



Article

Red List of liverworts and hornworts for Réunion (Mascarene archipelago)

CLAUDINE AH-PENG^{*1,5,6}, JACQUES BARDAT^{*2}, TAMÁS PÓCS^{*3}, LARS SÖDERSTRÖM^{*4},
 PIERRE STAMÉNOFF⁵ & DOMINIQUE STRASBERG⁵

^{*}Equal contributor to manuscript

¹Botany Department, University of Cape Town, Private Bag X3, 7701 Rondebosch, South Africa

²Département de Systématique et Evolution, Muséum National d'Histoire Naturelle, UMR CNRS 7502, 57, Rue Cuvier 75005 Paris, France

³Department of Botany, Eszterházy College, Eger, Pf. 43, H-3301, Hungary

⁴Department of Biology, Norwegian University of Science and Technology, N-7491, Trondheim, Norway

⁵UMR PVBMT, Université de La Réunion, 15 Avenue René Cassin, 97715 Messag Cedex 9, France

⁶Corresponding author; claudine.ahpeng@gmail.com

Abstract

A preliminary regional IUCN Red List for liverworts and hornworts is provided for Réunion (Mascarene archipelago), in accordance with the IUCN Red List criteria 3.1. A total of 327 species were assessed of which one species (*Bryopteris gaudichaudii* Gottsche) is considered to be regionally extinct (RE), fourteen species categorised as critically endangered (CR), eight species are endangered (EN), nine species are vulnerable (VU), eight species are considered Near Threatened (NT), and 177 species are at Least Concern (LC). Thirty-one species of liverworts reported on the island are threatened (CR, EN, VU), no hornwort are considered threatened.

We divided the category “Data Deficient” into two categories: DDt (data deficient for taxonomy) and DDd (data deficient for distribution) to facilitate future assessment when data would be available.

The current species threat analysis, which has generated the first regional Red List of bryophytes for Africa is hoped to promote future studies on the conservation of African bryophytes.

Key words: bryophytes, hornworts, hotspot of diversity, IUCN Red List, liverworts, Mascarenes, Réunion

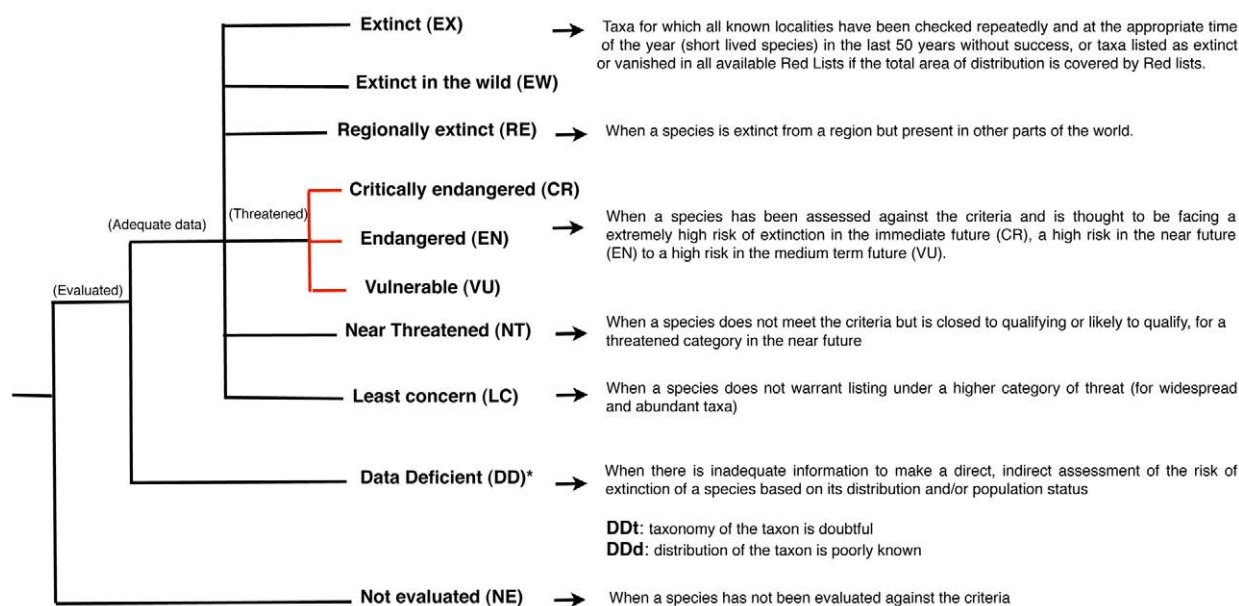


FIGURE 1: Structures of the categories from IUCN (2010), *DDt and DDd are additions from this work.

Introduction

Current threats to the planet's biodiversity are unprecedented and they particularly imperil insular systems (Caujapé-Castells *et al.* 2010). An island's biota is the result of successful dispersal events, colonisation and diversification from the niche vacancies and isolation creating unique faunal and floral assemblages. The very attributes that promote island speciation in evolutionary time also leave island endemics highly vulnerable (Fordham & Brook 2010). The recent and rapid impacts induced by habitat destruction, population expansion, land use and invasive species are devastating to small areas with distinct borders such as islands.

Red List data constitutes a source of information that is essential to guide conservation efforts focused on species. They are major indicators of the degree of threat and the changes of status for species, and have become a useful tool for conservation of ecosystems.

Sabovljević *et al.* (2004) state that the evaluation of the status of a species should be done in a global context. However, local and regional Red Lists are also important in the implementation of the protection of species by national or local stakeholders. In general, African plant taxa have been underrepresented on global Red Lists for a variety of reasons. This includes lack of knowledge of the taxonomy and distribution of the plants as well as few active specialists able to participate in a network specialising on threatened plants (Huntley *et al.* 1998; Hilton-Taylor 2000). In comparison to vascular plants, there is a significant gap for Red List assessments of non-vascular plant taxa such as bryophytes.

Bryophytes (mosses, hepatics and hornworts) represent around 17000 species around the world (Magill 2010; Villarreal *et al.* 2010; von Konrat *et al.* 2010). Although bryophytes seldom are the most conspicuous elements in the landscape (Vanderpoorten & Goffinet 2009), they are important structuring components of the ecosystem in some regions and habitats (e.g. boreal and tropical ecosystems) and exhibit a high species richness that often exceeds that of vascular plants in rainforest, on lava flows, among others. Bryophytes also play a major role in the functioning of ecosystems in terms of nutrient cycling, water retention and erosion, and their removal from bogs or tropical forests may disrupt the local hydrology and consequently be catastrophic to the ecosystem (Pócs 1980). They usually host animals (microinvertebrates), numerous arthropods depend on them as habitat or as food source, birds also use them for nest construction and they serve as a nursery for orchids and other vascular plants. Their chemistry reveal some interesting compounds and may be valuable for medicinal properties with anti-bacterial and anti-fungal activities (Asakawa 2004; Harinantenaina *et al.* 2006) and also for perfumery applications (Gauvin-Bialecki *et al.* 2010). However, their contribution to ecosystem services is profoundly less understood, and is usually underestimated by the biodiversity and conservation managers in the tropics where their richness and biomass peak. Thus, there is paucity of detailed information on threatened habitats of bryophyte species and the causes of the threats particularly in tropical regions and to a lesser extent in the subtropical and southern temperate zones (Hallingbäck & Hodgetts 2000). This is mainly due to a shortage of active bryologists resident in these areas, inadequate floras, reference specimens and literature from these countries.

In 2007, the French committee of the International Union for the Conservation for Nature (IUCN) and the National Museum of Natural History (Paris) agreed to work on the status of species present in mainland France and its overseas territories following the commitment of the French government at the International Convention on Biological Diversity to mitigate on the attrition of biodiversity.

The aim of this article is to provide the first regional Red List for Réunion liverworts and hornworts. Identifying threatened species for the island will locally benefit conservation practices by drawing attention to selected species and their required habitats and conservation needs. This work will also contribute to the global evaluation of the state of the biodiversity with less known taxa such as African bryophytes. We recognize that this work is designed to evolve overtime and hopefully will be implemented with further research and distribution data of species on this volcanic island.

Material and Methods

Study area:—The covered area is the island of Réunion (55°39' E, 21°00' S), which is 2512 km² making it the largest island of the Mascarene Archipelago in the Western Indian Ocean. This French overseas territory is located 780 km East of Madagascar and 210 km West of Mauritius. It is of recent volcanic origin (2.1 myr), with the Piton des Neiges volcano the highest summit at 3070 m a.s.l. as its highest peak. On its windward side, is the lately very active, Hawaiian type volcano, Piton de La Fournaise (2631 m), which has been erupting regularly during the last 10 years and produced new substrates that have covered older ones. Thirty percent of the vegetation on the island is still well preserved, divided into 20 native habitat units belonging to four macrohabitat units: costal-lowland, submontane, montane and subalpine habitats (Strasberg *et al.* 2005). Lagabriele *et al.* (2009) provide a recent status of the biodiversity of the island. Since 2007, 42.6% of the island is under the protection of the National Park. These conservation areas are however highly biased towards the uplands. The lowlands remain largely vulnerable due to increased socio-economic activities (urbanisation, agriculture) and, in the eastern part, by natural destruction from the lava flows of the Piton de La Fournaise volcano. In 2010, Réunion was designated a UNESCO World Heritage Site for its striking landscapes of its “Pitons, Cirques and Ramparts” coinciding with the core zone of the National Park, as well as for its threatened biodiversity.

Methods:—This first Red List assessment of bryophytes from Réunion is based on the recently updated checklist of the island (Ah-Peng *et al.* 2010a; 2010b). The bryophyte flora in the island is made up of more than 800 species of bryophytes consisting of 504 mosses, 322 liverworts and five hornworts. The experts discussed each species against the IUCN criteria reported in Table 1 and their application on a regional scale (Hallingbäck *et al.* 1998; IUCN 2010). A species is required to fulfil a minimum of one criterion (of criteria A to E) to qualify for any of the threatened categories on the Red List. A species is tested against all the categories and criteria; the species is allocated to the highest category that it fits.

Species reported for the island for which distribution data is lacking are categorized as Data Deficient for distribution (DDd). When a record is considered doubtful for the island, it is included in the DDd category. Similarly when the taxonomy of a species is poorly known, it has been classified as Data Deficient for taxonomy (DDt).

This preliminary Red List was initiated during the Tropical Bryology Group workshop in Réunion in September 2008. A parallel group meeting formed by C. Ah-Peng, J. Bardat, T. Pócs and L. Söderström started to discuss the list of liverworts and hornworts from Réunion, and their distribution and rarity on the island to chart the way forward.

GIS analysis:—Distribution maps with 1×1 km Grid Square were used to assess species area of occupancy on the island. The data (stored in a database) comes from herbaria specimens (in BM, BR, EGR, MO, PC, REU, S), recent field inventories and ecological surveys (Ah-Peng 2007) and from results from the Tropical Bryology Group workshop (Wilbraham 2009) and some additions (Ah-Peng 2010a, b; Frahm 2010) for the island. This database, created in collaboration with the National Botanical Garden of Mascarin (CBNM), contains 12 768 records of species for the island and is linked to accessible online taxonomic index for the island (<http://bryophyte.cbnm.org>), which is regularly updated. The REU herbarium specimens can be accessed at <http://nextic.univ-reunion.fr/herbier/fr>. For some species, distribution maps are provided and plotted using MapInfo Professional® 7.8.

TABLE 1: Methodology for assessing Red List categories adapted to bryophytes: summary of the 5 criteria (A–E) used following Hallingbäck *et al.* (1998) and IUCN (2010).

	CR	EN	VU
A. Population reduction	Declines measured over the longer of 10 years or 3 generations		
A1	≥ 90 %	≥ 70 %	≥ 50 %
A2, A3 & A4	≥ 80 %	≥ 50 %	≥ 20 %
A1. Population reduction observed, estimated, inferred or suspected in the past where the causes of reduction are clearly reversible AND understood AND have ceased, based on and specifying any of the following:			
(a) direct observation			
(b) an index of abundance appropriate for the taxon			
(d) a decline in area of occupancy (AOO), extant of occurrence (EOO) and/or Habitat quality			
(d) actual or potential levels of exploitation			
(e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.			
A2. Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased OR may not be understood OR may not be reversible, based on (a) to (e) under A1.			
A3* Population reduction projected or suspected to be met in the future (up to a maximum of 100 years) based on (b) to (e) under A1			
A4* An observed, estimated, inferred, projected or suspected population reduction (up to a maximum of 100 years) where the time period must include both the past and the future, and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible, based on (a) to (e) under A1.			
B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)			
B1. Extent of occurrence (EOO ^{**})	< 100 km ²	< 5 000 km ²	< 20 000 km ²
B2. Area of occupancy (AOO ^{***})	< 10 km ²	< 500 km ²	< 2 000 km ²
AND at least 2 of the following:			
(a) Severely fragmented, OR number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals.			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals.			
C. Small population size and decline			
Number of mature individuals	<250	<2 500	<10 000
AND either C1 or C2			
C1. An estimated continuing decline of at least	25 % in 3 years or 1 generation	20 % in 5 years or two generations (up to a max. of 100 years in future)	10 % in 10 years or three generations
C2. A continuing decline AND (a) and/or (b)			
(ai) Number of mature individuals in each subpopulation	<50	<250	<1000
or			
(aii) % of individuals in a subpopulation	90–100 %	95–100 %	100 %
(b) Extreme fluctuations in the number of mature individuals			
D. Very small or restricted population			
Either			
D1. Number of mature individuals	< 50	< 250	D1. <1000
D2. Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.			D2. typically AOO < 20 km ² or number of localities ≤ 5
E. Quantitative analysis			
Indicating the probability of extinction in the wild to be (max 100 years):	≥ 50% in 10 years or 3 generations	≥ 20% in 20 years or 5 generations	≥ 10% in 100 years

*A3 and A4 are rarely considered for bryophytes.

**Extent of Occurrence (EOO) is the geographical range, defined as the area contained within the shortest continuous imaginary that can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon.

***Area of Occupancy (AOO) is defined as the area, calculated by summing up all grid squares with the mesh size of 2×2 km that are actually occupied by a taxon, excluding cases of vagrancy.

Results

There are 39 taxa in the list of the threatened and near threatened species of liverworts and hornworts (Table 2) and one species considered as regionally extinct. The global distribution, habitat, threat, regional IUCN category and local distribution for Réunion is reported below for each species.

1. *Acanthocoleus madagascariensis* (Stephani 1912: 158) Kruijt (1988: 98)

Family:—Lejeuneaceae

Distribution:—Burundi, Comoros, Ethiopia, Guinea, Madagascar, Mauritius, Réunion, Rwanda, Sierra Leone, Tanzania, South Africa and Zimbabwe.

Habitat:—epiphyte, lignicolous

Threat:—known from less than 10 localities

IUCN threat category:—NT

Specimens:—Cilaos, 100 m above the village, 1100 m, 29/09/1962, *Een R197*, (S); Saint-Philippe, Réserve forestière touristique de Mare Longue, sur arbre de futaie, épiphyte, 08/08/1979, *Onraedt 79.R.8112*, (BM); Plaine des Cafres, source Samary, 1000 m, 28/07/1974, *Gimalac 74.R.8328* (BM); Plaine des Cafres, Piton Hyacinthe, sur les arbres, 1800 m, 06/19/1974 (BM); Plaine des Cafres, à l'Est des petits Pitons, sur des débris organiques, lignicole, 1000 m, 24/03/1974, *Gimalac 74.R.8369* (BM); Saint-Philippe, Gîte de Basse Vallée, in *Cryptomeria* plantation, 55°42'E, 21°19,5'S, 23/06/1996, *Kis 9604CA* (EGR); Saint-Philippe, in kipuka, corticolous 0-50 cm, 20/06/2005, *Strasberg, Ah-Peng & Bardat KIPC18C15R2* (REU).

2. *Amazoopsis gracilis* Engel & Smith Merrill (2004: 246)

Family:—Lepidoziaceae

Distribution:—Réunion and Seychelles.

Habitat:—Soil and rotten wood (saprolignicolous) at high altitudes, forest systems with high humidity and shade.

Threat:—Habitat destruction and disturbance and less than 5 localities known from the island.

IUCN threat category:—VU[D2]

Specimens:—Species known from the type collection in Réunion (E edge of Cirque de Mafate) and from one collection in the Seychelles (Engel & Smith Merrill 2004). Three other localities from Réunion: Forêt de Bélouve, Ravine Bringellier SSE from Gîte Bélouve, at 1460 m alt., on shady volcanic cliff, 22° 03' S, 55° 32.5' E, coll. *S. Rózsa, 9642/O* (EGR, F); Basse Vallée, along trail GR2 (Saint-Philippe), 16/07/1996, 21°3' S, 55°32' S, *Kis 1951/CE* (EGR); “Brulé de Baril” on the S slope of Piton de la Fournaise volcano, mossy cloud forest on a 400 years old lava flow at 1200 m alt., on soil under a rock overhang, *Szabó and Strasberg 9609/CS* (EGR, Herb. Mascarin in SAINT-LEU, MO, F).

3. *Andrewsianthus aberrans* (Montagne 1843: 250) Grolle (1963: 440)

Family:—Jungermanniaceae

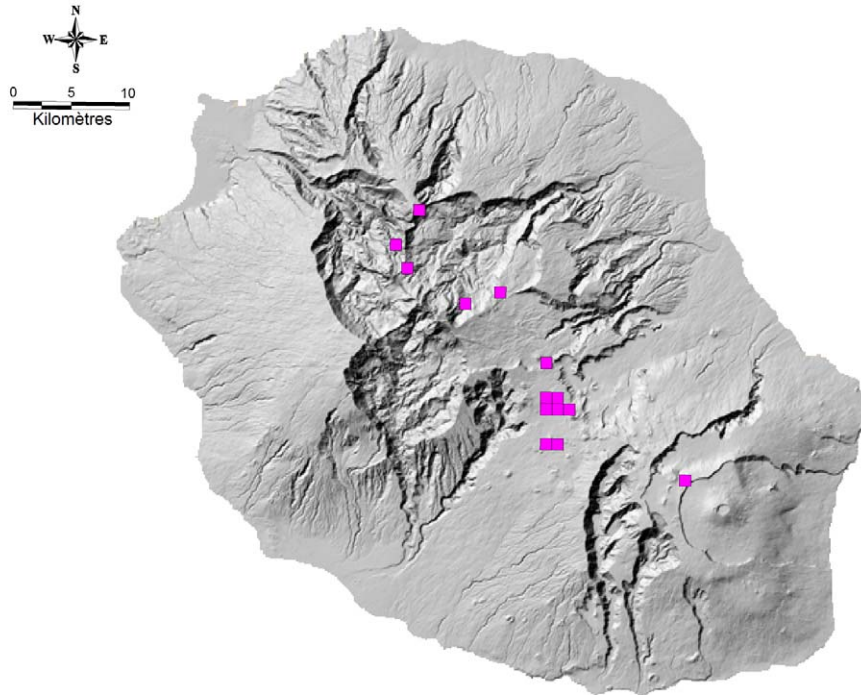
Distribution:—Madagascar, Mauritius and Réunion.

Habitat:—Soil, humocorticolous, montane, alpine, known from 5 localities in Réunion and from 14 specimens.

Threat:—Habitat destruction and global warming

IUCN threat category:—VU[D2]

Specimens:—Plaine des Cafres, Cirque de Mafate, Pas de Bellecombe, Roche Ecrite, GR Bélouve - Piton des Neiges.



Andrewsianthus aberrans (Nees & Mont.) Grolle

FIGURE 2: Distribution map of *Andrewsianthus aberrans*, 1×1 km Grid Square

4. *Asterella syngenesica* (Bory 1804: 95) Grolle & Onraedt (1974: 230)

Family:—Aytoniaceae

Distribution:—Mauritius and Réunion.

Habitat:—Shaded soil and rocks, terricolous to humo-terricolous on rocks, 270 - 2350 m, known from 18 localities in Réunion and from 48 records on the island

Threat:—Populations of this liverwort seem to be widely distributed on the island from low to upper land. It is possible that more investigations will increase the number of localities. As some populations are located closed to urban areas, the possibility that they could be affected in a close future can not be excluded. In Mauritius, the species is known only from two localities.

IUCN threat category:—NT

Specimens:—Cirque de Cilaos, Cirque de Salazie, Cirque de Mafate, Dos d’Ane, Heights of Basse Vallée, Makes, Plaine des Cafres, Piton de La Fournaise, Plaine des Palmistes, Takamaka, Valley of Langevin river (Figure 3).

5. *Bryopteris gaudichaudii* Gottsche (1857: 341)

Family:—Lejeuneaceae

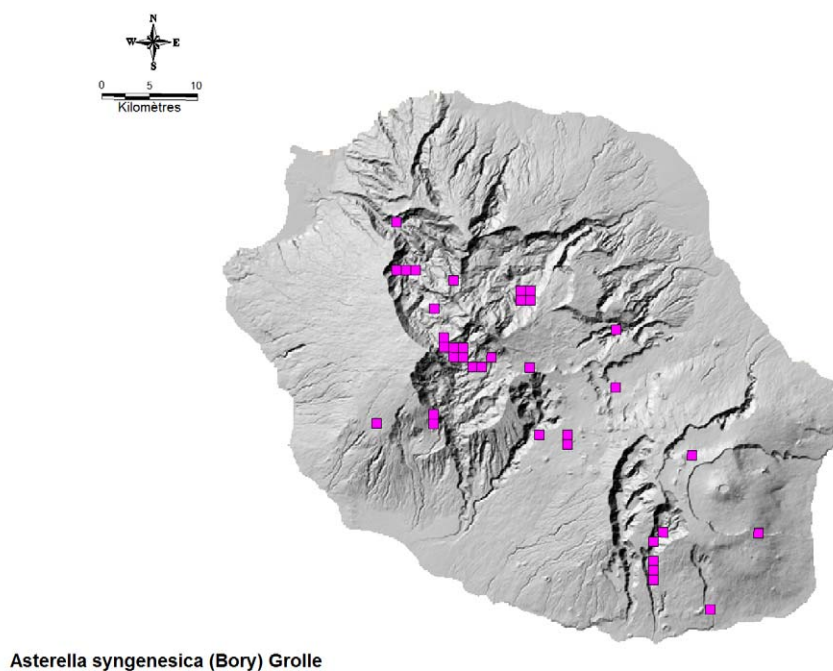
Distribution:—Madagascar, Mauritius and Réunion (one record, no precise locality for the island).

Habitat:—Coastal ericacean heath and montane rainforest on Madagascar. Not found again in Réunion since the collection of the type specimen “Voyage de M. Gaudichaud sur La Bonite 1836-37. Ile Bourbon, juillet 1837, PC101870”. The observation of the specimen gave some clues on the habit of the specimens: corticolous and pendant.

Threat:—Lowland habitat destruction.

IUCN threat category:—RE

Notes:—Despite recent exhaustive searches in the field, this species has not been found again and it is probably extinct on the island, probably due to disappearance of its habitat. The species is facing an extremely high risk of worldwide extinction in the immediate future (IUCN category Critically Endangered) based on its small distribution area (area of occupancy in Madagascar less than 10 km² in only two localities about 75 km from each other) in combination with declining extent of its habitat. Although dispersion via spores may be possible from Madagascar to Réunion, the potential for any re-colonization is unknown.



Asterella syngenesica (Bory) Grolle

FIGURE 3: Distribution map of *Asterella syngenesica*, 1×1 km Grid Square

6. *Calypogeia mascarenensis* Bischler (1970: 89)

Family:—Calypogeiaceae.

Distribution:—Comoros, Madagascar, Mauritius and Réunion.

Habitat:—Corticolous and terricolous.

Threat:—Few localities. Known from only three localities on the island, two of them are recreational areas.

IUCN threat category:—VU[D2]

Specimens:—Saint-Philippe, Sentier du Tremblet au sud de La Fournaise, 1900 m, 04.02.1971, *Gimalac* 71.R.8034; Plaine des Cafres, Source Samary, 1000 m, *Gimalac* 71.R.8034; idem *Gimalac* 74.R.8316; idem *Gimalac* 74.R.8329; idem *Gimalac* 74.R.8318; Plaine des Palmistes, Premier village, 900 m, on peaty ground *Kis* 9435/S (EGR).

7. *Cheilolejeunea cordigera* (Stephani 1896: 100) Grolle (1977: 530)

Family:—Lejeuneaceae.

Distribution:—Madagascar, Mauritius and Réunion.

Habitat:—Epiphyllous in the lowland to montane forest.

Threat:—Restricted distribution, known from two localities.

IUCN threat category:—EN[B2ab(iii)]

Specimens:—Plaine des Palmistes, rampe de la Grande Montée, épiphyll, forêt humide, ravine alt. ca. 1600 m, 3.08.1979, *Onraedt 79.R.8204/a* (BM); Sentier sur le Grand Etang, épiphyll sur Fougère, 500 m, 24 July 1979, *Onraedt 79.R.7935/a* (BM); alt. 480 m, 28 December 1973, *Onraedt 73.R.1983/3* (BM).

8. *Cheilolejeunea ecarinata* Vanden Berghen (1984a: 11)

Family:—Lejeuneaceae.

Distribution:—Endemic.

Habitat:—Corticolous in montane rainforest.

Threat:—Very restricted distribution, although maybe overlooked due to its small size.

IUCN threat category:—VU[D2]

Specimens:—“Au pied du Piton de Grande Montée, at 1600 m”, Dec. 1973, *De Sloover 17 262* (Type: BR, NAM); E edge of Cirque de Mafate, Ravine Savon at the S side of Plateau Mahot, 16.08.1994, 1350-1550 m, 21°02'20"S, 55°27'22"E, *Vojtkó 9427/AS* (EGR); Mare Longue reserve, On the S slope of Piton de la Fournaise, Sentier Botanique, 8.9.2008, 280 m, *I. Malombe* (EA); Forêt de Bélouve, cliff at the SE edge of Cirque de Salazie, along the route between Gîte de Bélouve and Kiosque Pilône view point, 13.9.2008, 1500 m, *I. Malombe* (EA); ibid, along the forestry road 3 km SSE of Gîte de Bélouve, 13.9.2008, 1500 m, *I. Malombe* (EA); Roche Ecrite Réserve, on the NE slope, above Le Brûlé village and Mamode Camp, 14.9.2009, 1250 m, *I. Malombe* (EA); Cirque de Salazie, Le Petite Col, 16.9.2008, 1750 m, *I. Malombe* (EA).

9. *Cololejeunea bidentula* (Stephani 1916: 868) Jones (1954: 423)

Family:—Lejeuneaceae.

Distribution:—Ethiopia, Kenya, Madagascar, Mauritius, Réunion, Tanzania and Uganda.

Habitat:—Montane, epiphyll.

Threat:—Habitat degradation.

IUCN threat category:—EN[B2ab(ii)]

Specimens:—Saint-Philippe, sentier de la Ravine du Tremblet, épiphyll, 300 m, 17.07.1979, *Onraedt s.n.*, *Onraedt 79.R.8222* (BM); Forêt domaniale de Saint-Philippe, Ravine du tremblet, 18.07.1973, *Onraedt 73.R.1499*; 10.09.1971, *Onraedt 71.R.9442*; épiphyll sur une feuille de fougère, 10.09.1971, *Onraedt 71.R.9445*; Forêt de Bébour, 01.08.1979, 1400 m, *Onraedt 79.R.7941*, épiphyll en forêt sur fougères, 5.1974, *Bosser s.n.* (PC); Saint-Benoît, sentier vers le Grand Etang, 28.07.1973, 480 m, épiphyll sur fougère, *Onraedt 73.R.1883K* (BM); Les Aviron, Tévelave, Bras sec, 800 m, 20.07.1963, *Cadet CT12* (S).

10. *Cololejeunea borbonica* Tixier (1985: 54)

Family:—Lejeuneaceae.

Distribution:—Madagascar and Réunion, no recent collection of the species on Réunion.

Habitat:—Epiphyllous in lowland.

Threat:—Habitat destruction and degradation of the lowland ground.

IUCN threat category:—EN[B2ab(iii)]

Specimens:—Known from two localities: Takamaka, épiphyll en forêt, 1.12.1972, *Bosser s.n.*—idem Saint-Philippe, *Bosser s.n.* (PC).

11. *Cololejeunea bosseriana* Tixier (1979: 235)

Family:—Lejeuneaceae.

Distribution:—Endemic, no recent collection of the species in Réunion.

Habitat:—Epiphyll on ferns.

Threat:—Known from only one locality.

IUCN threat category:—CR[B2ab(iii)]

Specimen:—One locality: Forêt de Bébour, épiphyll en forêt humide sur fougère, 1300 m, 5.12.1972, *Bosser s.n.* (Holotype, PC).

12. *Cololejeunea cuneata* (Lehmann 1832: 56) Herzog (1947: 320)

Family:—Lejeuneaceae.

Distribution:—Borneo, Comoros, Madagascar, Mauritius, New Guinea, Philippines, Réunion, Rodriguez, Tanzania and Singapore.

Habitat:—Epiphyte, lignicolous (saprolicolous).

Threat:—Two localities known, one of them (lava flow 1900) was destroyed by the eruption of the volcano in 2007.

IUCN threat category:—CR[B2ab(ii)]

Specimens:—Basse Vallée, 3.12.1972, *Bosser s.n.* (PC); Hauts de Sainte Rose, 1973, *Cailleux 57* (PC); Saint-Philippe, lava flow 1900, epiphyte between 0-50 cm, 190 m, 20.06.2005, *Strasberg et al. 1900B1C14R1* (REU); 245 m, epiphyte between 0-50 cm, *Strasberg et al. 1900B24C10R2*, (REU); 220 m, lignicolous, *Strasberg et al. 1900C23C3R2* (REU); 220 m, epiphyte between 0-50 cm, *Strasberg et al. 1900C25C10R2* (REU).

13. *Cololejeunea decemplicata* (Stephani 1916: 869) Tixier (1979: 213)

Family:—Lejeuneaceae.

Distribution:—Madagascar and Réunion.

Habitat:—Corticolous on *Acacia*.

Threat:—Habitat destruction especially as natural habitats in Plaine des Cafres have been replaced by farming.

IUCN threat category:—CR[B1b(iii)]

Specimens:—Known from three localities in Réunion: Cilaos, 100 m above the village, 1100 m, 29.09.1962, *Een B12605* (S); Plaine des Cafres, 1800 m. (loc.23), 12.10.1962, *G. Een B12613* (S); Plaine des Cafres, Derrière la plaine des sports de l'APECA, 08.01.1974, sur frêne, *Onraedt 74.R.1821* (BR); Plaine des Cafres, petit bois derrière l'atelier de l'APECA, sur rameau, 06.10.1974, *Gimalac 74.R.8756* (BR); Cirque de Mafate, Sentier du Taïbit, sur *Mimosa* sp., 22.08.1974, *Gimalac 74.R.8366* (BR).

14. *Cololejeunea leloutrei* (Jones 1953: 146) Schuster (1963: 173)

Family:—Lejeuneaceae.

Distribution:—Widespread in tropical Africa, Comores, Madagascar, Mauritius, Réunion and Seychelles.

Habitat:—Epiphyllous.

Threat:—Known from two localities, restricted distribution on the island, but widespread in Africa and probably not threatened at a continental base.

IUCN threat category:—NT

Specimens:—Saint-Philippe, La Ravine du Tremblet, forêt ombrophile, 300 m, 17.07.1979, *Onraedt 79.R8461*; 300 m, 17.07.1979, *Onraedt 79.R8462*; 200 m, 17.12.1973, *Onraedt 79.R.7960*; 18.12.1973, *Onraedt 73.R.1500*; 18.12.1973, *Onraedt 73.R.1397*; 18.12.1973, *Onraedt 73.R.1398*; 18.12.1973, *Onraedt 73.R.1501*; 17.07.1979, *Onraedt 79.R.8224*; Plaine des Palmistes, Chemin vers Grand Etang, épiphyllie, 500 m, 24.09.1979, *Onraedt 79.R.7925*; 29.07.1979, *Onraedt 79.R.7951*.

15. *Cololejeunea takamaka* Tixier (1985: 319)

Family:—Lejeuneaceae.

Distribution:—Endemic.

Habitat:—Epiphyll at ca. 1000 m.

Threat:—Habitat degradation, less than 5 localities found, very restricted endemic.

IUCN threat category:—CR[B1b(iii)]

Specimen:—Route de Takamaka, 1000 m, épiphyllie, 26.02.1976, *Bosser* s.n. (Holotype, PC).

16. *Colura heimii* Jovet-Ast (1954: 275)

Family:—Lejeuneaceae.

Distribution:—Comoros, Madagascar, Mauritius, and Réunion.

Habitat:—On twigs, lowland and upland forests.

Threat:—Natural habitat destruction by lava flows and anthropogenic influence following urbanization and agriculture.

IUCN threat category:—CR[B2b(iii)]

Specimens:—Known from 5 localities: Plaine des Cafres, Source Samary, epiphyllous, 28.07.1974, *Gimalac 74.R.8624* (BR); La Plaine des Palmistes, epiphyllous, 03.08.1979, *Onraedt 79.R.8210* (BR); Cirque de Mafate, Grand Rein, corticolous, 17.07.1976, *Gimalac 76.R.3730*; Saint-Philippe, lava flow, corticolous, 21°16,194' S, 55°47,409' E, 14.06.2005, *Ah-Peng, Bardat and Strasberg KIPA8C1R3* (REU); Saint-Philippe, lava flow, sur bloc, 21°16,194' S, 55°47,409' E, 14.06.2005, *Ah-Peng, Bardat and Strasberg KIPA11C11R2* (REU); Forêt de Bébour, Sentier de la rivière, 1300 m, 21°06,8'S, 55°33,8'E, 22.06.2000, *Pócs 00115/D* (EGR).

17. *Colura obesa* Jovet-Ast (1954: 273)

Family:—Lejeuneaceae.

Distribution:—Madagascar and Réunion.

Habitat:—Corticolous or ramicolous.

Threat:—Habitat destruction, the only record is from a kipuka (forest patch surrounded by lava flows).

IUCN threat category:—CR[B2ab(iii)]

Specimen:—one locality in Réunion: Saint-Philippe, lava flow, corticolous, 21°16,194' S, 55°47,409' E, 14.06.2005, *Ah-Peng, Bardat and Strasberg KIPA11C1R3* (REU).

18. *Diplasiolejeunea cogoensis* Infante *et al.* (1999: 9)

Family:—Lejeuneaceae.

Distribution:—Equatorial Guinea and Réunion.

Habitat:—Corticolous at 2 m high on *Agarista salicifolia* of 1 m diameter, on lava flow.

Threat:—Habitat destruction, the only record is from the lava flow

IUCN threat category:—VU[D2]

Specimen:—Only one locality in Réunion: Lava flow 1974 (Commune Sainte-Rose), UTM 374-7646, 290 m, 22 February 2005, *Ah-Peng R134*.

19. *Drepanolejeunea helenae* Pócs (1997: 198)

Family:—Lejeuneaceae.

Distribution:—Endemic.

Habitat:—On *Psidium cattleianum* trunk, known only from two localities, the type and a paratype specimen.

Threat:—Habitat destruction is the major threat as it is a very restricted endemic.

IUCN threat category:—CR[B2ab(iii)]

Specimens:—Two localities from Réunion: Basse Vallée, along trail GR2 (Saint-Philippe), on *Psidium cattleianum* bush, 16.07.1996, 21°3' S, 55°32,5 E, *Kis & Vojtkó 9651CC* (EGR); *Pócs 9651DH* (EGR, G, JE, PC, REU, MO, NY); le Grand Etang, W of Ste Anne, epiphyllous in remnants of tropical rainforest in the valley, 500-550 m, 21°5' S, 55°39' E, *A. Vojtkó 9433/AN* (microslide, EGR, Pócs 1997:203).

20. *Drepanolejeunea mascarena* (Arnell 1965: 69) Zhu & Grolle (2003: 467)

Family:—Lejeuneaceae.

Distribution:—Comoros, Madagascar, Mauritius and Réunion.

Habitat:—Rotting wood, corticolous and epiphyllous in lowland and submontane (100-800 m) forests.

Threat:—Habitat destruction, found in scarce population.

IUCN threat category:—EN[B2ab(iii)]

Specimens:—Two localities in Réunion: Ravine du Tremblet, au N de St. Philippe, at 100 m alt., 21°28,33 E, 55°78,33 S, 18.12.1973, *Onraedt 73.R.1491* (BR); Grand Etang, 10 km St-Benoît, alt 465-520 m, 21°05'46,9"S 55°39'11,7"E, secondary rainforest with many *Psidium cattleianum*, on decaying wood, 10.09.2008, *Pócs 8058/F*.

21. *Frullania anderssonii* Ångström (1873: 144)

Family:—Jubulaceae.

Distribution:—Comoros, Madagascar, Mauritius, Réunion, Seychelles and South Africa.

Habitat:—Corticolous to humo-rupicolous, 420-1800 m.

Threat:—Some localities are under urbanization and farming pressures.

IUCN threat category:—NT

Specimens:—Cilaos, les trois Salazes, forêt humide, sur écorce d'un arbre mort, 15.03.1986, *Gimalac 86.R.12560d* (BM); Réserve biologique, 1200 m, *Een R021* (S); 100 m above the village, 1100 m, *Een R255* (S); *Een R259* (S); Montée du Taïbit, 30.12.1974, *Gimalac 74.R.8668a*; Sentier du col du Taïbit, 17.07.1979, *Onraedt 79.R.8230*; Sentier GR R2 vers la cascade du Bras Rouge, corticolous, 1100 m, 10.03.1997, *Arts s.n.*; Bras de Benjoin, Forêt de Bois de Couleur, corticole, 25.12.1973, *de Sloover 17743*; Au Grand Matarum, épiphyte, 01.01.1974, 1500 m, *Onraedt 74.R.8577*; 01.01.1974, *Onraedt 74.R.8232*; 01.01.1974, epiphyte, *Onraedt 74.R.8227*; Saint-Paul, sentier de la Roche Plate à l'îlet des Orangers, corticole, 1100 m, 18.05.1975, *Gimalac 75.R946*; Cirque de Mafate, Marla, au plateau de Kerval, épiphyte, 09.05.1975, *Gimalac 75R930*; sur arbres, 25.03.1975, *Gimalac 75R936*; sur Ericacées, 28.12.1973, *Gimalac 75R921*; sentier de Kerval à

Marla, 1500 m, sur arbres, 14.07.1972, *Gimalac 72.R.219*; Sentier de Roche Plate à l'Ilet des Orangers, 1100 m, corticole, 18.05.1975, *Gimalac s.n.*; Le Tampon, W de La Fournaise, Piton des Sables, 2000 m, épiphyte, 17.12.1969, *Onraedt 69.R356*; Près du Pont d'Yves, 15.06.1957, 900 m, sur branches, *Bosser 11093*; sur tamarin des Hauts, 1600 m, 23.02.1974, *Onraedt 74.R.8233*; La Possession, sentier vers le Cap Noir, au dessus de Dos d'âne, 1400 m, 21.12.1969, *Onraedt 69.R.1104*; Entre-Deux, Bras de la Plaine vers Entre-deux, épiphyte, 01.09.1970, *Gimalac 74.R.8642*; Saint-Denis, à Saint-François, épiphyte, 05.01.1974, *Onraedt 74.R.8398*; La Montagne, au dessus de Saint-Denis, sur rocher suintant, 31.12.1973, *Onraedt 74.R.8246*; Saint-Benoît, Forêt de Bébou, 23.12.1973, 1350 m, *Onraedt 73.R.8230*; Cirque de Salazie, E slope of Roche Ecrute, N of Grand Ilet village, 1250-1540 m, *Szabó 9415/G, Vojtkó 9416/D* (EGR).

22. *Geocalyx orientalis* Bescherelle & Spruce (1891: 189)

Family:—Geocalycaceae.

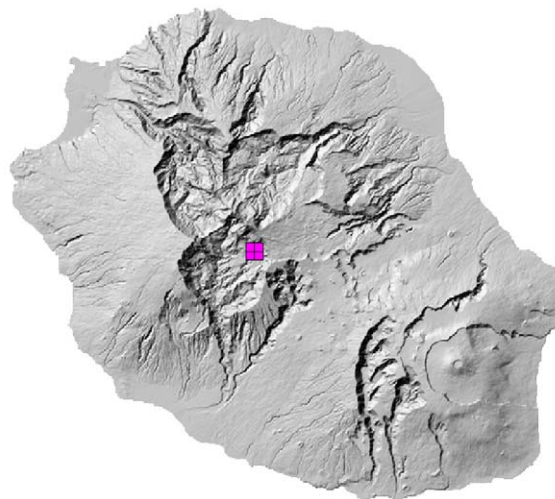
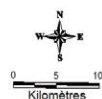
Distribution:—Endemic.

Habitat:—Soil and rotten wood in montane forest.

Threat:—Area of occupancy < 4 km² on the island. Major threats are habitat destruction and urbanization in the populated Cirque de Cilaos area.

IUCN threat category:—CR[B2ab(iii)]

Specimens:—One locality known in Réunion: Cirque de Cilaos, le long du sentier des eaux et forêt en direction de la cascade, 1500 m alt. épiphyte, 25.12.1973, *Onraedt 73.R.1231* (BR); Cirque de Cilaos, Mare à Joseph, sur rocher, 1300 m alt., 13.07.1979, *Onraedt 79.R.8035* (BR); Cirque de Cilaos, Bras de Benjoin, forêt de bois de couleur, 1450 m alt., 25.12.1973, *de Sloover 17724* (BR) (Figure 4).



Geocalyx orientalis Besch. et Spruce

FIGURE 4: Distribution map of *Geocalyx orientalis*, 1×1 km Grid Square

23. *Haplolejeunea sticta* Grolle (1975: 205)

Family:—Lejeuneaceae.

Distribution:—Réunion and Madagascar.

Habitat:—Rotten wood in lowlands.

Threat:—Known only from two localities in threatened lowland habitats in Réunion.

IUCN threat category:—CR[B2ab(iii)]

Specimens:—Mare longue (Saint Philippe), Réserve Naturelle, le long du GR R2, corticolous, between 175 and 300 m. alt, 05.09.1994, 21°20'30''S 55°44'30'' E, *Vojtko 9432* (EGR, REU); Gite Basse Vallée (Saint Philippe), *Cryptomeria* plantation, between 580 and 700 m alt., 23.06.1996 21°19.5'S 55°42'E, *Vojtko 9604AN* (EGR).

24. *Heteroscyphus grandistipus* (Stephani 1890: 283) Schiffner (1910: 172)

Family:—Geocalycaceae.

Distribution:—Réunion and Zimbabwe.

Habitat:—Corticolous in montane vegetation.

Threat:—Known from three localities in Réunion, of which one is highly threatened by land use for agricultural purposes.

IUCN threat category:—EN[B2ab(iii)]

Specimens:—Le Tampon, Plaine des Cafres, sentier GR-R2 vers le Piton des Neiges entre Piton Mare à Boue et Piton Tortue, 55°55 E 21°13S, corticolous at the base of *Erica* sp. 1700 m, 21.09.1997, *Arts 33/94* and *Arts 33/76*; Sainte-Rose, Piton de Crac, enclos de la Fournaise, 1300 m, 14.02.1971, *Onraedt 71.R.8510*; Saint-Denis, Plaine d’Affouches, forêt de *Cyathea*, sur branches mortes, 01.07.1969, *Hébrard J.P. 30/A*.

25. *Lepidolejeunea delessertii* (Montagne 1843: 260) Grolle (1984: 505)

Family:—Lejeuneaceae.

Distribution:—Mauritius and Réunion.

Habitat:—Humicolous on soil or tree bases, bark, ca. 1000 m, in small populations.

Threat:—Habitat destruction.

IUCN threat category:—NT.

Specimens:—Cirque de Cilaos, Cirque de Mafate, Plaine des Cafres, Forêt de Bébour, Forêt de Bélouve, Plaine d’Affouches, Roche Ecrite and Saint-Philippe (Figure 5).

26. *Lepidozia africana* Stephani (1922: 320)

Family:—Lepidoziaceae.

Distribution:—Madagascar, Mauritius, Réunion and Tanzania.

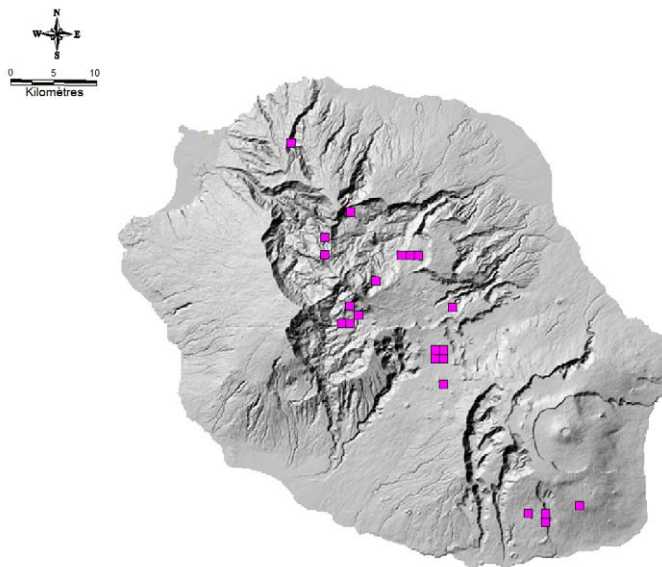
Habitat:—Corticolous and humicolous in lowland and mossy forests (200–2230 m).

Threat:—Habitat destruction.

IUCN threat category:—NT.

Specimens:—Saint-Benoît, GR Bélouve Piton des Neiges, 1950 m, humicolous, 21°05'17S 55°30'16E, 28.03.2008, *Ah-Peng et al. 1950PIQ1Hu2*; corticolous, *Ah-Peng et al. 1950 PIQ2TA1*; Cirque de Cilaos, Caserne du bras Chanson, 31.12.1970, *Onraedt 70.R.2001A*; Piton de La Fournaise, pas de Bellecombe, 26.09.1997, *Arts 50/02*; Cirque de Cilaos, sentier du Piton de Neiges, 29.12.1973, *de Sloover 17876*; Plaine des Cafres, Piton Mare à Boue, 12.12.1969, *Onraedt 69R.0482*; Saint-Benoît, Takamaka, sentier vers la cascade, 15.03.1997, *Arts s.n.*; Saint-Philippe, Route Forestière de Mare Longue (Réserve Naturelle), 07.03.1997, *Arts s.n.*; Salazie, Plaine des Merles, 24.08.1990, *Kis 9422*; Saint-Philippe, Basse Vallée, elfin forest and broadleaved mossy montane forest, 30.06.1996, *Pócs 9612DF*; S slope of Puy Ramond summit, *Erica* stand with *Blechnum tabulare* and *Nastus borbonicus*, 30.06.1996, *Pócs 9613CX*; S slope of Piton Lardé

along GR R2, Elfin forest with many *Philippia*, 16.07.1996, *Pócs 9653CO*; W slope of Piton Lardé, Mossy montane rain-forest with streamlet, 16.07.1996, *Pócs 9654CA*; Piton Lepervanche at W edge of the Plaine des Cafres, Mossy, ericaceous elfin forest (degraded by grazing), 22.07.1996, *Kis & Vojtkó 9660 CC*.



Lepidolejeunea delessertii (Nees et Mont.) Grolle

FIGURE 5: Distribution map of *Lepidolejeunea delessertii*, 1×1 km Grid Square

27. *Lopholejeunea minima* Vanden Berghen (1984b: 437)

Family:—Lejeuneaceae.

Distribution:—Endemic.

Habitat:—Trunks in lowland.

Threat:—Known from two localities in scarce population, subject to natural destruction from lava flows. These localities were destroyed during the 2007 eruption and the species has not been observed since then.

IUCN threat category:—CR[B2ab(iii)]

Specimens:—Saint-Philippe, lava flow 1899, 21°16,670'S 55°47, 487'E, 20.06.2005, *Ah-Peng & Bardat 1900B17C10R1*; Saint-Philippe, Ravine du tremblet, versant sud de La Fournaise, forêt très humide mais peu dense, epiphyte, 18.12.1973, *Onraedt 73.R.8794*; dans Kipuka, sur rachis de fougères, épiphyte, 190 m, 21°16,670'S 55°47,487'E, 20.06.2005, *Strasberg, Ah-Peng & Bardat KIPC6C16R1*; dans kipuka, sur tronc hauteur 0-50 cm, 21°16,194'S , 55°47,409' E, 14.06.2005, *Strasberg, Ah-Peng & Bardat KIPA23C1R1*; sur tronc hauteur 0-50 cm, 220 m, *Strasberg, Ah-Peng & Bardat KIPA23C1R2*; *Strasberg, Ah-Peng & Bardat KIPA23C2R1*; sur tronc hauteur 100-200 cm, 160 m, *Strasberg, Ah-Peng & Bardat KIPA23C3R2*; sur lave en grâton, 160 m, *Strasberg, Ah-Peng & Bardat KIPA8A5R1*; sur tronc hauteur 0-50 cm, 155 m, *Strasberg, Ah-Peng & Bardat KIPA8C1R3*; sur tronc hauteur 50-100 cm, 160 cm, *Strasberg, Ah-Peng & Bardat KIPA8C2R1*; sur tronc hauteur 50-100 cm, 160 m, *Strasberg, Ah-Peng & Bardat KIPA8C2R2*; *Strasberg, Ah-Peng & Bardat KIPA8C2R3*; sur tronc hauteur 100-200 cm, 155 m, *Strasberg, Ah-Peng & Bardat KIPA8C3R3*; *Strasberg, Ah-Peng & Bardat KIPA8C14R1*; sur branches et râmeaux, 205 m, *Strasberg, Ah-Peng & Bardat KIPA11A5R1*; sur tronc hauteur 50-100 cm, *Strasberg, Ah-Peng & Bardat KIPA11C2R3*; sur tronc hauteur 100-200 cm, *Strasberg, Ah-Peng & Bardat KIPA11C3R1*; sur frondes de fougères, 220 m, *Strasberg, Ah-Peng & Bardat KIPA11C11R1*; sur tronc hauteur 50-100 cm, 140 m, *Strasberg, Ah-Peng & Bardat KIPB25C1R1*; Versant S de La Fournaise volcano, ravine du Tremblet, 100 m, Dec. 1973, *Onraedt 73 R 8799* (Herb. Onraedt); *Onraedt 73 R 8794* (holotype: Herb. Onraedt, Isotype: BR).

28. *Lopholejeunea multilacera* (Stephani 1890: 349) Schiffner (1893: 129)

Family:—Lejeuneaceae.

Distribution:—Madagascar, Mauritius and Réunion.

Habitat:—Corticolous.

Threat:—Habitat destruction and degradation.

IUCN threat category:—CR[B2ab(iii)]

Specimens:—Two localities known from Réunion: Forêt de Bébour (Saint Benoit), 1350 m alt., epiphyte, 01.08.1979, 21°10,000'S 55°60,000'E, *Onraedt 79.R.8121* (BR). Type: “Bourbon, leg. Rodriguez”, Takamaka, 800 m, 21°05,5'S, 55°37,2'E, 22.06.2000, *Pócs 00116/G* (det. A. Gyarmati, EGR)

29. *Lopholejeunea paramultilacera* Vanden Berghen (1984: 435)

Family:—Lejeuneaceae.

Distribution:—Endemic.

Habitat:—Trunk in lowland (Takamaka, ca. 800 m), very local endemic.

Threat:—Habitat destruction.

IUCN threat category:—CR[B2ab(iii)]

Specimen:—Takamaka, gorge de la rivière des Marsoins, vers 790 m, 1971, *Onraedt 71R9310*, (holotype: BR).

30. *Microlejeunea strasbergii* Ah-Peng & Bardat (2011: 669)

Family:—Lejeuneaceae.

Distribution:—Endemic.

Habitat:—*Microlejeunea strasbergii* appears to be restricted to the Piton des Neiges volcano slopes, in montane and sub-alpine levels of the mesotherm forest (forest of *Acacia heterophylla* Willd.) and to the high ericoid formations (bushes of *Philippia* sp. or *Sophora* sp.). Ecologically, it seems that *M. strasbergii* is a specialist of corticolous habitats, growing over other bryophytes or directly on tree bark.

Threat:—Small and restricted populations with a narrow altitudinal range (1750–2350 m), maybe sensitive to global warming.

IUCN threat category:—VU[D2]

Specimens:—Known from 5 localities, Commune de Saint-Benoît, GR du Piton des Neiges, epiphyllous on corticolous bryophytes, 29 March 2008, 21°05'17''S, 55°30'16''E, *Ah-Peng, Bardat, Chuah-Petiot & Hedderson 1950P2Q2TC2*, (holotype: REU; isotypes: PC); Takamaka trail, eastern slope of Piton des Neiges, corticolous between 0–50 cm, 21°05'51 S, 55°35'19 E, 28 March 2008, 1150 m, *Ah-Peng et al. 1150P2Q3TA1*; GR Piton des Neiges trail, corticolous between 0–50 cm, 21°04'42 S, 55°31'42 E, 29 March 2008, 1750 m, *Ah-Peng et al. 1750P2Q3TA2*; idem, corticolous between 50 cm–1 m, *Ah-Peng et al. 1750P2Q3TB2*; idem corticolous between 1–2 m, 21°05'17 S, 55°30'16 E, 29.03.2008, 1950 m, *Ah-Peng et al. 1950P1Q3TC3*; idem corticolous between 50 cm–1 m, 21°05'15 S, 55°31'20 E, 1950 m, *Ah-Peng et al. 1950P2Q1TB3*; idem corticolous between 50 cm–1 m, 21°05'39 S, 55°30'57 E, 2150 m, *Ah-Peng et al. 2150P2Q1TB3*; idem corticolous between 0–50 cm, 21°05'56 S, 55°30'23 E, 2350 m, *Ah-Peng et al. 2350P1Q2TA3*.

31. *Plagiochila barteri* var. *valida* (Stephani 1904b: 587) Vanden Berghen (1981: 73)

Family:—Plagiochilaceae.

Distribution:—Ethiopia, Malawi, Principe, Réunion, Rodrigues and São Tomé.

Habitat:—Terricolous to humicolous.

Threat:—Habitat destruction, known only from two localities on the island.

IUCN threat category:—EN[B2ab(iii)]

Specimens:—Saint-Benoît, Route de Saint-Benoît, terricolous in *Philippia* stands, 760 m, 12.01.1974, *Onraedt* 74.R.4334; Leg Rodriguez 225; Saint-Denis, zone de tamarin, 1600 m, 11.10.1962, *Een* R238.

32. *Plagiochila boivinii* Stephani (1902: 987)

Family:—Plagiochilaceae.

Distribution:—Madagascar and Réunion.

Habitat:—Humicolous, corticolous, lowland to montane, one locality on Réunion (Saint-Philippe).

Threat:—Major threat of habitat destruction and degradation.

IUCN threat category:—VU[D2]

Specimens:—Saint-Philippe, Réserve forestière de Mare-Longue, forêt primaire dégradée, épiphyte, 200 m, 18.12.1969, *Onraedt* 69.R.967; *Onraedt* 69.R.974; *Onraedt* 69.R.958; Route forestière de Mare Longue (Réserve naturelle), corticolous, 200 m, 07.03.1997, Arts; Sentier du Tremblet, épiphyte, 300 m, 18.12.1973, *Onraedt* 73.R6420; Massif du Piton de La Fournaise, Enclos Fouqué, Coulée 1700, corticolous (0-50 cm), 55°47,409' E, 21°S16,194' S, 220 m, *Ah-Peng et al. KIPA23C1R2*; 55°47,594' E, 21°S16,436' S, 190 m, *Ah-Peng et al. KIPA23C1R3*; *Ah-Peng et al. KIPA25C1R1*; corticolous (50-100 cm), *Ah-Peng et al. KIPB25C2R1*; *Ah-Peng et al. KIPB25C2R2*; *Ah-Peng et al. KIPB5C2R1*.

33. *Plagiochila flabellata* Stephani (1886: 82)

Family:—Plagiochilaceae.

Distribution:—Bioko, Cameroon, D.R. Congo, São Thomé, Seychelles, Tanzania and Réunion.

Habitat:—Rupicolous and terricolous.

Threat:—Major threat of habitat destruction and degradation in the lowland.

IUCN threat category:—EN[B2ab(iii)].

Specimens:—Three localities known for the island: Le Tampon, Plaine des Cafres, au Piton Desforges, sur bloc volcanique, 1550 m, 09.12.1969, *Onraedt* 69.R.828; rupicole, 09.12.1969, *Onraedt* 69.R.282; Source Rheillac, au sol, 15.01.1974, 1610 m, *Onraedt* 74.R.4335; Saint-Denis, zone de bois de couleur, 11.10.1962, 1500 m, *Een* R079.

34. *Plagiochila renauldii* Stephani (1904a: 156)

Family:—Plagiochilaceae.

Distribution:—Réunion and Mauritius.

Habitat:—Upper cloud forests, corticolous and humicolous at the base of trunks.

Threat:—This species has a narrow elevational range (1750 – 2518 m). The species may be sensitive to global warming.

IUCN threat category:—VU[D2]

Specimens:—Three localities known from Réunion: Cirque de Cilaos, betw. Petit Matarum—Gite

Caverne Dufour, subalpine ericaceous heath, between 1930 and 2518 m alt., 11.07.1996, 21°6'S 55°29.7-30.1'E, *Szabó 9640CS* (EGR); Saint-Benoît, GR Bélouve Piton des Neiges, 21°04'42S 55°31'42E, 1750 m, 29.03.2008, *Bardat & Chuah-Petiot 1750P1Q1TB1*; *Bardat & Chuah-Petiot 1750P1Q1TA3*.

35. *Plagiochila rodriguezii* Stephani (1890: 290)

Family:—Plagiochilaceae.

Distribution:—Comoros, Mauritius and Réunion.

Habitat:—Trunks in montane forests (500-1700 m), epiphyte, rupicolous.

Threat:—Rare species, habitat degradation in lowland and montane forest.

IUCN threat category:—VU[D2]

Specimens:—Cirque de Cilaos, sentier de la Caverne Dufour, epiphyte, 1700 m, 21/12/1973, *Onraedt 73.R.4315*; Commune de Saint-Denis, Route de la Montagne, sur rocher humide, alt. 500 m, 31/12/1973, *Onraedt 73.R.4331*; Plaine des Cafres, Le Piton Hyacinthe, sur très vieille souche, 1300 m, 6/10/1974, *Gimalac 74.R.8733*; Plaine des Cafres, bas fond du Piton Manuel, sur bloc de basalte, 1600 m, 03/02/1974, *Gimalac 74.R.8457*; Basse Vallée (Commune de Saint-Philippe), bottom SSW from the Gîte, submontane rainforest with *Pandanus purpureus*, 500-600 m, 18/07/1996, *Pócs 9656CD*; Cilaos, Réserve Biologique, 1200 m, 30/09/1962, *Een R020*.

36. *Porella prolixa* (Stephani 1910: 260) Jones (1963: 460)

Family:—Porellaceae.

Distribution:—Endemic.

Habitat:—Habitat unknown. The genus is rare in Africa, but the other African species occur at high altitude > 2000 m, as rupicolous or corticolous.

Threat:—Known only from type locality “Insula Bourbon, Icono Steph. 096289”. *Porella prolixa* appeared to be distinct from any other African species, none of which has apiculate leaves (Jones 1963).

IUCN threat category:—CR[B2ab(i)]

Specimen:—type: leg. Richard, *G 9645*, ex. Hb. Bescherelle.

37. *Schiffneriolejeunea parviloba* (Stephani 1890: 286) Gradstein (1974: 335)

Family:—Lejeuneaceae.

Distribution:—Mauritius, Réunion and Thailand.

Habitat:—Corticolous, lowland to montane.

Threat:—Only known from two localities on the island, of which one is threatened by natural destruction by the volcano.

IUCN threat category:—EN[B2ab(iii)]

Specimens:—Cilaos, Réserve Biologique, alt. 1200 m. (loc.2), 30.09.1962, *Een R064* (S); Cilaos, 100 m. above the village, alt. 1100 m. (loc.1), 29.09.1962, *Een R280* (S); Saint-Philippe, lava flow 1899, under block, 240 m alt., 21°16,673' S, 55°47,485' E, 15.06.2005, *Ah-Peng, Bardat & Strasberg 1900A1C1R2* (REU).

38. *Taxilejeunea furcicornuta* Grolle (1974: 93)

Family:—Lejeuneaceae.

Distribution:—Madagascar, Mauritius and Réunion.

Habitat:—Corticolous.

Threat:—Only two localities known.

IUCN threat category:—VU[D2]

Specimens:—Cirque de Mafate, Ravine de Bémale, sur fougère, 1260 m alt., 22/06/1975, *Gimalac* 75.R.1468 (BR); Takamaka, les hauts de la rivière des Marsouins (Saint Benoit), épiphyllé sur fougère, 790 m alt., 07/09/1971, *Onraedt* 71.R.9331 (BR); around the Cascade de l'Arc en Ciel, on mosses, 520-800 m, 21°14'S, 55°37-40'E, 1994, *Kis, det. Pócs, 9436/AV* (EGR, Pócs 1995: 261).

39. *Thysananthus spathulistipus* (Reinwardt et al. 1824: 212) Gottsche et al. (1845: 284)

Family:—Lejeuneaceae.

Distribution:—Africa (Cameroon, D.R. Congo, Gabon, Ghana, Ivory Coast, Madagascar, Mauritius, Nigeria, Réunion, Seychelles), Australia (Queensland) and SE Asia (Indochina, Malaysia) (Sukkharak 2011)

Habitat:—Forest, corticolous, on rotten branches and logs.

Threat:—One restricted locality on the island, in forest systems subject to invasions by *Psidium cattleyanum* and *Rubus alceifolius*. The species has not been found since 1973, despite inventories on the site. It is however cosmopolitan in distribution for the tropics.

IUCN threat category:—NT

Specimens:—Au Sud—Ouest de St-Benoît, entre le Grand Etang et la route, forêt de Bois de couleur de basse altitude, sur branchette, 400 m, 28.12.1973, *de Sloover 17855*; Sentier vers le Grand Etang, forêt humide, épiphyte, 200 m, 28.12.1973, *Onraedt 73.R.1387*.

TABLE 2: List of the threatened and near threatened species of this regional IUCN Red List of Réunion

CR	EN	VU	NT
- <i>Cololejeunea bosseriana</i>	- <i>Cheilolejeunea cordigera</i>	- <i>Amazoopsis gracilis</i>	- <i>Acanthocoleus</i>
- <i>Cololejeunea cuneata</i>	- <i>Cololejeunea bidentula</i>	- <i>Andrewsianthus aberrans</i>	- <i>madagascariensis</i>
- <i>Cololejeunea decemplicata</i>	- <i>Cololejeunea borbonica</i>	- <i>Calypogeia</i>	- <i>Asterella syngenesica</i>
- <i>Cololejeunea takamakae</i>	- <i>Drepanolejeunea</i>	- <i>mascarenensis</i>	- <i>Cheilolejeunea ecarinata</i>
- <i>Colura heimii</i>	- <i>mascarena</i>	- <i>Diplasiolejeunea</i>	- <i>Cololejeunea leloutrei</i>
- <i>Colura obesa</i>	- <i>Heteroscyphus</i>	- <i>cogoensis</i>	- <i>Frullania anderssonii</i>
- <i>Drepanolejeunea helenae</i>	- <i>grandistipus</i>	- <i>Microlejeunea</i>	- <i>Lepidolejeunea delessertii</i>
- <i>Geocalyx orientalis</i>	- <i>Plagiochila barteri</i> var.	- <i>strasbergii</i>	- <i>Lepidozia africana</i>
- <i>Haplolejeunea sticta</i>	- <i>valida</i>	- <i>Plagiochila boivinii</i>	- <i>Thysananthus spathulistipus</i>
- <i>Lopholejeunea minima</i>	- <i>Plagiochila flabellata</i>	- <i>Plagiochila renauldii</i>	
- <i>Lopholejeunea multilacera</i>	- <i>Schiffneriolejeunea</i>	- <i>Plagiochila rodriguezii</i>	
- <i>Lopholejeunea</i>	- <i>parviloba</i>	- <i>Taxilejeunea</i>	
- <i>paramultilacera</i>		- <i>furcicornuta</i>	
- <i>Porella proluxa</i>			
- <i>Xylolejeunea grolleana</i>			

40. *Xylolejeunea grolleana* (Pócs 1999: 285) He & Grolle (2001: 32)

Family:—Lejeuneaceae.

Distribution:—Madagascar and Réunion.

Habitat:—Decaying tree bark and rotten wood.

Threat:—Only known from one locality, very rare and when present scarce population.

IUCN threat category:—CR[B2ab(iii)].

Specimens:—One locality known, from two samples: Mare Longue Réserve Naturelle, on the S slope of Piton de La Fournaise, 21°21'0" S 55°44'32.7" E, lowland rainforest, 300 m alt. 8.09.2008, *Ellis & Wilbraham R08-71c*, Det. Ellis & Wilbraham; Mare Longue Réserve Naturelle, on decaying bark mixed with *Telaranea coactilis* (Spruce) J.J.Engel et G.L.Merr. and *Prionolejeunea grata* (Gottsche) Schiffn., 24.04.2005, *Ah-Peng R179*, det. Pócs.

Discussion

In this first Red List of liverworts and hornworts from Réunion, 327 species were assessed, of which one species is considered as regionally extinct (RE), 14 critically endangered (CR), eight endangered (EN), nine vulnerable (VU) and eight near threatened (NT) (Table 2, 3). The data deficient category counts 105 species of which 26 need more taxonomical work and 79 lack distribution data (Table 3, 4).

The least concern category represents the non-threatened liverwort and hornwort flora and counts 177 species for the island (Table 3). Two main habitats (corticolous and epiphyllous) host 58 % of the threatened species (CR, EN and VU categories) that were assessed for the island.

TABLE 3: Number of species of liverworts and hornworts assessed in this preliminary IUCN regional Red List and attributed categories.

	RE	CR	EN	VU	NT	LC	DDd	DDt	Total
Liverworts	1	14	8	9	8	177	79	26	322
Hornworts						3	2		5

The threats that the bryophyte flora encounters are mainly due to human population growth leading to urbanization, habitat degradation, destruction and loss, clearing of native forest for cattle farming in the uplands and more recently moss harvesting for horticultural purposes. As an example, the endemic *Pandanus* mountain thickets (900 - 1000 m) in the East of the island are presently highly threatened by growing urbanization. This habitat hosts more than 52 % of the vascular plant species endemic to the Mascarenes, and is particularly rich in both vascular and non-vascular epiphytes. The diversity of bryophytes in this habitat is still being revealed. *Sphagnum magellanicum* ssp. *magellanicum* was e.g. recently recorded as new for the island in this habitat (Ah-Peng *et al.* 2010a) and two new liverwort species are waiting to be described. Because the *Pandanus* mountain thickets are located outside the boundaries of the National Park and close to urbanized areas, their vulnerability is high, especially high since they do not serve any recreational purposes either. Consequently, the area is submitted to high pressures for land use.

TABLE 4: List of Species of the Data Deficient category for taxonomy (DDt) and for distribution (DDd)

Data Deficient for distribution (DDd)
<p><i>Allisoniella nigra</i> (Rodway) R.M.Schust., <i>Alobiellopsis heteromorpha</i> (Lehm.) R.M.Schust., <i>Anastrophyllum revolutum</i> Steph., <i>Aneura latissima</i> Spruce, <i>Anthoceros sambesianus</i> Steph., <i>Archilejeunea mauritiana</i> Lindenb. ex Steph., <i>Calypogeia bidentula</i> (F.Weber) Nees, <i>Calypogeia microstipula</i> (Steph.) Steph., <i>Cephalozia connivens</i> ssp. <i>fissa</i> (Steph.) Váňa, <i>Cephaloziella anthelioides</i> S.W.Arnell, <i>Cephaloziella umtaliensis</i> S.W.Arnell, <i>Ceratolejeunea diversicornua</i> (Steph.) Steph., <i>Ceratolejeunea floribunda</i> Steph., <i>Cheilolejeunea camerunensis</i> S.W.Arnell, <i>Cheilolejeunea cordistipula</i> (Steph.) Grolle ex E.W.Jones, <i>Cheilolejeunea decursiva</i> (Sande Lac.) R.M.Schust., <i>Cheilolejeunea intertexta</i> (Lindenb.) Steph., <i>Cheilolejeunea pocsii</i> E.W.Jones, <i>Chiloscyphus regularis</i> Steph., <i>Cololejeunea appressa</i> (A.Evans) Benedix, <i>Cololejeunea cardiocarpa</i> (Mont.) A.Evans, <i>Cololejeunea ceatocarpa</i> (Ångstr.) Steph., <i>Cololejeunea duvignaudii</i> E.W.Jones, <i>Cololejeunea duvignaudii</i> var. <i>papillata</i> Tixier, <i>Cololejeunea latilobula</i> (Herzog) Tixier, <i>Cololejeunea microscopica</i> (Taylor) Schiffn., <i>Cololejeunea microscopica</i> var. <i>africana</i> (Pócs) Pócs & Bern.-Lück., <i>Cololejeunea microscopica</i> var. <i>exigua</i> (A.Evans) Pócs, <i>Cololejeunea sintenisii</i> (Steph.) Pócs, <i>Colura digitalis</i> var. <i>mucronata</i> Pócs, <i>Cuspidatula contracta</i> (Reinw., Blume et Nees) Steph., <i>Cyathodium cavernarum</i> Kunze ex Lehm. et Lindenb., <i>Cylindrocolea</i> cf. <i>gittinsii</i> (E.W.Jones) R.M.Schust., <i>Diplasiolejeunea</i> cf. <i>rudolphiana</i> Steph., <i>Drepanolejeunea</i> cf. <i>angustifolia</i> (Mitt.) Grolle, <i>Drepanolejeunea cultrella</i> (Mitt.) Steph., <i>Exormotheca pustulosa</i> Mitt., <i>Folioceros fuciformis</i> (Mont.) D.C.Bharadwaj, <i>Frullania angulata</i> Mitt. var. <i>angulata</i>, <i>Frullania humberitii</i> Vanden Berghen, <i>Frullania usambarana</i> var. <i>reducta</i> Vanden Berghen, <i>Frullanoides tristis</i> (Steph.) van Slageren, <i>Herbertus juniperoideus</i> (Sw.) Grolle, <i>Jensenia spinosa</i> (Lindenb. et Gottsche) Grolle, <i>Jungermannia balfourii</i> Váňa, <i>Jungermannia renauldii</i> Steph., <i>Lejeunea exilis</i> (Reinw., Blume et Nees) Grolle, <i>Lejeunea isophylla</i> E.W.Jones, <i>Lejeunea leucosis</i> Besch. et Spruce, <i>Lopholejeunea quinquecarinata</i> Vanden Berghen, <i>Marchesia madagassa</i> Steph., <i>Marsupella emarginata</i> (Ehrh.) Dumort., <i>Marsupella subintegra</i> S.W.Arnell, <i>Mastigolejeunea auriculata</i> (Wilson) Schiffn., <i>Mastigolejeunea rhodesica</i> (Vanden Berghen) E.W.Jones, <i>Metzgeria consanguinea</i> Schiffn., <i>Metzgeria madagassa</i> Steph., <i>Metzgeria nudifrons</i> Steph., <i>Microlejeunea kamerunensis</i> Steph., <i>Plagiochasma eximium</i> (Schiffn.) Steph., <i>Plagiochasma rupestre</i> var. <i>volkii</i> Bischl., <i>Plagiochila angusta</i> Lindenb., <i>Plagiochila artsii</i> Pócs, <i>Plagiochila barteri</i> Mitt., <i>Plagiochila squamulosa</i> var. <i>crispulo-caudata</i> (Gottsche) Vanden Berghen, <i>Plagiochila squamulosa</i> var. <i>sinuosa</i> (Mitt.) Vanden Berghen, <i>Porella triquetra</i> (Steph.) E.W.Jones, <i>Radula carringtonii</i> J.B.Jack, <i>Radula quadrata</i> Gottsche, <i>Radula retroflexa</i> Taylor, <i>Riccardia compacta</i> (Steph.) S.W.Arnell, <i>Riccardia erosa</i> (Steph.) E.W.Jones, <i>Riccardia obtusa</i> S.W.Arnell, <i>Riccardia saccatiflora</i> (Steph.) S.W.Arnell, <i>Riccia helenae</i> Ast, <i>Riccia hortorum</i> Bory ex Lindenb., <i>Schiffneriolejeunea</i> cf. <i>fragilis</i> Gradst. et E.W.Jones, <i>Schiffneriolejeunea ferruginea</i> (Steph.) Gradst., <i>Solenostoma perloi</i> Gola, <i>Stictolejeunea balfourii</i> (Mitt.) E.W.Jones var. <i>balfourii</i>, <i>Wiesnerella denudata</i> (Mitt.) Steph.</p>
Data Deficient for taxonomy (DDt)
<p><i>Ceratolejeunea cornuta</i> (Lindenb.) Steph., <i>Ceratolejeunea variabilis</i> (Lindenb.) Steph., <i>Chiloscyphus lepervanchei</i> (Steph.) J.J.Engel et R.M.Schust., <i>Cololejeunea bebourensis</i> Tixier, <i>Cololejeunea xaveri</i> (Lacout. ex Steph.) E.W.Jones, <i>Fossombronina stephanii</i> Schiffn. ex Steph., <i>Frullania borbonica</i> Lindenb., <i>Gongylanthus scariosus</i> (Lehm.) Steph., <i>Lejeunea grossecristata</i> (Steph.) E.W.Jones, <i>Lopholejeunea borbonica</i> Gottsche ex Steph., <i>Lopholejeunea grandicrista</i> Steph., <i>Microlejeunea inflata</i> Steph., <i>Microlejeunea oblongistipula</i> (Gottsche) Pearson, <i>Nardia arnelliana</i> Grolle, <i>Odontoschisma africanum</i> (Pearson) Sim, <i>Plagiochila exigua</i> (Taylor) Taylor, <i>Plagiochila incerta</i> Gottsche, <i>Plagiochila pseudoattenuata</i> S.W.Arnell, <i>Riccardia nudiflora</i> (Steph.) Grolle, <i>Riccardia ramosissima</i> (Steph.) Grolle, <i>Riccardia</i> sp. (<i>Aneura caespitans</i> Steph.), <i>Riccardia</i> sp. (<i>Aneura comosa</i> Steph.), <i>Riccardia</i> sp. (<i>Aneura lepervanchei</i> Steph.), <i>Schiffneriolejeunea pappeana</i> var. <i>bidentata</i> Gradst. et Vanden Berghen, <i>Targionia lorbeeriana</i> Müll.Frib., <i>Tylimanthus africanus</i> Pearson.</p>

Other threats that need to be surveyed include modification of habitats on the island by invasive plants, global warming and natural destruction by the volcano. This latter is quite unique as a pressure that bryophytes can face, but not to be underestimated. Lava flows and their environment form an important habitat on Réunion and cover 13 % of the surface of the island. These habitats are characterized by the creation of randomly localized new lava flows and they host, at different successional vegetation stages, some restricted species that have not been found elsewhere on the island.

As their contribution to ecosystem services is important (biomass, water retention, nutrient cycling, nursery for other plants and microfauna, etc.), it is hoped with the production of tools like GIS maps, regional Red List, etc. that conservation planners will include bryophytes in their protocols, which remains the main challenge for the protection of these less known plants on the island. It is urgent to start with the protection of their habitats. Similarly as with other small organisms, bryophytes depend on the integrity of their habitats. Preserving their environments will ensure their perennity in ecosystems. A bryoflora of liverworts and hornworts of the Mascarene archipelago is in development by the first two authors. In the future, it will help in identifying these small plants, promote studies and inventories in these islands and thus increase the knowledge on the distribution of these species.

Acknowledgements

The use of the bryophyte GIS was possible due to funding from REAVOLC that covered the expenses to its elaboration and the BRYOLAT project (French Foundation for Research in Biodiversity) that transferred the distribution data of ecological studies to the data base. The elaboration of this regional Red List was supported by European funding FEDER (POE 3.21), the National Park of Réunion and the Regional Council of Réunion. We are grateful to Hermann Stieperaere for his collaboration to transfer the data of BM herbarium on Réunion bryophytes to our database. Tomas Hallingbäck, Uppsala, Itambo Malombe, Nairobi, and Anders Hagborg, Chicago, helped with valuable comments on the manuscript. The first author is grateful to the Claude Leon Harris foundation for a postdoctoral fellowship.

References

- Ah-Peng, C. (2007) *Diversité, distribution et biogéographie des bryophytes des coulées de laves du volcan Piton de la Fournaise (La Réunion, France)*. PhD, Université de La Réunion, Saint-Denis, 438 pp.
- Ah-Peng, C. & Bardat, J. (2011) *Microlejeunea strasbergii* sp. nov. (Lejeuneaceae) from Réunion Island (Mascarenes). *The Bryologist* 114: 668–673.
- Ah-Peng, C., Bardat, J., Ellis, L., Hedderson, T.A.J., Malombe, I., Matcham, H., Pócs, T., Porley, R., Séneca, A., Söderström, L. & Wilbraham, J. (2010a) Additions to the bryoflora of Réunion Island 3: new and interesting records from the Tropical Bryology Group (British Bryological Society). *Journal of Bryology* 32: 288–295.
- Ah-Peng, C., Bardat, J., Staménoff, P., Hedderson, T. & Strasberg, D. (2010b) Bryophytes de La Réunion: Diversité, endémicité et conservation. *Cryptogamie, Bryologie* 31: 241–270.
- Ångström, J. (1873) Förteckning och beskrifning öfver mossor, samlade af Professor N.J. Andersson under Fregatten Eugénies verdensomsegling åren 1851–53. IV.–VIII. *Öfversigt af Förhandlingar: Kongl. Svenska Vetenskaps-Akademien* 30(5): 113–151.
- Arnell, S. (1965) Hepaticae collected by Mr. Gillis Een in Mauritius and Réunion in 1962. *Svensk Botanisk Tidskrift* 59: 65–84.
- Asakawa, Y. (2004) Chemosystematics of the Hepaticae. *Phytochemistry* 65: 623–669.
- Bescherelle, E. & Spruce, R. (1889 [1891]) Hépatiques nouvelles des colonies françaises. *Bulletin de la Société Botanique de France* 36: 177–189.
- Bischler, H. (1970) Les espèces du genre *Calypogeia* sur le continent africain et les îles africaines. *Revue Bryologique et Lichénologique* 37: 63–134.
- Bory de St Vincent, J.B.G.M. (1804) Voyage dans les Quatre Principales Îles des Mers d'Afrique. T. II. Paris, 431 pp.
- Caujapé-Castells, J., Tye, A., Crawford, D.J., Santos-Guerra, A., Sakai, A., Beaver, K., Lobin, W., Florens, V.F.B.,

- Moura, M., Jardim, R., Gûmes, I. & Kueffer, C. (2010) Conservation of oceanic island floras: Present and future global challenges. *Perspectives in Plant Ecology, Evolution and Systematics* 12: 107–129.
- Engel, J.J. & Smith Merrill, G.L. (2004) Austral Hepaticae. 35. A taxonomic and phylogenetic study of *Telaranea* (Lepidoziaceae), with a monograph of the genus in temperate Australasia and commentary on extra-Australasian taxa. *Fieldiana: Botany, n.s.* 44: 1–265.
- Fordham, D.A. & Brook, B.W. (2010) Why tropical island endemics are acutely susceptible to global change. *Biodiversity and Conservation* 19: 329–342.
- Frahm, J.-P. (2010) Additions and corrections to the moss flora of Réunion. *Archives for Bryology* 60: 1–16.
- Gauvin-Bialecki, A., Ah-Peng, C., Smadja, J. & Strasberg, D. (2010) Fragrant volatile compounds in the liverwort *Drepanolejeunea madagascariensis* (Steph.) Grolle: Approach by the HS-SPME technique. *Chemistry and Biodiversity* 7: 639–648.
- Gottsche, C.M. (1857) Pugillus Novarum Hepaticarum e recensione Herbarii Musei Parisiensis, congestus. *Annales des Sciences Naturelles; Botanique, sér. 4* 8: 318–348.
- Gottsche, C.M., Lindenberg J.B.G. & Nees von Esenbeck C.G. (1845) Synopsis Hepaticarum, fasc. 2. Hamburg, pp. 145–304.
- Gradstein, S.R. (1974) Studies on Lejeuneaceae subfam. Ptychanthoideae. I. Nomenclature and taxonomy of *Ptychocoleus*, *Acrolejeunea* and *Schiffneriolejeunea*. *Journal of the Hattori Botanical Laboratory* 38: 327–336.
- Grolle, R. (1963) Zwei Gattungen der Lophoziaceae neu für Afrika. *Transactions of the British Bryological Society* 4: 437–445.
- Grolle, R. (1974) Eine neue *Taxilejeunea* aus Madagaskar und Reunion. *Journal of Bryology* 8: 93–96.
- Grolle, R. (1975) *Haplolejeunea* aus Madagaskar - Eine weitere neue Gattung der Tuyamaelloideae. *Journal of the Hattori Botanical Laboratory* 39: 203–210.
- Grolle, R. (1977) Miscellanea Hepaticologica 161–170. *Journal of Bryology* 9: 529–538.
- Grolle, R. (1984) Miscellanea Hepaticologica 221–230. *Journal of the Hattori Botanical Laboratory* 55: 501–511.
- Grolle, R. & Onraedt, M. (1974) Lebermoose aus Madagaskar und den Maskarenen (1). *Lindbergia* 2: 230–233.
- Hallingbäck, T., Hodgetts, N., Raeymaekers, G., Schumacker, R., Sérgio, C., Söderström, L., Stewart, N. & Vána, J. (1998) Guidelines for application of the revised IUCN threat categories to bryophytes. *Lindbergia* 23: 1–12.
- Hallingbäck, T. & Hodgetts, N. (2000) *Mosses, Liverworts, and Hornworts. Status survey and Conservation Action Plan for Bryophytes*. IUCN, Gland, Switzerland and Cambridge, U.K., 106 pp
- Harinantenaina, L., Kurata, R., Takaoka, S. & Asakawa, Y. (2006) Chemical constituents of Malagasy liverworts: Cyclomyltaylanoids from *Bazzania madagassa*. *Phytochemistry* 67: 2616–2622.
- He, X.-L. & Grolle, R. (2001) *Xylolejeunea*, a new genus of the Lejeuneaceae (Hepaticae) from the Neotropics, Madagascar and the Seychelles. *Annales Botanici Fennici* 38: 25–44.
- Herzog, T. (1947) Hepaticae von der Comoreninsel Johanna. *Botaniska Notiser* 1947: 317–334.
- Hilton-Taylor, C. (2000) *2000 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland, xviii + 61 pp.
- Huntley, B.J., Matos, E.M., Aye, T.T., Nermark, U., Nagendran, C.R. & Seyani, J.H. (1998) *Inventory, evaluation and monitoring of botanical diversity in Southern Africa: a regional capacity and institution building network (SABONET)*. SANBI, Pretoria, South Africa, 73 pp.
- Infante, M., Heras, P. & Pócs, T. (1999) Bryophytes from the Republic of Equatorial Guinea (West Central Africa). V. *Diplasiolejeunea cogoensis* sp. nov. *Tropical Bryology* 17: 9–12.
- IUCN (2010) *Guidelines for using the IUCN Red List Categories and Criteria. Version 8.1 (August 2010)*. Prepared by the Standards and Petitions Subcommittee in March 2010. Downloadable from <http://intranet.iucn.org/webfiles/doc/SSC/RedList/RedListGuidelines.pdf>.
- Jones, E.W. (1953) African hepatics. II. *Leptocolea* with hyaline-margined leaves. *Transactions of the British Bryological Society* 2: 144–157.
- Jones, E.W. (1954) African hepatics. X. *Leptocolea* and *Cololejeunea*. *Transactions of the British Bryological Society* 2: 408–438.
- Jones, E.W. (1963) African hepatics. XVI. *Porella* in tropical Africa. *Transactions of the British Bryological Society* 4: 446–461.
- Jovet-Ast, S. (1954) Le genre *Colura*, Hépatiques, Lejeunéacées, Diplasiae. *Revue Bryologique et Lichénologique* 22: 206–312.
- Kruijt, R.C. (1988) A monograph of the genera *Dicranolejeunea* and *Acanthocoleus*. *Bryophytorum Bibliotheca* 36: 1–136.
- Lagabrielle, E., Rouget, M., Payet, K., Wistebaar, N., Durieux, L., Baret, S., Lombard, A. & Strasberg, D. (2009) Identifying and mapping biodiversity processes for conservation planning in islands: A case study in Réunion Island (Western Indian Ocean). *Biological Conservation* 142: 1523–1535.
- Lehmann, J.G.C. (1832) *Novarum et Minus Cognitarum Stirpium Pugillus quartus quem Indici Scholarum in Gymnasio Academico Hamburgiense Anno Scholastico 1832 habendarum*. Hamburg: Meissner, 64 pp.
- Magill, R.E. (2010) Moss diversity: New look at old numbers. *Phytotaxa* 9: 167–174.

- Montagne, J.F.C. (1843) Quatrième centurie de plantes cellulaires exotiques nouvelles, décades I–VI. *Annales des Sciences Naturelles; Botanique, sér. 2* 19: 238–266.
- Pócs, T. (1980) The epiphytic biomass and its effect on the water balance of two rain forests types in the Uluguru Mountains (Tanzania, East Africa). *Acta Botanica Scientiarum Hungaricae* 26:143–167.
- Pócs, T. (1997) New or little known epiphyllous liverworts. VII. Two new Lejeuneaceae species from the Mascarene Islands. *Cryptogamie: Bryologie, Lichénologie* 18: 195–205.
- Pócs, T. (1999) *Trachylejeunea grolleana*, a new representative of the Neotropical subgenus *Hygrolejeuneopsis* in Madagascar. *Hausknechtia, Beiheft* 9: 283–290.
- Reinwardt, C.G.C., Blume, C.L. & Nees von Esenbeck, C.G. (1824) Hepaticae Iavanicae, editae coniunctis studiis et opera. *Nova Acta Physico-Medica Academiae Caesareae Leopoldino-Carolinae Naturae Curiosorum* 12: 181–238.
- Sabovljević, M., Cvetić, T & Stevanović, V (2004) Bryophyte Red List of Serbia and Montenegro. *Biodiversity and Conservation* 13: 1781–1790.
- Schiffner, V. (1893) Hepaticae (Lebermoose). In: Engler E. & Prantl K. (eds.), *Die Natürlichen Pflanzenfamilien*. Leipzig: Engelmann.
- Schiffner, V. (1910) Über die Gattungen *Chiloscyphus* und *Heteroscyphus* n. gen. *Österreichische Botanische Zeitschrift* 60: 169–173.
- Schuster, R.M. (1963) An annotated synopsis of the genera and subgenera of Lejeuneaceae. I. Introduction; annotated keys to subfamilies and genera. *Beihefte zur Nova Hedwigia* 9: 1–203.
- Stephani, F. (1886 “1887”) Hepaticae africanae. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 8: 79–95.
- Stephani, F. (1890) Hepaticae africanae novae in insulis Bourbon, Maurice et Madagascar lectae. *Botanical Gazette. Crawfordsville, Chicago* 15: 281–292.
- Stephani, F. (1896) Hepaticarum species novae IX. *Hedwigia* 35: 73–140.
- Stephani, F. (1902) Species Hepaticarum 2. *Bulletin de l'Herbier Boissier, sér. 2* 2: 969–987.
- Stephani, F. (1904a) Species Hepaticarum 2. *Bulletin de l'Herbier Boissier, sér. 2* 4: 153–168.
- Stephani, F. (1904b) Species Hepaticarum 2. *Bulletin de l'Herbier Boissier, sér. 2* 4: 584–601.
- Stephani, F. (1910) Species Hepaticarum 4. Genève & Bale, pp. 97–464.
- Stephani, F. (1912) Species Hepaticarum 5. Genève & Bale, pp. 1–176.
- Stephani, F. (1916) Species Hepaticarum 5. Genève & Bale, pp. 849–1008.
- Stephani, F. (1922) Species Hepaticarum 6. Genève, pp. 241–368.
- Strasberg, D., Rouget, M., Richardson, D.M., Baret, S., Dupont, J. & Cowling, R.M. (2005) An assessment of habitat diversity and transformation on La Réunion Island (Mascarene Islands, Indian Ocean) as a basis for identifying broad-scale conservation priorities. *Biodiversity and Conservation* 14: 3015–3032.
- Sukkharak, P. (2011) Taxonomy and Phylogeny of the liverwort genus *Thysananthus* (Marchantiophyta: Lejeuneaceae). Ph.D., Georg-August-Universität Göttingen, Göttingen, 189 pp.
- Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press, Cambridge.
- Tixier, P. (1977 [1979]) La famille des Cololejeuneoideae Grolle dans l'océan Indien occidental. *Bulletin Trimestriel de l'Académie Malgache, n.s.* 55: 173–247.
- Tixier, P. (1985) Contribution à la connaissance des Cololejeunoideae. *Bryophytorum Bibliotheca* 27: 1–440.
- Vanden Berghen, C. (1981) Le genre *Plagiochila* (Dum.) Dum. (Hepaticae) à Madagascar et aux Mascareignes, principalement d'après les récoltes de M. Onraedt. *Bulletin du Jardin Botanique National de Belgique* 51: 41–103.
- Vanden Berghen, C. (1984a) Lejeuneaceae (Hepaticae) nouvelles de La Réunion: *Marchesinia obtusifolia* sp. nov. et *Cheilolejeunea ecarinata* sp. nov. *Bulletin du Jardin Botanique National de Belgique* 54: 7–14.
- Vanden Berghen, C. (1984b) Le genre *Lopholejeunea* (Spruce) Schiffn. (Lejeuneaceae, Hepaticae) en Afrique. *Bulletin du Jardin Botanique National de Belgique* 54: 393–464.
- Villarreal, J.C., Cargill, D.C., Hagborg, A., Söderström, L. & Renzaglia, K.S. (2010) A synthesis of hornwort diversity: Patterns, causes and future work. *Phytotaxa* 9: 150–166.
- von Konrat, M., Söderström, L., Renner, M.A.M., Hagborg, A., Briscoe, L. & Engel, J.J. (2010) Early Land Plant Today (ELPT); How many liverwort species are there? *Phytotaxa* 9: 22–40.
- Wilbraham, J. (2009) Bryophytes and volcanoes: La Réunion. *Field Bryology* 97: 24–31.
- Zhu, R.-L. & Grolle, R. (2003) On the genus *Capillolejeunea* (Lejeuneaceae, Hepaticae) from the East African islands. *Systematic Botany* 28: 467–470.