

---

**Report**

---

**The urban pteridophyte flora of Singapore**

Benito C. Tan<sup>1,\*</sup>, Angie Ng-Chua L.S.<sup>2,3</sup>, Anne Chong<sup>3</sup>, Cheryl Lao<sup>3</sup>, Machida Tan-Takako<sup>3</sup>, Ngiam Shih-Tung<sup>3</sup>, Aries Tay<sup>3</sup>, Yap Von Bing<sup>3</sup>

<sup>1</sup> *RMBR, Department of Biological Science, National University of Singapore, Singapore 119267*

<sup>2</sup> *Plant Study Group Leader, Nature Society (Singapore)*

<sup>3</sup> *Members of Nature Society (Singapore) Plant Study Group*

\*Corresponding author: btakakia@yahoo.com

**Abstract**

A total of 81 species in 41 genera of pteridophytes were collected and documented from the urbanized parts of Singapore. Eight introduced and ornamental species are confirmed to have escaped and are growing wild in Singapore today. The endangered status of several fern species in Singapore reported in the second edition of Singapore Red Data Book are updated based on new distribution data.

**Keywords:** Singapore, Pteridophytes, Ferns, Fern allies, Endangered species, Distribution, Singapore Red Data Book

**Introduction**

The rich flora of pteridophytes of Singapore has been comparatively well collected and studied by Holttum (1968), Johnson (1977) and Wee (1995). In his special volume treating the fern flora of Peninsular Malaysia, Holttum (1968) listed 170 species of ferns from Singapore. Johnson (1977) discussed the characters used for identifying 166 species of ferns found in Singapore and provided many with local Malay names. Nonetheless, based on literature search, Turner (1993) found 182 names of fern species reported from Singapore, including a few naturalized alien species. A year later, in a follow-up publication, the number of species was reduced to 174 (see Turner, 1994), and then down to 130 species (Turner et al., 1994).

A century of urbanization in Singapore has brought drastic changes, if not damage, to the local vegetation landscape and biodiversity. Today, the remaining primary and secondary forests of Singapore have been reduced to about 2.5% of the island's vegetation area cover (Ng & Corlett, 2011). Accordingly, the extinction rate of various plant groups on the island has been estimated to vary from 29% for inland forest seed plant groups to 86% for epiphytic Orchidaceae (Turner, 1994; Turner et al., 1994). However, no

estimate has been made for the rate of extinction of the pteridophyte flora. The second edition of the Singapore Red Data Book (Davison et al., 2008) listed 121 species of pteridophytes as vulnerable, endangered and critically endangered. This figure represents about 70% of the total known pteridophyte flora of the republic.

Since the pteridophyte flora of Bukit Timah Nature Reserve has been re-surveyed in recent years by a National University of Singapore (NUS) thesis student (Liu, 2002), and that of the Central Catchment by another NUS thesis student (Tan, 2010), we conducted from 2010-2011 a survey of the biodiversity of the pteridophytes in urbanized parts of the Singapore main island. Ornamental and exotic species, as well as popular garden cultivars, planted on roadside tree trunks and around houses and city parks, were excluded from the study. The pteridophytic flora of Pulau Ubin and Pulau Tekong, the two large offshore islands, were also excluded from this survey.

In summary, the new survey has yielded a total of 81 species of pteridophytes in 41 genera. Two of these were species were reported as new to Singapore very recently, namely *Pleocnemia conjugata* and *Heterogonium pinnatum* (Tan & Ng, 2012). Eight are introduced, ornamental species of exotic origin that have now been confirmed to become naturalized locally. They are *Adiantum tenerum*, *A. capillus-veneris*, *A. latifolium*, *Lygodium japonicum*, *Salvinia molesta*, *Selaginella plana*, *Pityrogramma calomenanos* and *Tectaria incisa* (cf. Hoshizaki & Moran, 2001). There is a conspicuous absence of humidity loving fern families of the primary forest, namely Hymenophyllaceae and Lomariopsidaceae, in the urban parts of the island.

Interestingly, several species reported as common in a recent publication (Chong et al., 2009), e.g., *Acrostichum speciosum*, *Sphaerostephanos heterocarpus* and *Ophioglossum reticulatum*, were found by us to be rather uncommon. In contrast, a number of vulnerable and endangered species listed in the second edition of the Singapore Red Data Book, such as *Amphineuron opulentum*, *Cheilanthes tenuifolia*, *Cyathea latebrosa*, *Pteris semipinnata*, *Sphaerostephanos polycarpus*, *Goniophlebium subauriculatum*, *Lygodium longifolium*, *Nephrolepis acutifolia* and *Pteris tripartita*, were observed to be relatively widespread and have populations growing among patches of forest remnants outside the two nature reserves in Singapore. Their national status of being endangered requires a re-assessment.

At present, the most common species of pteridophytes seen in urban areas of

Singapore are *Asplenium nidus*, *Christella dentata*, *Davallia denticulata*, *Dicranopteris linearis*, *Drynaria quercifolia*, *Haplopteris elongata*, *Lycopodiella cernua*, *Nephrolepis biserrata*, *Pyrrosia lanceolata*, *Pyrrosia longifolia*, *Pyrrosia piloselloides*, *Pteris multifida*, *Pteris vittata* and *Selaginella ciliaris*, to name a few. Some of them appeared to be planted originally; however, there is good evidence of the spreading of individual plants by spores at present.

We estimate that the number of surviving indigenous pteridophyte species of the island as of 2012, including those found in the two nature reserves (see Wee, 1995; Liu, 2002; Tan, 2010; Turner & Chua, 2011), is between 95-100 species. This translates into a high extinction rate of 41-44% for this group of spore producing vascular plants within the short history of the island republic since 1965.

True to the discussion of flora in a highly degraded urban landscape written by Williams et al. (2009), the pteridophytes of urbanized parts of Singapore island consists of three main groups -- the surviving residential native taxa, the regional indigenous species found in neighbouring countries with no previous record from the island, and the introduced ornamental plant species, including invasive alien species, that have become naturalized *in situ*.

Finally, our study supports the recommendation of Turner & Corlett (1996) and Corlett & Turner (1997) to protect the remnants of disturbed secondary forests in an urban setting. In the case of Singapore, a number of endangered native species, such as *Diplazium esculentum*, *D. crenatoserratum*, *Huperzia phlegmaria*, and *Pleocnemia conjugata*, have isolated populations in disturbed secondary and planted forests. Inevitably, the protective action of the secondary forest helps conserve the overall plant biodiversity of the country.

In the alphabetical list of the urban pteridophytes of Singapore presented below, we have included the family classification, the local distribution of species, the latest nomenclatural changes, synonymy of some widespread species and comments on the diagnostic taxonomic characters of confused taxa. Habitat information is omitted to discourage the wanton collecting of threatened species in Singapore.

To identify the plant specimens collected, we made use of the reference and keys to the genera and species in Holttum (1968) and supplemented it by the coloured photos of Malayan ferns in Piggott (1988). Family classification is

based on our preference, but the generic treatment and taxonomic synonymy accepted in the checklist follows mainly Parris & Latiff (1997). Voucher specimens of the endangered species and the new locality records of other species are deposited at SING Herbarium.

## A 2012 list of alphabetized urban Pteridophytes of Singapore

This new list of urban Singapore pteridophytes was updated last in November of 2012. We provided no locality information for species found to be common. Only for rare and threatened species we have included the details of confirmed locality information, including their records known from Bukit Timah NR and Central Catchment (see Liu, 2002; Tan, 2010) to give a complete picture of the species range.

SRDB II - Singapore Red Data Book, Second edition.

SBG - Singapore Botanic Gardens

NUS - National University of Singapore (main campus)

*Acrostichum aureum* L. (Pteridaceae); common.

*Acrostichum speciosum* Willd. (Pteridaceae); less common than *A. aureum* in local mangrove communities. A recent publication had synonymized these two species under *Acrostichum aureum*, being the older binomial (Sedaya et al., 2012).

*Adiantum capillus-veneris* L. (Adiantaceae); escaped from cultivation, growing wildly on stone wall at Fort Canning. Holttum (1968) and Johnson (1977) both alleged that this widespread species in tropical and temperate regions is introduced to Singapore. *Adiantum capillus-veneris* is often confused with *A. tenerum*. The latter is easily identified by the presence of a thickened articulation at the junction of the base of leaflet (pinnule) and its subtending stalk (petiolule).

*Adiantum latifolium* Lam. (Adiantaceae); an invasive alien species that has become well naturalized on the island, widespread.

*Adiantum tenerum* Sw. (Adiantaceae); a species native to tropical America that has escaped from cultivation and found growing wild in Tampines area. Collections of *A. tenerum* from Singapore at SINU and SING herbaria have been confused with *Adiantum stenochlamys* Baker. The latter species, which is now considered nationally extinct in SRDB II, is a smaller plant with nearly round sori. The base of pinnule of *A. stenochlamys* forms an angle wider than a right angle. The base of pinnule of *A. tenerum* forms a cuneate angle of less than 90 degrees and

- is articulated to the subtending stalk; also, its sori are somewhat oblong. This is the first report of *A. tenerum* growing wild in Singapore.
- Amphineuron opulentum* (Kaulf.) Holttum [syn. *Cyclosorus extensus* (Blume) Ching; *Cyclosorus impressus* (Desv.) Alston] (Thelypteridaceae); common. This species is identified by the linear pinnae and the confinement of sori to the lobes of pinna segments, and also the presence of many conspicuous tiny yellow glands on the lower surface of the pinna. SRDB II classified this as an endangered species, a conclusion not supported by our observation.
- Angiopteris evecta* (Forst.) Hoffm. (Marattiaceae); uncommon, often planted as an ornamental fern; roadside near Russian Embassy, Labrador Park, Old Thomson Road, Admiralty Park, Old Jurong rail track, Bukit Timah NR., Central Catchment. SRDB II classified this as a vulnerable species.
- Asplenium longissimum* Blume (Aspleniaceae); uncommon; Upper Thomson Road, Old Upper Thomson Road, Bukit Brown Cemetery, Mt Pleasant Road, Admiralty Park, Punggol forest. The formation of adventitious buds at the tip of the long pinnate frond is diagnostic.
- Asplenium nidus* L. (Aspleniaceae); common.
- Blechnum orientale* L. (Blechnaceae); common.
- Cheilanthes tenuifolia* (Burm.f.) Sw. (Pteridaceae); uncommon, locally abundant; Bukit Brown Cemetery, Bukit Chermin Road, Holland Park. SRDB II classified this as a vulnerable species, which is different from our field observation.
- Christella arida* (D. Don) Holttum [syn. *Cyclosorus aridus* (D. Don) Ching] (Thelypteridaceae); uncommon, but not endangered; Bukit Gombak, Bukit Brown Cemetery, Mt. Pleasant Road. Specimens of this species are confused often with *Sphaerostephanos unitus* growing in the same disturbed, open, and somewhat wet wasteland. Although both species produce fronds singly along a long-creeping rhizome, the underside of the pinna of *C. arida* has scattered long, erect and whitish hairs, while pinna of *S. unitus* is covered thickly by brownish, appressed hairs.
- Christella dentata* (Forssk.) Brownsey & Jermy [syn. *Cyclosorus dentatus* (Forssk.) Ching] (Thelypteridaceae); common.
- Christella parasitica* (L.) H. Lév. [syn. *Cyclosorus parasiticus* (L.) Farw.] (Thelypteridaceae); uncommon; Upper Thomson Road, Ang Mo Kio T/G West, Lornie Road, Arcadia Road, Old Thomson Road, Mt. Pleasant Road, Bukit Gombak, NUS Bukit Timah campus, BBC Station at Turut Track. The presence of sori along the costa and not reaching the lobes of many pinnae is a diagnostic character for this species.
- Christella subpubescens* (Blume) Holttum [syn. *Cyclosorus latipinna* (Benth.)

- Tardieu, *Cyclosorus sumatranus* (Alderw.) Ching] (Thelypteridaceae); common.
- Cyathea latebrosa* (Hook.) Copel. [syn. *Alsophila latebrosa* Hook.] (Cyatheaceae); common, often planted along roadside or at forest margin. SRDB II classified this as a vulnerable species, a conclusion different from our field observation.
- Cyclosorus interruptus* (Willd.) H. Ito (Thelypteridaceae); uncommon; Kranji marshland, Tampines Bike Park, Marymount Road, Punggol forest. The production of fronds along a long-creeping rhizome and the shallow pinna lobes with sori are diagnostic.
- Davallia denticulata* (Burm.f.) Mett. [syn. *Wibelia denticulata* (Burm.f.) M. Kato & Tsutsumi] (Davalliaceae); common.
- Dicranopteris curranii* Copel. (Gleicheniaceae); common.
- Dicranopteris linearis* (Burm.f.) Underw. (Gleicheniaceae); common.
- Diplazium esculentum* (Retz.) Sw. [syn. *Athyrium esculentum* (Retz.) Copel.] (Athyriaceae); endangered; Bukit Brown Cemetery, Pulau Ubin. SRDB II classified this as a vulnerable species. The presence of this edible species in Bukit Brown Cemetery is a surprise. As this fern species is not consumed by Singaporeans, the population at the cemetery has grown into a tall and thick colony.
- Diplazium crenatoserratum* (Blume) T. Moore (Athyriaceae); endangered; Bukit Timah Nature Reserve, Central Catchment, Punggol forest. The population of this species at Punggol forest produces several adventitious buds at the tip of the pinnate frond. SRDB II classified this as a vulnerable species, a conclusion different from our recent observation.
- Dipteris conjugata* Reinw. (Dipteridaceae); endangered; Pulau Tekong, Pulau Sarimbun, Poyan Reservoir. SRDB II classified this as a critically endangered species.
- Drynaria quercifolia* (L.) J. Sm. (Polypodiaceae); common.
- Drynaria sparsisora* (Desv.) T. Moore (Polypodiaceae); uncommon; NUS, Holland Village.
- Goniophlebium percussum* (Cav.) W.H. Wagner & Grether [syn. *Goniophlebium verrucosum* (Hook. & Bauer) J. Sm.] (Polypodiaceae); common. SRDB II classified this as a vulnerable species not supported by our recent finding.
- Goniophlebium subauriculatum* (Blume) C. Presl (Polypodiaceae); common. SRDB II classified this as a vulnerable species.
- Haplopteris elongata* (Sw.) E.H. Crane [syn. *Vittaria elongata* Sw.] (Vittariaceae); common.

- Haplopteris ensiformis* (Sw.) E.H. Crane [syn. *Vittaria ensiformis* Sw. ] (Vittariaceae); common.
- Heterogonium pinnatum* (Copel.) Holttum (Tectariaceae); endangered. A small population with fertile fronds was found in early 2012 growing wild on a pile of limestone rocks at a shaded, humid corner of Singapore Botanic Gardens. Holttum (1968) had reported this calciphilous fern species propagating at the Gardens by itself by means of vegetative budding, but the name of this species was not mentioned in any subsequent checklists of ferns and vascular plants of Singapore (Johnson, 1977; Turner, 1993; Chong et al., 2009). It is a welcome discovery to find this native fern still surviving today on its own at SBG in Singapore.
- Huperzia phlegmaria* (L.) Rothm. (Lycopodiaceae); endangered; Dalvey Road, Tyersall Road, Bukit Timah NR, Central Catchment. SRDB II classified this also as an endangered species.
- Lindsaea ensifolia* Sw. [syn. *Schizoloma ensifolium* (Sw.) J. Sm.] (Lindsaeaceae); common.
- Lycopodiella cernua* (L.) Pic. Serm. (Lycopodiaceae); common.
- Lygodium circinnatum* (Burm.f.) Sw. (Lygodiaceae); vulnerable; Mt. Pleasant Road, Dalvey Road, Bukit Timah NR and Central Catchment. Specimens of *L. longifolium* with small leaf marginal teeth preserved at SING and SINU herbaria are often misidentified as *L. circinnatum*. *Lygodium circinnatum* has palmately lobed pinnae with entire and thickened leaf margins, while *L. longifolium* has toothed leaf margins lacking a thickened border.
- Lygodium flexuosum* (L.) Sw. (Lygodiaceae); common.
- Lygodium japonicum* (Thunb.) Sw. (Lygodiaceae); escaped from cultivation, widespread today; Mt. Pleasant Road, Admiralty Park, Balmoral Park, Punggol forest, Tampines Park Connector, Telok Blangah. Compared to the weedy *Lygodium microphyllum*, *L. japonicum* can be distinguished by the absence of a thickened protrusion at the junction of the base of pinnule and its subtending petiolule, and has numerous tiny hairs growing on the petiolule.
- Lygodium longifolium* (Willd.) Sw. (Lygodiaceae); uncommon. SRDB II classified this as a vulnerable species, a different evaluation from our observation.
- Lygodium microphyllum* (Cav.) R. Br. (Lygodiaceae); common.
- Lygodium salicifolium* C. Presl (Lygodiaceae); uncommon; Mt. Pleasant Road, Sentosa, Punggol forest, Pulau Tekong Kechil.
- Mesophlebion chlamydophorum* (Rosenst.) Holttum [syn. *Thelypteris chlamydophora* (Rosenst.) Ching] (Thelypteridaceae); endangered; Admiralty Park, Bukit Timah NR, Central Catchment. SRDB II classified

this as a vulnerable species. As this is a forest and shade-loving species and has few plants at each location, its protection classification needs to be upgraded to endangered category.

*Mesophlebion crassifolium* (Blume) Holttum [syn. *Mesophlebion motleyanum* (Hook.) Holttum, *Thelypteris crassifolia* (Blume) Ching] (Thelypteridaceae); vulnerable; Mt. Pleasant Road, Central Catchment. The thick and coriaceous frond with free veins is characteristic of this species.

*Microlepia speluncae* (L.) T. Moore (Dennstaedtiaceae); uncommon.

*Microsorium punctatum* (L.) Copel. (Polypodiaceae); uncommon; Bukit Brown Cemetery, Leedon Park, Arcadia Road, Upper Thomson Road, Grange Road, Punggol forest.

*Microsorium longissimum* (Blume) Copel. [syn. *Phymatodes longissima* (Blume) J.Sm., *Phymatosorus longissimus* (Blume) Pic. Serm.] (Polypodiaceae); vulnerable; Outram Park, SBG, Bukit Timah NR, Central Catchment. Large populations were observed planted as ornamentals at several country club premises and city parks. SRDB II classified this as an endangered species, a conclusion which is not supported by our recent survey.

*Microsorium scolopendria* (Burm.f.) Copel. [syn. *Phymatodes scolopendria* (Burm.f.) Ching, *Phymatosorus scolopendria* (Burm.f.) Pic. Serm.] (Polypodiaceae); common.

*Nephrolepis acutifolia* (Desv.) Christ. (Nephrolepidaceae); vulnerable; SBG, Jalan Hang Jebat, Ford Avenue, Whitley Road. Plants of *Nephrolepis acutifolia* form beautiful drapes hanging from branches of tree (**Figure 1A**). Its elongate sori are rather unique for the genus. SRDB II classified this as an endangered species.

*Nephrolepis biserrata* (Sw.) Schott (Nephrolepidaceae); common. Turner (1993) listed *Nephrolepis auriculata* (L.) Trimen as a synonym of this species. Nonetheless, Hovenkamp and Miyamoto (2005) listed *N. auriculata* as a synonym of *N. cordifolia* (L.) C. Presl. The latter, which has pinnae with obtuse or round apex, is a widespread species in Malesia at middle elevation above 500 m. The populations of *N. cordifolia* seen in a few places in Singapore are planted as ornamentals.

*Nephrolepis falciformis* J. Sm. (Nephrolepidaceae); common, planted in HDB vicinity and city parks. *Nephrolepis falcata* (Cav.) C. Chr. sensu Holttum (1968) is this species. *Nephrolepis falciformis* is best identified by the strongly falcate median pinnae of a fully developed frond.

*Nephrolepis hirsutula* (G. Forst.) C. Presl (Nephrolepidaceae); common. Turner

(1993) listed *Nephrolepis multiflora* (Roxb.) Jarrett as a synonym of this species. In a new revision, Hovenkamp & Miyamoto (2005) considered *N. multiflora* a synonym of *Nephrolepis brownii* (Desv.) Hovenkamp & Miyam. The latter is a species often confused with *N. hirsutula* and differ from it in having hairs on the upper side of the leaf costa. *Nephrolepis brownii* is reportedly widespread in Malesia (Hovenkamp & Miyamoto 2005), but has no record yet from Singapore.

*Nephrolepis radicans* (Burm.f.) Kuhn (Nephrolepidaceae); common. The scrambling growth habit of this species with its long and obtuse pinnae is distinctive.

*Ophioglossum pendulum* L. (Ophioglossaceae); endangered; Margaret Drive, Simei, Changi Point, Central Catchment, planted in Eco-garden at Science Museum Singapore and Alexandra Hospital compound. SRDB II classified this as a critically endangered species.

*Ophioglossum reticulatum* L. (Ophioglossaceae); vulnerable; Bt Merah, Redhill, NUS, Bukit Gombak, SBG, Central Catchment. Populations of this fern can be seen growing among dicot weeds and grasses in a few car parks in the city.

*Pityrogramma calomelanos* (L.) Link (Pteridaceae); a widespread and very well naturalized species originally from tropical America.

*Platycterium coronarium* (J. Koenig) Desv. (Polypodiaceae); vulnerable; often



**Figure 1.** Photo of two pteridophyte plants. A Habit of *Nephrolepis acutifolia* hanging from tree branches. Photo by Aries Tay. B A large frond of *Sphaerostephanos polycarpus* held by one of the authors (BCT). Photo by Angie Ng.

planted on trees for ornamental purpose; Bukit Timah NR, Central Catchment, East Coast Park, Pasir Ris Park, Arcadia Road, Old Upper Thomson Road, Marymount Road, Changi Point, NUS. Only a few young plants were observed growing naturally on trees in urban habitat. This indicates that the species still needs human propagation for its long term survival in Singapore.

*Pleocnemia conjugata* (Blume) C. Presl (Tectariaceae); vulnerable; Nassim Road, Bukit Gombak, Pulau Ubin. The bipinnate to tripinnatifid fronds of *P. conjugata* can grow to 120 cm long in shaded forest. The presence of a small tooth-like structure at the sinus between two adjacent broad lobes of the pinna is characteristic of the species. The venation is mainly free in the lobe of the pinna, but forms a few areoles around the area of sinus. The sori are indusiate. The species was reported by Holttum (1968) to be distributed in the region and at one time planted in the Singapore Botanic Gardens. This is a new species record for Singapore reported very recently by Tan & Ng (2012).

*Pleocnemia irregularis* (C. Presl) Holttum [syn. *Archypteris irregularis* (C. Presl) Holttum] (Tectariaceae); uncommon, but locally abundant; Mandai Reservoir, Bukit Gombak, Bukit Timah NR, Central Catchment. This species can be distinguished from *P. conjugata* by the formation of many small vein areoles around the sinuses of the lobed pinna.

*Pronephrium triphyllum* (Sw.) Holttum [syn. *Abacopteris triphylla* (Sw.) Ching] (Thelypteridaceae); common.

*Psilotum nudum* (L.) P. Beauv. (Psilotaceae); common.

*Pteris ensiformis* Burm.f. (Pteridaceae); common.

*Pteris multifida* Poir. (Pteridaceae); common. This weedy fern growing nearly everywhere in Singapore on concrete walls of old houses and fences today was listed in Chong et al. (2009), but surprisingly not listed for Singapore in Turner (1993), nor for Malaysia in Parris and Latiff (1997).

*Pteris semipinnata* L. (Pteridaceae); uncommon, but not endangered; Pearl's Hill Park, Bukit Chermin Road, Mt. Pleasant Road, Jalan Minyak, Telok Blangah Hill Park, Alexandra Park, Malcolm Park, Punggol forest. The species is not listed for Singapore in Turner (1993). It seems to be expanding in its range on the island. SRDB II classified this as a vulnerable species, which differs from our field observation.

*Pteris tripartita* Sw. (Pteridaceae); vulnerable; Labrador Park, Binchan Rise P/G at Bishan, Upper Thomson Road, Admiralty Park, NUS. This widespread paleotropical species is a popular garden plant in Singapore and can be seen growing wide in several semi-shaded forest sites on the island. SRDB II classified this as an endangered species.

- Pteris vittata* L. (Pteridaceae); common.
- Pyrrosia angustata* (Sw.) Ching (Polypodiaceae); vulnerable; Sentosa, SBG, Bukit Timah NR. Among its congeners, *Pyrrosia angustata* is best identified by the large, discrete sori arranged in a single row along both sides of the leaf midrib. The species seems to be shrinking in range today based on herbarium specimen records. We agree with its placement as a vulnerable species in the SRDB II.
- Pyrrosia lanceolata* (L.) Farw. [syn. *P. adnascens* (Sw.) Ching, *P. varia* (Kaulf.) Farw.] (Polypodiaceae); common.
- Pyrrosia longifolia* (Burm.f.) C.V. Morton (Polypodiaceae); common.
- Pyrrosia piloselloides* (L.) M.G. Price [syn. *Drymoglossum piloselloides* (L.) C. Presl] (Polypodiaceae); very common.
- Salvinia molesta* D.S. Mitch. (Salviniaceae); invasive alien plants, commonly planted as an ornamental aquatic plant; NUS, Bishan Park Lotus Pond, Ang Mo Kio Town Garden West Pond, Labrador Nature Reserve Pond, Toa Payoh Town Park Pond, SBG.
- Selaginella ciliaris* (Retz.) Spring (Selaginellaceae); common.
- Selaginella plana* (Desv. ex Poir.) Hieron. (Selaginellaceae); this is a Malaysian species not native to Singapore, but commonly planted in city landscapes. The species was seen growing wide in forest groves in Bukit Brown Cemetery and Mt. Pleasant Road area. This is the first report of this cultivated species growing wild in Singapore.
- Selaginella willdenowii* (Desv.) Baker (Selaginellaceae); vulnerable; Mt. Pleasant Road, Thomson Road, Bukit Timah NR, Central Catchment. SRDBII classified it also as vulnerable. Because of its pretty bluish iridescent foliage, it is commonly planted in gardens. Its survival in Singapore island through human intervention is assured.
- Sphaerostephanos heterocarpus* (Blume) Holttum [syn. *Cyclosorus heterocarpus* (Blume) Ching] (Thelypteridaceae); endangered; Admiralty Park, Kent Ridge Park, Bukit Timah NR, Central Catchment. The numerous pairs of very small pinnae on the stipe of the frond is characteristic of this and other species in the genus.
- Sphaerostephanos polycarpus* (Blume) Copel. [syn. *Cyclosorus polycarpus* (Blume) Holttum]; (Thelypteridaceae); rather common and locally can be abundant; Tyersall forest, Bukit Brown Cemetery, Mandai Reservoir, Bukit Gombak, Khean Hock Road, Admiralty Park. The large fronds measuring to 2-3 meters long (**Figure 1B**) with several pairs of closely arranged and much reduced pinnae along the stipe of the frond are distinctive. In addition, the sori of this species are golden brown and elongate. SRDB II classified this as a vulnerable species which is

different from our observation.

*Sphaerostephanos unitus* (L.) Holttum [syn. *Cyclosorus unitus* (L.) Ching] (Thelypteridaceae); uncommon; Tyersall forest, Ridley/Loewen, Punggol forest, BBC Station at Turut Track.

*Stenochlaena palustris* (Burm.f.) Bedd. (Blechnaceae); common.

*Sticherus truncatus* (Willd.) Nakai (Gleicheniaceae); uncommon, but locally can be abundant; Admiralty Road, Mandai Road, Kent Ridge Park, Holland Village, Bukit Timah NR, Central Catchment. SRDB II classified this as a vulnerable species, a conclusion different from our observation.

*Taenitis blechnoides* (Willd.) Sw. [syn. *Taenitis interrupta* Hook. & Grev.] (Pteridaceae); common.

*Tectaria barberi* (Hook.) Copel. (Tectariaceae); uncommon to rare; Upper Thomson Road. Chong et al. (2009) reported this to be common in Singapore, but the species is rarely seen in urbanized parts of the island.

*Tectaria incisa* Cav. (Tectariaceae); an invasive alien plant; SBG, Tyersall Forest, Central Catchment. For a detailed discussion of this species, see Tan and Tan (2010).

*Tectaria singaporeana* (Hook. & Grev.) Copel. (Tectariaceae); uncommon, but locally abundant; Kent Ridge Park, SBG. Chong et al. (2009) reported this to be common in Singapore, but natural populations of this species are rarely seen in urbanized parts of the island unless in planted landscapes.

*Tectaria vasta* (Blume) Copel. (Tectariaceae); endangered; Labrador Park, Chua Chu Kang. The broad decurrent wing along the costa and stipe of the deeply lobed leaf is a good recognizing character of the species. SRDB II classified this as an endangered species which agrees with our observation.

## Acknowledgements

We are indebted to Dr. Alan J. Smith at the University of California in Berkeley for his valuable comments on the recent nomenclatural changes published on fern species and also in the latest system of fern family classification.

## References

- Sedaya A, Hovenkamp PH, Nootboom HP. 2012. Acrostichum. In: H.P. Nootboom et al., Pteridaceae subfamily Parkerioideae. *Flora Melesiana Series II* 4:137-144
- Chong KY, Tan HTW, Corlett RT. 2009. *A Checklist of the Total Vascular Plant*

- Flora of Singapore: Native, Naturalised and Cultivated Species*. Raffles Museum of Biodiversity Research, NUS (e-publication)
- Corlett RT, Turner IM. 1997. Long-termed survival in tropical forest remnants in Singapore and Hong Kong. In: Laurance WF, Bierregaard RV (eds). *Tropical Forest Remnants, Ecology, Management and Conservation of Fragmented Communities*. University of Chicago Press. Pp.333-346
- Davison GWH, Ng PKL, Ho HC. 2008. *The Singapore Red Data Book, Threatened Plants and Animals of Singapore*. Second Edition. Nature Society (Singapore)
- Holtttum RE. 1968. *Flora of Malaya, vol. II (Ferns)*. Second edition. Government Printing Office, Singapore
- Hoshizaki BJ, Moran RC. 2001. *Fern Grower's Manual*. Timber Press, Oregon
- Hovenkamp PH, Miyamoto F. 2005. A conspectus of the native and naturalized species of *Nephrolepis* (Nephrolepidaceae) in the world. *Blumea* 50:279-322
- Johnson A. 1977. *A Student's Guide to the Ferns of Singapore Island*. Second Edition. Singapore University Press
- Liu S-Z. 2002. *Biodiversity and conservation of pteridophyte biodiversity of Bukit Timah Nature Reserve* (B.Sc Honours Thesis). National University of Singapore
- Ng PKL, Corlett RT. 2011. Biodiversity in Singapore: an overview. In: Ng PKL, Corlett RT, Tan HTW (eds). *Singapore Biodiversity, an Encyclopedia of the Natural Environment and Sustainable Development*. Editions Didier Millet, Singapore. Pp.18-25
- Parris BS, Latiff A. 1997. Towards a pteridophyte flora of Malaysia: a provisional checklist of taxa. *Malayan Nature Journal* 50: 235-280
- Piggott AG. 1988. *Ferns of Malaysia in Colour*. Tropical Press Sdn. Bhd., Kuala Lumpur
- Tan BC, Tan JSY. 2010. A spreading alien fern in Singapore - *Tectaria incisa* Cavanilles. *Gardenwise* 35:4-5
- Tan BC, Ng A. 2012. Three new records of little known Singapore ferns. *Nature Watch* 20(3):2-7
- Tan JSY. 2010. *Pteridophyte diversity of Central Catchment Nature Reserve: Past, Present and Conservation* (B.Sc Honours Thesis), National University of Singapore
- Turner IM. 1993. The names used for Singapore plants since 1900. *Gardens Bulletin Singapore* 45:1-287
- Turner IM. 1994. The taxonomy and ecology of the vascular plant flora of Singapore: a statistical analysis. *Botanical Journal of Linnean Society* 114:215-227
- Turner IM, Chua KS. 2011. *Checklist of the Vascular Plant Species of the Bukit Timah Nature Reserve*. Raffles Museum of Biodiversity Research (e-publication)

- Turner IM, Corlett RT. 1996. The conservation value of small, isolated fragments of lowland tropical rain forest. *Trends in Ecology & Evolution* 11:330-333
- Turner IM, Tan HTW, Wee YC, Ibrahim A, Chew PT, Corlett RT. 1994. A study of plant species extinction in Singapore: lessons for the conservation of tropical biodiversity. *Conservation Biology* 8:705-712
- Wee YC. 1995. Rain Forest in the City: Bukit Timah Nature Reserve Singapore: Pteridophytes. *Gardens' Bulletin (Singapore) Supplement* 3:61-69
- Williams NSG, Schwartz MW, Vesik PA. 2009. A conceptual framework for predicting the effects of urban environments on floras. *Journal of Ecology* 97:4-9