A note on the taxonomy, ecology, distribution and conservation status of the ferns (Pteridophytes) of Rapa Nui (Easter Island)

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Ferns are an important component of the flora of the remote islands of the Pacific, especially on Rapa Nui (Easter Island), with 16 native species (i.e., 35% of its existing vascular flora) including four island endemics. In this paper, their former and new valid scientific names, their distribution, and abundance are reassessed based on previously published data and recently conducted field surveys (2008-2012). All of the fern species can be considered threatened because of the past and current destruction or modification of their natural habitats, over-grazing by introduced ungulates (horses, cattle, sheep, and goats), fires, and invasive alien plants. Moreover, four species collected in the early 20th century have not been observed since, and might be considered extinct. Habitat restoration projects and conservation plans for the most endangered fern species (including propagation in plant nurseries) should be urgently implemented to conserve the remaining native fern diversity of the island before it is completely lost.

Los helechos son un componente importante de la flora de las islas aisladas del Pacífico, especialmente de Rapa Nui (Isla de Pascua). En Rapa Nui, hay 16 especies indígenas (35% de la flora vascular actual), de las cuales cuatro son endémicas. En este artículo, reviso sus nombres científicos pasados y actuales, así como su distribución y abundancia, basándonos en los trabajos ya publicados y en prospecciones recientes de terreno (2008-2012). Todos los helechos de la isla pueden ser considerados amenazados debido a la destrucción o modificación, en el pasado y en la actualidad, de sus hábitats naturales, al sobrepastoreo por el ganado introducido (caballos, bovinos, ovejas y cabras), a los incendios, y a las plantas introducidas invasoras. Además, cuatro especies recolectadas al principio del siglo XX no se han visto desde entonces, por lo que se deduce que probablemente están extintas. Proyectos de restauración de hábitat y planes de conservación para las especies más amenazadas (incluyendo propagación en vivero) deben ser iniciados con urgencia para preservar la diversidad restante de helechos de la isla, antes de que desaparezca completamente.

Introduction

The importance of ferns in the Pacific Islands and Rapa Nui

For the past century, the extinct and extant native flora of Rapa Nui (Easter Island) has received a great deal of attention, the flowering plants (Angiosperms) being the most studied taxonomic group (Flenley 2001; Guillaumin et al. 1936; Orliac 1998; Rull et al. 2010; Skottsberg 1921; Zizka 1991). Many papers have been published on woody species, particularly the "toromiro" tree (*Sophora toromiro*, Fabaceae), a species extinct in the wild since the 1950s (MacKinder & Staniforth 1997; Maunder et al. 2000; Schlätzer 1965), and the extinct large palm *Paschalococos disperta* (or *Jubaea sp.*, Arecaceae) whose seeds and phytoliths have been found in archaeological deposits (Delhon & Orliac 2010; Dransfield et al. 1984; Mieth & Bork 2009). Despite extensive studies conducted on the fossil flora based on palynology (Flenley & King 1984; Flenley et al. 1991; Mann et al. 2008) and wood charcoal or anthracology (Orliac 1998, 2000), very little is said by these authors about the past and current fern flora. This may be explained by the fact that they are less charismatic than flowering plants, but also by the difficulty in identifying them at the species and even the genus level using fossil spores (M. Prebble, pers. comm. 2013).

However, ferns (Pteridophytes) and their allies (Lycophytes) form an important component of the native vascular flora in the Pacific Islands, especially in small and remote Oceanic islands. Indeed, their microscopic spores can be dispersed over long distances, allowing them to colonize isolated islands (Carlquist 1974). For

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Table 1. Comparison of the vascular flora including the fern flora in selected island groups or islands in the Pacific Ocean.

Island or island group	Area (km²)	Native vascular plants	Native ferns and fern allies (% total flora)	Endemic ferns (% endemism)	Source (ferns only)
Hawai'i	16,880	966	161 (16.7 %)	114 (70.8 %)	Palmer, 2003
Fiji	18,270	1302	325 (24.9 %)	48 (14.8 %)	Brownsey & Perrie 2011
Marquesas (French Polynesia)	1,050	331	118 (35.6%)	-	Lorence & Wagner 2011
Mo'orea, Society Is. (French Polynesia)	135	300	122 (40.7%)	-	Nitta et al. 2011
Austral Is. (French Polynesia)	148	202	81 (40.1 %)	15 (18.5 %)	Florence et al. 1995
Rapa Nui	166	46	16 (34.8 %)	4 (25 %)	This study
Gambier Is. (French Polynesia)	46	72	19 (26.4 %)	9 (47.3 %)	Florence et al. 1995
Pitcairn Islands	45.2	86	23 (26.7 %)	2 (8.7 %)	Florence et al. 1995

example, ferns represent between 16% and 41% of the flora of single islands or island groups (archipelagos) in the Pacific Ocean with an endemism rate reaching 50% to 70% in some of the most isolated islands, such as Hawai'i or Mangareva in the Gambier Archipelago (French Polynesia) (Table 1).

With a total of 16 native species, which represents 35% of the current vascular flora, including four island endemics (one endemic variety not counted) (see Table 1), the fern flora of the small island (166km²) of Rapa Nui is of great importance. Thus, this taxonomic group should not be neglected in palaeo- or neo-ecological studies and should be considered carefully in conservation and restoration projects.

Objectives

Being involved in a project on ecological restoration on Rapa Nui since 2008 that includes both the monitoring of native species in pilot sites (Rano Kau, Rano Raraku, Ovahe) after alien weed control, and their propagation and cultivation for future reintroduction or population reinforcement, I was faced with the challenge of identifying several native ferns. This was made difficult by the fact that different names were used by different authors during the past century. In the absence of a detailed analysis of a modern fern flora on the island (only a species list was published by Godoy & Figueroa in 1989, whereas the angiosperms were thoroughly treated by Zizka in 1991), the absence of a fern collection (or herbarium) on the island, and the difficulty of access to specimens and types in the Pacific region, Chile, Europe, or the US, I became interested in not only their taxonomical identification, but also their conservation status. All the available literature published on ferns that are present on the island were consulted, and were supplemented by field surveys during four one-week field trips conducted on the island between 2008 and 2012.

The main aims of this paper are: (1) to propose a list of native fern species for the island with valid, or at least accepted, scientific names, supplemented with all the corresponding names used in published papers, reports and books by past authors; (2) to determine the current conservation status for most species according to recent field observations, compared to past surveys and studies; and (3) to document the alien species that were intentionally introduced in recent times mostly as garden ornamentals, but with a risk of naturalization in the future. My hope is that this work will be useful for research scientists, resource managers, and students, as well as the Rapa Nui local authorities and community, and that it will stimulate further species conservation plans and habitat restoration projects.

Results

There are no fern specimens represented in the first plant collections from Rapa Nui made in 1774 by the botanists Johann Reinhold and Georg Forster during James Cook's second expedition around the world (Nicolson & Fosberg 2004). Ferns were first sampled by A. Agassiz during the *Albatross Expedition* in 1904 (listed and described by Christensen & Skottsberg 1920), then by Francisco Fuentes and Walter Knoche in 1911 (Fuentes 1913), by Carl Skottsberg in 1916-1917 (Christensen & Skottsberg 1920; Skottsberg 1921) and by the *Mission Franco-Belge* between 29 July 1934 and 3 January 1935 (Guillaumin et al.

Table 2. Biogeographical status and distribution range of the 16 extinct and extant ferns of Rapa Nui (by alphabetical order of genus name).

Scientific name	Biogeographical status	Distribution range (various sources)
Asplenium polyodon var. *squamulosum*	Endemic variety	Asia, tropical Australia, New Zealand, Polynesia at species level
Asplenium obtusatum var. *obtusatum*	Indigenous	West coast of South America, Australia, New Zealand
Blechnum paschale	Island Endemic	
Davallia solida	Indigenous	Pan-tropical
Diplazium fuenzalidae	Island Endemic	
Dryopteris karwinskyana	Indigenous	Tropical America
Elaphoglossum skottsbergii	Island Endemic	
Haplopteris ensiformis	Indigenous	Tropical Asia, Malaysia, Australia, Polynesia
Microlepia strigosa	Indigenous	South-East Asia, Sri Lanka, Japan, Polynesia
Microsorum parksii	Indigenous	Pacific
Ophioglossum lusitanicum subsp. *coriaceum*	Indigenous	Australia, New Zealand, New Caledonia, Bolivia, Chile
Ophioglossum reticulatum	Indigenous	Pan-tropical (South East Asia, New Guinea, Philippines, Melanesia, Polynesia, Mascarenes)
Polystichum fuentesii	Island Endemic	
Pneumatopteris costata var. *hispida*	Southeastern Polynesia Endemic	Rarotonga (Cook Is.), Pitcairn (Pitcairn Is.)
Psilotum nudum	Indigenous	Pan-tropical
Thelypteris interrupta	Indigenous	Pan-tropical

1936). Later, C. Skottsberg (1953, 1956) added some new species and revised some names. "Official" lists of ferns of Rapa Nui were then published (Baeza et al. 1998; Godoy & Figueroa 1989; Looser 1958) but without creation of any plant collections during the past few decades (Table 2).

Taxononomical changes and valid scientific names

A small number of taxa have not changed names since their first collection, e.g., *Microlepia strigosa*, but many others have experienced taxonomical changes, e.g., *Elaphoglossum* with three different names, or *Dryopteris karwinskyana* which was described as *Dryopteris Espinosai* by Fuentes (1913), Christensen & Skottsberg (1920), and Guillaumin et al. (1936), and then named *Thelypteris Espinosae* (Godoy & Figueroa 1989). Skottsberg's *Dryopteris gongylodes* refers to *Thelypteris interrupta* (syn. *Cyclosorus interruptus*). Christensen & Skottsberg (1920) didn't include *Polystichum aculeatum*, cited by F. Fuentes (1913), in their original list of ferns, noting the "dubious record of *Polystichum aculeatum*", although Skottsberg (1921) included *Polystichum fuentesii* later on. Both authors also rejected *Polypodium fuentesii* described by Fuentes (1913), stating that it "is one of the larger forms, but certainly not distinguishable even as a variety" (Christensen & Skottsberg 1920:52).

Recent revisions have been published in the past decades, and new names and combinations proposed: *Doodia paschalis* is now called *Blechnum paschale* (Christenhusz et al. 2011). *Dryopteris* (or *Thelypteris*) *parasitica* and *D. dentata*, described by the earlier authors, must have been misidentified and were clumped into a single taxon *Pneumatopteris costata* var. *hispida* by Holttum (1977). This taxon seems to be a species also found in the Australs and Gambiers, French Polynesia (J. Florence pers. comm. 2012). *Microsorum scolopendria* of past authors is considered to be *Microsorum parksii* (Nooteboom 1997), but may be closely related to *Microsorum powellii* (syn. *Microsorium pitcairnense*, Copeland 1938; *Phymatosorus powellii*, Florence et al. 1995). *Asplenium polyodon* var. *squamulosum* might be a synonym of *Asplenium indusatum* (Copeland 1938), also found in the Australs and the Gambiers (J. Florence pers. comm. 2012). It is interesting to note that two different morphs of *Haplopteris* (syn. *Vittaria*) *ensiformis* are observed on Rapa Nui: an erect

Table 3. List of the 16 native ferns of Rapa Nui with the different scientific names used by past authors (and with spelling errors kept) and the proposed valid name based on recent taxonomical revisions (*) and the "Plant List" (http://www.theplantlist.org)

Family	Fuentes 1913	Christensen & Skottsberg 1920, Skottsberg 1921, 1953 *Skottsberg 1956	Guillaumin et al. 1936	Godoy & Figueroa 1989	Baeza et al. 1998	Proposed valid name (this study)
Aspleniaceae	–	*Asplenium adiantoides* (L.) C. Chr. var. *squamulosum* nov. var. **Asplenium adiantoides* (L.) C. Chr. var. *squamulosum* C. Chr. et Skottsb.	–	*Asplenium adiantoides* (L.) C. Chr.	*Asplenium polyodon* G. Forster *var. squamulosum* (C. Chr.) R. A. Rodr.	*Asplenium polyodon* G. Forst. var. *squamulosum* (C. Chr.) R.A. Rodr.
	Asplenium obtusatum Forst.	*Asplenium obtusatum* Forst.	*Asplenium obtusatum* Forst.	*Asplenium obtusatum* Forst.	*Asplenium obtusatum* G. Forster var. *obtusatum*	*Asplenium obtusatum* G. Forster var. *obtusatum*
Blechnaceae	–	*Doodia paschalis* nov. spec. **Doodia paschalis* C. Chr. et Skottsb.	*Doodia paschalis* C. Chr. et C. Skottsberg	*Doodia paschalis* C. Chr. et Skottsb.	*Doodia paschalis* C. Chr.	*Blechnum paschale* (C. Chr.) Christenh. comb. nov. *
Davalliaceae	–	**Davallia solida* (Forst.) Sw.	*Davallia solida* (Forst.) Swartz.	*Davallia solida* (Forst.) SW.	*Davallia solida* (G. Forster) Sw.	*Davallia solida* (J. G. Forster) O. P. Swartz
Dennstaedtiaceae	*Microlepia strigosa* (Thbg.) Pr.	*Microlepia strigosa* (Thbg) Presl. **Microlepia strigosa* (Thunb.) Presl.	*Microlepia strigosa* (Thunberg) Presl.	*Microlepia strigosa* (Thunb.) Presl.	*Microlepia strigosa* (Thumb. ex Hurray) K. Presl	*Microlepia strigosa* (Thunb.) C. Presl.
	–	–	*Microlepia* sp.	–	–	–
Dryopteridaceae	*Dryopteris Espinosai* Hicken	*Dryopteris Espinosai* Hicken	*Dryopteris Espinosai* Hicken.	*Thelypteris espinosae* (Hicken.) Rodriguez	*Dryopteris karwinskyana*	*Dryopteris karwinskyana* (Mett.) Kuntze
	Polystichum aculeatum (L.) Schott.	**Polystichum fuentesii* Espinosa	–	*Polystichum fuentesii* Espinoza	*Polystichum fuentesii* Espinosa	*Polystichum fuentesii* Espinosa
Lomariopsidaceae	*Elaphoglossum Gayanum* (Fee) Moore.	*Elaphoglossum tahitense* Brack. (syn. *E. Gayanum* Hicken) **Elaphoglossum Skottsbergii* Krajina	–	*Elaphoglossum skottsbergii* Krajina	*Elaphoglossum skottsbergii* Krajina	*Elaphoglossum skottsbergii* Krajina
Ophioglossaceae	–	*Ophioglossum coriaceum* A. Cunn. **Ophioglossum lusitanicum* L. subsp. *coriaceum* (Cunn.) Clausen	–	*Ophioglossum lusitanicum* L.	*Ophioglossum lusitanicum* L.	*Ophioglossum lusitanicum* L. subsp. *coriaceum* (A. Cunn.) R. T. Clausen
	–	*Ophioglossum reticulatum* L.	–	*Ophioglossum reticulatum* L.	*Ophioglossum reticulatum* L.	*Ophioglossum reticulatum* L.

Family	Fuentes 1913	Christensen & Skottsberg 1920, Skottsberg 1921, 1953 *Skottsberg 1956	Guillaumin et al. 1936	Godoy & Figueroa 1989	Baeza et al. 1998	Proposed valid name (this study)
Polypodiaceae	*Polypodium Phymatodes* L.	*Polypodium phymatodes* L. (syn. *P. phymatodes, P. Fuentesii* Hicken)	*Polypodium phymatodes* L.	*Phymatodes scolopendria* (Burm.) Ching	*Microsorum scolopendria* (Burm. F.) Copel	*Microsorum parksii* (Copel.) Copeland * ?
		**Polypodium scolopendria* Burm.				
	Polypodium Fuentesi, Hicken n. sp.	(dubious record)	–	–	–	–
Psilotaceae	–	**Psilotum nudum* (L.) Griseb.	*Psilotum triquetrum* Swartz.	*Psilotum nudum* (L.) Briseb.	*Psilotum nudum* (L.) P. Beauv.	*Psilotum nudum* (L.) P. Beauv.
Thelypteridaceae	*Dryopteris parasitica* (L) O. Ktze	*Dryopteris parasitica* (L.) OK.	*Dryopteris parasitica* (L.) Ktze	*Thelypteris dentata* (Forst.) E. St John	*Thelypteris dentata* (Forssk.) F. P. St. John	*Pneumatopteris costata* var. *hispida* Holttum*
		**Dryopteris dentata* (Forsk.) C. Chr.				
	–	*Dryopteris gongylodes* (Schkuhr) OK.	–	*Telypteris interrupta* (Willd.) Iwats.	*Thelypteris interrupta* (Willd.) K. Iwatsuki	*Thelypteris interrupta* (Willd.) K. Iwats.
Vittariaceae	*Vittaria costata* Kze.	*Vittaria elongata* Sw. (syn. *V. costata* Hicken *non* Kunze)	*Vittaria elongata* Swarts.	*Vittaria elongata* SW.	*Vittaria ensiformis* Sw.	*Haplopteris ensiformis* (Sw.) E.H. Crane
Woodsiaceae	–	–	–	*Diplazium fuenzalidae* Espinoza	*Diplazium fuenzalidae* Espinosa	*Diplazium fuenzalidae* Espinosa
Total number according to author(s)	9	12 (*15)	10	16	16	16

form growing in the open habitat of the Rano Kau wetland (peat bog), and a pendant form in shady rocky crevasses, caves, and lava tubes (pers. obs. 2012-2013).

Conservation status and threats

During his survey conducted in 1911, Fuentes (1913:327) wrote that "Todos estos helechos son comunes principalmente en los volcanes apagados Rana-Kao i Rana-Roi, parajes que presentan la vegetación mas lozana i variada. Viven sobre rocas, en las cavernas o entre el pasto." [all these ferns [the nine species he listed] are common, mainly in the extinct volcanoes of Rano Kau and Rano Aroi, sites with the most luxuriant and diverse vegetation. They grow on rocks, in caves or between the grasses].

Davallia solida and *Psilotum nudum*, which were collected for the first time in 1934-35 (Guillaumin et al. 1936) have never been found since. These two species, which are very common and abundant in many other Pacific islands, seem to have been totally extirpated from Rapa Nui. Two other common ferns, the terrestrial *Nephrolepis hirsutula* (Nephrolepidaceae) and the epiphytic *Pyrrosia serpens* (Polypodiaceae, called *Cyclophorus serpens*), were found in a Rapa Nui fern collection (in an unspecified herbarium) but without the date of collection, the collector name, or any island locality on the specimen label (Tardieu-Blot, cited by Guillaumin et al. 1936). There is thus doubt cast on their exact origin, and they may have been collected by the botanist Raymond F. Fosberg in 1934 in the Pitcairn Islands rather than on Rapa Nui.

Among the 16 species listed for Rapa Nui (Table 3), four can be considered extinct (*Davallia solida*, *Psilotum nudum*, *Dryopteris karwinskyana, Polystichum fuentesii*) as they were not observed or collected since more than 75 years ago (Appendix). The 12 other species (Table 4) can all be considered threatened because of the past and current destruction of their natural habitats, over-grazing by domesticated or feral ungulates (horses, cattle, sheep, and goats),

Table 4. Status of the 12 threatened species (by alphabetical order of genus name). Distribution range: W = widespread, L = localized, HL =Highly localized; Abundance: ++ = uncommon, + = rare, vr = very rare; Conservation status (IUCN 2003): VU = Vulnerable, EN= Endangered; CR= Critically endangered.

Scientific name	Habitat (locality)	Distribution range	Abundance	Threat(s)	Conservation status
Asplenium obtusatum	mostly in coastal area on rocky beaches and sea cliffs, from sea-level up to 300m (Orongo)	W	++	Grazing ungulates, fires, invasive plants	VU
Asplenium polyodon var. squamulosum	only found in the Rano Kau crater in the wetland area ("peat bog")	HL (1 pop.)	+ (< 100 indiv.)	Fires?	EN
Blechnum paschale	in shady rocky cavities, fissures, caves and lava tubes up to 400m	W	++	Grazing ungulates, fires, invasive plants	VU
Diplazium fuenzalidae	in canyon near Rano Aroi at 350m	L (few pop.)	vr (< 30 indiv.)	Grazing ungulates, fires, invasive plants	CR
Elaphoglossum fosbergii	on rocky cliff in wet cave near Rano Aroi at 370m	HL (1 pop.)	vr (< 10 indiv.)	Grazing ungulates, fires, invasive plants	CR
Haplopteris ensiformis	in Rano Kau wetland (erect form), rare in shady rocky crevasses, caves and lava tubes (pendant form), up to 400m, and in caves on Motu Nui	L	++	grazing animals (horses, cattle), fires	EN
Microlepis strigosa	in the understory of secondary forest in the Rano Kau crater, on riversides and canyons of Rano Aroi up to 400m, rocky plains	W	++	Grazing ungulates, fires, invasive plants	VU
Microsorum parksii	in Rano Kau crater	L	++	Grazing ungulates, fires, invasive plants over-harvesting	VU
Ophioglossum coriaceum	Not observed	HL?	vr?	grazing animals (horses, cattle), fires	CR?
Ophioglossum reticulatum	in grassland up to 300m	L (few pop.)	+	grazing animals (horses, cattle), fires	EN
Pneumatopteris costata var. hispida	in the understory of secondary forest in Rano Kau crater (terrestrial), in canyons near waterfalls and riversides (on wet and shaded rocky cliffs) near Rano Aroi	L	++	grazing animals (horses, cattle), fires	VU
Thelypteris interrupta	in wetland vegetation around the lake of Rano Kau and Rano Aroi	L (few pop.)	+	Grazing ungulates, invasive plants	VU

accidental or intentional fires, invasive alien plants and weeds (mainly the grass *Melinis minutiflora*, Meyer 2008) and over-harvesting of *Microsorum parksii*, which is used as a traditional medicinal plant (Fajreldin 2002). The most endangered ferns are *Diplazium fuenzalidae* and *Elaphoglossum skottsbergii*, currently only known from one location, with less than 10 and 30 individuals respectively. The current status of the *Ophioglossum coriaceum* remains unknown, and this species might be critically endangered.

Fossil spores of Pteridaceae have been found on Rapa Nui (Flenley et al. 1991), including in a recent study by C. Gossen (2011) conducted in Rano Kau in 2008, and identified as *Pteris sp.* Fossil *Pteris* spores (usually *P. comans*) have commonly been reported in many locations throughout East Polynesia (M. Prebble pers. comm. 2013). Other extinct ferns include taxa in the Dennstaedtiaceae, Lycopodiaceae (probably *Lycopodiella cernua*, syn. *Lycopodium cernuum*) and Cyatheaceae families (Flenley et al. 1991). Endemic tree ferns of the genus *Cyathea*, alternatively placed by some authors in *Alsophila* and *Sphaeropteris* (Cyatheaceae), are commonly found in South Pacific Islands including Rapa Iti (Australs), and the island of Juan Fernandez has a monotypic endemic genus *Thyrsopteris* (Thyrsopteridaceae). The total absence

of epiphytes on Rapa Nui (Godoy & Figueroa 1989), such as Hymenophyllaceae ('filmy ferns') or Grammitidaceae which are common in other Pacific high volcanic tropical islands, may be related to the current lack of native rainforests and cloudforests on the island caused by deforestation.

Local names

The extinction and decrease in abundance of ferns is also associated with the loss of traditional knowledge, including the local names in the Rapanui language. During the 19th century, A. Métraux (cited by M.L. Tardieu-Blot in Guillaumin et al. 1936:555) wrote that islanders don't distinguish fern species and that local names seem to have been given randomly ("J'ai l'impression que les Pascuans ne distinguent pas les Fougères entre elles, les noms semblent avoir été donnés au petit bonheur"). The Rapanui name *nehe nehe* is indeed given to most of the fern species (Table 5). The name *kava kava atua*, reported by M.L. Tardieu-Blot for the fern *Haplopteris* (syn. *Vittaria*) *ensiformis* might be a misidentification, as *kava kava atua* is the Polynesian name of a small shrub *Macropiper latifolium* (Piperaceae) in the Marquesas (Brown 1935) and on Rarotonga in the Cook Islands (Wilder 1931). A song or hymn of the world creation, collected in 1886 by A. Métraux on the island, and translated by local experts in the Rapanui language (Métraux 1941:72) tells about "les langoustes, le poisson po'opo'o, les congres, le poisson nohu, la mousse, les fougères et la plante kavakava-atua" [lobsters, fishes, moray eels, the nohu fish, moss, ferns and the plant kavakava-atua], thus showing a clear distinction between ferns and the plant called "*kavakava-atua*".

Microsorum parksii, formely called "*matua pua*" (Guillaumin et al. 1936) and "*matu'a pu'a*" (Rauch et al. 1996) is used as a traditional medicinal plant (Fajreldin 2002), but the latter name was barely known in the early 1990s (V. Fajreldin pers. comm. 2012). The species is morphologically similar to *Microsorum grossum*, which is called "*metua pua'a*" in Tahiti (Nadeaud 1864; Pétard 1986). In the same way, "*tiapito*" is the Tahitian name given to *Ophioglossum reticulatum*, which is also used as a medicinal plant (Nadeaud 1864; Pétard 1986).

Introduced ferns

Four non-native (or alien) species were found during our botanical surveys between 2008 and 2012 (Table 6). All of them were observed being cultivated in gardens in the village of Hanga Roa, thus might have been introduced as ornamentals. One species, *Cyclosorus cf. parasiticus* was observed along roadsides and might be naturalized.

Table 5. Local names of ferns in Rapanui language (by alphabetical order of genus name) according to botanists and scientists based on local informants.

Scientific name	Rapanui names		
Source	Tardieu-Blot (in Guillaumin et al. 1936)	Etienne et al. 1982	Rauch et al. 1996
Asplenium obtusatum	Kohe, Nehe-nehe kava-kava atua	nehe-nehe	nehe nehe
Asplenium polyodon		nehe-nehe	nehe nehe
Blechnum paschale	Nehe-nehe momoko, Nehe-nehe pata-pata, Nehe-nehe vaero, Nehe-nehe rapa pepe pepe	nehe-nehe	
Davallia solida	–	–	–
Dryopteris karwinskiana	Vara-vara, Nehe-nehe	–	–
Haplopteris ensiformis	Kava-kava atua	atua	atua
Microlepis strigosa	Vaero, Nehe-nehe, piti-piti, Nehe-nehe vaero	nehe-nehe	nehe nehe
Microsorum parksii	Taro vaiho iti, Taro nguhu haha tete, Tepineva nui-nui, Matua pua	nehe-nehe	matu'a pu'a
Ophioglossum coriaceum	–	tia pito	tia pito
Ophioglossum reticulatum	–	tia pito	tia pito
Pneumatopteris costata	Taro hiva, Tepineva nui-nui, Pipi-pipi, Nehe -nehe	Pipi-pipi, nehe-nehe	
Psilotum nudum	Raiore rapa nui	–	–

Table 6. List of alien ferns of Rapa Nui and their locations based on personal observations.

Scientific name	Family	Location(s)	Abundance
Adiantum cf. raddianum	Adiantaceae	Hanga Roa	Rare, in cultivation (gardens)
Cyrtomium falcatum	Dryopteridaceae	Hanga Roa	Rare, in cultivation (gardens)
Nephrolepis cf. cordifolia	Nephrolepidaceae	Orongo	Uncommon (< 100 indiv.) in cultivation (gardens)
Cyclosorus cf. parasiticus (syn. *Christella parasitica*)	Thelypteridaceae	Hanga Roa	Uncommon (< 50 indiv.) in cultivation and roadsides

The potential of these ferns to spread in the surrounding vegetation and in the "wild" is of concern (*Adiantum raddianum* is widely naturalized in French Polynesia), although the risk of invasion or genetic pollution seems very low. However, introduction of alien ferns should be strictly controlled for biosecurity (phyto-sanitary) reasons, as some plants may carry pathogenic agents (e.g., fungal pathogens, viruses, or bacteria).

Conclusions

Ferns (Pteridophytes) and their allies (Lycophytes) form an important component of the flora of the small and remote islands of the Pacific, including Rapa Nui with 16 native species representing 35% of its current vascular flora. The native fern flora comprises four island endemics, a possible endemic variety, and a species restricted to Southeastern Polynesia. All of these species can be considered threatened because of the past and current destruction or modification of their natural habitats, over-grazing by introduced ungulates (horses, cattle, sheep, and goats), invasive alien plants, and fires. Moreover, four species cited in the early 20th century have not been observed since, and might be considered extinct. Habitat restoration projects and conservation plans for the most endangered fern species (including propagation in plant nurseries) should be urgently implemented to conserve the remaining native fern diversity of the island before it is definitively lost, and to reverse this "ecological collapse".

I recommend the following: (1) more field surveys to be conducted, especially in areas which are difficult to access (e.g., sea-cliffs around the island, the Rano Kau crater rim, small caves and lava tubes), in order to search for the extinct or extremely rare species; (2) taxonomical and (phylo-)genetic studies to confirm species identification and their biogeographical status; and (3) the establishment of a local herbarium with plant specimens associated with a database, including their locations and digital pictures. These management tools would be important for the training of local botanists and resource managers, as well as for public education.

Appendix. Past distribution, localities, and abundance of the native extinct and extant ferns of Rapa Nui (by alphabetical order of genus name) according to different authors, and proposed conservation status.

Scientific name	Christensen & Skottsberg 1920, Skottsberg 1921 (Appendix. "Ferns collected by the Albatross Expedition"), 1953	Guillaumin et al. 1936	Conservation status (Baeza et al. 1998, www.mma.gob.cl)
Asplenium polyodon var. *squamulosum*	In the crater lake of Rano Kao, c. 110m, growing on the firm peat moss "Crater of Rano Kao, near foot, scarce" Rano Kao, June 23, 1917. The peat bog. A sordid green peat cover of unknown thickness, floating on the water		Considerada como En Peligro de Extinción por una drástica disminución de su densidad y área de distribución Crece entre rocas del litoral (CONC) Vulnerable (Rodriguez 1995) CR B1ab(iii)
Asplenium obtusatum var. *obtusatum*	Rocks, near the sea shore, probably not uncommon "Scattering, near shore, on rocks"; "crater of Rano Kao, not abundant"	Rano Kao 31.10.34	Considerada como Vulnerable por su distribución restringa y antecedentes de disminución de su densidad VU

Scientific name	Christensen & Skottsberg 1920, Skottsberg 1921 (Appendix. "Ferns collected by the Albatross Expedition"), 1953	Guillaumin et al. 1936	Conservation status (Baeza et al. 1998, www.mma.gob.cl)
Asplenium obtusatum var. *obtusatum* – continued	Hanga Ho Orno (La Pérouse Bay), June 15, 1917. Stony and rocky shore; scattered colonies. Below Mataveri, June 21, 1917. Rocky shore. ..Storm zone at the base of the cliffs. Honeycombed lava blocks. Plant cover irregular, whitish from the salt spray….Steep to almost vertical rock face… In rock fissures Fissure on the slopes of Vaintu Rova, c. 300m. June 16, 1917.		
Blechnum paschale	Eastern headland, humid fissures on the steep slopes of Vaintu Rova and Tea-tea; Rano Aroi, rocks inside the crater, c. 420m, rare Fissure on the slopes of Vaintu Rova, c. 300m. June 16, 1917. Deep, dark crevice on Tea-tea, c. 290m. In the bottom a spring	Poike 9.10.34	En Peligro de Extinción por antecedentes de disminución de su densidad y área de distribución Crece en las fisuras húmedas de las faldas del Raintu Rova y Tea-Tea, y en el interior de cráteres apagados de sus volcanes (Looser 1958 ; Rodriguez 1995) Vulnerable (Rodriguez 1995) CR B1ab(iii)+2ab(iii)
Davallia solida		Rano Kao 7.10.34	Clasificada como Vulnerable por distribución restringida y baja densidad
Diplazium fuenzalidae			Considerada como En Peligro de Extinción por antecedentes de disminución de la densidad y del área de distribución. Maunga Terevaca (200-400m) (Looser 1958) CR B1ab(iii)
Dryopteris karwinskyana	Only found in the crater of Rano Aroi, c. 420m, between large boulders Rano Aroi, June 25, 1917. Rano Aroi is a shallow crater without arboreous vegetation. The lower talus slopes, elev. 400-420 m, are composed of smaller stones and boulders …*Dryopteris espinosai* generally under stones	Rano Aroi 9.10.34	Clasificada como Vulnerable por su baja densidad y crece en la actualidad en lugares alterados
Elaphoglossum skottsbergii	Fissures in the rocks in Rano Aroi, c. 420 m. Rano Aroi, June 25, 1917. Rano Aroi is a shallow crater without arboreous vegetation. The lower talus slopes, elev. 400-420m, are composed of smaller stones and boulders		En Peligro de Extincion por antecedentes de disminución de la densidad y del área de distribución Crece a 420m de altura (Rodriguez 1995) Crece en fisuras de las rocas de la Laguna Rano Aroi (Looser 1958) CR B1ab(iii)+2ab(iii)
Haplopteris ensiformis	In fissures between blocks, with moss, in the craters of Rano Aroi, c. 420m and Rano Kao, c. 125 m, in the last mentioned also in the moss peat of the crater lake	baie La Pérouse 11.10.34	Clasificada como Vulnerable porque es escasa u crece especialmente en el interior de los cráteres apagados, lugares frecuentemente alterados por acción antrópico.

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Scientific name	Christensen & Skottsberg 1920, Skottsberg 1921 (Appendix. "Ferns collected by the Albatross Expedition"), 1953	Guillaumin et al. 1936	Conservation status (Baeza et al. 1998, www.mma.gob.cl)
Haplopteris ensiformis – continued	"summit of Rano Kao, scarce" Rano Aroi, June 25, 1917. Rano Aroi is a shallow crater without arboreous vegetation. The lower talus slopes, elev. 400-420m, are composed of smaller stones and boulders Local communities on the talus slopes in the craters. Rano Kao, June 22-23, 1917		En las laderas internas de los cráteres inactivos de la Isla de Pascua (Christensen & Skottsberg 1920) VU
Microlepia strigosa	Eastern headland, Vaintu Rova and Tea-tea; plains near Hanga Ho Orno (La Pérouse Bay), not rare; Rano Aroi, fairly common; between Hanga Roa village and Mataveri, scattered; Rano Kao, in the crater, not rare "About rocks in all places where moisture is available" ; "from crater of Rano Kao, abundant, the common fern of the island" Lava plains of Hanga Ho Orno. June 15-16, 1917. A flat country near the sea; cracked basalt beds strewn with numerous slabs and boulders. Plant cover more or less open, closing between the stones and along the fissures. Crater of Rano Kao, inside, higher slopes, c. 275m. June 23, 1917. Fissure on the slopes of Vaintu Rova, c. 300m. June 16, 1917. Deep, dark crevice on Tea-tea, c. 290m. In the bottom a spring Local communities on the talus slopes in the craters. Rano Kao, June 22-23, 1917…The vegetation is a complex of association fragments : carpets of *Microlepia* and other ferns, with some trees…	Poike 9.10.34, La Pérouse 11.10.34, Rano Kao 31.10.34, Rano Raraku 24.10.34, Rano Aroi 13.10.34	Clasificada como Vulnerable por distribución restringida, baja densidad, y por la fragilidad del hábitat, sujeto a alteraciones antrópicas que cambian frecuentemente el paisaje
Ophioglossum lusitanicum subsp. *coriaceum*	With the preceding, slope of Mt Katiki, and at Hanga Ho Orno Slopes of Maunga Katiki, June 16, 1917. Lower slopes, below 300m…Stones hidden under a dense grass cover Higher slopes, 300-400m. Moister.		Clasificada como Vulnerable por alteración de hábitat
Ophioglossum reticulatum	West slope of Mt Katiki, near the landing place in Hanga Ho Orno; near Mataveri; also seen in the centre of the island Slopes of Maunga Katiki, June 16, 1917. Lower slopes, below 300m…Stones hidden under a dense grass cover		Clasificada como Vulnerable porque es escasa y su hábitat est altamente por caminos, agricultura y pastoreo

Scientific name	Christensen & Skottsberg 1920, Skottsberg 1921 (Appendix. "Ferns collected by the Albatross Expedition"), 1953	Guillaumin et al. 1936	Conservation status (Baeza et al. 1998, www.mma.gob.cl)
Microsorum scolopendria	Eastern headland, Vaintu Rova and Tea-tea, humid fissures, not rare ; Rano Aroi, fairly common ; Rano Kao, stone-heaps near the lake, c. 125m, but also seen higher up "summit of Rano Kao"; "along large rocks near bottom of crater of Rano Kao" Fissure on the slopes of Vaintu Rova, c. 300m. June 16, 1917. Deep, dark crevice on Tea-tea, c. 290m. In the bottom a spring. On the vertical walls	Rano Aroi 18.10.34, 13.10.34	Clasificada como Vulnerable por el hábitat fuertemente alterado por la acción antrópico.
Pneumatopteris costata var. *hispida*	Crater of Rano Aroi, c. 420m, and also crater of Rano Kao, c. 125m, among boulders about inside of crater of Rano Kao, in cave at summit of Rano Kao	Rano Aroi 13 et 18.10.34	Clasificada como Vulnerable porque crece entre rotados de las faldas de los cráteres apagados, (de las lagunas que forman los cráteres apagados) lugares frecuentemente alterados por acción antrópico. VU
Polystichum fuentesii			En Peligro de Extinción por antecedentes de disminución de su densidad y distribución EXTINTA
Psilotum nudum		Rano Aroi ?	Clasificada como Insuficientemente Conocida, fue citada una sola vez para la isla y es dudosa su presencia allí. IC
Thelypteris interrupta	Rano Aroi, c. 400m, edge of the crater lake with *Polygonum acuminatum*, very scarce; Rano Kao, bottom of crater, c. 110 m, in the *Scirpetum*, and among the large boulders a little higher up Rano Kao, June 23, 1917. Reed-swamp zone, of very variable width.		VU

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