

A new species of *Fissurina* and new records of *Graphidaceae* from Vietnam

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Abstract – *Fissurina hemithecioides* from Vietnam is described for the first time. The new taxon is characterized by prominent ascomata with swollen labia, 2-3-spored asci, rather large, muriform, I- to weakly amyloid ascospores and the presence of the stictic acid chemosyndrome. In addition, records of the genera *Carbacanthographis*, *Chapsa*, *Graphis*, *Pallidogramme*, *Phaeographis* and *Thecographa* are listed, including important diagnostic characteristics of species along with distribution, ecology and illustrations.

Bidoup Nui Ba National Park / corticolous / Da Lat / *Graphis striatula* / lichen / muriform / stictic acid / taxonomy / tropical

INTRODUCTION

Vietnam is located in the center of Southeast Asia and includes various climatic zones, resulting in high biodiversity throughout the country. The rich biodiversity in Vietnam has been given attention in terms of its global conservation, particularly to those forest elements having broad scope and world-wide importance (De Koninck, 1999; Tran, 2011). The diverse flora of Vietnam is a composition of plant components that migrated from the Himalaya-Yunnan-Guizhou flora in the northwest, the India-Myanmar flora in the west, and the Malaysia-Indonesian flora in the south and southeast (Tran, 2011; Trung, 1998).

The northern and central highlands of Vietnam contain many lichen communities with high diversity, making them ideal target areas for lichenological studies (Aptroot & Sparrius, 2006; Joshi *et al.*, 2013a, 2013b, 2013c, 2013d; Joshi *et al.*, 2014). Among crustose lichens, graphidaceous taxa have only recently attracted attention, revealing the occurrence of several new and interesting species. Yet, very few attempts have been made to investigate the family *Graphidaceae* in detail, despite its high species diversity in the country (Joshi *et al.*, 2013a, 2013b,

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2013c, 2013d; Joshi *et al.*, 2014). Vinh Phuc, Ha Noi and Phu Tho provinces in the northern highlands and Dak Nong and Dak Lak in the central highlands have shown particularly high diversity among this family (Aptroot & Sparrius, 2006; Joshi *et al.*, 2013a, 2013b, 2013c, 2013d; Joshi *et al.*, 2014).

During the course of further investigations of lichens from Vietnam, other interesting elements of *Graphidaceae* were observed among specimens collected from Bidoup Nui Ba National Park (BNBNP) in Langbian-Da lat Plateau of Lam Dong Province in the southeastern portion of the Central Highlands (Fig. 1). Bidoup Nui Ba National Park is a mountainous region that occupies a number of mountain peaks, including Mt. Langbian (2163 m), and is dominated by montane evergreen forest, with small patches of coniferous forest and mixed broadleaf-coniferous forest. The luxuriant biodiversity of the park can be attributed to its high conservation prioritization and wide elevation gradient (650-2300 m), which results in characteristics ranging from montane to tropical zones. Besides that, more than 90% of the land in this area is covered by forests (Tran, 2011). BNBNP together with neighboring Chu Yang Sin Park of the Da Lat Plateau contain globally significant biota, and most of the reports on *Graphidaceae* originate from the plateau and the adjoining areas (Hughes, 2010; Joshi *et al.*, 2013c, 2013d).

In the present study, a novel species, *Fissurina hemithecioides*, collected from BNBNP, is described. The new species is distinguished by a smooth, shiny, olive-green thallus that produces the stictic acid chemosyndrome, prominent, unbranched, labiate and slightly gaping lirellae, a clear hymenium, 2-3-spored asci, and large, muriform, thick-walled, I- to weakly amyloid ascospores. In a previous study, Joshi *et al.* (2013c) recorded five species of the genus *Fissurina* from Chu Yang Sin Park, which were additions to four species that had previously been identified in the northern highlands (Aptroot & Sparrius, 2006).

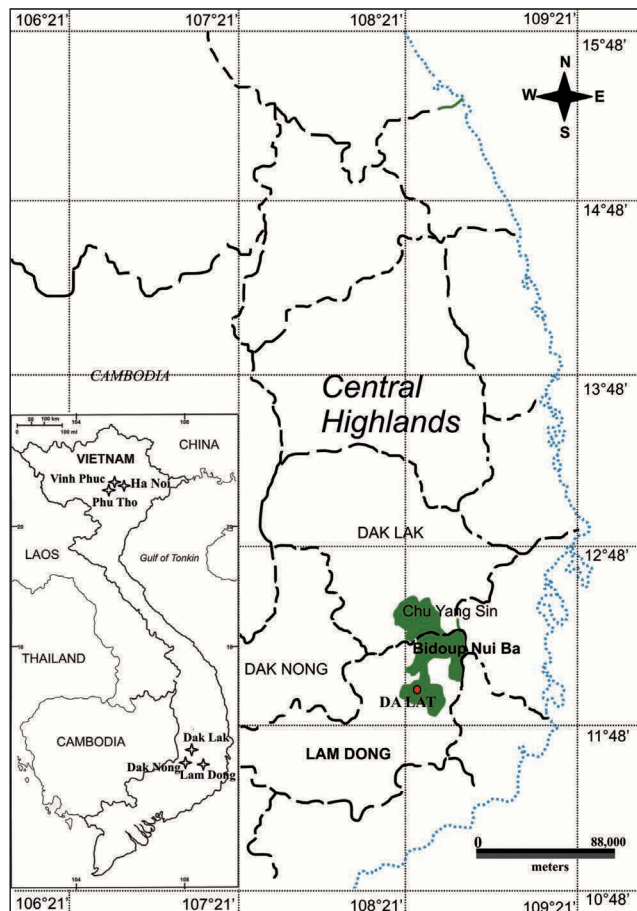


Fig. 1. Map showing Bidoup Nui Ba National Park (type locality) and localities (inset) surveyed for *Graphidaceae* in Vietnam.

In addition, the present study includes an artificial key to the genus *Fissurina* in Vietnam, as well as ten new reports of Vietnamese *Graphidaceae*: *Carbacanthographis salazinica*, *Chapsa leprocarpa*, *C. megaphlyctidioides*, *Graphis longiramea*, *G. marginata*, *G. pertriosa*, *G. vittata*, *Pallidogramme chrysenderon*, *Phaeographis quadrifera* and *Thecographa prosiliens*.

The present inventory also resolves the dubious identity of *Graphis striatula* (Ach.) Spreng. in Vietnam. The existence of this species in the country was doubtful due to its unresolved identity (Aptroot & Sparrius, 2006), but a few samples from our collection were determined as *G. striatula*. Thus, we reinstate the species for Vietnam here. *Graphis striatula* is characterized by a corticolous, epiperidermal, crustose, continuous, dull, whitish grey to grey, loosely corticate, thin thallus lacking lichen substances. The species has sessile, simple to scarcely furcated lirellae of 0.5-1.5 × 0.2-0.4 mm, striate labia, concealed discs, laterally carbonized proper exciple, clear hymenium, and 2-6-spored asci. Additionally, it has hyaline, fusiform, transversely septate, with 15-18 locular ascospores of 60-80 × 9-11 µm.

MATERIALS AND METHODS

The lichenological expedition was organized in 2014 by Prof. Nguyen at Tay Nguyen University, Vietnam. The specimens were preserved in the lichen herbarium of the Korean Lichen Research Institute, Sunchon National University, South Korea (KoLRI). Duplicates of the specimens were deposited in the Biotechnology Center of Tay Nguyen University, Buon Ma Thuot City, Vietnam (BCTNU). The taxonomy of the lichen material was studied following recent protocols (A. W. Archer, 2009; Joshi *et al.*, 2013a, 2013b, 2013c, 2013d; Joshi *et al.*, 2014; Lücking & Rivas Plata, 2008; Lücking *et al.*, 2009; Rivas Plata *et al.*, 2010, 2012; Staiger, 2002). The morphology of the specimens was examined under a Magnus Zoom Stereo Trinocular (MSZ-TR) dissecting microscope. Thin hand-cut sections of the apothecia and thalli were mounted in tap water, cotton blue, 5% KOH and iodine solution, and observed under a compound microscope (LEICA DM 500). Chemical spot tests and TLC (using solvent system A) were conducted according to Orange *et al.* (2010).

TAXONOMY

Fissurina hemithecioides S. Joshi, Upreti & Hur **sp. nov.**

Figs 2-7

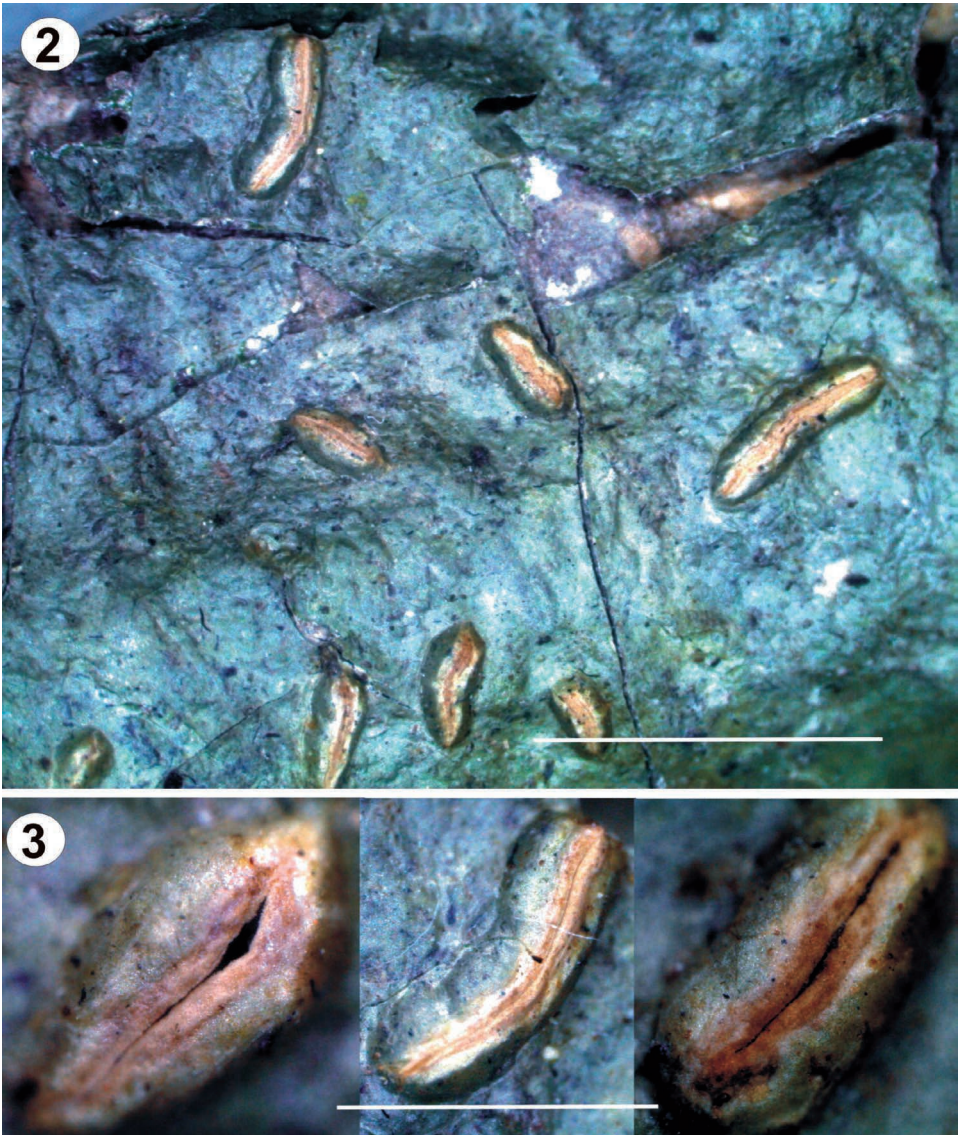
Mycobank no.: MB814907

Diagnosis: differing from *Fissurina simplex* in having prominent, labiate ascomata resembling those of *Hemithecium*.

Type: VIETNAM. Lam Dong Province, Bidoup Nui Ba National Park, Da Lat City, 12°10'38.9" N, 108°40'37.9" E, 1426 m alt., on tree bark, 08 January 2014, Hur & Oh VN140150 (KoLRI-holotypus).

Thallus corticolous, epiperidermal, crustose, continuous, smooth, shiny, olive-green to green, 150-200 µm thick in cross section, corticate. **Cortex** well

developed, 20-25 μm . **Photobiont** layer continuous, 20-30 μm . **Medulla** white, crystalline, mostly endoperidermal 50-80 μm . **Prothallus** white. **Ascomata** lirelliform, prominent, short, simple, labiate, 0.5-3 \times 0.5-0.7 mm. **Labia** \pm gaping, entire, pale yellow to cream colored. **Disc** slit-like, epruinose. **Proper exciple** hyaline to reddish brown, 40-90 μm wide, laterally covered by corticate aligerous thallus of 180-190 μm , including a thick layer of crystals. **Epihymenium** greyish, crystalline, 10-15 μm . **Hymenium** hyaline, clear, 150-200 μm high; paraphyses glabrous,



Figs 2-3. *Fissurina hemithecioides*. 2. Habit & habitat (holotype). 3. Ascomata. Scales: 2 = 5 mm, 3 = 1 mm.

unbranched. **Subhymenium** indistinct, hyaline, $\leq 25 \mu\text{m}$ high. **Asci** clavate, 2-3-spored, $140\text{--}170 \times 30\text{--}40 \mu\text{m}$, I+ wine red. **Ascospores** hyaline, ellipsoidal, richly muriform, $50\text{--}80 \times 20\text{--}30 \mu\text{m}$, halonate, I+ weak blue or I–.

Chemistry: K+ yellow, PD+ yellow-orange, C–; stictic, constictic and cryptostictic acids detected by TLC.

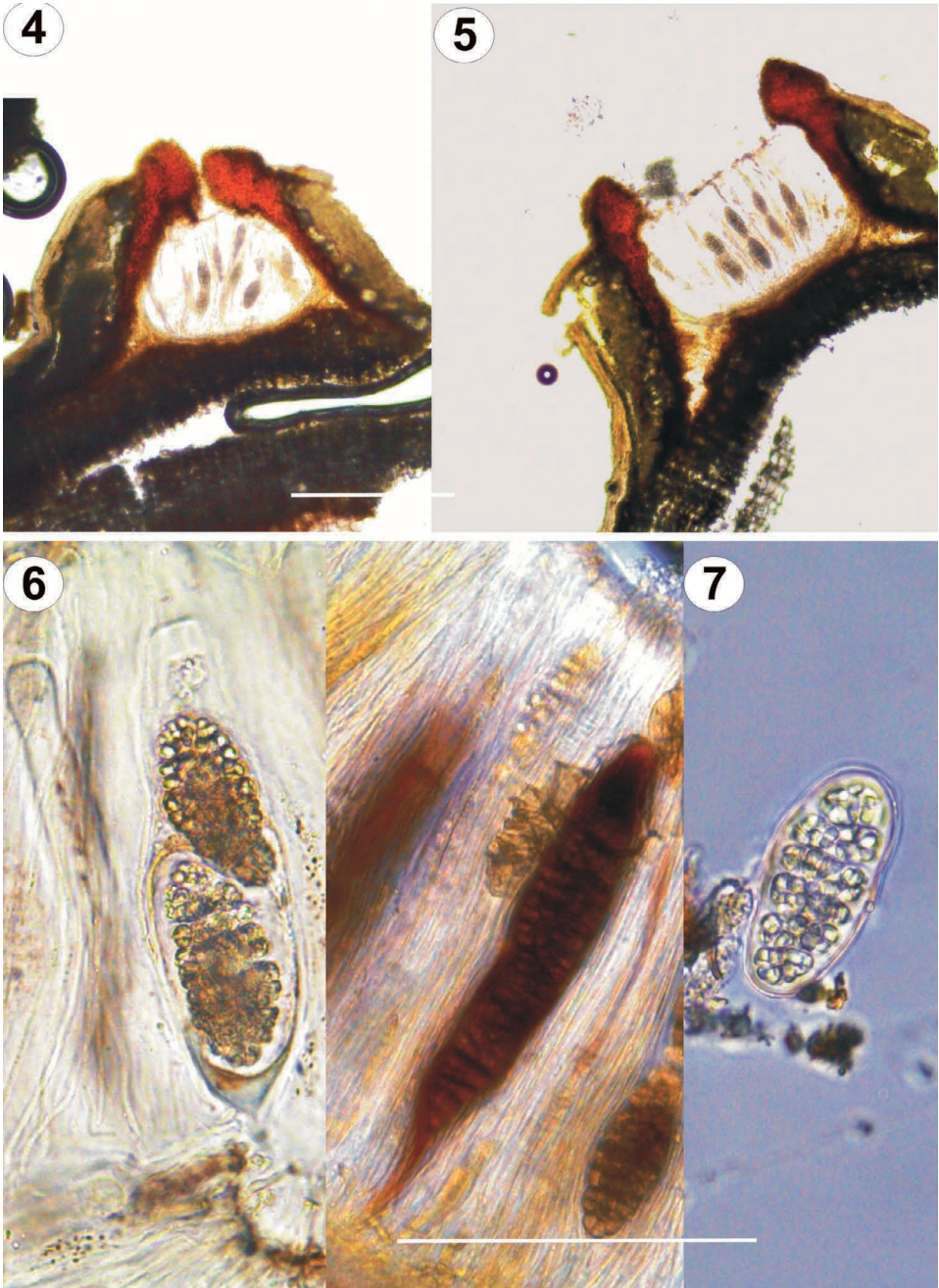
Etymology: The specific epithet refers to the resemblance of the lichen genus *Hemithecium* with the new taxon.

Ecology and distribution: The new species is only known from the type locality and was collected at c. 1400 m from a thick and smooth barked tree, where it was growing luxuriantly and spread largely in association with *Sarcographa lybrinthica* and *Chapsa megaphlyctidioides*.

Specimens examined: VIETNAM Lam Dong Province, Bidoup Nui Ba National Park, Da Lat City, $12^{\circ}10'38.9''$ N, $108^{\circ}40'37.9''$ E, 1426 m alt., on tree bark, 08 January 2014, *Hur & Oh* VN140150, VN140146 (KoLRI).

Discussion: The new taxon is well characterized by prominent, simple and raised ascomata, with entire labia and a reddish brown proper exciple circumscribed by a thick thalline margin. The new species has 2-3-spored asci; weakly amyloid to non-amyloid, rather large, muriform ascospores, and a thallus producing substances of the stictic acid complex. It is most similar in ascospore type and chemistry to *Fissurina simplex* B. O. Sharma, Khadilkar & Makhija, which produces immersed-erumpent, fissurine lirellae with an only slightly swollen thalline margin, 1-4-spored asci, and muriform, I– ascospores $70\text{--}78 \times 20\text{--}25 \mu\text{m}$. (Sharma *et al.*, 2012). Very similar *Fissurina* species producing muriform ascospores and stictic acid are *F. phluangii* V. Poengsungnoen & K. Kalb, *F. microcarpa* B. O. Sharma, Khadilkar & Makhija, *F. incrustans* Fée, *F. undulata* (Müll. Arg.) M. Nakan & Kashiw, and *F. abdita* (A.W. Archer) A. W. Archer. *Fissurina phluangii* and *F. microcarpa* differ from the new species in ascomata producing inconspicuous, fissurine, immersed and branched lirellae. Moreover, *Fissurina microcarpa* produces single-spored asci and comparatively larger ascospores, measuring also $\leq 125 \mu\text{m}$ (Sharma *et al.*, 2012; Poengsungnoen *et al.*, 2014). *Fissurina incrustans*, *F. undulata* and *F. abdita* can also be distinguished by different lirellae types and much smaller ascospores $\leq 35 \mu\text{m}$ (Staiger, 2002). *Fissurina elaiocarpa* (A. W. Archer) A. W. Archer has prominent and labiate lirellae comparable to those present in the new taxon, but differs mainly in \pm verrucose thallus lacking lichen substances, and has smaller, amyloid ascospores, $21\text{--}28 \mu\text{m}$ long (Archer, 2009). The new species shows proximity to *Fissurina monospora* C. Knight in producing muriform ascospores, which also differs in a verrucose thallus lacking lichen compounds, and has single spored asci (Sharma *et al.*, 2012).

Fissurina hemithecioides is distinct in morphology and superficially resembles *Hemithecium* rather than *Fissurina* species. Though the neotropical *F. gigas* Sipman and *F. hemithecioides* share similar hemithecioid lirellae, *F. gigas* is clearly distinguished by a thallus lacking lichen substances (Sipman *et al.*, 2014). The new species is comparable to *Hemithecium radicolica* (A. W. Archer) A. W. Archer in having simple lirellae, 2-4-spored asci, muriform ascospores and a thallus containing stictic acid, but differs in having larger, non-amyloid ascospores and more prominent lirellae with thicker labia (Archer, 2005). *H. epixanthum* (Mont. & Bosch) Chitale & Makhija also produces stictic acid and ascospores of $50\text{--}71 \times 15\text{--}25 \mu\text{m}$, but is distinguished in producing multistriate, long lirellae and amyloid ascospores (Chitale *et al.*, 2009).



Figs 4-7. *Fissurina hemithecioides*. 4. Cross section of ascomata. 5. Cross section of ascomata after applying K. 6. Ascus with ascospores (note the iodine reaction). 7. Ascospore. Scales: 4-5 = 200 μ m; 6-7 = 100 μ m.

Key to *Fissurina* species recorded from Vietnam

A revised key to the genus *Fissurina* is presented here for ten species, including the new taxon. The taxonomic characters of previously known species were extracted from Joshi *et al.* (2013c), with slight amendments.

1. Thallus containing stictic acid (2)
1. Thallus lacking secondary metabolites (3)
 2. Lirellae immersed to erumpent, fissurine with recurved margins, ascospores transversely septate, 15-20 × 4-9 μm *F. dumastioides*
 2. Lirellae prominent, hemithecioid, ascospores muriform, 50-80 × 20-30 μm *F. hemithecioides*
3. Ascospores transversely septate (4)
3. Ascospores muriform (5)
 4. Lirellae mostly aggregate, radiate, forming a pseudostroma *F. radiata*
 4. Lirellae dispersed, solitary, branched, non-radiate *F. dumastii*
5. Ascospores non-amyloid (6)
5. Ascospores distinctly amyloid (7)
 6. Lirellae immersed, ± fissurine, ascospores 20-27 × 10-12 μm ... *F. rubiginosa*
 6. Lirellae prominent, labiate, ascospores 22-32(-35) × 10-13 μm ... *F. undulata*
7. Lirellae immersed, fissurine, roof like margins, ascospores 15-23 × 7-10 μm
..... *F. egena*
7. Lirellae immersed to erumpent or prominent (8)
 8. Lirellae ± prominent, labiate, proper exciple well-developed, ascospores 21-28 × 13-18 μm *F. elaiocarpa*
 8. Lirellae immersed to ± erumpent, labiate to fissurine (9)
9. Lirellae labiate, proper exciple well developed, ascospores 13-20 × 7-11 μm
..... *F. instabilis*
9. Lirellae indistinctly labiate to fissurine, proper exciple poorly developed, ascospores 15-28 × 7-13 μm *F. incrustans*

New records in *Graphidaceae* from Vietnam

Carbacanthographis salazinica (A. W. Archer) A. W. Archer, *Telopea* 11: 70 (2005)

Fig. 8

Thallus corticolous, epiperidermal, crustose, continuous, smooth to slightly verrucose, dull, whitish green to greyish green, 100-200 μm thick in cross section, corticate. **Cortex** 8-10 μm. **Photobiont** layer 40-50 μm. **Medulla** crystalline, 85-90 μm. **Prothallus** blackish, merged with neighboring lichens. **Apothecia** lirelliform, conspicuous, white, sessile, straight or curved, sinous, irregularly branched, 5-10 × 0.5-0.7 mm. **Labia** entire to ± striate in older ascomata, black. **Thalline margin**, white powdery apically, 60-95 μm thick. **Proper exciple** laterally to completely carbonized, concealed in the thalline margin. Periphysoids warty, present on the tip of the labia, 20-40 μm long. **Epihymenium** brown, crystalline, 10-15 μm high. **Hymenium** hyaline, clear, 90-100 μm high. Paraphyses apically warty, up to 1 μm thick. **Subhymenium** 25-50 μm high. **Asci** clavate, 8-spored, 80-85 × 15-20 μm. **Ascospores** hyaline, ellipsoid, muriform, 19-20 × 6-7 μm, 4-7 × 1-2 locular, I- or I+ weak blue.

Chemistry: K+ red, PD+ yellow-orange, C-; salazinic acid detected by TLC.

Ecology and distribution: Eastern Palaeotropics (Archer, 2006). In Vietnam, it was found growing at 1400-1500 m in association with *Graphidastra*, *Pertusaria* and leprose species on tree trunks.

Specimen examined: VIETNAM. Lam Dong Province, Bidoup Nui Ba National Park, Da Lat City, 12°10'55.4" N, 108°40'50.1" E, 1454 m alt., on tree trunk, 07 January 2014, *Hur & Oh* VN140080 (KoLRI).

Discussion: *Carbacanthographis marcescens* (Feé) Staiger & Kalb is nearer to our specimen in having laterally carbonized proper exciple and similar geographical distribution, but differs in having small ascospores of 12-17 µm. The lirellae of the examined material shows lateral carbonization in the excipulum that becomes complete after developing a thick carbonized layer at the base in the older and middle part of the ascomata.

***Chapsa leprocarpa* (Nyl.) A. Frisch, Biblioth. Lichenol. 92: 108 (2006) Fig. 9**

Thallus corticolous, crustose, epiperidermal, thin, ± rimose due to uneven substrate, shiny, greyish white to greyish green, up to 130 µm thick in cross section, ecorticate. **Photobiont** layer up to 100 µm. **Medulla** indistinct. **Prothallus** indistinct to appear blackish and merged with associated leprose species. **Ascomata** apothecioid to chroodiscoid, erumpent, round to irregular, solitary to aggregates of 2-3, 1-2 mm in diam. **Disc** open, greyish, distinctly white pruinose. **Thalline margin** lobed, irregular, ± layered, erect to recurved, 120-130 µm wide. **Proper exciple** thin, hyaline pale yellow, 15-30 µm wide, internally layered by 20-30 µm long periphysoids. **Epihymenium** brownish, crystalline, up to 20 µm high. **Hymenium** hyaline, clear, 120-180 µm. **Subhymenium** indistinct. **Asci** broadly clavate, 1(-2)-spored, 130-135 × 30-40 µm. **Ascospores** hyaline, muriform, oblong to fusiform, 80-115 × 20-32 µm, halonate, halo 5-6 µm thick, I-.

Chemistry: K-, PD-, C-; no lichen substances detected by TLC.

Ecology and distribution: Pantropical (Mangold *et al.*, 2009). In Vietnam, it was reported at 1400-1500 m on a thin and loose tree bark in an evergreen forest. The other lichens growing in association were unknown leprose taxa and members of *Pannariaceae* and *Collemataceae*.

Specimen examined: VIETNAM. Lam Dong Province, Bidoup Nui Ba National Park, Da Lat City, 12°10'55.4" N, 108°40'50.1" E, 1454 m alt., on tree bark, 07 January 2014, *Hur & Oh* VN140103 (KoLRI).

Discussion: This species is most similar to *Chapsa patens* (Nyl.) A. Frisch and *C. pseudophlyctis* (Nyl.) Frisch in ascoma morphology and thallus chemistry, but differs in hymenium and ascospore size.

***Chapsa megaphlyctidioides* Mangold, Fl. Australia 57: 654 (2009) Fig. 10**

Thallus corticolous, crustose, epi- to endoperidermal, continuous, green, greyish-green to olive-green, ≤ 100 µm thick in cross section, corticate. **Cortex** poorly developed, 5-10 µm. **Photobiont** layer 50-60 µm. **Medulla** crystalline, mostly endoperidermal to 60 µm. **Prothallus** brownish to indistinct. **Ascomata** apothecioid to chroodiscoid, erumpent, round to angular, solitary to aggregates of 2-3, 0.5-1 mm in diam. **Disc** open, flesh colored, finely white pruinose. **Thalline margin** ± layered, erect, 60-80 µm wide. **Proper exciple** thin, hyaline to pale yellow, 10-20 µm wide, internally layered by indistinct periphysoids. **Epihymenium** greyish, crystalline, 5-10 µm high. **Hymenium** hyaline, clear, 50-65 µm high. **Subhymenium** hyaline, 10-15 µm high. **Asci** clavate, 8-spored, 60-65 × 10-12 µm. **Ascospores** hyaline, transversely septate, ellipsoidal, fusiform, 14-18 × 3-4 µm, 8-locular, halonate, halo I-.

Chemistry: K+ yellow, PD–, C–; stictic and hypostictic acids detected by TLC.

Ecology and distribution: Australia (Mangold *et al.*, 2009). In Vietnam, it was found at c.1400 m, where it was growing in association with *Sarcographa labyrinthica* and *Fissurina* on smooth barked tree twigs.

Specimen examined: VIETNAM. Lam Dong Province, Bidoup Nui Ba National Park, Da Lat City, 12°10'38.9" N, 108°40'37.9" E, 1426 m alt., on tree bark, 08 January 2014, *Hur & Oh* VN140146-A (KoLRI).

Discussion: This species resembles *Chapsa minor* (Kantvilas & Vězda) Mangold & Lumbsch, and *C. phlyctidioides* (Müll. Arg.) Mangold in having a jagged ascomatal margin and thallus containing stictic acid, but *C. minor* produces larger ascospores, $\leq 28 \mu\text{m}$, while *C. phlyctidioides* has an ecorticate thallus. *Chapsa albomaculata* (Sipman) Sipman & Lücking also produces stictic acid, but differs in having fused ascomata, entire exipulum and amyloid ascospores.

Graphis longiramea Müll. Arg., Journ. Linn. Soc., London, Bot. 29: 225 (1892)

Fig. 11

Thallus corticolous, epidermal, crustose, continuous, smooth, \pm shiny, whitish grey to greenish grey, 100-200 μm thick in cross section, corticate. **Cortex** well developed, 15-30 μm . **Photobiont** layer 20-30 μm . **Medulla** white, crystalline, mostly endoperidermal to 60 μm . **Prothallus** not seen. **Ascomata** lirelliform, immersed, elongate, radiately to irregularly branched, 10-20 \times 0.5-0.6 mm. **Labia** entire, black. **Disc** close to slightly open (*longiramea*-morph), epruinose. **Thalline margin** lateral to sometimes complete, 130 μm to apically less than 30 μm wide. **Proper exciple** apically to laterally carbonized, 50-80 μm wide. **Ephymenium** brownish, 10-20 μm high. **Hymenium** hyaline, clear, 140-170 μm high. **Subhymenium** hyaline, 20-30 μm high. **Asci** clavate, 8-spored, 130-160 \times 17-22 μm . Ascospores hyaline, fusiform, transversely septate, 15-16 locular, 68-71 \times 9-10 μm , I+ blue.

Chemistry: K+ yellow, PD+ yellow-orange, C–; stictic acid chemosyndrome detected by TLC.

Ecology and distribution: Eastern Palaeotropics (Lücking *et al.*, 2009). In Vietnam, the species was collected at c. 1400 m from a thick and smooth barked tree, where it was growing luxuriantly and spread largely with lecideoid lichen taxa.

Specimen examined: VIETNAM. Lam Dong Province, Bidoup Nui Ba National Park, Da Lat City, 12°10'55.4" N, 108°40'50.1" E, 1454 m alt., on tree bark, 07 January 2014, *Hur & Oh* VN140058 (KoLRI).

Discussion: *Graphis salacinilongiramea* Adaw. & Makhija also has entire labia, a laterally carbonized proper exciple, clear hymenium, transversely septate large ascospores, and a thallus containing stictic acid, but differs from *G. longiramea* in that it produces salazinic acid in addition.

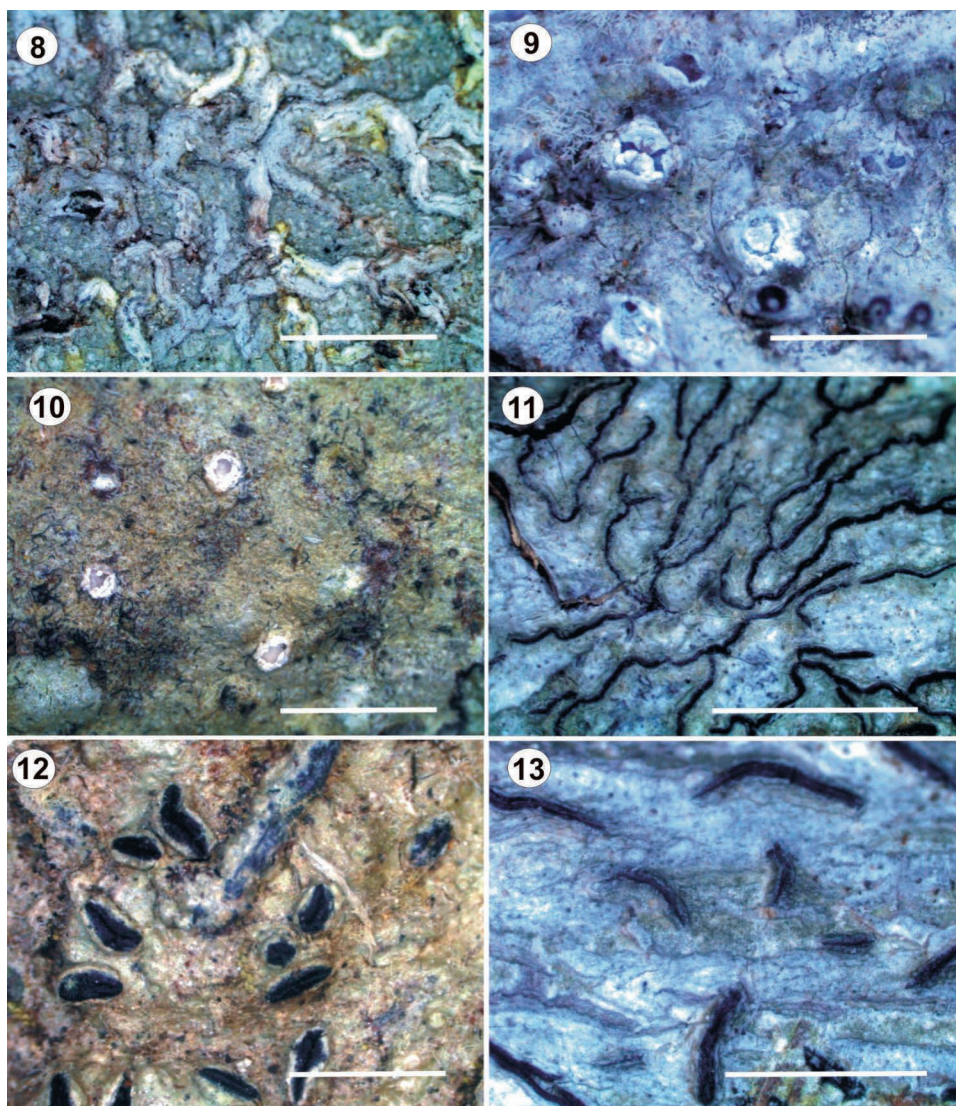
Graphis marginata Raddi, Atti Soc. Nat. Mat. Modena 18: 344 (1820) **Fig. 12**

Thallus corticolous, epidermal, crustose, uneven, \pm shiny, continuous, green to olivaceous, up to 140 μm thick in cross section, corticate. **Cortex** 20-40 μm . **Photobiont** layer 10-20 μm . **Medulla** white, crystalline, 60-80 μm . **Prothallus** dark brown merged with neighboring crustose lichens. **Ascomata** lirelliform, prominent to sessile; simple to furcate, short, 1-3 \times 0.5-0.8 mm. **Labia** entire, black, epruinose; **Disc** concealed. **Thalline margin** lateral, 100-115 μm wide. **Proper exciple** completely carbonized, 80-110 μm wide. **Ephymenium** brown, crystalline, 10-15 μm high. **Hymenium** hyaline, clear, 190-250 μm high. **Subhymenium** indistinct to 45 μm high. **Asci** clavate, 8-spored, 250-270 \times 30-

60 μm . **Ascospores** hyaline, fusiform, transversely septate, 15-31 locular, 88-165 \times 12-23 μm , I+ blue.

Chemistry: K+ yellow turning red, PD+ yellow-orange, C-; norstictic and stictic acids detected in TLC.

Ecology and distribution: Pantropical (Lücking *et al.*, 2009). In Vietnam, the species was collected at below 1500 m from thick and hard barked trees, where it was growing among mosses.



Figs 8-13. New records in *Graphidaceae* from Vietnam. **8.** *Carbacanthographis salazinica*. **9.** *Chapsa leprocarpa*. **10.** *C. megaphlyctidioides*. **11.** *Graphis longiramea*. **12.** *G. marginata*. **13.** *G. pertriosa*. Scale bar for 8, 11 & 12 = 5 mm; for 9, 10, 13 = 2 mm.

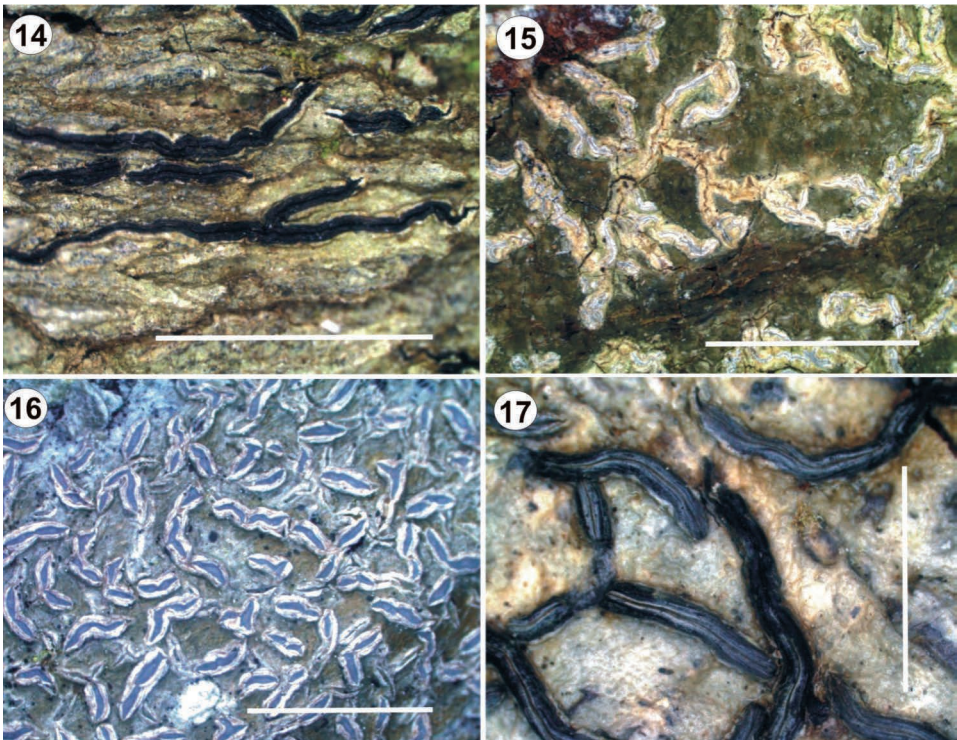
Specimen examined: VIETNAM. Lam Dong Province, Bidoup Nui Ba National Park, Da Lat City, 12°10'55.4" N, 108°40'50.1" E, 1454 m alt., on tree bark, 07 January 2014, *Hur & Oh* VN140059 (KoLRI).

Discussion: *Graphis rustica* Kremp. resembles *G. marginata* in its morpho-anatomical taxonomic characteristics, but differs in having a thallus lacking norstictic acid. The anatomically similar *G. schroederi* Zahlbr. has lirellae completely covered by a thalline margin (*subserpentina*-morph) and produces only stictic acid.

Graphis pertricensa (Krempf.) A.W. Archer, *Telopea* 11: 75 (2005)

Fig. 13

Thallus corticolous, epiperidermal, crustose, smooth, continuous, whitish grey to greyish white, up to 100 µm thick in cross section, loosely corticate. **Cortex** 10-20 µm. **Photobiont** layer 15-25 µm. **Medulla** indistinct. **Prothallus** black. **Apothecia** lirelliform, emergent, linear, unbranched, 0.5-2 × 0.1-0.2 mm. **Labia** entire, black. **Disc** open, white pruinose. **Thalline margin** lateral to apically thin, 60-75 µm wide. **Proper exciple** laterally carbonized, 37-62 µm wide. **Epithymenium** greyish, granular, 10-15 µm. **Hymenium** hyaline, densely interspersed with oil globules removed by K, 80-90 µm. **Subhymenium** indistinct. **Asci** clavate, 8-spored, 80-100 × 13-23 µm. **Ascospores** hyaline, ellipsoid, muriform, 8-9 × 1-3 locular, 30-40 × 5-10 µm, I+ blue.



Figs 14-17. New records in Graphidaceae from Vietnam. 14. *G. vittata*. 15. *Pallidogramme chrysenteron*, 16. *Phaeographis quadrifera*. 17. *Thecographa prosiliens*. Scale bars = 5 mm.

Chemistry: K+ yellow turning red, PD+ yellow-orange, C-; norstictic acid detected by TLC.

Ecology and distribution: Eastern Palaeotropics including Australia (Lücking *et al.*, 2009). In Vietnam, the species was collected at 1700-1800 m, where it was poorly spread over the bark of thin tree trunks in an evergreen forest.

Specimens examined: VIETNAM. Lam Dong Province, Mt. Langbian, Da Lat City, 12°02'18.6" N, 108°25'35.1" E, 1779 m alt., on tree bark, 09 January 2014, Hur & Oh VN140287 (KoLRI).

Discussion: *Graphis insulana* (Müll. Arg.) Lücking is the only other species producing norstictic acid in a group having entire labia, a laterally carbonized proper exciple, interspersed hymenium and muriform ascospores, which differs from the examined specimen in having 1-2-spored asci and large ascospores, 50-110 µm long (Lücking *et al.*, 2009). The studied material is rather small in quantity, but easily identifiable to *G. pertriosa* due to distinct anatomical and chemical characteristics.

Graphis vittata Müll. Arg., Flora 65: 335 (1882)

Fig. 14

Thallus corticolous, epidermal, crustose, uneven, continuous, ± verrucose, dull, ≤ 100 µm thick in cross section, corticated. **Cortex** 5-10 µm. **Photobiont** layer 30-40 µm. **Medulla** crystalline, mostly endoperidermal to 50 µm. **Prothallus** brownish to indistinct. **Ascomata** lirelliform, emergent, elongate, branched, 5-10 × 0.2-0.3 mm. **Labia** multi-striate, epruinose. **Disc** concealed. **Thalline margin** lateral, 70-110 µm wide. **Proper exciple** apically carbonized, 110-170 µm wide. **Epihymenium** brownish, granular, 5-10 µm high. **Hymenium** hyaline, clear, 80-100 µm high. **Subhymenium** hyaline, 25-30 µm high. **Asci** clavate, 8-spored, 110-120 × 18-20 µm. **Ascospores** hyaline, fusiform, transversely septate, 10-12-locular, 32-50 × 6-8 µm, I+ blue.

Chemistry: K+ yellow, PD+ yellow-orange, C-; stictic acid detected by TLC.

Ecology and distribution: Pantropical (Lücking *et al.*, 2009). In Vietnam, the species was collected at 1400-1500 m, where it was growing luxuriantly and spread largely on undulating thick and rough bark of trees.

Specimen examined: VIETNAM. Lam Dong Province, Bidoup Nui Ba National Park, Da Lat City, 12°10'55.4" N, 108°40'50.1" E, 1454 m alt., on tree bark, 07 January 2014, Hur & Oh VN140073 (KoLRI).

Discussion: *Graphis vittata* shares some taxonomical characters with *G. stenotera* Vain., which differs in having short and sparsely branched lirellae and slightly smaller ascospores, ≤ 40 µm long.

Pallidogramme chrysenderon (Mont.) Staiger, Kalb & Lücking, Fieldiana, Bot. 38: 9 (2008)

Fig. 15

Thallus corticolous, epidermal, crustose, continuous, dull, olivaceous green to pale green, fawn, ≤ 400 µm thick in cross section, corticate. **Cortex** 30-50 µm. **Photobiont** layer 80-90 µm. **Medulla** white, crystalline, ≤ 200, mostly endoperidermal. **Prothallus** black. **Ascomata** lirelliform, prominent, long, irregularly branched, sinuous, 4-6 × 0.5-0.7 mm. **Labia** striate, white pruinose, ≤ 100 µm wide. **Disc** concealed. **Thalline margin** white, eroded, ≤ 140 µm wide. **Proper exciple** reddish brown, apically sulcate, 90-170 µm wide. **Epihymenium** greyish, crystalline, 10-15 µm. **Hymenium** densely interspersed with oil, 90-150 µm high. **Subhymenium** hyaline, 30-40 µm high, ≤ 35 µm high. **Asci** clavate, 8-spored, 70-80 × 8-9 µm. **Ascospores** hyaline becoming brown, ellipsoid, muriform, 10-12 × 1-3-locular, 40-45 × 10-12 µm, I-.

Chemistry: K+ yellow, PD+ yellow-orange, C-; stictic acid detected by TLC.

Ecology and distribution: Pantropical (Staiger, 2002). In Vietnam, the species was collected at 1400-2000 m from smooth barked trees, where it was growing in close association with *Pallidogramme chlorocarpoides*.

Specimens examined: VIETNAM. Lam Dong Province, Bidoup Nui Ba National Park, Da Lat City, 12°10'55.4" N, 108°40'50.1" E, 1454 m alt., on tree bark, 07 January 2014, *Hur & Oh* VN140093 (KoLRI). Mt. Langbian, Da Lat City, 12°02'28.2" N, 108°25'40.8" E, 1865 m alt., on tree bark, 09 January 2014, *Hur & Oh* VN140186 (KoLRI). 12°02'45.5" N, 108°25'55.6" E, 1911 m alt., on tree bark, 09 January 2014, *Hur & Oh* VN140109 (KoLRI).

Discussion: The lirellae of most of the specimens examined were sterile or over-mature, and only a few produced ascospores. The investigated samples of *Pallidogramme* differed only in number of ascospores per ascus and ascospore size, while the color and other morphological features were similar. Part of the investigated material contains 8-spored asci and ascospores in a range of ≤ 45 μm ; therefore, they were placed in *Pallidogramme chrysenferon*. This species is closely related to *P. chlorocarpoides* (Nyl.) Staiger, Kalb & Lücking, which differs only in having 2-4-spored asci and larger ascospores up to 100 μm long (Archer, 2009).

Phaeographis quadrifera (Nyl.) Staiger, Biblioth. Lichenol. 85: 344 (2002) **Fig. 16**

Thallus corticolous, crustose, \pm dull, smooth, continuous, green, greyish green to pale green, up to 200 μm thick, corticate. **Cortex** thin, 10-15 μm . **Photobiont** layer 50-75 μm long. **Medulla** 70-85 μm . **Prothallus** dark brown to blackish. **Ascomata** lirelliform, immersed, single to branched, simple to branched, 1-1.5 (-5) \times 0.3-0.5 mm. **Disc** greyish, finely pruinose, 0.1-0.2 mm wide. **Thalline margin** well developed, whitish, lighter than thallus color, 2-3-layered. **Proper exciple** poorly developed. **Epithemium** brown, 5-7 μm high. **Hymenium** hyaline, clear, 7595 μm high; paraphyses 1-2 μm thick. **Subhymenium** 35-45 μm high. **Asci** 8-spored, clavate, 75-100 \times 10-15 μm . **Ascospores** 24-29 \times 6-8(-9) μm .

Chemistry: K+ yellow turning red, PD+ yellow, C-; norstictic acid detected by TLC.

Ecology and distribution: Africa (Staiger, 2002). In Vietnam, the species was luxuriantly spread over smooth barked trees.

Specimens examined: VIETNAM. Lam Dong Province, Mt. Langbian, Da Lat City, 12°02'18.6" N, 108°25'35.1" E, 1779 m alt., on tree bark, 09 January 2014, *Hur & Oh* VN140252, VN140253, VN140254, VN140255, VN140256 (KoLRI). 12°02'28.2" N, 108°25'40.8" E, 1865 m alt., on tree bark, 09 January 2014, *Hur & Oh* VN140181, VN140182, VN140184 (KoLRI). Bidoup Nui Ba National Park, Da Lat City, 12°10'55.4" N, 108°40'50.1" E, 1454 m alt., on tree bark, 07 January 2014, *Hur & Oh* VN140040, VN140064, VN140091 (KoLRI).

Discussion: This species is similar to *Phaeographis tortuosa* (Ach.) Müll. Arg. in having muriform ascospores of 25-40 μm long, which differs in lacking lichen substances. *Phaeographis amazonica* Staiger produces norstictic acid and muriform ascospores, but differs from *P. quadrifera* in that the ascomata lacking a thalline margin and has slightly larger ascospores ≤ 70 μm (Staiger, 2002).

Thecographa prosiliens (Mont. & Bosch) A. Massal., Atti I. R. Istit. Veneto ser 3 5: 316 (1860) **Fig. 17**

Thallus corticolous, crustose, epidermal, \pm shiny, continuous, pale grey to greenish grey, 100-200 μm , corticated. **Cortex** well developed 20-50 μm . **Photobiont** layer 30-50 μm , interspersed with large crystals (40-90 μm). **Medulla** mostly endoperidermal, interspersed with crystals. **Prothallus** blackish to dark brown.

Ascomata lirelliform, robust, sessile, elongate, linear to furcate, 10-12 × 5-8 µm. **Labia** slightly striate, pruinose. **Disc** concealed. **Thalline margin** basal to absent. **Proper exciple** completely carbonized, convergent, laterally 100-200 µm, extended below up to 400 µm. **Epihyemium** dark brown, 9-12 µm. **Hymenium** hyaline, densely interspersed with oil globules, oval in shape, 300-400 µm. **Asci** broadly clavate, 1-spored, 280-320 × 40-70 µm. **Ascospores** hyaline to brown at maturity, ellipsoidal, with round to sub-acute ends, muriform, 130-160 × 20-30 µm, I-.

Chemistry: K-, PD-, C-; no lichen substances detected by TLC.

Ecology and distribution: Malaysia and Papua New Guinea (Staiger, 2002). In Vietnam, the species was luxuriantly spread over tree bark at 1400-1500 m.

Specimens examined: VIETNAM. Lam Dong Province, Bidoup Nui Ba National Park, Da Lat City, 12°10'55.4" N, 108°40'50.1" E, 1454 m alt., on tree bark, 07 January 2014, Hur & Oh VN140086, VN140103, VN140109 (KoLRI).

Discussion: *Thecographa prosiliens* is the only representative of the genus *Thecographa*. This species is characterized by robust, black and sessile lirellae lacking a thalline margin, similar to those found in *Opegrapha* and *Platygramme*. The genus *Opegrapha* is entirely different in its ascospore configuration, while *Platygramme* usually has open discs covered by fine white to greyish white purina. Moreover, the latter genus produces a wedge-shaped, apically to laterally carbonized exciple. Another genus, *Thecaria*, differs in having a thick and complete thalline margin and exposed apothecial disc. *Thecographa* can be comparable to species of the *Graphis nuda* (Magn.) Staiger & Lücking group, but differs in producing brown, non-amyloid ascospores.

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