

# 〔報文〕 Lichens Found in Ta Nei Temple and Its Adjacent Areas of Angkor, Siem Reap, Cambodia

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## 1 . Introduction

The present study deals with lichen flora of Angkor, Siem Reap, Cambodia. Lichens are widely distributed in various areas in the world and are one of the most common organisms in Cambodia as in other areas in tropic. Lichens grow on various kinds of substrata such as rock surface of temples (sandstone and laterite), trunks and even branches of trees in precincts or secondary forests surrounding temples (Figs. 1A and 1B). It is unfortunate, however, that no checklist of lichens has been published in this country, and we have only little knowledge about Cambodian lichens.

Kashiwadani, Moon and Futagami had a chance to make field surveys of lichens around temples of Angkor area as well as in Beng Mealea Village in Siem Reap Province from 2005 to 2011. They were carried out as a part of the Joint Research Project on Conservation of Stone at Ta Nei Temple, supported by the National Research Institute for Cultural Properties, Tokyo. During the survey, we collected more than 500 lichen specimens.

The study of Cambodian lichens was first made by Kashiwadani<sup>1)</sup> in 2008. He reported *Graphis acharii* Fée in his lichen exsiccata, *Lichenes Rarioris et Critici Exsiccati*, published from the National Science Museum, Tokyo. Subsequently, nine species of Graphidaceae were reported by Nakanishi et al.<sup>2)</sup> Moon et al.<sup>3)</sup> reported three species of the family. In 2012, Kashiwadani et al.<sup>4)</sup> added *Pyrgillus cambodiensis* Kashiw., K.H.Moon & Aptroot and *Tylophoron moderatum* Nyl. In addition, Schumm and Aptroot<sup>5)</sup> reported eight species, *Caloplaca subsquamosa* (Müll.Arg.) Zahlbr., *Graphis rongklaensis* Sutjaritturakan, *G. tenuirima* (Shirley) A.W. Archer, *G. tenuissima* Fée, *Letrouitia leprolyta* (Nyl.) Hafellner, *Leucodecton glaucescens* (Nyl.) Frisch, *Porina tetracerae* (Ach.) Müll.Arg. and *Pyrenula thailandica* Aptroot, for the lichen flora of Cambodia. Therefore, only 20 species of lichens have been reported for Cambodia. In the present paper, we listed 45 lichen species based on our taxonomic study of our collection. However, many specimens, especially crustose

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Fig. 1. Prominent lichen habitats found at Ta Nei temple. A. Saxicolous lichens forming mosaic pattern on sandstone. B. Corticolous lichens on bark. (See Color Plate)

lichens, remain requiring taxonomic study.

As for the study on the conservation of stone monuments, biodeterioration of stone monuments by microorganisms such as lichens and mosses has been a matter of concern in the Angkor area. Apart from obvious alteration of the appearance of such monuments, the nature of the chemical or physical reactions that bring about or accelerate the deterioration of stone surfaces and the rate at which these reactions occur have been debated. This study contributes for understanding the effect of each species of lichen.

## 2. Materials and Methods

The present study is based on ca 520 specimens of lichens collected in Cambodia by Kashiwadani and Moon in 2005 to 2011. The main collection sites were around Ta Nei

temple, but also include backyard of Bayon, Banterey Srei, Prasat Top, Ta Keo and Ta Prohm temples in the Angkor Area. In addition, they also include northwest of Beng Mealea village where sandstones used for fundamental building blocks of temples were mined in previous times (Fig. 2). The specimens used for the present study are kept in the herbarium of the National Museum of Nature and Science (TNS). Saxicolous lichens were removed by hand and corticolous ones were taken with substrates by a knife. Morphological investigation of lichen was done by a biological microscope and a stereomicroscope. Thin sections of the samples were made to observe internal structure. Asci and spores were soaked in Lugol's solution to check iodine reaction. Color reaction, microchemical tests and thin-layer chromatography by Culberson and Johnson<sup>6)</sup> were used for the identification of lichen secondary metabolites. Sections of apothecia and thalli were cut by hand-razor and mounted in GAW (glycerin:ether:water = 1:1:1) or lacto-phenol cotton blue solutions.

### 3. List of Localities

Collection sites are abbreviated as follows:

**Banteay Srei:** Cambodia. Banteay Srei, Northern part 40 km from Seam Reap (13°35'N, 103°57'E). Elevation 30 m. July 20, 2006.

**Bayon:** Cambodia. Prov. Siem Reap: Bayon Temple, Angkor Thom, Siem Reap. Elevation about 30 m. July 22, 2006. December 11, 2011.

**Beng Mealea:** Cambodia. Prov. Siem Reap: northwest of Beng Mealea village (13°29'N, 104°13'E). Elevation about 30 m. September 14, 2007.

**Prasat Top:** Cambodia. Prov. Siem Reap: Prasat Top Temple, Angkor complex, Siem Reap. Elevation about 30 m. December 20, 2005. November 24, 2010.

**Ta Keo:** Cambodia. Prov. Siem Reap: Around Ta Keo Temple, Angkor complex, Siem Reap. Elevation about 30 m. December 20, 2005. December 10, 2011. November 25, 2010.

**Ta Nei:** Cambodia. Prov. Siem Reap: Around Ta Nei Temple, Angkor complex, Siem Reap. Elevation about 30 m. December 20, 2005. July 18, 2006. November 23, 2010. July 20, 2008. July 27, 2009. November 23, 2010. December 9, 2011.

### 4. Results

#### 4-1. The Species

In the following systematic account, genera and species are arranged alphabetically. As the diagnostic features of each taxon are usually obvious, and since there are morphological descriptions in other publication, no descriptions are provided below except for the habitat of each species. Only representative specimens are cited and localities visited by us are represented by their abbreviated names according to the list of localities (see above). The collectors are abbreviated as follows; K. H. Moon=KHM and H. Kashiwadani=HK. Species new to the lichen flora of Cambodia are marked with one asterisk.

Most species of the following genera or families are excluded from this paper, as more taxonomic studies are required for Cambodian specimens; *Acanthothecis*, *Acarospora*, *Arthoniaceae*, *Bacidia*, *Bacidopsisora*, *Buellia*, *Caloplaca*, *Chrysothrix*, *Fissurina*, *Glyphis*,

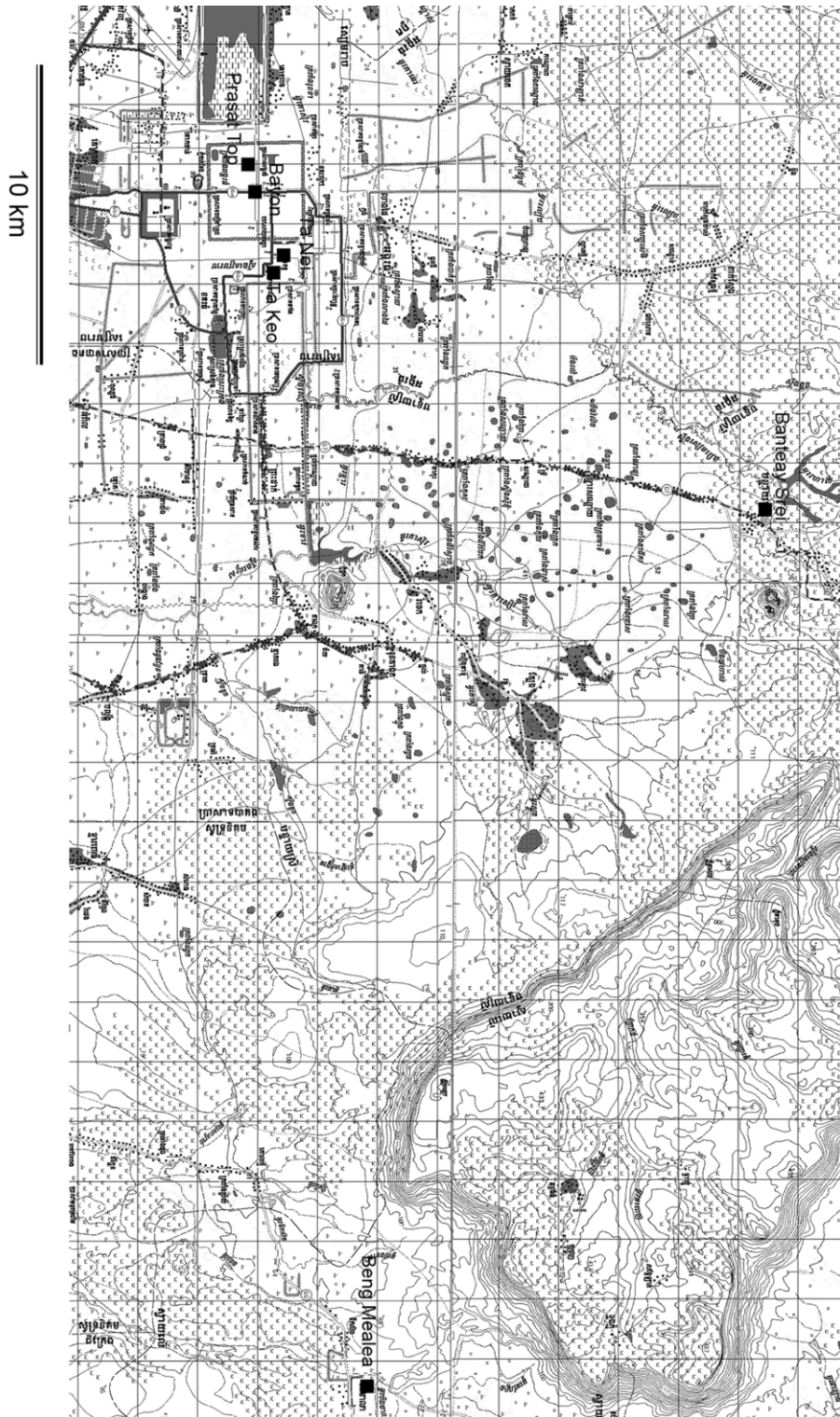


Fig. 2. Location of the collection sites, Siem Reap Province, Cambodia.

*Graphis*, *Hemithecium*, *Lecidella*, *Leiorreuma*, *Lepraria*, *Malmidea*, *Phaeographis*, *Pseudopyrenula*, *Pyrenula*, *Roccellaceae*, *Sarcographa*, *Thelotrema*, *Trypetheliopsis* and *Verrucariaceae*.

- 1 . **\*Agonimia tristicula** (Nyl.) Zahlbr.; common on trees and on mossy rock in shaded habitats. Ta Nei: HK 48469 and 48467.
- 2 . **\*Arthonia cinnabarina** (DC.) Wallr.; locally abundant on bark of *Dipterocarpus*, *Ficus* and *Tetrameles*. Ta Nei: HK (50402) & KHM, HK 47786. Prasat Top : HK 50452.
- 3 . **Caloplaca subsquamosa** (Müll.Arg.) Zahlbr. (Fig. 3A); previously reported by Schumm and Aptroot<sup>5)</sup>. Locally abundant on exposed rocks, especially on sandstone. This species is very unique in having grayish white squamulose thallus with lacinate margin, 2-3 mm across and stiped apothecia with orange discs. It was described from Costa Rica by Müller Argoviensis<sup>7)</sup> but no additional locality has been recorded. Beng Mealea: 48476. Ta Nei temple: HK 47884.
- 4 . **Carbacanthographis induta** (Müll.Arg.) Lücking; previously reported by Nakanishi et al.<sup>2)</sup>. Locally abundant on bark of old growth *Dipterocarpus* and *Tetrameles* in sunny condition. One specimen (HK 49289), however, was found on sand stone (Fig. 3B) at the Ta Keo temple. Ta Nei temple: HK 47749 and 50151, HK (47865) & KHM. Ta Keo: HK 49289.
- 5 . **\*Chapsa indica** A. Massal.; this species was described by Massalongo<sup>9)</sup> basing on a specimen from Sri Lanka. It is widely distributed in tropical areas including Africa (Sierra Leone, Kenya, Tanzania and Mozambique) and tropical Asia (Sri Lanka, India, Borneo, Malay and Australia (Andreas by pers. comm., Lumbsch et al.<sup>10)</sup>). However, it was collected only once in the present area, where grows on bark of *Tetrameles nudiflora*. Ta Nei: HK 47860.
- 6 . **\*Coccocarpia erythroxyli** (Spreng.) Swinscow & Krog; rare, found at only one locality where it grows on bark in secondary forest. Beng Mealea village: HK 48477.
- 7 . **\*Coenogonium pineti** (Schr. ex Ach.) Lücking & Lumbsch; rare, collected at only one locality, where it was found on decayed wood in shaded condition. Ta Nei: HK 47886.
- 8 . **Collema sp.**; *Collema* has a wide distribution in the world, but it was very rare in this area. The only specimen found on bark was sterile and we could not identify it at the moment. Ta Nei: HK (50417) & KHM.
- 9 . **\*Dictyonema moorei** (Nyl.) Henssen; occasional on bark or on rocks with mosses in rather shaded condition. Ta Nei HK 47921.
10. **Diorygma hieroglyphicum** (Pers.) Staiger & Kalb; formerly reported by Nakanishi et al.<sup>2)</sup>. abundant on bark. This species (Fig. 3C) is one of the most common species of *Graphidaceae* in the present area. Ta Nei: HK (47911 and 47926) & KHM.
11. **\*Dirinaria consimilis** (Stirt.) D.D.Awasthi; common on rock and tree bark in exposed condition. *Dirinaria consimilis* (Fig. 3D) is easily distinguished from allied species by the postulate thallus and the production of sekikaic acid. Ta Nei: HK 47791 and HK 47750.
12. **\*Endocarpon pallidulum** (Nyl.) Nyl.; common on rock (sandstone). Ta Nei: 47887.
13. **\*Fellhanera fuscata** (Müll.Arg.) Vězda; common on rock (sandstone). Ta Nei; HK

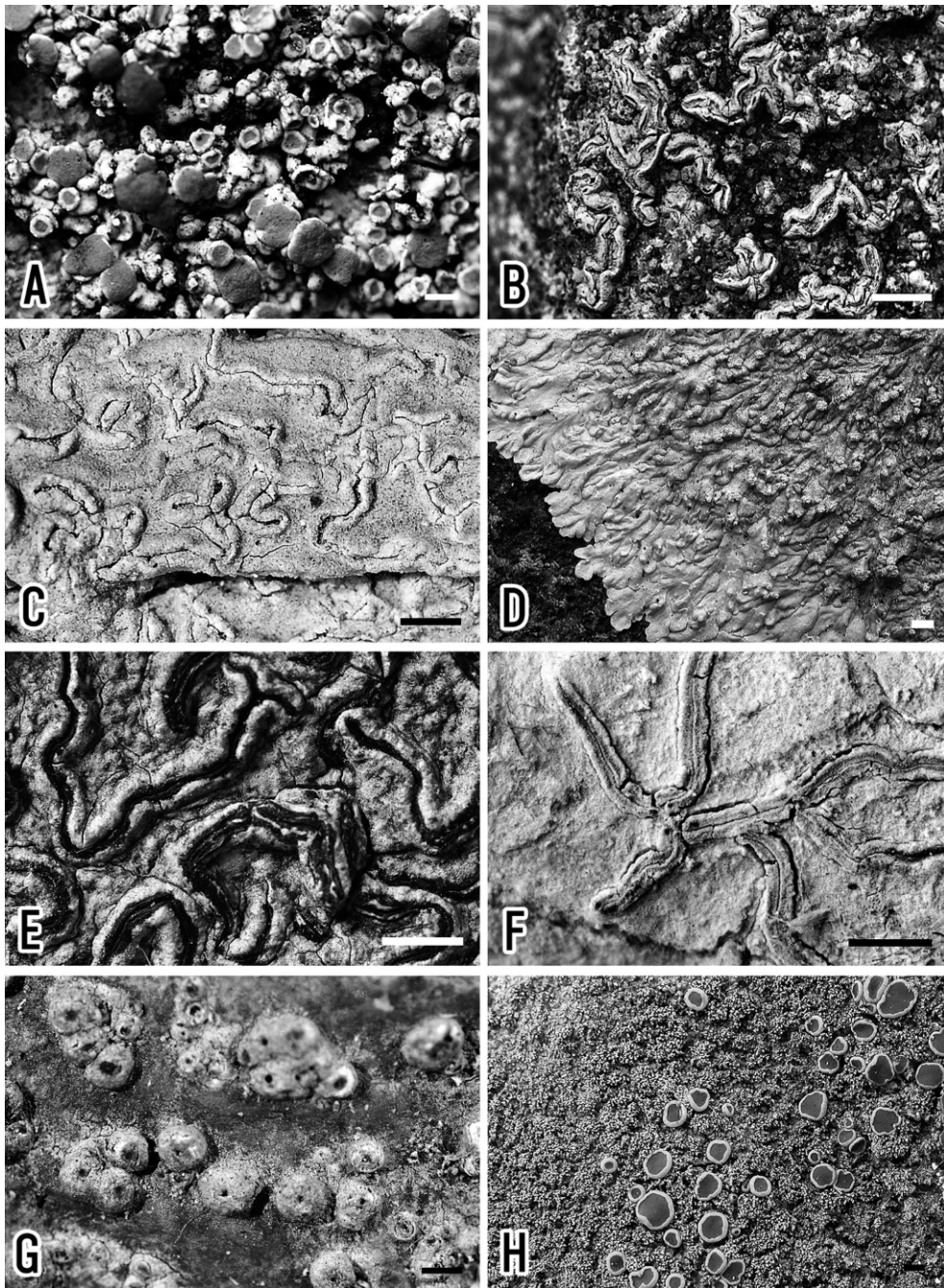


Fig. 3. Noteworthy species of lichens found in the study area. Pictures were taken from the specimens examined cited in each species. A. *Caloplaca subsquamosa*. B. *Carbacanthographis induta*. C. *Diorygma hieroglyphicum*. D. *Dirinaria consimilis*. E. *Graphis cambodiensis*. F. *Graphis taneina*. G. *Laurera benguelensis*. H. *Letrouitia leprolyta*. Scale bars= 1 mm.

- 47875 and 47882.
14. **Fissurina batavana** (Zahlbr.) M.Nakan., K.H.Moon & Kashiw.; formerly reported by Moon et al.<sup>3)</sup>. In spite of our frequent searches for lichens in Angkor, it was found only twice, and it must be rare in the present area, where it was found on bark of *Ficus* and *Careya*. Ta Nei; HK (50116 and 50184) & KHM.
  15. **Fissurina dumastii** Fée; formerly reported by Nakanishi et al.<sup>2)</sup>, rarely found on bark of *Tetrameles* in rather shaded condition. Ta Nei; HK 50137 and 50186.
  16. \***Flakea papillata** O.E.Erikss.; rare, found on very restricted area in Ta Nei temple where it grows on sandstone together with mosses. Ta Nei: HK (47883 & 47890) & KHM.
  17. **Graphis cambodiensis** M.Nakan., Kashiw. & K.H.Moon (Fig. 3E); rare, found on bark of *Tetrameles*. This species was described from Cambodia by Nakanishi et al.<sup>2)</sup> and no additional record has been done. Ta Nei; HK 47773 & 47744, HK (50378) & KHM.
  18. **Graphis chlorotica** A.Massal.; formerly reported by Moon et al.<sup>3)</sup>. It was collected at only one locality, where it grows on bark. Ta Nei: HK (50058) & KHM.
  19. **Graphis glaucescens** Fée; formerly reported by Nakanishi et al.<sup>2)</sup>. It was collected only twice in the area investigated, where it grows on bark of *Ficus* sp. Ta Nei: HK (47931) & KHM. Beng Mealea: HK 48939.
  20. **Graphis supracola** A.W.Archer; formerly reported by Nakanishi et al.<sup>2)</sup>. Rare, found on bark of *Ficus* sp. Ta Nei: HK 50063, HK (47755b) & KHM.
  21. **Graphis taneina** M.Nakan., Kashiw. & K.H.Moon (Fig. 3F); this species was described from Cambodia by Moon et al.<sup>3)</sup>. Common, found on bark of *Ficus*, *Planchonia*, *Tetramelos*, etc. This species was described from Cambodia by Nakanishi et al.<sup>4)</sup> in 2011. It is easily distinguished from allied species by having sorediate thallus and producing a unique chemical substance, 2-methoxypsoromic. These characters are rather rare in the genus. Ta Nei; HK (49023 & 49024) & KHM. Prasat Top; HK 50476.
  22. **Gymnographa heterospora** (Nyl.) Staiger; formerly reported by Nakanishi et al.<sup>2)</sup>. This species has been collected from few localities in Australia, Réunion and West Indies as reported by Staiger<sup>8)</sup>. Specimens reported before were always corticolous but the Cambodian ones were found on rock (sandstone) in rather shaded condition. Ta Nei: HK (47290, 47767) & KHM.
  23. **Hemithecium aphanes** (Mont.) M.Nakan. & Kashiw.; formerly reported by Nakanishi et al.<sup>2)</sup>. Very rare, collected at only one locality where it grows on bark of *Tetrameles*. Ta Nei: HK 47770.
  24. \***Hyperphyscia granulata** (Poelt) Moberg; rare, on sandstone. Ta Nei: HK 47799.
  25. \***Hyperphyscia syncolla** (Tuck.) Kalb; rare, on sandstone. Ta Nei: HK 47917.
  26. \***Laurera benguelensis** Zahlbr. (Fig. 3G); commonly on bark of *Ficus* and *Dipterocarpus* in sunny condition. Ta Nei HK (47785) & KHM. Beng Mealea: HK (48466, 50428) & KHM.
  27. **Letrouitia leprolyta** (Nyl.) Hafellner (Fig. 3H); previously reported by Schumm and Aptroot<sup>5)</sup>. Common on bark and on rocks. This species is easily distinguished from other lichens in having crustose thallus with isidia, biatorine apothecia with reddish

- brown disc circumscribed by orange margin and in producing orange pigments in the thallus and epihymenium. The color of thallus of this species varies extensively from pale grayish yellow (in shaded condition) to brilliant orange (in sunny condition), depending on the contents of the pigments. It is one of the most common crustose lichens both on bark and on sand rock in the present area. HK (47895 and 50406) & KHM.
28. \***Myriotrema punctum** (Ach.) Hale; common on bark, Ta Nei: HK (47751) & KHM.
  29. \***Nadvornikia sorediata** R.C.Harris; rare, restricted on bark of *Tetrameles nudiflora* in sunny condition. Ta Nei HK (47763 and 47872) & KHM.
  30. \***Parmotrema saccatibulum** (Taylor) Hale (Fig. 4A); this species has been reported from northeastern Australia, India, Micronesia, Singapore, South Pacific and Taiwan as shown by Kurokawa<sup>11)</sup>. The distribution now includes Cambodia. It was collected only once on bark at Ta Nei temple. Ta Nei: HK 50081.
  31. \***Peltula omphaliza** (Nyl.) Wetmore; rare, on sandstone. Beng Mealea: HK (48462 and 48470) & KHM.
  32. \***Phyllopsora furfuracea** (Pers.) Zahlbr.; common on base rock (sandstone) of temples. Ta Nei: HK (47778 and 47805) & KHM.
  33. \***Physciella melanchra** (Hue) Essl.; locally abundant, found on sandstone. Ta Nei: HK (47904) & KHM.
  34. \***Porina mastoidea** (Ach.) Müll.Arg.; common on rock (laterite). Ta Nei: HK (47810) & KHM.
  35. \***Porina nuculastrum** (Müll.Arg.) R.C.Harris; common on rock (laterite). Ta Nei: HK (47814) & KHM.
  36. \***Porina papuensis** P.M.McCarthy; locally abundant on rock (laterite). Ta Nei: HK (47900) & KHM
  37. **Porina tetracerae** (Ach.) Müll.Arg.; previously reported by Schumm and Aptroot<sup>5)</sup>. Locally abundant, common on sandstone but rarely found on laterite. Ta Nei: HK (47813) & KHM.
  38. \***Pyrenula quassiaecola** Fée; occasional, found on bark. Ta Nei: HK (47745) & KHM.
  39. **Pyrgillus cambodiensis** Kashiw., K.H.Moon & Aptroot (Fig. 4B); rare, found on bark of *Tetrameles* and *Dipterocarpus*. This species was recently described from Cambodia by Kashiwadani et al.<sup>3)</sup>. It is easily distinguished from other species of the genus in having ostioles with orange-red pigments and the absence of xanthonones in the thallus. Prasat Top: HK (50508) & KHM. Ta Nei: HK 47894.
  40. \***Pyxine coralligera** Malme (Fig. 4C); one of the most common foliose lichens on rock (sandstone) in this area. Ta Nei: HK (47787) & KHM.
  41. \***Pyxine meissnerina** Nyl. (Fig. 4D); common on rock (sandstone) in sunny condition. *Pyxine meissnerina* and *P. coralligera* are the most common foliose lichens in the present area. They both grow on sand stone in sunny condition. *P. meissnerina* is easily distinguished from *P. coralligera* by the presence of soredia; *P. coralligera* is a isidiate species. Ta Nei: HK (47924) & KHM.
  42. \***Rinodina atrofusata** (Vain.) Aptroot; occasional, on bark of trees. Ta Nei: HK



(47869) & KHM.

43. **Sarcographa gyrizans** (Leight.) Müll.Arg. (Fig. 4E); formerly reported by Nakanishi et al.<sup>2)</sup>. Common on bark, having been reported from Cambodia by Nakanishi et al. (2010). Ta Nei: HK 47912. Prasat Top: HK 50181.
44. \***Trapelia coarctata** (Turner ex Sm.) M.Choisy; occasional on rock (sandstone). Beng Mealea: HK 48465.
45. **Tylophoron moderatum** Nyl.; formerly reported by Kashiwadani et al.<sup>4)</sup>. This species is locally abundant but found in very restricted area at Ta Prohm Temple, where it grows on bark of *Tetrameles nudiflora*. Ta Prohm: (50382 and 50562) & KHM.

#### 4 – 2. Characteristics of the lichen flora in Angkor

Most species commonly found in and around Ta Nei temple and its adjacent areas are those widely distributed in tropical and subtropical areas in other countries. As we have only little knowledge about Cambodian lichens cited above, it is too early to discuss about species diversity in this country. However, it is noteworthy that 1) the list includes three new species, *Graphis cambodiensis* M.Nakan., Kashiw. & K.H.Moon, *G. taneina* M.Nakan., Kashiw. & K.H.Moon and *Pyrgillus cambodiensis* Kashiw., K.H.Moon & Aptroot, 2) 28 of 45 species reported here are new to Cambodia and 3) *Fissurina batavana* and *Graphis chlorotica* are the second collection for the two species in the world. Taxonomic investigation for our lichen specimens has been carried on by Kashiwadani and Moon.

#### 4 – 3. Prominent Lichen Habitats

Prominent lichen habitats are shown below, and species found the respective habitats are presented.

4 – 3 – 1. Trees around temples. Old growth trees such as *Careyea*, *Dipterocarpus*, *Ficus*, *Schleicheria* and *Tetrameles* around precinct provide good habitat to the corticolous lichens. Narrow branches also a good habitat for crustose lichens (Fig. 4F). Most commonly found on bark or on branches are as follows; *Agonimia tristicula*, *Dirinaria consimilis*, *Carbacanthographis induta*, *Diorygma hieroglyphicum*, *Fissurina dumastii*, *Laurera benguelensis*, *Pyxine coralligera*, *Pyxine meissnerina* and *Sarcographa gyrizans*.

4 – 3 – 2. Rocks. Rocks for lichen substrata in the present area are sandstone and laterite. Sandstone brocks are used for walls, pillars or roofs of temples. Laterite blocks are mainly used for basement of temples (Figs. 4G and 4H).

Most common lichens found on sandstone are as follows; *Agonimia tristicula*, *Bacidia* sp., *Chiodecton* sp., *Dimerella* sp., *Dirinaria consimilis*, *Endocarpon pallidulum*, *Fellhanera fuscata*, *Enterographa* sp., *Lecidella* sp., *Lepraria* sp., *Letrouitia leprolyta*, *Phyllopsora furfuracea*, *Porina tetracerae*, *Pyxine coralligera*, *Pyxine meissnerina*, *Verrucaria* sp. and two undetermined sorediate or isidiate crusts.

Most common lichens found on laterite are as follows; *Bacidia* sp., *Chiodecton* sp., *Dirinaria consimilis*, *Endocarpon pallidulum*, *Enterographa* sp., *Lecidella* sp., *Lepraria* sp., *Letrouitia leprolyta*, *Phyllopsora furfuracea*, *Porina mastoidea*, *P. nuculastrum*, *Pyxine coralligera*, *Pyxine meissnerina*, *Verrucaria* sp. and undetermined sorediate crust.

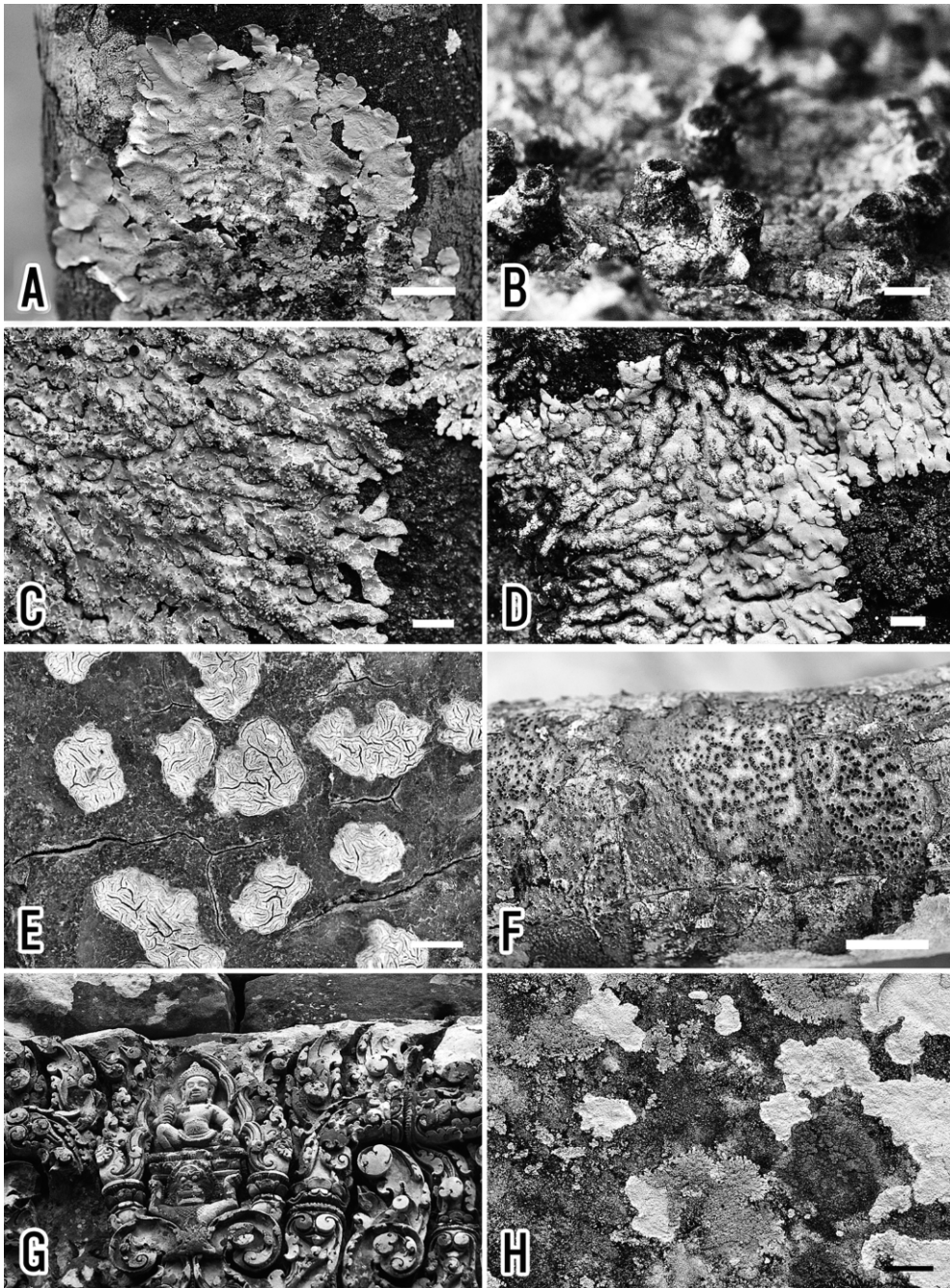


Fig. 4. Noteworthy species or habits of lichens found in the study area. Pictures from A to E were taken from the specimens cited in each species. A. *Parmotrema saccatilobum*. B. *Pyrgillus cambodiensis*. C. *Pyxine coralligera*. D. *Pyxine meissnerina*. E. *Sarcographa gyrizans*. F. Narrow branches covered with crustose lichens at Ta Nei temple. G. Carved sandstone beam covered with crustose lichens at Ta Nei temple. H. Lichen community on fallen rock (sandstone) dominated by *Pyxine* and *Chiodecton* at Ta Nei temple. Scale bars = 1 mm.

Species composition between two types of stones is very similar except for dominant species in each substrate. But *Porina mastoidea* and *P. nuculastrum* are found only on laterite. In addition, two rare species, *Flakea papillata* and *Gymnographa heterospora* grow only on sandstone. It is noteworthy that species of *Cladonia* are completely lacking and *Parmelia* (s. lat.) are rarely collected as these genera are usually very commonly found lichens on bark or on rocks in other countries.

4 – 3 – 3 . Soil. Soil is usually good habitat for lichens in most areas in the world. However, no lichen has been found in the present area. This is probably due to swollenness in rainy season.

#### 4 – 4 . Penetration of lichen fungi to the rock substrata

As discussed by Moon et al.<sup>12)</sup>, analysis with the SEM and image analyzer revealed that some lichens penetrate into substrata by medullary hyphae. We analyzed DNA extracted from the lichen hyphae that penetrated a stone sample and from the lichen thallus growing on the same stone sample in order to determine the identity of these lichen components.

Penetration of hyphae of crustose lichens (*Porina*, *Calopla* etc.) is confirmed at the depth of 7 to 20 mm from sandstone surface except for *P. coralligera* (foliose lichen). In contrast, the hyphae of *P. coralligera* merely adhered to the stone substrate but did not penetrate it. In the case of the species that grew on laterite, namely, *P. mastoidea* and *P. nuculastrum*, the hyphae penetrated the stone to a depth of 6 to 8 mm. Considering the fact that various lichen species exist on the stone surface at Ta Nei Temple and that most of these are crustose or squamulose lichens, it can be assumed that the lichen hyphae penetrate the stone of the monument. Penetrations of lichen hyphae, however, seem to be highly influenced by the crack formation of substrata. Further studies will be necessary to identify the penetration of hyphae as well as other effects of each species on stone surface.

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## Lichens Found in Ta Nei Temple and Its Adjacent Areas of Angkor, Siem Reap, Cambodia

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The lichens flora of Angkor, Siem Reap, Cambodia was investigated from 2005 to 2011 with special attention to the Ta Nei temple. So far we have recognized 15 families (including two incertae sedis), 15 genera and 45 species of lichens from the area, and an annotated checklist of them is provided. Among them following 25 species are new records for lichen flora of Cambodia; *Agonimia tristicula*, *Arthonia cinnabarina*, *Chapsa indica*, *Coccocarpia erythroxyli*, *Coenogonium pineti*, *Dictyonema moorei*, *Dirinaria consimilis*, *Fellhanera fuscata*, *Flakea papillata*, *Hyperphyscia granulate*, *Hyperphyscia syncolla*, *Laurea benguelensis*, *Myriotrema compunctum*, *Nadvornikia soredate*, *Parmotrema sacatilobum*, *Peltula omphaliza*, *Phyllopsora furfuracea*, *Porina mastoidea*, *Porina nuculastrum*, *Porina papuensis*, *Pyrenula quassiaecola*, *Pyxine coralligera*, *Pyxine meissnerina*, *Rinodina atrofusca* and *Trapelia coarctata*.

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## カンボジア・アンコール遺跡群のタ・ネイ遺跡および その周辺で見られる地衣類

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カンボジアのアンコール遺跡群周辺で地衣類の野外調査を行い、約520点の標本を得た。調査は2005年から2011年にかけて年1回（毎次3－7日間）行われ、主としてタ・ネイ寺院遺跡周辺で実施されたが、アンコール遺跡群の他の寺院、及びベン・メリア北西部の砂岩採掘遺構周辺でも実施された。ここでは、これらの標本の分類学的研究に基づき、種名が判明している45種を掲載した。

これらの多くは熱帯から亜熱帯に広く分布する種であるが、次の25種はカンボジア新産である。*Agonimia tristicula*, *Arthonia cinnabarina*, *Chapsa indica*, *Coccocarpia erythroxyli*, *Coenogonium pineti*, *Dictyonema moorei*, *Dirinaria consimilis*, *Fellhanera fuscata*, *Flakea papillata*, *Hyperphyscia granulata*, *Hyperphyscia syncolla*, *Laurera benguelensis*, *Myriotrema compunctum*, *Nadvornikia soledata*, *Parmotrema saccatilobum*, *Peltula omphaliza*, *Phyllopsora furfuracea*, *Porina mastoidea*, *Porina nuculastrum*, *Porina papuensis*, *Pyrenula quasiaeicola*, *Pyxine coralligera*, *Pyxine meissnerina*, *Rinodina atrofusca*, *Trapelia coaractata*.

また、本調査による採集品をもとにして、*Graphis cambodiensis* M.Nakan., Kashiw. & K. H.Moon (Nakanishi et al.)<sup>2)</sup>, *G. taneina* M.Nakan., Kashiw. & K.H.Moon (Moon et al.)<sup>3)</sup>, *Pyrgillus cambodiensis* Kashiw., K.H.Moon & Aptroot (Kashiwadani et al.)<sup>4)</sup>の3種が新種として記載発表されている。

尚、リストには掲載されていないが、分類学的研究途上にある分類群には次の属や科に属する種が認められる。*Acanthothecis*, *Acarospora*, *Arthoniaceae*, *Bacidia*, *Bacidiopsora*, *Buellia*, *Caloplaca*, *Chapsa*, *Chrysothrix*, *Endocarpon*, *Fissurina*, *Glyphis*, *Graphis*, *Hemithecium*, *Lecidella*, *Leiorreuma*, *Lepraria*, *Malcolmiella*, *Phaeographis*, *Pseudopyrenula*, *Pyrenula*, *Roccellaceae*, *Sarcographa*, *Thelotrema*, *Trypetheliopsis*, *Verrucariaceae* 等。

一方、熱帯～亜熱帯に広く分布するハナゴケ属 *Cladonia* やカラタチゴケ属 *Ramalina* は全く発見されず、広義のウメノキゴケ類 *Parmelia* (s. lat.) も極端に少ないことは特筆に値する。

調査地における地衣類の生育場所は、遺跡寺院の土台に使われているラテライト、壁部及び屋根部の砂岩、寺院周囲に生育する樹木などである。それぞれの基物に着生する主な種には次のようなものが認められた。

樹皮に着生する普通種：*Dirinaria consimilis*, *Carbacanthographis induta*, *Diorygma hieroglyphicum*, *Fissurina dumastii*, *Laurera benguelensis*, *Pyxine coralligera*, *Pyxine meissnerina*, *Sarcographa gyrizans*.

ラテライトに着生する主な種：*Bacidia* sp., *Chiodecton* sp., *Dirinaria consimilis*, *Endocarpon pallidulum*, *Enterographa* sp., *Lecidella* sp., *Lepraria* sp., *Letrouitia leprolyta*, *Phyllopsora furfuracea*, *Porina mastoidea*, *P. nuculastrum*, *Pyxine coralligera*, *P. meissnerina*, *Verrucaria* sp.

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砂岩に着生する主な種：*Bacidia* sp., *Chiodecton* sp., *Dimerella* sp., *Dirinaria consimilis*, *Endocarpon pallidulum*, *Fellhanera fuscata*, *Enterographa* sp., *Lecidella* sp., *Lepraria* sp., *Letrouitia leprolyta*, *Phyllopsora furfuracea*, *Porina tetracerae*, *Pyxine coralligera*, *P. meissnerina*, *Verrucarua* sp.

ラテライトと砂岩に着生する地衣類は生育地の条件によって優占種は異なるものの、種の構成要素はよく似ている。しかし、*Porina mastoidea* や *P. nuculastrum* のようにラテライト上でも砂岩上でも生育する種があるが、*Caloplaca subsquamosa*, *Flakea papillata*, *Gymnographa heterospora* のように砂岩上だけで生育が確認された種も存在する。

なお、岩上性地衣類の菌糸が岩石内に陥入する現象がタ・ネイ遺跡で採取された標本で確認されている<sup>12)</sup>。特に固着地衣類でその現象が著しく、表面から8–20mmの深さまで陥入している。一方、葉状地衣類の仮根は岩石に付着するだけで、陥入しないことが確認された。このように、地衣類の菌糸や仮根の陥入の程度は種類により異なることから、本報文は、岩石表面に対して地衣類の及ぼす影響を正しく評価するための基礎的な情報となる。