon Eclipse 50i compound microscope. Ascospores were mounted in water for measurements and stained with Lugol's solution to check the amyloid reaction. Secondary metabolites were identified by thin-layer chromatography (TLC) using solvent A (180 toluene: 45 dioxane: 5 acetic acid), following Orange *et al.* (2001).

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New Combinations

Carbacanthographis garoana (Nagarkar & Patw.) Pushpi Singh & Kr. P. Singh comb. nov.

MycoBank No.: MB 830948

Graphis garoana Nagarkar & Patw., *Biovigyanam* **8**, 126 (1982); type: India, Meghalaya, Garo Hills, Darugiri Reserve Forests, 6 December 1978, *M. B. Nagarkar* 78.387 (AMH!—holotype).

(Fig. 1A)

Thallus corticolous, greyish brown to yellowish brown, continuous, smooth; cortex indistinct.

Ascomata lirellate, conspicuous, emergent, simple to sparsely branched, covered with lateral thalline margin, 1–2 mm long, 0.2–0.3 mm wide; *disc* slit-like, covered laterally with whitish pruina and coated with warty periphysoids; *labia* entire; *exciple* laterally carbonized; *hymenium* hyaline, clear, 85–100 µm high; *asci* 8-spored; *ascospores* colourless, transversely 10–12-septate, 35–74 × 7.0–8.5 µm, I+ pale blue; norstictic and salazinic acids present.

Notes. Examination of the type material of *Graphis garoana* (AMH!) revealed that it belongs to the genus *Carbacanthographis*. *Carbacanthographis indica* B. O. Sharma & Khadilkar, a species from Meghalaya, India appears to be somewhat close to *C. garoana* in the laterally carbonized exciple and transversely septate ascospores. However, *C. garoana* is easily distinguished by its simple, emergent, flexuous, 3–8 mm long lirellae and in the presence of norstictic acid in addition to salazinic acid in the thallus (Nagarkar & Patwardhan 1982). It also resembles *C. induta* (Müll. Arg.) Lücking in the laterally carbonized exciple and transversely septate ascospores but the latter species differs in its larger ascospores and the presence of stictic acid (Nakanishi *et al.* 2010).

Diorygma occultum (Adaw. & Makhija) Pushpi Singh & Kr. P. Singh comb. nov.

MycoBank No.: MB 830950

Platythecium occultum Adaw. & Makhija, *Mycotaxon* **92**, 392 (2005); type: India, Tamil Nadu, Chitteri, 14 November 1985, *M. B. Nagarkar & P. G. Patwardhan* 85.1446 (AMH!—holotype)

(Fig. 1B)

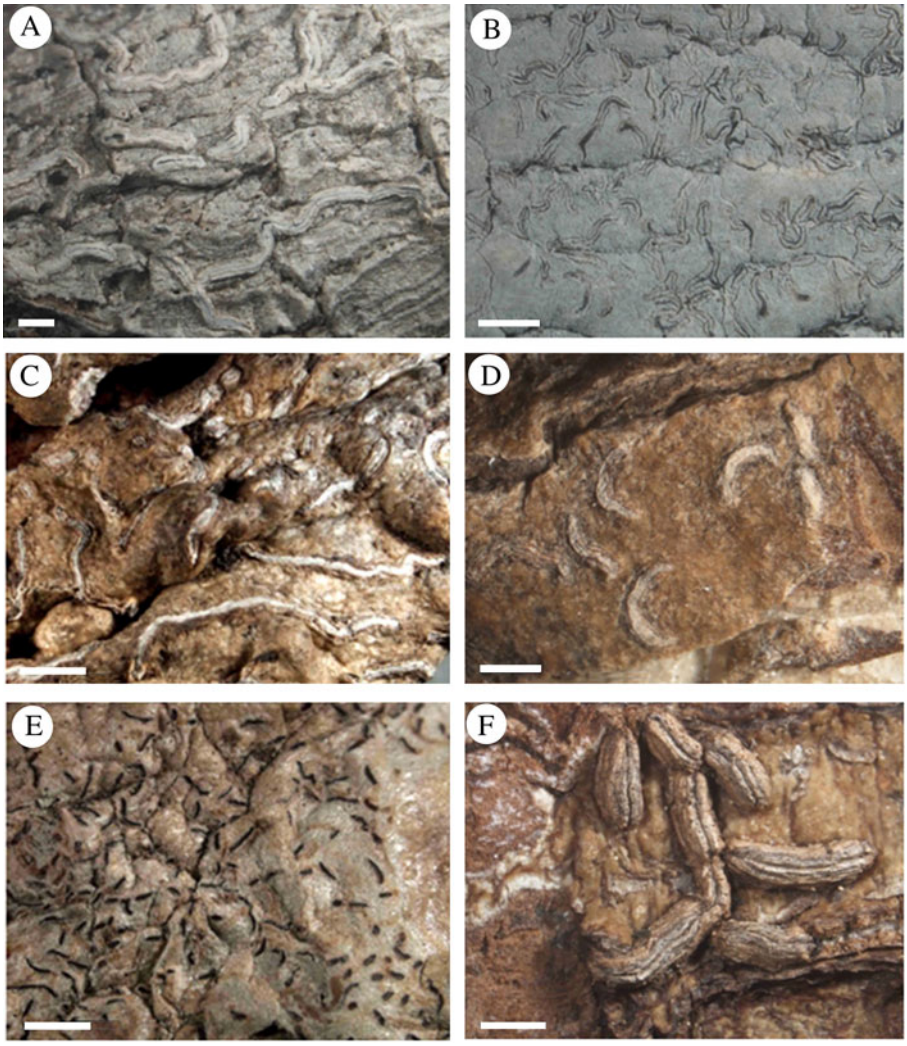

Fig. 1. Habitus of studied species (holotypes). A, *Carbacanthographis garoana*; B, *Diorygma occultum*; C, *Fissurina leucocarpoides*; D, *Fissurina shivamoggensis*; E, *Fissurina parvicarpa*; F, *Pallidogramme canarensis*. Scales = 1 mm. In colour online.

Thallus corticolous, crustose, epiphloeodal, greyish white, cracked, ecorticate.

Ascomata lirellate, immersed, simple to branched, covered by lateral thalline margin; *disc* narrow to exposed, blackish, faintly whitish pruinose; *exciple* uncarbonized, covered by lateral thalline margin; *hymenium* clear, I−; *asci* 6–8-spored; *ascospores* colourless, transversely 5–7-septate, 18–28 × 7–8 µm, amyloid, I+ blue; lichexanthone, norstictic and constictic acids (see under notes).

Notes. Examination of the type material of *Platythecium occultum* (AMH!) revealed that it belongs to the genus *Diorygma*, based on the *Diorygma*-like thallus and ascomata. The occurrence of both norstictic and constictic acids is exceptional and rarely found in the *Graphidaceae*. However, both substances were observed in TLC as mentioned in the protologue. The same rare condition was also observed by Kalb *et al.* (2004) for *Diorygma hieroglyphicum* (Pers.) Staiger & Kalb and a small number of other species in their monograph. Externally it is very similar to *Diorygma hieroglyphicum,* which has single-spored asci and larger ascospores (95–150(–170) × 30–45 µm; *fide* Kalb *et al.* 2004). In ascospore characteristics, it closely resembles *D. minisporum* Kalb *et al.*, although this contains hypostictic, hypoconstictic, stictic and constictic acids.

Fissurina leucocarpoides (Nyl.) Pushpi Singh & Kr. P. Singh comb. nov.

MycoBank No.: MB 830952

Graphis leucocarpoides Nyl., *Bull. Soc. Linn. Normandie, sér. 2*, **7**, 176 (1873).—*Graphina leucocarpoides* (Nyl.) Zahlbr., *Cat. Lich. Univ.* **2**, 412 (1923); type: India, Andaman Islands, 1867, *S. W. Kurz* s. n. H-NYL No. 7692 (H!—lectotype).

Fissurina shivamoggensis Pushpi Singh & Kr. P. Singh, *NeBIO* **8**, 21 (2017); type: India, Karnataka, Shivamogga District, Sagar-Shivamogga road, Chithrate forest, 17 December 2014, *K. P. Singh* 9743 (BSA!—holotype).

(Fig. 1C & D)

Thallus corticolous, pale fawn or yellowish brown, smooth, glossy, effuse, continuous; corticate.

Ascomata lirellate, numerous, immersed, conspicuous, sparsely branched, closely scattered, almost straight to curved, 2–12 mm long and 0.4–0.6 mm wide; *labia* striate, divergent; *disc* exposed, whitish pruinose; *exciple* uncarbonized; *hymenium* clear; *asci* 1-spored; *ascospores* colourless, oblong, densely muriform,

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100–150(–160) × 38–55 µm, with amyloid halo, 11–23 µm thick; lichen substances absent.

Notes. Examination of the type material of *Graphis leucocarpoides* (H!) revealed that it belongs to the genus *Fissurina*. Morphologically, it closely resembles *Fissurina niveoalba* Poengs. & Kalb, which has 8-spored asci and smaller, 17–25 µm long ascospores (Poengsungnoen *et al.* 2014). In ascospore character, it also closely resembles *F. submonospora* B. O. Sharma *et al.* which has short emergent (0.5–1.0 mm long) lirellae with a slit-like disc; the labia are entire and the exciple convergent and entirely covered by a thalline margin (Sharma *et al.* 2012).

Singh & Singh (2017*b*) described *Fissurina shivamoggensis* (Fig. 1D) from Karnataka, India. While attempting to resolve the status of taxa reported under the name *Graphina* from India, we concluded that *F. shivamoggensis* is conspecific with *F. leucocarpoides.* The former is therefore synonymized here.

Fissurina parvicarpa (Makhija & Adaw.) Pushpi Singh & Kr. P. Singh comb. nov.

MycoBank No.: MB 830954

Platythecium parvicarpum Makhija & Adaw., *Mycotaxon* **91**, 351 (2005); type: India, Andaman Islands, South Andaman, Baratang Island, Nilambur, 20 February 1985, *P. G. Patwardhan* 85.368 (AMH!— holotype).

(Fig. 1E)

Thallus corticolous, pale brown, smooth, glossy.

Ascomata lirellate, immersed, short, simple, blackish; *disc* narrow to open, dark brown, epruinose; *exciple* uncarbonized; *hymenium* clear; *periphysoids* indistinct; *epihymenium* pale brown; *asci* 8-spored; *ascospores* colourless, transversely 3-septate, 12–16 × 5.0–5.8 µm, with a thin halo, faintly I+ blue; lichen substances absent.

Notes. Examination of the type material of *Platythecium occultum* (AMH!) revealed that it belongs to the genus *Fissurina*. It closely resembles *F. andamanensis* B. O. Sharma *et al.*, *F. khasiana* Makhija & Adaw. and *F. humilis* (Vain.) Staiger with its 3-septate amyloid ascospores. *Fissurina andamanensis* is distinguished by its fissurine lirellae, large, 20–27 µm long ascospores (Sharma *et al.* 2012) and the presence of salazinic acid, while *F. khasiana* has large, 16–19 × 8–10 µm ascospores and contains stictic and constictic acids. *Fissurina humilis* has a laterally carbonized exciple and large, 14–25 × 7–9 µm ascospores.

Pallidogramme canarensis (Patw. & C. R. Kulk.) Pushpi Singh & Kr. P. Singh comb. nov.

MycoBank No.: MB 830956

Phaeographina canarensis Patw. & C. R. Kulk., *Indian J. Bot.* **2**(2), 135 (1979); type: India, Karnataka, Agumbe to Udupi road, Hebri, *A. V. Prabhu & M. B. Nagarkar* 74.3050 (AMH!— holotype).

(Fig. 1F)

Thallus corticolous, brownish, glossy, continuous, wrinkled to warty, corticate.

Ascomata lirelliform, prominent, simple to sparsely branched, 5–8 mm long, 0.4–0.5 mm wide, obtuse at the ends; *disc* slit-like; *labia* convergent, striate, blackish; *exciple* uncarbonized, pale brown to brown, covered by lateral thalline margin encrusted with numerous crystals; *hymenium* hyaline, clear, I−; *epihymenium* dark brown; *asci* 4(–8)-spored; *ascospores* brown, oblong, ellipsoid, muriform, (40–)60–118 × (12–)20–32 µm, I+ red; norstictic acid present.

Notes. Examination of the type material of *Phaeographina canarensis* (AMH!) revealed that it belongs to the genus *Pallidogramme*. It closely resembles *P. chlorocarpoides* (Nyl.) Staiger *et al.* which has an inspersed hymenium and stictic acid complex chemistry. In chemistry, it closely resembles *P. parvicarpum* (Sharma & Khadilkar) Lücking, which has an inspersed hymenium and 1–2-spored asci.

Further New Synonyms

Diorygma aeolum (Stirt.) Pushpi Singh & Kr. P. Singh

Lichenologist **49**, 527 (2017).—*Graphis aeola* Stirt., *Proc. Roy. Phil. Soc. Glasgow* **11**, 316 (1879) [1878]; type: India, Tamilnadu, 'Nelghiri' (Nilgiri hills), *G. Watt*, s.n. (BM 0010973831!—lectotype).

Diorygma indicum (Müll. Arg.) S. Joseph & G. P. Sinha, *Indian J. For. Add. Ser.* **VI**, 155 (2018).—*Enterodictyon indicum* Müll. Arg., *J. Linn. Soc., Bot.* **29**, 230 (1892); type: India, Manipur, 1881–1882, *G. Watt* s. n. (G!—lectotype).

Notes. Müller-Argoviensis (1892) described *Enterodictyon indicum* as a new species from Manipur, India. Joseph *et al.* (2018) transferred it to the genus *Diorygma* as *D. indicum*. After a critical study it was found that the latter agrees well with *D. aeolum*, in morphology, anatomy and chemistry. *Diorygma indicum* is, therefore, synonymized here.

Graphis flavovirens Makhija & Adaw.

Mycotaxon **91**, 374 (2005); type: India, Andaman Islands, Middle Andaman, Parlobjig Island, 23 December 1985, *M. B. Nagarkar & P. K. Sethy* 85.2264 (AMH!—holotype).

Graphis sitapurensis Makhija & Adaw., *Mycotaxon* **91**, 378 (2005); type: India, Andaman Islands, North Andaman, Diglipur Range, Sitapur, in moist deciduous forest, 2 January 1986, *P. K. Sethy & P. G. Patwardhan* 86.145 (AMH!—holotype).

Graphis longissima Makhija & Adaw., *Mycotaxon* **91**, 377 (2005); type: India, Andaman Islands, North Andaman, Pathar Thikri, Tugapur Range, deciduous forest, 29 December 1985, *P. K. Sethy & P. G. Patwardhan* 85.2715 (AMH!—holotype).

Graphis andamanica Swarnal., *Phytotaxa* **313**, 144–146 (2017); type: India, Andaman Islands, South Andaman, Wright Myo, alt. *c.* 30 m, 18 April 1961, *A. Singh* 88290 (LWG—holotype).

(Fig. 2A)

Thallus corticolous, yellowish brown to whitish grey.

Ascomata lirellate, erumpent; *exciple* completely carbonized with entire labia; *hymenium* inspersed; *asci* 2–8-spored; *ascospores* colourless, transversely 10–18-septate, 48–60 × 7–10 µm, amyloid; stictic and constictic acids present.

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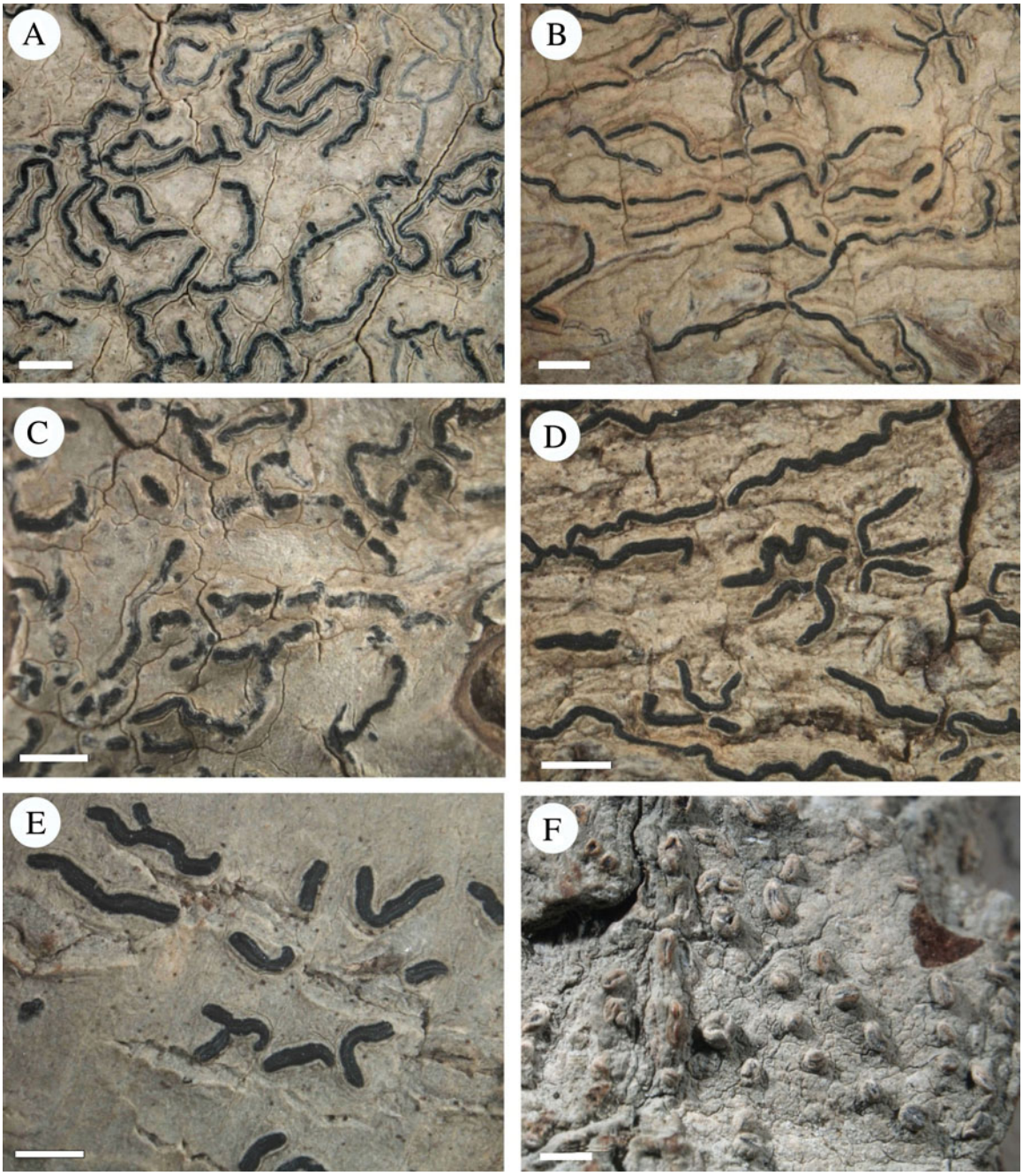

Fig. 2. Habitus of studied species (holotypes). A, *Graphis flavovirens*; B, *G. longissima*; C, *G. sitapurensis*; D, *G. nigrocarpa*; E, *G. kollaimalaiensis*; F, *Schistophoron tenue* (holotype of *Phaeographina nakanishii*). Scales = 1 mm. In colour online.

Notes. Makhija & Adawadkar (2005) simultaneously described three species, namely *Graphis flavovirens*, *G. longissima* (Fig. 2B) and *G. sitapurensis*. (Fig. 2C), from the Andaman Islands (AMH!). Lücking *et al.* (2009), in their world key, assigned *G. flavovirens* to 'Group 8', *G. longissima* to 'Group 17' and *G. sitapurensis* to 'Group 4', based on details given in the protologues. We have examined the types of the above species and found that all agree in morphology, anatomy (such as the inspersed hymenium) and chemistry. Compared to the protologues (Makhija & Adawadkar 2005), *G. flavovirens* has 14–18-septate, 49–54 µm long ascospores and not 3–9-septate, 16–42 × 4–6 µm large ascospores; *G. sitapurensis* has a completely instead of laterally carbonized exciple; *G. longissima* has entire labia and rarely shows striae. Therefore, both *G. longissima* and *G. sitapurensis* are synonymized here under *Graphis flavovirens* and a revised brief description is provided above.

Recently, Swarnlatha (2017) described *G. andamanica* from the Andaman Islands. The author mentioned cinnamon red granules in the hymenium but this is not a constant character. Our examination of the type material revealed that this taxon is also conspecific with *G. flavovirens* and is therefore synonymized here.

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In the worldwide key to the genus *Graphis* (Lücking *et al.* 2009), *G. flavovirens* is correctly keyed out under 'Group 10', where it is most similar to *G. gloriosensis* A. W. Archer & Elix, but the latter differs in its smaller ascospores (50–90 × 10–12 µm).

Graphis nigrocarpa Adaw. & Makhija

Mycotaxon **96**, 56 (2006); type: India, Tamil Nadu, Munnar to Kodai, 24 January 1976, *M. B. Nagarkar & Gole* 76.623 (AMH!—holotype).

Graphis kollaimalaiensis Adaw. & Makhija, *Mycotaxon* **96**, 55 (2006); type: India, Tamil Nadu, Kollaimalai, 15 October 1985, *M. B. Nagarkar & P. G. Patwardhan* 85.1526 (AMH!—holotype).

(Fig. 2D & E)

Thallus corticolous, greenish to yellowish, cracked, uneven, thick.

Ascomata lirellate, partially raised to emergent, prominent, black, simple to triradiate or irregularly branched, straight to flexuose, wavy with obtuse ends, 1–10 mm long, 0.15–0.8 mm wide; *disc* narrowly closed, blackish brown; *exciple* carbonized, present at the base; *labia* completely carbonized, entire, convergent with lateral thalline margin; *hymenium* inspersed with small granules, 125–175 µm high, KI−, I−; *asci* (4–)6–8-spored; *ascospores* hyaline, 8–13 transversely septate, ellipsoidal, 35–65 × 5–9 µm, I+ blue; norstictic acid; thallus UV−.

Notes. Adawadkar & Makhija (2006) simultaneously described *Graphis kollaimalaiensis* Adaw. & Makhija and *G. nigrocarpa* Adaw. & Makhija as new species from India. We have examined the types (AMH!) of both taxa and found that they are similar in morphology, anatomy (such as the inspersed hymenium) and chemistry, except there is variation in the length of the lirellae (1–10 mm long) in *G. nigrocarpa*. When comparing the protologues (Adawadkar & Makhija 2006), *G. kollaimalaiensis* has a hyaline hymenium which is not inspersed, while *G. nigrocarpa* has a clear to sometimes inspersed hymenium with crystals. However, we observed a distinct inspersed hymenium in both the taxa. Therefore, in the worldwide key to the species of *Graphis* (Lücking *et al.* 2009), this species is keyed out under 'Group 10', where it is most similar to *G. desquamescens* (Fée) Zahlbr. although this species lacks a thalline margin and has smaller ascospores (25–50 µm long). As it represents better material, *G. nigrocarpa* is adopted here as the name for the taxon while *G. kollaimalaiensis* is synonymized and a revised brief description is given above.

Schistophoron tenue Stirt.

Proc. Nat. Hist. Soc. Glasgow **4**, 165 (1876).

Phaeographina nakanishii Patw. & Nagarkar, *Biovigyanam* **5**, 136 (1979); type: India, West Bengal, Darjeeling District, 10 km to Teesta on Rangpo road, in evergreen forest, November 1977, *P. G. Patwardhan & M. B. Nagarkar* 77.1977 (AMH!—holotype).

(Fig. 2F)

Notes. Patwardhan & Nagarkar (1979) described *Phaeographina nakanishii* as a new species from India. We examined the type (AMH!) and found that it agrees with *Schistophoron tenue* in morphology, anatomy and chemistry. The former is therefore synonymized here. In India, this species is distributed in Andhra Pradesh, Orissa and Tamil Nadu (Singh & Sinha 2010).

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