Conservation Priorities for Tree Ferns (Cyatheaceae) in Sri Lanka

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(Manuscript received 6 December 2010; accepted 25 March 2011)

ABSTRACT: Diversity, phytogeography and conservation status of Sri Lankan tree-ferns are discussed in this paper. The family Cyatheaceae is represented by eight taxa (seven species and one doubtful variety) in Sri Lanka with a high rate of endemism of 75%. Apart from Cyathea walkerae and C. gigantea, the other species are restricted to geographically isolated areas in the country with limited population sizes. Fortunately, all Sri Lankan species of Cyathea occur within the protected areas of the wet zone. However, ex situ conservation is limited to C. walkerae and C. crinita at Botanic Gardens in Hakgala. Despite the family being listed in Annex II of CITES, its species have not yet been assessed in Sri Lanka for the Red Listing criteria. Identification of the nature and level of threat to Sri Lankan Cyathea species is therefore a major priority, followed by the monitoring of populations in situ in protected areas in the wet zone. Ex situ conservation of rare species and cultivation of Cyathea species from spores have also been identified as priority areas. A strong programme should be developed with the National Herbarium to explore little known forest patches in the wet zone to enhance our knowledge of Cyathea species in Sri Lanka. Such information will provide a strong basis for preparing a conservation and management plan for tree-ferns in the country.

KEY WORDS: Conservation priorities, Cyatheaceae, endemism, Sri Lanka, tree-ferns.

INTRODUCTION

The region including Sri Lanka and the Western Ghats of India is one of 34 global biodiversity hotspots identified in the world due to exceptional species diversity combined with a high level of endemism and multiple threats faced by the natural ecosystems (Mittermeier et al., 2005). In Sri Lanka, a considerable level of information is available on the composition and ecology of the country’s angiosperms among the flora and on the fish, amphibians, birds, reptiles and mammals among the fauna (see Bambaradeniya, 2006; Dassanayake and Clayton, 1995-2000; Dassanayake and Fosberg, 1980-1991; Dassanayake et al., 1994; IUCN, 2007; MFE, 1999; NSF, 2000). Several national and international publications also exist on the pteridophyte flora of the country, including checklists, description of species, families and cytology. Currently, about 348 Pteridophyte taxa from 30 families have been recorded from Sri Lanka (Shaffer-Fehre, 2006). Among Asian countries, Sri Lanka is second only to Taiwan in terms of the number of pteridophyte species per 10,000 km² (Ranil et al., 2008a). However, more than 30 pteridophyte species have not been recorded from Sri Lanka during the last and present century (Sledge, 1982) and as many as 90 species are considered as threatened (MFE, 1999). As an example of the decline, a recent study conducted by Ranil et al. (2006) revealed that while 29 taxa were recorded from Udawattakele forest reserve in Sri Lanka during the period 1888-1954, only nine species were recorded in 2006. Although many pteridophyte species have been reported as threatened in south Asia for many reasons (see, for example, Chandra et al., 2008), none of the pteridophyte species from Sri Lanka is assessed for the national Red Listing criteria (IUCN, 2007). Many previous studies and collections were conducted mainly during the colonial era, followed by the detailed cytological and monographic work of Manton and Sledge (1954) and Sledge (up to Seldge, 1982). More recently, various Sri Lankan workers have published on ferns, culminating in the publication of the Revised Handbook of the Flora of Ceylon (Shaffer-Fehre, 2006).

The family Cyatheaceae is one of the most interesting families among the pteridophytes due to their striking morphology and wide geographical distribution combined with pronounced local endemism (Tryon and Gastony, 1975). The family consists of about 500 species worldwide with diversity centers in tropical rain forests (Conant et al., 1996; Tryon and Gastony, 1975). It is represented in Sri Lanka by what is often treated nowadays as a single genus, Cyathea, which includes seven species and one doubtful variety (Holttum, 1965; Ranil et al., 2010a; Ranil et al., 2010b; Shaffer-Fehre, 2006; Sledge, 1982). The present paper focuses on reviewing the diversity, phytogeography and...
conservation status of the tree-ferns of Sri Lanka providing conservation priorities and required further studies.

**METHODOLOGY**

We have reviewed published and unpublished literature to date and studied the herbarium specimens of Cyatheaceae at the National Herbarium of the Royal Botanic Gardens, Peradeniya. Specimens from foreign herbaria listed by Philcox (2006), who cited 172 specimens, were also used. Specimens with information on the locality of collection, date, collector and herbarium have been used here for identification of the past distribution of each species. New information on the present distribution was also obtained from a series of studies and collections carried out by the authors throughout the country. Ferneries of the Royal Botanic Gardens, Peradeniya located in mid country wet zone, the Botanic Gardens, Hakgala located in the upcountry wet zone and the Henarathgoda Botanic Gardens, Gampaha located in low country wet zone of Sri Lanka were also observed to identify the presence of mature Cyathea collections and their status. Occurrence of Cyathea species in surrounding areas of Sinharaja and Kanneliya forests and Nuwara Eliya area was also observed to identify the distribution of populations outside protected areas (i.e. private lands etc). The taxonomic classification followed in this study was based on that utilised by Philcox (2006) and Sledge (1982), who followed Holttum (1965) in adopting a more conservative approach of not splitting Cyathea into several genera. We analyzed taxon diversity, level of endemism and the past and present distribution of taxa, for five provenances and 10 administrative districts within Sri Lanka. Conservation priorities are suggested based on information on distribution, population size and existing and potential in situ and ex situ conservation measures.

**RESULTS AND DISCUSSION**

Diversity and taxonomic status of Cyathea taxa in Sri Lanka

According to Holttum (1965), the genus Cyathea in Sri Lanka represented by six taxa (five species and one doubtful variety). Sledge (1982) also listed six taxa but omitted the variety as of less taxonomic importance and included a suspected natural hybrid. The recent revision of the Cyatheaceae of Sri Lanka by Philcox (2006) also suggested six taxa (five species and one doubtful variety) but omitted the suspected hybrid. However, Ranil et al. (2004) and in continued studies, collected a considerable number of specimens of the previously mentioned suspected natural hybrid from Kanneliya and Sinharaja forests and confirmed its taxonomic status as a species, Cyathea sledgei Ranil et al. (Ranil et al., 2010a). Recently, Ranil et al. (2010a) described a new species of Cyathea, C. srilankensis Ranil, from Sri Lanka. However, the doubtful variety was not found even in recent investigations by authors. It is therefore concluded that the family Cyatheaceae is represented by eight taxa (seven species and one dubious variety) in Sri Lanka (Table 1). Geographical isolation combined with antiquity and the wide range of climatic, elevational and edaphic variation has been suggested to be the main reasons for the exceptionally high level of endemism (75% of the known diversity) in this family in Sri Lanka.

Morphological Clusters of the Sri Lankan Taxa

Sri Lanka contains some morphologically unique tree fern species. Cyathea sinuata (Fig. 1A) is the only species which has simple leaves, out of about 500 known Cyathea species world wide (Kramer, 1990). Cyathea sinuata tree trunk grows up to 2 m, usually erect, but occasionally slant and trailing on ground. Diameter of trunk is 1.4-1.6 cm, and the trunk is entirely covered by persistent dead petiole bases. C. sinuata can be easily distinct from other species having 45-55 cm long and 2.4-3.2 width simple leaves and 1-3 pairs of indusiate sori in beneath of the 1-3 pairs of veins.

C. hookeri (Fig. 1C) grows up to 1-3.6 m. Lamina (90-120 × 21-28 cm) crowded at the apex of the stem. It can distinguish form other Sri Lankan tree fern species which having simply pinnate lamina with, 5-14 cm long stipe, shallowly lobed pinnae, lobe to 1/4-1/3 towards costa with 3-4 pairs of simply pinnate veins. It is a relatively rare species and limited to a few isolated forest patches in Sinharaja and Kanneliya lowland rain forests, where it is associated with C. simata. It can be immediately identified and distinguished from other taxa by its unique, simply pinnate, strap-shaped fronds.

C. sledgei (Fig. 1D) is show intermediate characters of C. simata and C. hookeri. It grows up to 0.9-1.35 m and tree trunk entirely covered by persistent dead petiole bases. The unique character of C. sledgei is 60-90 cm long, deeply lobed, pinnatifid lamina. It is further differed from other species having once forked, 8-10 pairs of veins in each segment and 8-10 pairs of sori in each segment in two rows on either side of the costa.

Although little is known of the genetic diversity of any Cyathea species in Sri Lanka, a cluster analysis has been carried out for C. simata and its close relatives using twenty-five morphological characters, including C. sledgei and C. hookeri. In contrast to the clusters for C. hookeri and C. sledgei, C. simata showed a wide range of morphological diversity for some characters and two main subgroups were also identified, which suggests...
that two morphotypes of *C. sinuata* appear to exist (Ranil et al., 2009). These two morphotypes are often growing as separate populations. The two can be distinguished by their leaf characters, such as leaf width, and length, margins and base, number of veinlets, number of sori and their arrangement (Fig. 1B). Further study is required to investigate whether these forms are constant, or exhibit phenotypic plasticity under different conditions and how much they might overlap.

A new tree-fern species was recently described as *C. srilankensis* (Fig. 1E) by Ranil et al. (2010a) from the Sinharaja forest. Its trunk is erect and grows up to 2.1 m in height and 5 cm in diameter. Lamina is large (130-202 × 40-65 cm) with 18-28 cm long chestnut coloured petiole. Even though it is some what similar to *C. hookeri*, *C. srilankensis* deviated from having pinnate-pinnatifid leaves, deeply lobed pinnae sinus to the costa, free pair of basal pinnul and costa with densely hairy in adaxially.

*C. walkerae* (Fig. 1F) is endemic to Sri Lanka, and is distributed over a wide range of climatic and geographical areas there. It was also reported from south India by Nayar and Geevarghese (1993), but according to Fraser-Jenkins (2008a), this was a misidentification for the south Indian species, *C. nilgirensis* (Holttum) R.M. Tryon. *C. walkerae* grows in pockets, mainly along streams in secondary forests. It has relatively large tree trunk with 2.5-5 m tall and (5-)8-20 cm diameter. Tree trunk covered by persistent bases of stipes with 30-40 cm in long. Lamina bipinnate and it is deviated from having indusiate sori from other bipinnate tree ferns in Sri Lanka. *C. walkerae var. tripinnata* Hook. & Baker is known only from the type specimen at the Kew (C.P. 1398) and was recorded by Thwaites (1886) without citing a locality. There have been no further records of it since and more exploration, study of the range of variation in the species, and examination of the type specimen are required. Its taxonomic status and whether it should be recognized nomenclaturally are unclear and it might perhaps be better understood as merely part of the range of variation in the species, not or hardly worthy of nomenclatural recognition. It is deviated from usual *C. walkerae* by secondary pinnae up to 15 × 3 cm, largest with several pairs of deeply-lobed, tertiary lobes.

*C. gigantea* (Fig. 1G) occurs commonly in many south and southeast Asian countries. It has 1-1.5 m long tree trunk with 8-10 cm diameter. About 160 × 100 cm bipinnate lamina crowded at the top of the trunk. Veins distinct on both surfaces, each lobe of secondary pinnae furnished with mid-vein with 4-6 pairs of lateral venules. Sori are 3-4.5 pairs and exindusiate. It can be distinguished easily from other species by its inverted “V” shaped soral arrangement in each pinnule lobe. Populations known until now in Sri Lanka are limited to only a few locations in Central province. But the authors identified a single individual from Kanneliya forest located in the southern part of the island. However, there is insufficient information concerning the status of its distribution, habitat and populations and collections of *C. gigantea* are too scarce due to the lack of exploration of many wet zone forests.

The magnificent tree-fern, *C. crinita* (Fig. 1H), is the largest tree fern in Sri Lanka and it grows up to 12 m in
height and 12-25 cm diameter. It appears to be confined to Nuwara Eliya district in high altitude areas and prefers very cool climatic conditions. It is the only *Cyathea* species in Sri Lanka which has leaf scars visible on the main trunk while the trunks of other species are totally covered by persistent leaf petiole bases. It is distinct from other Sri Lankan tree ferns in having long stipe (40-85 cm), and the 3.5-4 cm long, 2-5 mm wide petiole scales with relatively large lamina (100-200× 50-100 m). It also has distinctive, very dense, pale and narrow scales at the growing apex of the trunk. *C. crinita* is relatively rare due to its restricted distribution, but is locally common where it does occur.

**Phytogeographical relations**

Different suggestions have been proposed with respect to the affinities of Sri Lankan tree-ferns with other regions. Of the species confined to the Sri Lankan/south Indian, or "Hindulankan" region (see Fraser-Jenkins, 2008b), Holttum (1981) suggested an affinity of some species with African elements (e.g. an affinity of *C. hookeri* and *C. srilankensis* with *C. humilis* Hieron. and *C. schliebnii* (Kuhn) Domin from Tanzania and Kenya (see also Ranil et al., 2010a). Such a disjunct pattern might have resulted from an ancestral species that was widespread across the ancient continent of Gondwana (Strahler and Strahler, 2005) and there is a known African element of fern species in Sri Lanka and south India. However, the African affinity of *C. hookeri* and *C. srilankensis* is probably rather doubtful, due to generally strong development of local endemism and lack of geographical overlap among tree-ferns (Tryon and Gastony, 1975). Furthermore, based on molecular study of *C. hookeri*, *C. sinuata* and *C. walkerae*, Janssen et al. (2008) have subsequently suggested that Sri Lankan tree-ferns form a monophyletic group not closely related to African tree-ferns, though this may require further study and consideration. The phylogenetic position and phytogeographical affinities of the "Hindulankan" *Cyathea* species in Sri Lanka thus remain to be determined based on both genetic and other information. As would be expected from general Sri Lankan pteridophyte phytogeography, one other species, *C. gigantea* is a southeast Asian (Malesian) element, widespread in India and southeast Asia.

**Distribution and collection of tree ferns in Sri Lanka**

During the period of 1844 – 2004 (excluding recent and ongoing studies), about 215 specimens of *Cyathea* species have been collected in Sri Lanka (Table 2). Nearly 90% of them were collected by foreign pteridologists during the colonial era (pre 1947) and nearly 50% are deposited herbaria outside Sri Lanka (Table 2). The type specimens of *C. hookeri*, *C. walkerae*, *C. walkerae var tripinnata*, and *C. crinita* are deposited at Kew, and the type of *C. sinuata* is at Edinburgh. The types of *C. sledgei* and *C. srilankensis* are deposited at the National Herbarium, Peradeniya.

The numbers of previous (before 2004) and new (after 2004) specimens of tree-ferns from different provinces of Sri Lanka are given in Table 3. In the past, the majority of specimens of *Cyathea* species were collected from Central (42%), Sabaragamuwa (27%) and Southern (22%) provinces. The majority of new specimens collected during the present study are also from these regions. These evidences indicate that lowland, sub montane and montane rain forests of Sri Lanka provide the most favorable habitats for tree-ferns. The number of new specimens we collected was limited due to collection of only a single specimen from each locality. The present specimen collection also indicates that the paucity of occurrence of *Cyathea* species in new localities.

According to previous and present observations, *C. sinuata*, *C. hookeri* and *C. sledgei* are restricted to a few isolated pockets of two lowland rain forests bordering Southern and Sabaragamuwa provinces, where the elevation ranged from 110 – 410 m altitude. Interestingly, new species were observed in the same area (Ranil et al., 2010a, 2010b). Of the three taxa, *C. sinuata* was observed to be the most abundant with a high population density (1,100 plants/100 m²), whereas *C. hookeri* was of low density (14 plants/100 m²) (Ranil et al., 2009). Two plant of the *C. sledgei*, was originally collected by F.

### Table 2. Specimen collection of Cyatheaceae from Sri Lanka from 1844 to 2004.

<table>
<thead>
<tr>
<th>Species</th>
<th>BM</th>
<th>E</th>
<th>LIV</th>
<th>K</th>
<th>P</th>
<th>PDA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>C. sinuata</em></td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>12</td>
<td>4</td>
<td>10</td>
<td>36</td>
</tr>
<tr>
<td>2. <em>C. hookeri</em></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>3. <em>C. sledgei</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>4. <em>C. srilankensis</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>5. <em>C. walkerae</em></td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>34</td>
<td>6</td>
<td>21</td>
<td>64</td>
</tr>
<tr>
<td>6. <em>C. walkerae var tripinnata</em></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>7. <em>C. crinita</em></td>
<td>2</td>
<td>4</td>
<td>-</td>
<td>9</td>
<td>4</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>8. <em>C. gigantea</em></td>
<td>1</td>
<td>6</td>
<td>-</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8</td>
<td>19</td>
<td>2</td>
<td>72</td>
<td>19</td>
<td>95</td>
<td>215</td>
</tr>
</tbody>
</table>
Table 3. Before 2004 and after 2004 collections of Cyathea species in the different provinces and administrative districts of Sri Lanka.

<table>
<thead>
<tr>
<th>Species</th>
<th>Central</th>
<th>Southern</th>
<th>Sabaragamuwa</th>
<th>Uva</th>
<th>Western</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>1. C. sinuata</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>2. C. hookeri</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>3. C. sledgei</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>4. C. walkerae</td>
<td>13</td>
<td>-</td>
<td>12</td>
<td>14</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5. C. walkerae var. tripinnata</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. C. srilankensis</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. C. crinita</td>
<td>1</td>
<td>-</td>
<td>11</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8. C. gigantea</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>*</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
<td><strong>2</strong></td>
<td><strong>28</strong></td>
<td><strong>30</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>

A = Kandy; B = Matale; C = Nuwara Eliya; D = Galle; E = Matara; F = Rathnapura; G = Kegalle; H = Badulla; I = Monaragala; J = Kalutara district.

* indicates that the species was observed, but specimens were not collected. Italics numbers represent collections before 2004 and normal numbers represent collections after 2004. Thirty four specimens collected before 2004 had no locality information and are thus excluded from the table.

Ballard and W.A. Sledge from “Panagala” (close to the Kanneliya forest reserve) in 1951 and deposited at Kew (FB 1548 and 908). It has been identified it as a suspected hybrid between C. sinuata and C. hookeri. Fifty years after this single collection, Ranil et al. (2004) and in recent further studies by the authors have collected more than 30 more specimens of this species from both Kanneliya and Sinharaja forests. This formerly presumed hybrid was confirmed as a new species and named Cyathea sledgei Ranil et al. (Ranil et al., 2010b). Present observations reveal that this species occurs as a few number of individuals often associated with C. sinuata and C. hookeri (not more than 1 plant/100 m²). The distribution of C. srilankensis is limited to few localities in the Sinharaja forest at an elevation of about 480 m. The population of this species, as presently known, is restricted to limited number of individuals on stream bank and roadside bank in the Sinharaja forest.

The endemic C. walkerae is the most widespread and common tree-fern species in Sri Lanka. It has a wide altitude range from 60 to 1,525 m elevation, and covers lowland, sub-montane and montane forests. Based on observations by the authors, the populations from Rathnapura district in Sabaragamuwa province were the most substantial. C. walkerae var. tripinnata is known only from the type specimen at Kew. As no records are available thereafter it is difficult to assess it and reach a conclusion and more exploration is needed to attempt to refine it for further study.

Even though C. gigantea is of common occurrence in south and southeast Asian countries, populations in Sri Lanka are mainly limited to a few localities in Central province at up to 1,600 m elevation. According to previous records (Table 3), it is limited to medium-high elevation in Central province. However, there is a recently collected a single specimen of it from Blackwood forest of Badulla district, at an elevation of 1,525 m. The authors also collected it from Kanneliya forest in the southern part of the country at an elevation of 92 m. This shows that the presumed restriction of this species to higher elevations was merely due to lack of exploration and inadequate study and might apply to certain other plants of a similar category.

C. crinita is common to both Sri Lanka and south India and its distribution is limited to cool montane areas at elevations around 1,500-2,000 m. Nearly, all the Sri Lankan records of C. crinita are limited to Nuwara Eliya district of Central province, with only one other from Kandy district. C. crinita has been classified as of the "at risk" category in India (Chandra et al., 2008). The population in Sri Lanka is therefore of global importance. Although there are records of the occurrence of C. crinita in Sinharaja forest (at 529 m elevation) in Southern province, collected by Mueller-Dombois and Balakrishna, our current studies did not confirm the presence of C. crinita in Sinharaja forest. It is a misidentification of C. walkerae as C. crinita. No C. crinita were found in recent intensive survey on the pteridophyte flora of Sinharaja and long term monitoring of C. sinuata and C. hookeri populations there.

The distribution of all the Cyathea taxa in Sri Lanka
Conservation priorities and further research

As with many other pteridophytes, detailed information on tree-ferns in Sri Lanka is not readily available. Limited information is a major barrier to conservation and management of these species. In Sri Lanka, only C. sinuata and C. hookeri have been designated as locally threatened species under the Fauna and Flora Protection Ordinance (FFPO). Despite the family being listed in Annex II of CITES, no member of the family has been assessed for red listing. It is thus an immediate requirement to identify the levels of threat to tree-ferns and categorize them according to red listing criteria. Such information provides a strong base to prepare conservation and management guidelines and plan for the protection of tree-ferns in Sri Lanka.

Populations of almost all Cyathea species occur in protected areas in the wet zone of Sri Lanka. In situ conservation in natural forests is therefore an attainable priority for those tree-fern species. However, our preliminary study of the distribution of the species and their population sizes shows that further observation and monitoring of existing populations are required for effective conservation. This is mainly because of the restricted number of individuals observed in several species. Furthermore, recent exploration has revealed occurrences of previously undetected populations of tree-ferns, and even a new species. An island-wide survey of all wet zone forests is therefore of high priority in order to explore further the availability of different species and their population sizes, especially in protected areas.

At present, ex situ conservation is limited only to C. walkerae and C. crinita, at the Botanic Gardens, Hakgala. No ex situ collection of living Cyathea species is available at the Royal Botanic Gardens, Peradeniya or Henarathgoda Botanic Gardens, Gampaha. Therefore, collection of germplasm and the establishment and propagation of the various taxa at national and international Botanic Gardens is urgently required as a supplementary conservation measure for Sri Lankan Cyathea species. The urgency of these measures is because most species are restricted to few or very few individuals and though protected, many forests are already fragmented in the wet zone area and are being subjected to increasing human disturbance.

Utilization of Cyathea species is not properly regulated in Sri Lanka. Illegally use of the trunks of C. walkerae and C. crinita as growth media for orchid cultivation is frequently found. C. crinita is also used as an ornamental landscaping plant in Nuwara Eliya District. In almost all cases the plants are collected from the wild, potted and planted or sold. It is therefore important to study and regulate this or other ethnobotanical uses of tree-ferns for their sustainable utilization with minimum disturbance to natural populations. For this purpose research into cultivation of the species is an essential requirement. No previous research has been conducted locally on spore germination and subsequent development of sporophytes on artificial media to facilitate cultivation. However, a recent paper by Ranil et al. (2008b) provides encouraging results on effective spore germination media, gametophyte morphology and the successful raising of sporophytes from gametophytes and their transfer to general growth media in C. walkerae. Public awareness programs on the conservation and sustainable utilization of tree-ferns should be initiated promoting in situ and ex situ conservation.

CONCLUSIONS

Sri Lanka contains eight taxa of tree-ferns, of which 75% are endemic to the country. Lowland rainforests and montane forests located in the wet zone harbour most of the Cyathea species but populations of many species are restricted to small areas in these forests. The survival of tree-ferns in Sri Lanka depends primarily on the effective in situ conservation and monitoring of the country’s remaining fragments of rainforests and inclusion of species under ex situ programmes for propagation and re-establishment, utilizing the resources of Botanic Gardens. Recent new findings indicate the biological significance and diversity of Sri Lankan Cyathea species and the urgent necessity of further exploration of surviving wet zone forests.

ACKNOWLEDGEMENTS

The authors are indebted to the Herbarium staff of the National Herbarium of Sri Lanka for their generous support. We also thank Dr. Monika Shaffer-Fehre, Herbarium, Royal Botanic Gardens, Kew, London, UK, Mr. Tom Stuart, Coordinator of the American Fern Society and Mr. W.P. de Winter, Wageningen University and Research Centre, Netherlands, for providing important information on the family Cyatheaceae. The authors wish to express their gratitude to the Forest Department, Sri Lanka for granting permission to carry out this study in the Sinharaja and Kanneliya forest reserves.
LITERATURE CITED


斯里蘭卡樹蕨（桫欏科，Cyatheaceae）的保育優先性

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(收稿日期: 2010 年 12 月 6 日；接受日期: 2011 年 3 月 25 日)

摘要：本文探討斯里蘭卡樹蕨的多樣性、植物地理和保護現狀。斯里蘭卡的桫欏科由八個類群（七種類及一可疑變種）所組成，具有 75% 的高特有率。除了 Cyathea walkerae 和 C. gigantea 外，其他種類在該國均為地理上孤立分布的有限族群。所幸，所有斯里蘭卡的桫欏屬植物均出現在濕地保護區的範圍內。然而，目前已進行移地保育的物種卻相當有限，僅 C. walkerae 和 C. crinita 被保育於 Hakgala 的植物園中。儘管該科已列入華盛頓公約附錄 II 物種，在斯里蘭卡其各種類尚未依紅皮書的標準加以評定。因此，鑑定斯里蘭卡桫欏屬植物的特性及其受威脅程度為主要的優先事項，其次為監測分布於濕地保護區的種群；移地保育珍稀的桫欏屬種類，並以孢子進行培養也是優先的保育措施。斯里蘭卡當局應發展一個強固的計畫與國家植物標本館合作，探索在森林區塊中鮮為人知的濕地地帶，以提升對桫欏屬植物的知識。這些資料將為該國在樹蕨保育及管理計畫的準備工作提供有力的依據。

關鍵詞：保育優先性、桫欏科、固有性、斯里蘭卡、樹蕨。

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