

An Introduction to the Lichen Flora of Khao Yai National Park, Thailand

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Summary

A workshop in tropical forests of Khao Yai National Park on lichenized fungi, identified major components of the lichen flora on corticolous, foliicolous and saxicolous substrata. 161 taxa were recorded in three areas of the park including a riverine site on the Lam Takhong river, a montane forest at Khao Khieo and areas of tropical forest around the park headquarters. Species new to Thailand included foliicolous and corticolous species of equatorial forests, and others yet to be identified or described.

Introduction

Khao Yai National Park, Thailand lies between latitudes 14°05' N and 14°35' and longitudes 101°05' and 101°50' E on the westernmost part of the Dongrak mountain range. The park covers 2168 km² in the provinces of Saraburi, Nakhon Nayok, Nakhon Rachsima and Prachinburi in the northeast of Thailand. Much of the area is a sandstone plateau, of which no more than 75 km² rises above 1000 m, the major part being at 200-900 m above sea level. Khao Khieo is the highest peak at 1351 m. Average rainfall is 2270 mm, over 84% falling between May and October during the south west monsoon. The driest months are December and January, which are also the cool months with an average temperature of *c.* 17°C. In the hottest months of April and May temperatures average 28°C, while humidity averages 86% (Conservation Data Centre, 1989). Many rivers dissect the plateau producing four major watersheds and *c.* 1900 m³ of water a year, the Lam Takhong river running through the headquarters area of the park.

The park supports the most extensive area (70% of the park land) of primary lowland rainforest in Thailand, dominated by evergreen dipterocarps with deciduous leguminous trees ('mixed deciduous'), the better drained and drier parts having a 'dry evergreen' forest and the moister sites having a gallery forest along the river valleys. Other components include small areas of 'lower montane' oak forest above 800 m, and of 'deciduous dipterocarp' forest and secondary forest at its lowland margins (Santisuk *et al.*, 1991; Smitinand, 1968, 1977). In

Khao Yai the lowland forest contains many palms and species that are characteristic of the rain forests of peninsular Thailand and Malaysia while the montane forest contains elements of more temperate montane floras including *Dacrydium elatum* Wall. (Smitinand, 1968). Terminology for forest types in monsoon climates varies considerably, and this paper follows Santisuk *et al.* (1991) where major forest types at Khao Yai are described as mixed deciduous on elevations of 400-1000 m.a.s.l., dry evergreen forest at 200-600 m.a.s.l., and lower montane forest 800-1800 at m.a.s.l. It is estimated that the park contains 2000-2500 plant species, including seven endemic species. This extensive area of forest supports 67 species of mammal, including large populations of Asian elephant, gaur, tiger and gibbon and 16 species of bat, and 318 species of bird representing 35% of Thailand's species (UNESCO, 1992).

This key site for conservation of wildlife was established as the first National Park in Thailand in 1962 by a Royal Decree. At first Khao Yai was administered by a section of the Royal Forest Department's Silviculture Division, later becoming the National Park Division in 1972. As the first national park, Khao Yai is the best known of all the protected areas, and appreciated by the general public for its scenic beauty and rich wildlife, and for its contribution to education and recreation.

The Khao Yai National Park area had always been one of the country's extensive and pristine areas until about 60 years ago when some 30 families from two villages in a nearby lowland area moved to the mountains of Khao Yai to farm, hunt and collect forest products for their living. Later, when the isolated village became a hideout for criminals and a potential refuge for communist insurgents, the government disbanded the village and moved the settlers back to the lowlands. The grasslands around the present headquarters of the park remain as evidence of the villagers' agricultural activities. Before Khao Yai was decreed a national park, a part of the cleared ground had been developed for recreation and a golf course, now maintained as tourist facilities covering *c.* 39 km² or 1.8% of the park, and administered by the tourism authority of Thailand overseen by the National Park Division of the Royal Forest Department.

Lichenological background

Following a Danish expedition to Siam in 1899-1900, Vainio prepared the first lichen account as a contribution to the Flora of Koh Chang, including 95 species in 29 genera, describing several new species (Vainio, 1909). Further collections on Doi Suthep were described by Vainio (1921), and from Kaw Tao (Suratthani) by Paulson (1930), on Doi Suthep and Doi Inthanon by Sato (1962). Collections made in the north of Thailand 1978 by Warncke and identified by Yoshimura (1978) are at Arrhus, Denmark and Kochi Gakuen College, Japan, and those by Hale and Kurokawa in 1964 are in the Smithsonian Institution and Tokyo National Museum. A project on lichens as indicators of environmental change in tropical forests of northern Thailand at the Natural History Museum, London produced a literature review (Aguirre-Hudson & Wolseley, 1994) and a checklist of *c.* 307 taxa; papers including species lists (Wolseley, 1997; Wolseley *et al.*, 1991, 1994, 1997a, 1997b), and collections adding a further 144 species to the checklist (manuscript). Collections from this project are at BM, BKF and CMU.

Following the formation of a lichen group at Ramkhamhaeng University, further collections were made by Boonpragob, Mongkolsuk and Homchantara in the area of Queen Sirikit Botanic Garden, Chiang Mai (1993), and the forest of Puteensuansai, Loei in 1994-5 for Ramkhamhaeng University herbarium. During a biodiversity survey of Chiang Dao in 1995 Gardner with others made lichen collections for the herbarium at Biology Department Chiang Mai University (duplicates at BM). It is apparent from this account that no previous collections or surveys of lichens had included Khao Yai. This area is known to contain a great diversity of species, including those not found elsewhere in Thailand, and relatively undisturbed habitats where maximum development of ecological niches is possible.

The lichen investigation in Khao Yai National Park was organized by Ramkhamhaeng lichen research group in collaboration with BIOTEC (the National Institute Centre for Genetic Engineering and Biotechnology), part of Thailand's National Science and Technology Department Agency and Khao Yai National Park.

Methods

Survey and collection of lichens was concentrated in three areas of Khao Yai National Park in November 1997; the area of mixed deciduous forest around the National Park headquarters and the Lam Takhong Creek, including an area of dry evergreen forest in grassland south of headquarters, an area of gallery forest along the Lam Takhong Creek between Pha Kluai Mai and Heo Suwat waterfall 400-600 m, and montane forest on Khao Khieo at *c.* 1300 m. Species were collected from a range of microhabitats including tree bark (corticolous), evergreen leaves of trees and palms (foliicolous), on rocks by water courses (saxicolous), and on banks, soil and rotting wood at the edge of paths (terricolous). Where possible tree species were identified.

Results

During the workshop in Khao Yai National Park 161 lichenized taxa were recorded. Of these, 117 were found on corticolous substrata, 34 foliicolous, and *c.* 12 on riverside saxicolous boulders and bedrock (Appendix I). One terricolous basidiolichen, a species of *Multi clavula*, was recorded along the Orchid trail to Heo Suwat.

A. Corticolous lichens

Tropical forest provides an extensive area of bark substratum for corticolous species, so it is not surprising that 117 taxa were recorded in this habitat, with additional species of sterile crusts which, although conspicuous, are not included here for lack of systematic information. Within the forest the spatial structure of emergents and understorey trees, their evergreen or deciduous character affects conditions of light and shade on the trunks and branches. The great diversity of tree species provides variations in bark types, including bark thickness and corrugation, age, moisture content and pH, all of which affect corticolous lichen species (Wolseley & Aguirre-Hudson, 1997a).

Mixed deciduous forest

The mixed deciduous forest is dominated by evergreen dipterocarps of great size (up to 45 m tall) with other large deciduous leguminous trees such as *Pterocymbium javanicum* R.Br. Evergreen trees abound in the understorey and include large numbers of *Lauraceae* and *Magnoliaceae*. Evergreen trees often retain high bark moisture in the dry season, which may be a critical factor for epiphytic species, so that lichen species sensitive to seasonal drought are frequent in the river valleys, but may also survive on moist-barked trees such as *Magnoliaceae*. Lichens with cyanobacteria as photobionts, such as *Coccocarpia*, *Collema* and *Leptogium*, require a permanently high moisture supply. For example, *Pseudocyphellaria argyracea* was found with a *Sticta* with marginal isidia, together with *Coccocarpia palmicola*, *C. pellita*, *Parmeliella brisbanensis* and *Leptogium cyanescens* on slender branches of a shrub overhanging the Lam Takhong Creek. This site was more open and well lit than in the forests and we also found other foliose species with trebouxoid photobionts, such as *Parmotrema nilgherrense*, *P. dilatata* and two species of *Relicina*, occurring on rocks. Elsewhere in this more shaded forest, foliose species were rare, the trunks being dominated by crustose and squamulose species with trentepohlioid photobionts, including a great diversity of *Thelotre mataceae* often with large thalli more than 30 cm diam., appearing to be almost as old as the tree. However it was observed that several usually sterile species produce scale-like phyllidia that are probably distributed by rainwater, and had colonized lower parts of the trunk where they grew and coalesced to form an extensive thallus. Several other species have adopted similar strategies and are frequent in the mixed evergreen forest. Species with byssoid thalli were frequent and included fertile *Crocynia pyxinoides*. Other fertile crustose species included *Anthracotheceium prasinum* with large perithecia, *Porina mastoidea* and two species new to Thailand (*P. americana* and *P. tetracerae*) together with many other pyrenocarpic lichens which remains to be identified. Two new generic records for Thailand of species more characteristic of the aseasonal equatorial rainforests were found in this riverine zone on the Lam Takhong Creek: a sterile specimen of *Myeloconis erumpens* (see McCarthy & Elix, 1996) with a beautiful yellow medulla, and *Dichosporidium boschianum* (see Thor, 1990). Of the squamulose species, both *Phyllopsora* spp. and *Eschatagonia prolifera* were frequent but rarely fertile in this habitat, both having very successful means of vegetative propagation. By contrast, *Physcidia cylindrophora* and *P. wrightii* were infrequent, and as in other areas of Thailand appear to be good indicators of primary forest (Wolseley *et al.*, 1994).

The National Park headquarters are situated in an area of mixed deciduous forest which has been considerably disturbed. Around open areas with buildings there are scattered forest trees, and adjacent forest often has an understorey of bamboo. The latter supported a characteristic flora of crusts including *Cryptothecia candida* and *Sarcographa meduselina*. Corticolous species on exposed forest trees included characteristic moist forest species together with species characteristic of well-lit branch communities including many *Graphidaceae* and *Ocellularia* species, as well as *Laurera benguelensis* and *Gyrostomum scyphuliferum*, which were not recorded elsewhere during our survey.

Dry evergreen forest

A small fragment of a drier evergreen forest was visited in the area of grassland where there had been former settlements, south of headquarters. Forests on the edge of grasslands are frequently burned, so that only species that have some resistance to fire survive. Lichen communities here also contained species more characteristics of drier, fire-resistant forests, including crustose species with red coloured apothecia containing anthraquinones which may protect the spore-bearing hymenium from high temperature damage (Wolseley, 1997). These species include *Brigantiaea leucoxantha*, *Letrouitia domingensis* and *Pyrrhospora russula*. The last species was also found on branches in other forest types. However this forest also contained several lichens of the moister forest, including species of *Myriotrema*, *Phyllopsora* and *Porina*, indicating that this forest is in a transitional state (Wolseley & Aguirre-Hudson, 1997b).

Lower Montane forest

At altitudes above 1000 m rainfall is higher and moisture is available as cloud cover, but temperature falls rapidly with increasing altitude so that species characteristic of more temperate conditions are found at higher altitudes. In the forest on Khao Khieo evergreen tree species of *Quercus* and *Castanopsis*, together with species of *Podocarpus* and *Dacrydium elatum*, form a rather dense closed canopy forest except where it is intercepted by the road to the summit. On twigs and branches on the well-lit road edge there is a luxuriant cover of epiphytic foliose lichens, including species of *Heterodermia*, *Hypotrachyna*, and *Parmotrema*, and occasionally the conspicuous thalli of *Erioderma solediatum*. Species of *Usnea* were rather rare, which was surprising at this altitude where they would normally be abundant, and could be due to the proximity of this exposed peak to industrial areas of Bangkok. However, some *Usnea* thalli were seen on overhead telephone wires! In the shadier forest *Leprocaulon arbusculum* grows, together with species of *Phycidia* and *Crocynia*, and many crustose species such as fertile *Megalospora tuberculosa*, a species of *Polymeridium*, and several species of *Lecidea s. lat.* and *Bacidia s. lat.* with biatorine apothecia that have yet to be identified.

B. Saxicolous lichens

Although boulders and outcrops of bedrock are scattered throughout the forests at Khao Yai, they are most numerous and accessible along water-courses, and it is here that the continuum of communities from aquatic to truly terrestrial can best be studied. Saxicolous lichens were closely examined at two sites in the National Park, and particular attention was given to the distinctive aquatic and semi-aquatic pyrenolichens. These organisms have been studied in some detail in SE Asia and adjacent regions, especially southern China (Zahlbruckner, 1930; Harada & Wang, 1996), Java and Sumatra (Zahlbruckner, 1934) and tropical Australia (McCarthy, 1995). Several of the taxa at Khao Yai are almost certainly undescribed, and these are currently being documented.

Lam Takhong Creek

This creek, from Pha Kluai Mai to Heo Suwat Falls, has moderately shaded to

comparatively exposed bedrock and boulders of sandstone in and beside the creek. It is 10-20 m wide, with a flow that ranges from rather sluggish to torrential. The rock at and just above the water level is colonized by a thalloid vascular plant, *Hydrobryum griffithii* (Griff.) Tulasne (*Podostemaceae*), above which is found a distinct zone dominated by crustose cyanobacteria and rhodophyta. These are associated with sterile thalli of cyanophilic lichens, the minutely lobed *Endocarpon adscendens* and an unidentified species of *Staurothele*. The *Staurothele* has a pale and rather thick rimose thallus with black punctulae and a carbonized basal layer, and while it is somewhat similar to the tropical Australian *S. pallidopora* P.M. McCarthy, it is almost certainly distinct from this and other species reported from the region.

Several species of *Porina* occur in the spray zone, and one, somewhat similar to *P. ulceratula* Zahlbr. (described from Sumatra), is especially abundant. *Verrucaria*, a dominant genus on aquatic rocks in temperate regions is uncommon here, and probably elsewhere in the tropics. One species was collected from semi-aquatic rocks, and although it is unidentified, it appears to be distinct from other taxa reported from southern China (Zahlbruckner, 1930), Indonesia (Zahlbruckner, 1934) and tropical Australia (McCarthy, 1995). In the upper part of the spray zone, *Ionaspis tropica*, recently described from New Guinea (Aptroot *et al.*, 1997), was found to be locally abundant.

Exposed rocks above the spray zone supported a diverse saxicolous flora dominated by species of *Graphidaceae*, *Thelotre mataceae* and *Pertusaria*, most of which were also found in corticolous habitats. Other normally corticolous taxa that were found only on rock in this area included species of *Relicina*.

Khao Khieo

Here we investigated a narrow seasonal rivulet, deeply shaded by overhanging vegetation. Water trickled over slippery rocks heavily encrusted with cyanobacteria. Aquatic lichens were less abundant and diverse than at Lamtakhong Creek; the *Endocarpon*, *Staurothele*, *Verrucaria* and *Porina* aff. *ulceratula* were replaced by other *Porina* spp. One is especially abundant, and while it is reminiscent of the tropical Australian *P. chlorotricula* P.M. McCarthy, it has a very distinctive rimose to areolate thallus. A second species is clearly related to the pantemperate *P. guentheri* (Flot.) Zahlbr., but the ascospores are larger and more septate and the perithecial involucrellum is exceptionally thin.

C. Foliicolous lichens

The upper surface of leaves of evergreen shrubs and trees in tropical forests are an important substratum for an often diverse community of obligately foliicolous lichens. Most genera and many species occur throughout the tropics.

Foliicolous lichens were collected at three localities: near Pa Na San Lodge, along the Orchid Trail (from Pha Kluai Mai to Heo Suwat Falls) and below the summit of Khao Khieo. A preliminary assessment of the specimens indicates a rich foliicolous flora at Khao Yai. Indeed, of the 34 taxa listed below, only *Porina epiphylla* has been previously reported in the published literature (Santesson, 1952).

Discussion

This brief survey of a few sites in Khao Yai National Park has added several new components to the known lichen flora of Thailand. The lowland forest is rich in species with long-lived evergreen leaves that support a diversity of foliicolous species, most of which are new to the lichen flora. Many of these species are pantropical in distribution being found in equatorial rainforests, whereas a few, such as *Chroodiscus mirificus* and several *Porina* species, are paleotropical and associated with the Malesian region. Other new records for Thailand belonging to the aseasonal tropical forest flora include the genera *Dichosporidium* and *Myeloconis* and species of *Porina*, *P. americana* and *P. tetracerae*. These results suggest that the lowland tropical forest in Khao Yai has strong affinities to the tropical rain forests of Malesia, in contrast to the montane forest which has similarities to floras of cooler temperate as exemplified by species of *Cetrelia*, *Heterodermia* and *Hypotrachyna*. The high biodiversity of Khao Yai is in part due to the coincidence of aseasonal tropical southern elements with temperate elements that have survived on the isolated islands of cool mountain tops as relics of the colder climates of the Cretaceous and early Tertiary (Wolseley, 1991; Wolseley & Aguirre-Hudson, 1997a).

Critical microclimatic factors in seasonal tropical forests affecting lichen communities include humidity and amount of shading. Humidity is high throughout the year in gallery forest along river banks, in mixed deciduous forest where transpiration of the evergreen tree species contributes to high relative humidity throughout the year, and in montane forest above 1000 m where cooler temperatures produce condensation and cloud over. Species that are moisture-dependent may occur in all forest types, while species that are temperature-dependent may be restricted by altitude. Shade-tolerant species include those with cyanobacterial and trentepohlioid photobionts, whereas many foliose and crustose species with trebouxoid photobionts require well-lit situations and are found only in the canopies of evergreen forests (Wolseley & Aguirre-Hudson, 1997a).

The present day distribution of species is strongly influenced by the seasonal climate, especially water, often available only as vapour or condensation droplets during the dry season. During this preliminary survey, moisture-dependent tropical species were found only in the riverine gallery forest along the Lam Takhong river between Pha Kluai Mai and Heo Suwat. In this area two species of *Relicina* were found on rocks above the water level. This genus is widely distributed in the open canopies of dipterocarps in equatorial tropical rain forests (Hale, 1975), but in mainland Thailand is found more frequently on rocks (Wolseley pers. obs.). Other moisture-dependent taxa, such as *Crocynia*, *Eschatagonia*, *Phyiscidia*, *Phyllopsora* and *Sticta*, have a bimodal distribution, being found in both the gallery forest along the river and in the lower montane forest, where moisture was also permanently high. No areas of long-established dry evergreen forest were visited on this survey, the area of former settlement south of headquarters having a secondary forest with epiphytic species characteristic of fire-prone dry forests and others characteristic of the moist mixed deciduous forest. Much of the dry forest at lower altitudes is considerably degraded with an understorey dominated by bamboo. Further survey of epiphytic species will show whether there are long established dry forests in Khao Yai

with a characteristic lichen flora or whether these forests are a product of fire-management (Wolseley & Aguirre-Hudson, 1997b).

Conclusions

Khao Yai National Park is well known for the high biodiversity of its flora and fauna, supporting its World Heritage status (UNESCO, 1992). A survey of three sites within the park for lichenized fungi in November 1997 supported the high interest of this site for corticolous, foliicolous and aquatic saxicolous taxa, adding many new records to the flora of Thailand. New records were most apparent in taxa with an equatorial distribution, especially those that occur on leaves. These species form an important addition to the epiphytic flora of Thailand being remnants of a more equatorial forest ecosystem. It is also apparent that several undescribed species have been found, mainly represented by sterile corticolous crusts and by crustose lichens on rocks in rivers and streams. The latter habitats have not been studied previously in Thailand, so will provide a new impetus to researchers. Already research is in progress on the *Thelotrema*taeae, which contributed 37 species in 3 genera to the checklist, and will include new records for Thailand and the region.

APPENDIX I

Preliminary checklist of lichens in Khao Yai National Park

The checklist is very much preliminary for three main reasons: many collections await critical study, even to assign the specimens to genera or species groups; even after critical study accurate naming is often hampered because of the lack of monographic systematic studies for many tropical genera; many more species will undoubtedly be discovered by further careful collecting from the wide range of available substrata to be found in the wide range of habitat types present in the Park.

In the following list the substratum (or substrata) for each entry is indicated as follows: C – corticolous, F – foliicolous, S – saxicolous, T – terricolous.

- | | |
|--|---|
| <i>Anisomeridium foliicola</i> R. Sant. & Tibell, F | <i>Canoparmelia ecaperata</i> (Müll.Arg.) Elix & Hale, C |
| <i>Anthracotheicum prasinum</i> Hampe ex A. Massal., C | <i>Cetrelia japonica</i> (Zahlbr.) W. Culb. & C. Culb., C |
| <i>Arthonia</i> aff. <i>mira</i> R. Sant., F | <i>Chaenotheca trichialis</i> (Ach.) Th.Fr., C |
| <i>Arthonia</i> spp., C | <i>Chroodiscus mirificus</i> (Kremp.) R. Sant., F |
| <i>Arthothelium</i> sp., C | <i>Chroodiscus</i> sp., F |
| <i>Bacidia</i> s. lat. sp., C | <i>Cladonia furcata</i> (Huds.) Schrad., C |
| <i>Brigantiaea leucoxantha</i> (Spreng.) R. Sant. & Hafellner, C | <i>C. modesta</i> Ahti & Krog, T |
| <i>Buellia</i> sp., C | <i>C. squamosa</i> Hoffm., C |
| <i>Bulbothrix meizospora</i> (Nyl.) Hale, C | <i>Cladonia</i> sp., T |
| <i>Bunodophoron</i> sp., T | <i>Coenogonium</i> sp., C |
| <i>Byssoloma chlorinum</i> (Vain.) Zahlbr., F | <i>Coccocarpia erythroxyli</i> (Spreng.) Swinscow & Krog, C |
| <i>B. leucoblepharum</i> (Nyl.) Vain., F | <i>C. glaucina</i> Kremp., C |
| <i>B. tricholomum</i> (Mont.) Zahlbr., F | <i>C. palmicola</i> (Spreng.) Arv. & D.J. Galloway, C |
| <i>Calenia graphidea</i> Vain., F | <i>C. pellita</i> (Arch.) Müll.Arg., C |
| <i>C. aff. phyllogena</i> (Müll.Arg.) R. Sant., F | |
| <i>Calopadia</i> aff. <i>fusca</i> (Müll.Arg.) Vezda, F | |

- Collema coilocarum* (Müll.Arg.) Zahlbr., C
Collema sp., C
Crocynia pyxinoides, C
Cryptothecia candida (Kremp.) R. Sant., C, F
Cryptothecia sp., C
Cyclographina sp., C
Dichosporidium boschianum (Mont.) Thor, C
Dimerella sp., C
Echinoplaca epiphylla Fée, F
E. pellicula (Müll.Arg.) R. Sant., F
Endocarpon adscendens (Anzi) Müll.Arg., S
Eremothecella macrocephala (R. Sant.) Thor et al., F
Erioderma sorediatum D.J. Galloway & P.M. Jørg., C
Eschatagonia prolifera (Mont.) R. Sant., C
Fellhanera sp., F
Glyphis sp., C
Graphina spp., C
Graphis afzelii Ach., C
Graphis spp., C
Gyalideopsis aff. *rubescens* Vezda, F
Gyrostomum scyphuliferum (Ach.) Nyl., C
Heterodermia microphylla (Kurok.) Skorepa, C
Heterodermia spp., C, S
Hypotrachyna ducalis (Jatta) Hale, C
H. formosana (Zahlbr.) Hale, C
H. orientalis (Hale) Hale, C
Ionaspis tropica Aptroot, S
Lasioloma cf. *arachnoideum* (Kremp.) R. Sant., F
Laurera benguelensis (Müll.Arg.) Zahlbr., C
L. madreporeiformis (Eschw.) Riddle, C
L. meristospora (Mont. & Bosch) Zahlbr., C
Lecidea s. lat. spp., C, S
Leprocaulon arbuscula (Nyl.) Nyl., C
Leptogium azureum (Ach.) Mont., C
L. cyanescens (Rabenh.) Körb., C
L. denticulatum F. Wilson, C
Letrouitia domingensis (Pers.) Hafellner & Bellem., C
L. subvulpina (Nyl.) Hafellner & Bellem., C
Mazosia melanophthalma (Müll.Arg.) R. Sant., F
Megalospora tuberculosa (Fée) Sipman, C
Micarea sp., C
Microtheliopsis uleana Müll.Arg., F
Multiclavula sp., T
Myeloconis erumpens P.M. McCarthy & Elix, C
Myriotrema albocinctum Hale, C
M. costgariacense (Müll.Arg.) Hale, C
M. clandestinum (Fée) Hale, C
M. aff. fissurinum Hale, S
M. masonhalei (Patw. & C. Kulk.) Hale, C.
M. microsporum (Mont.) Hale, C, S
M. terebatulum (Nyl.) Hale, C
Normandina pulchella (Borrer) Nyl., C
Ocellularia allosporoides (Nyl.) Patw. & C. Kulk., C
O. ascidioidea Hale, C
O. asiatica (Vain.) Hale, C
O. concolor Meyen & Flot., C
O. diacida Hale, C
O. aff. dolichotata (Nyl.) Zahlbr., C, S
O. emersa (Kremp.) Müll.Arg., C
O. fissa (Nyl.) Hale, C
O. groenhartii Hale, C
O. guptei (Nagarka et al.) Awasthi, C
O. leucina (Müll.Arg.) Hale, C
O. marivalensis (Vain.) Hale, C
O. massalongoi (Mont.) Hale, C
O. nylanderiana Hale, C
O. papillata (Leight.) Zahlbr., C
O. perforata (Leight.) Müll.Arg., C
P. pertusariiformis (Leight.) Zahlbr., C
O. punctulata (Leight.) Zahlbr., C
O. sticticans Hale, C
Opegrapha sp., C
Parmeliella brisbanensis (C. Knight) P.M. Jørg & D.J. Galloway, C
Parmotrema dilatatum (Vain.) Hale, C
P. chinense (Osbeck) Hale, C
P. cristiferum (Taylor) Hale, C
P. lobulascens (J. Steiner) Hale, C
P. nilgherrense (Nyl.) Hale, C
P. cf. procera (J. Steiner & Zahlbr.) Hale, C
Pertusaria spp., C, S
Phaeographina sp., C
Phaeographis spp., C
Phyllopsora furfuracea (Pers.) Zahlbr., C
Phyllopsora sp., C
Physcidia cylindrophora (Taylor) Hue, C
P. wrightii Tuck., C
Polymeridium sp., C
Porina aff. *albicera* (Kremp.) Overeem, F
P. americana Fée, C
P. conica R. Sant., F
P. corruscans (Rehm) R. Sant., F
P. epiphylla (Fée) Fée aggr., F
P. lucida R. Sant., F
P. mastoidea (Ach.) Müll.Arg., C
P. tetracerae (Ach.) Müll.Arg., C
P. aff. octomera (Müll.Arg.) F. Schill., F
P. rufula (Kremp.) Vain., F
P. aff. ulceratula Zahlbr., S
P. aff. vezdae (Kremp.) Müll.Arg., F
P. virescens (Kremp.) Müll.Arg., F
Pseudocyphellaria argyrea (Delise) Vain., C
Pyrenula spp., C
Pyrgillus javanicus (Mont. & Bosch) Nyl., C
Pyrrhospora russula (Arch.) Hafellner, C

- Relicina abstrusa* (Vain.) Hale, C
R. subabstrusa (Gyeln.) Hale, C
Relicina spp., S
Sarcographa meduselina (Nyl.) Müll.Arg., C
Sarcographina sp., C
Sporopodium sp., F
Staurothele sp., S
Sticta sp., C
Strigula maculata (Cooke & Masee) R. Sant.,
 F
S. melanobapha (Kremp.) R. Sant., F
S. smaragdula Fr.:Fr., F
S. subtilissima (Fée) Müll.Arg., F
Staurothele sp., S
Thelotrema astroideum (Berk. & Broome)
 Hale, C
- Thelotrema alborosellum* (Nyl.) Tuck., C
T. colobicum Nyl., C
T. expallescens Nyl., C
T. leprocarpoides Hale, C
T. nureliyum Hale, C
T. poeltii Patw. & C. Kulk., C
T. phlyctidiodes (Müll.Arg.) Hale, C
T. porinoides Mont. & Bosch, C
T. rugatulum Nyl., C
T. turgidulum (Müll.Arg.) Hale, C
 aff. *Trapelia* sp., C
Tricharia aff. *vainioi* R. Sant., F
Trypethelium tropicum (Ach.) Müll.Arg., C
T. cf. eluteriae Spreng., C
Verrucaria sp., S

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