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A review of the conservation status of the threatened western Indian Ocean island tree *Pisonia sechellarum* (Nyctaginaceae)

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Abstract: The status of the tree *Pisonia sechellarum* F. Friedmann (Nyctaginaceae) endemic to the western Indian Ocean is reviewed. Five populations have been located: four in the Seychelles Islands (three on Silhouette Island and one on Mahé) and one on Mayotte. The species is associated with montane forest and ravine habitats and the genetic identity of different populations remains to be investigated. This species is considered to be endangered.

Keywords: Conservation status, Mayotte, Nyctaginaceae, *Pisonia*, Seychelles, tree.

French Abstract: Le status de *Pisonia sechellarum* F. Friedmann (Nyctaginaceae), arbre endémique de l'Océan indien occidental, est révisé. Cinq populations sont maintenant connues, quatre dans les îles seychelloises (trois à Silhouette et une à Mahé) et une à Mayotte. Cette espèce croit dans les forêts d'altitude et près des cours d'eau. Des travaux génétiques seraient utiles pour préciser l'identité de chacune de ces populations. Cette espèce est considérée en danger.

Mots clés: Arbre, Mayotte, *Pisonia*, status de conservation, Seychelles.

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Author Details and Contribution: Justin Gerlach - Scientific Cooridnator of Nature Protection Trust of Seychelles, has carried out research on all aspects of the biodiversity of the Seychelles islands since 1986, including all the ecological surveys of the *Pisonia sechellarum* forest. Lead author of the manuscript. Bruno Senterre, PhD in agronomy science, at the Université Libre de Bruxelles, is specialized on the study of vegetation types in tropical environments. He also worked on phytogeography of central Africa, functional ecology, island ecosystems and taxonomy. He is currently consultant mostly for the government of Seychelles and United Nations Development Programme (UNDP). Fabien Barthelat is a botanist and a public agent that has worked for the French ministry of agriculture from 2000 to 2007 in Mayotte where he was inventorying the flora in collaboration with the "Muséum National d'Histoire Naturelle" of Paris. Then he was working for the national forest department in Guadeloupe (French West Indies) and he was seconded to IUCN in 2010 to implement projects in the Caribbean.

INTRODUCTION

Pisonia sechellarum F. Friedmann is a moderately sized tropical tree confined to the islands of the western Indian Ocean. According to Friedmann (1994) it is thought to be related to the Indo-Pacific *P. umbellifera* (J.R. Forster & G. Forster) Seemann but there have been no detailed studies of its affinities to date. As with many of the plants of the region its survival is considered to be threatened by invasive species. In the context of the western Indian Ocean islands its 20m height is relatively large, and it is a locally significant component of the forest canopy. The species was discovered in 1986 from one small area of Silhouette Island (Friedmann 1986). Subsequently (in 2009 and 2012) two more populations were discovered on the island, on the slopes of Mont Dauban (Senterre & Nolin pers. obs. 03 November 2009) and Mont Pot à Eau (Senterre pers. obs. 27 November 2012). A sterile specimen from Mahé island (Morne Blanc) from 1874 appeared to be this species but this could not be confirmed by Friedmann (1994). Nevertheless, this record was confirmed in 2010 when a group of local botanists explored a steep ravine close to Morne Blanc and observed a single plant, still sterile but definitely belonging to the species *P. sechellarum* (Chong-Seng & Senterre pers. obs. 24 October 2010). It is now known not to be a Seychelles endemic, being also found on the main island of Mayotte (Barthelat & Boullet 2005).

In 1990 the main population (known as the 'Pisonia forest') was the focus of a three-month ecological study which identified plant and animal diversity of the site, estimated the number of trees and investigated the reproductive ecology of *P. sechellarum* (OUSE 1990). During this study only one potential pollinator species was identified, an undescribed species of heliodinid moth, *Epicroesa* sp. This moth was observed visiting flowers and ovipositing in them. Larvae of the moth were found to feed on developing fruit resulting in 100% fruit loss in 1990 (Floater 1995). The lack of recruitment was considered to be a threat to the long-term survival of the species, with most trees apparently originating as suckers from a small number of parent trees. As with other *Pisonia* species, this tree produces sticky fruits which are presumed to be adapted to bird dispersal. The fruits are larger than those of most *Pisonia* (around 4cm) and no dispersal agent has been identified.

Prior to the discovery of the Mahé, Mayotte and smaller Silhouette populations this tree was considered to be Endangered on the basis of its restricted range and small population, and the presence of invasive species (Ismail et al. 2011). The new discoveries require a re-evaluation of its status. The available data are collated here, combined with monitoring data for the main population gathered over 20 years.

Recorded populations

The populations (marked on Fig. 1) are defined as:

1. *Pisonia* forest (4^{0}28'54S & 55^{0}14'01E) - This was the first population to be discovered (in 1986). It is the main Silhouette population in the Anse Mondon Valley, found at 450–550 m. *P. sechellarum* is the dominant tree at this site.

2. South of Mont Pot à Eau (4^{0}29'02S & 55^{0}14'13E) - This population was discovered in November 2012 in a ravine near the "*Pisonia* forest". This is an extensive *P. sechellarum* dominated forest similar in size and composition to the "*Pisonia* forest". It extends from 496–557 m.

3. Above Grande Barbe (4^{0}29'03S & 55^{0}13'55E) - The population above Grand Barbe was located in 2009. It is found towards the southern slopes of Mont Dauban, in the upper part of the Rivière Quatre Cent (410m elevation). In this area, many small ravines are running southwards down from the slopes of Mont Dauban, with much smaller granite boulders than in the "Pisonia forest", which may explain why it does not form a distinct forest type like in the *Pisonia* forest. No detailed inventory has been done, but the two botanists who discovered it estimated that fewer than ca. 10 trees were present. All were sterile and rather small, i.e. less than 10m high. Other species observed in this new locality included several rare species found in the "*Pisonia* forest", e.g. *Tectaria* species.

4. Morne Blanc (4^{0}39'19S & 55^{0}25'56E) - The population of Morne Blanc is limited to only one individual tree observed in 2010 in a very similar habitat to the "*Pisonia* forest", i.e. a very steep ravine with large granite boulders at 475m elevation. Nevertheless, the local botanists who found it could not explore the difficult terrain further, and no other expedition has been organised to return to this site.

5. Mayotte, Réserve Forestière de Majimbini (12^{0}46'10S & 45^{0}10'42E) - on Mayotte, this species was first collected in 2003. The first identified locations was in the Réserve Forestière de Majimbini where few specimens of *P. sechellarum* are found at 400–500 m on a river side in a humid forest with *Grisollea myrianthea* Baillon, *Labramia mayottensis* Labat, Pignal & O. Pascal, *Cynometra floretii* Labat & O. Pascal, *Marattia fraxinea* Sm. ex J.F.Gmel and also the invasive *Syzygium jambos* (L.) Alston.

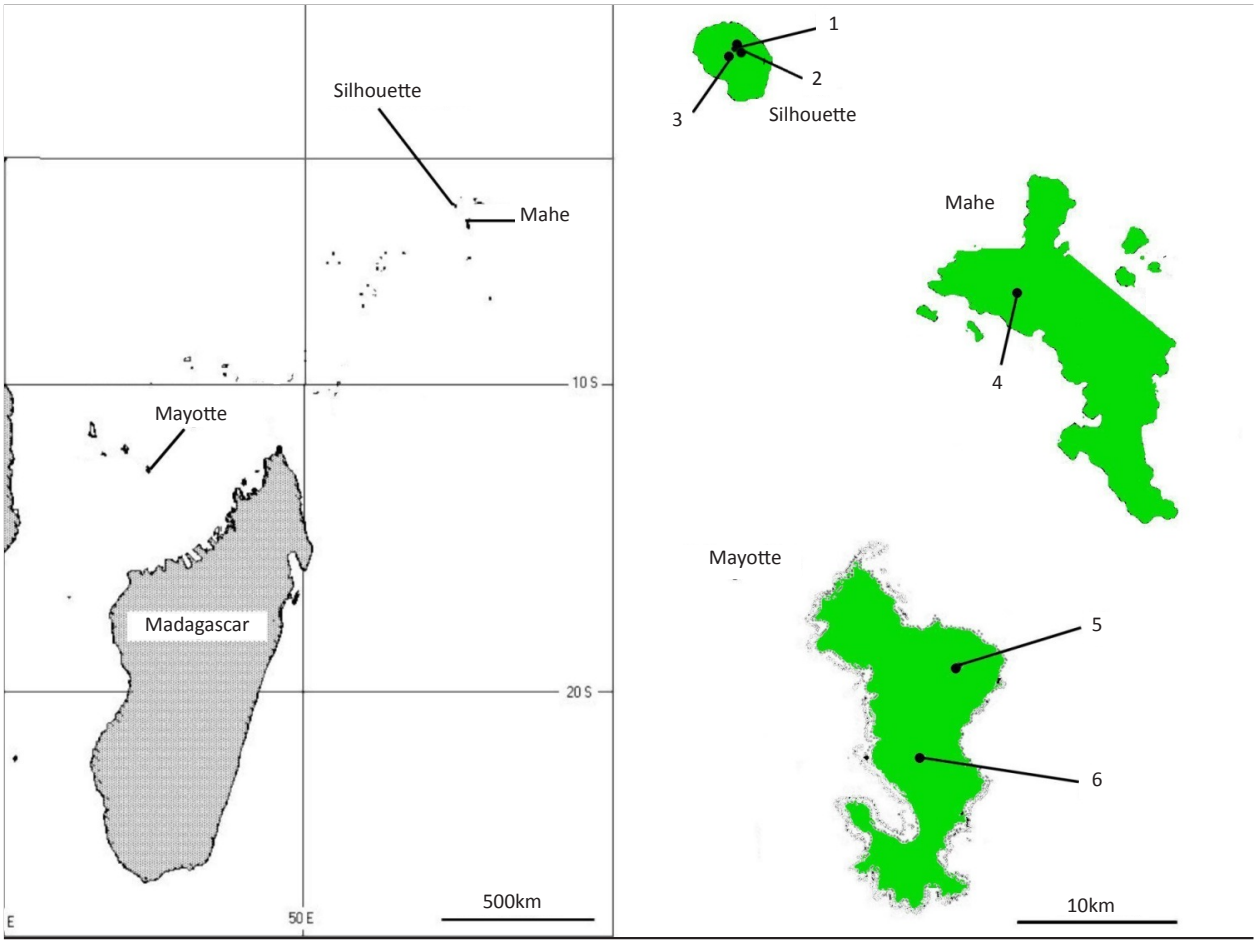

Figure 1. Location of the populations. 1 - *Pisonia* forest; 2 - south Mont Pot à Eau; 3 - above Grande Barbe; 4 - Morne Blanc; 5 - Réserve Forestière de Majimbini; 6 - Réserve Forestière des Crêtes du Sud

6. Mayotte, Réserve Forestière des Crêtes du Sud (12^{0}51'29S & 45^{0}09'01E) - The second known location is a single tree and situated in the Réserve Forestière des Crêtes du Sud (foothill of the Tchourembo) at 350–400 m. This tree is found in a disturbed place alongside indigenous and exotic plants including *Mangifera indica* L. and *Litsea glutinosa* (Lour.) C.B. Robinson. However, the slopes of this mountain are little studied; it is possible that more trees occur in the "rocky" humid forest of the slopes. Basaltic boulders are present in both known locations. The identification of the Mayotte trees was confirmed by F. Friedmann and they have been referred to in literature (Barthelat & Boullet 2005) but not discussed in detail. The Conservatoire Botanique National de Mascarin is carrying out an inventory of the Réserve Forestière de Majimbini.

METHODS

The only site to have been studied in detail is the *Pisonia* forest on Silhouette Island. This site was studied in 1990, 2000 and 2010. In 1990 the forest was mapped, with forest boundaries being defined as the outermost *P. sechellarum* trees known at the time. Subsequently, some isolated trees have been located outside this boundary but these are sparse and the boundary remains a reasonable definition of the area. A transect of 180m length was taken down the centre of the valley and used as a reference line for all studies. This line was not straight due to the extremely rocky nature of the terrain, but provides a reference line rather than a true line of orientation. Climatic factors (temperature and humidity) were recorded at a fixed point at the top of the line throughout July–September 1990.

The number and size of trees was studied in 10x10 m quadrats at 10 points along the transect line. In each quadrat all the trees over 1.5m tall were counted.

This was repeated in the top section in 2000 and 2010. Tree heights were measured by trigonometry with a clinometer and four trees were measured in each of three areas along the transect line. This was carried out once, in 1990.

Vegetation was determined using 2x2 m quadrats along the line, spaced 2m apart. Every 2m along the line two quadrats were surveyed either side of the line, giving a total of 130 quadrats and totalling 520m^2. In each quadrat the percentage of ground covered by each species was recorded. This was repeated in 2010 using the upper 10 original points. These could be accurately relocated as the position of the transect line in the upper section was well defined by the trees and rocks used to secure the line in 1990.

Canopy cover was investigated by taking 10 photographs from the upper vegetation quadrat points. The camera was positioned vertically at head height and a 35mm lens was used to photograph the canopy. The resultant digital photograph was converted to a black and white image and the number of black and white pixels counted (analysed in Gimp), giving a percentage of cover. This was calculated for 1993 and 2010.

Analysis

Changes in the cover of each plant species in the two surveys of the *Pisonia* forest were evaluated using a paired sample t-test of the arcsine transformed percentage cover, following tests for normality and homoscedasticity, the transformed data were confirmed to show a normal distribution. Numbers of *Pisonia* trees were not normally distributed and were compared using a Wilcoxson matched pair test.

Surveys

Surveys of potentially suitable sites were carried out on all islands in attempts to locate further populations of *P. sechellarum*. The species is associated with steep boulder filled ravines above 500m and most of these areas have been visited. On Silhouette all the larger ravines have been examined. On Mahé more ravines exist and surveys are not fully complete. The areas surveyed comprise the ravines around Morne Blanc, Congo Rouge and Morne Seychellois, Mont Coton and Pérard (two ravines explored, others remain unexplored) and Montagne Planneau (extensively explored, but many ravines are difficult to access and remain unexplored).

Image 1. *Pisonia sechellarum* forest showing habit of a large tree in centre.

RESULTS

***Pisonia* forest (Image 1)**

The area defined as the *Pisonia* forest on Silhouette covers 4820m^2. The additional isolated trees expand this area to about 5500m^2. *P. sechellarum* were recorded from 446–560 m. In this site in July–September 1990 temperature remained in the range 18–26 ^{0}C with a mid-day mean of 23^{0}C and humidity ranged between 84–100 % with a mid-day mean 93%. The 1990 study estimated the density of *Pisonia* trees at 410±50 per hectare, giving an estimated 190 trees within the *Pisonia* forest. Height decreased down the line with means and standard deviations varying from 23±0.6 m (0–40 m), to 21±1.5 m (80–120 m) and 13±2.25 m (120–180 m). The tallest tree measured was 24m tall. The full list of plant species recorded at the site is given in Appendix I and the distribution of the main species is shown in Fig. 2.

No significant change was found in the number of *P. sechellarum* trees, or most other species, between 1990 and 2010. The only significant changes in

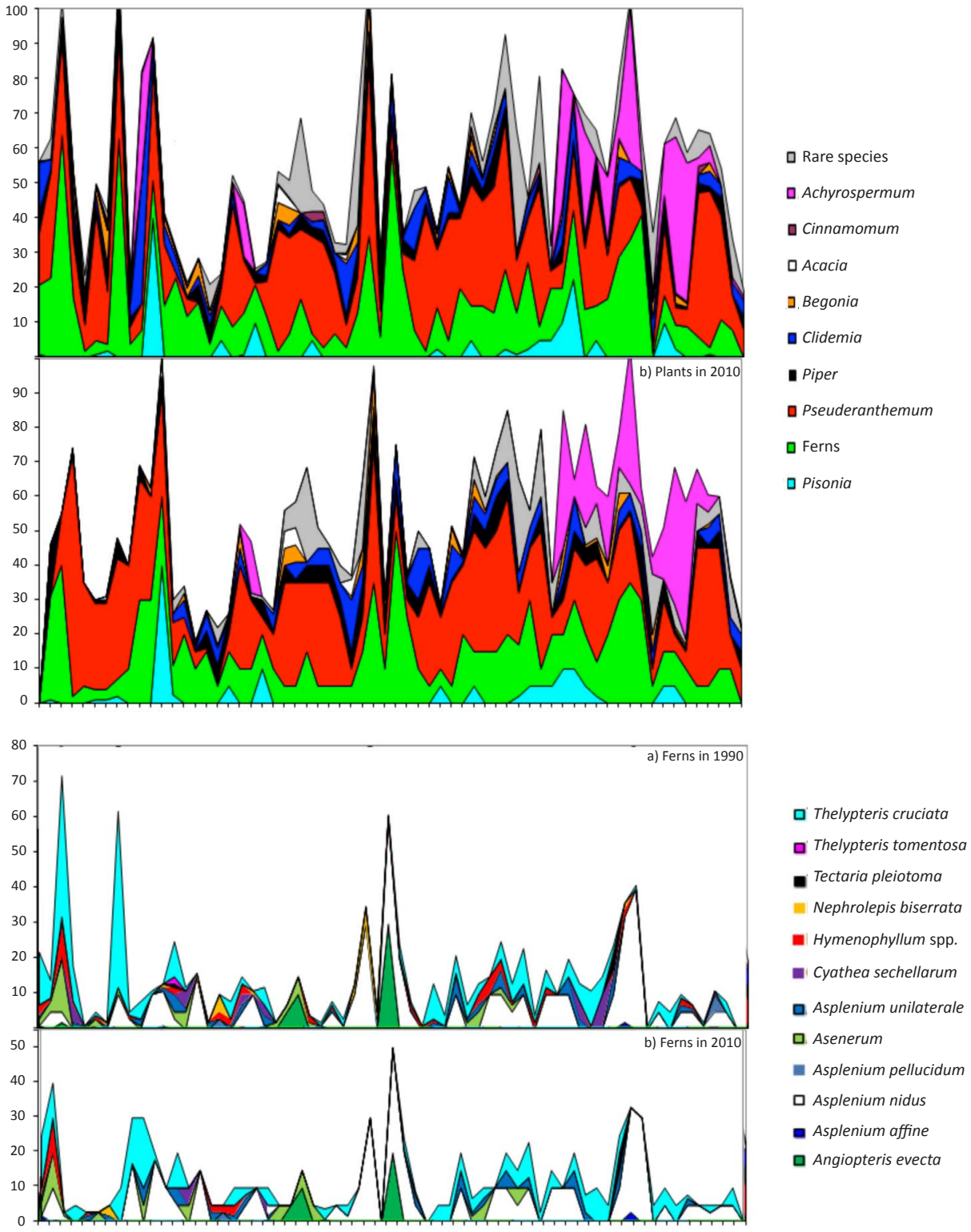

Figure 2. Ground vegetation cover in the *Pisonia* forest, showing percentage cover along the transect line. 'Rare species' are those that formed no more than 5% cover in any quadrat.

plant cover throughout the forest were a decrease in *Cinnamomum verum* Presl (0.758–0.001, t=2.460, $P_{(2)59}$<0.05) and *Dracaena reflexa* Lam. (1.531–0.001, t=2.808, $P_{(2)59}$<0.01). In the top section of the forest four species disappeared from quadrats: *Clidemia hirta* (L.) D. Don (from 4.313; t=2.952, P<0.01), *Ci. verum* (from

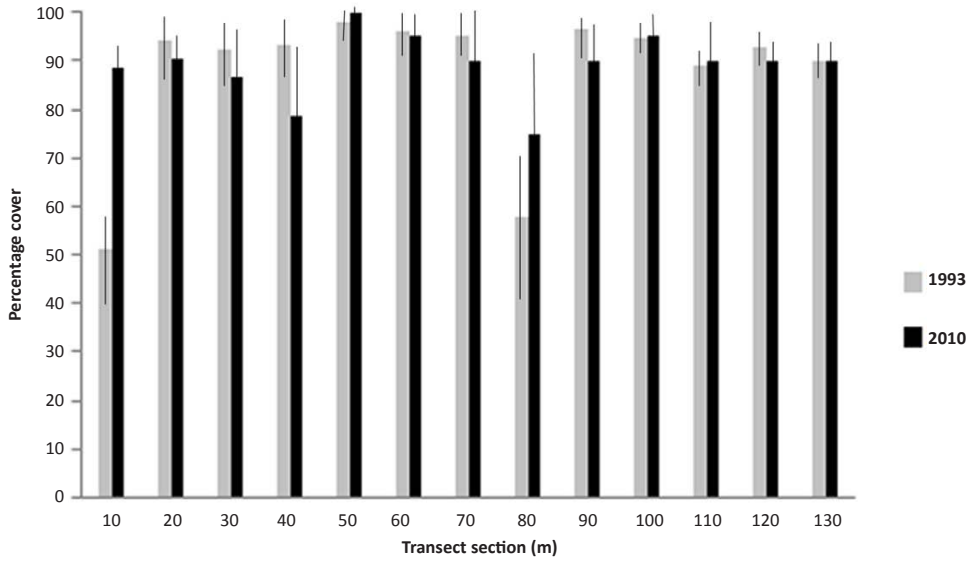

Figure 3. Canopy cover along the transect, showing a significant increase in cover at the top of the transect, but no change elsewhere.

0.688; t=2.460, $_{(2)9}$<0.05), *D. reflexa* Lam. (from 2.313, t = 2.808, $P_{(2)9}$<0.05) and *Begonia seychellensis* Hemsl. (from 2.188; t = 1.898, $P_{(2)9}$>0.05). The decrease in cover of *Cl. hirta* and *Ci. verum* seedlings in the top sections of the transect (Fig. 2) may be related to shading due to increased canopy cover in this area (Fig. 3).

Seedlings of *P. sechellarum* were not located in 1990 but were observed subsequently. A single seedling was found in 2003 at the top edge of the forest and five found scattered throughout the forest in 2011.

South Mont Pot à Eau

The number of trees in this site is not known, it is estimated to be similar to the *Pisonia* forest (at least 100 trees). Several saplings under 2m tall were observed. The flora is similar to that of the *Pisonia* forest but apparently lacks *Piper seychellarum* Gerlach and *Psychotria silhouettae* F. Friedmann.

Above Grande Barbe (Image 2)

About 5–10 individuals ranging in size from 5–8 m high. Surrounding vegetation consists of closed forest, mostly submontane but with elements of montane forests, typically associated with small ravines. Two *Tectaria* were observed plus the endemic *Impatiens gordonii* Horne ex Baker, among other rare species, but no detailed species inventory was made.

Morne Blanc

One tree 4–6 m high. Surrounding vegetation open, with sparse tree cover, in a very steep ravine with big granite boulders, just at the foot of a cliff; the ravine extended westwards but could not be explored. No detailed inventory has been made for associated species. Nevertheless, one of the *Tectaria* species found in the two sites of Silhouette was also observed here.

Image 2. *Pisonia sechellarum* plant above Grande Barbe.

Mayotte (Image 3)

No quantitative data are currently available for Mayotte.

DISCUSSION

The population of *P. sechellarum* is stable in the "*Pisonia* forest" on Silhouette island. Some change in vegetation composition in the site has been recorded

Image 3. *Pisonia sechellarum* of Mayotte
a - fruit; b - male flowers; c - female flowers; d - habit

since 1990 but this is attributable to a local effect of increased canopy cover. The number of mature trees has remained unchanged and some successful recruitment has been observed (contrary to earlier suggestions that seed predation by the endemic *Epicroesa* sp. moth was preventing any regeneration (Floater 1995)).

The other Seychelles populations are very poorly known and may be larger than recorded here. However, searches for *P. sechellarum* have been undertaken in many other montane ravines on Mahé without success. It therefore seems to be extremely rare on that island. The second largest Silhouette population (south of Mont Pot à Eau) is similar in importance to the "*Pisonia* forest". The third population, on the southern slopes of Mont Dauban, contains two distinct sites in two adjacent ravines. This may be a significant population due to the abundance of many such ravines running down the slopes of Mont Dauban. Nevertheless, these ravines are all much smaller than in the "*Pisonia* forest" and the Mont Dauban population may be less healthy than the upper Anse Mondon one. Small populations may also exist in the numerous and poorly explored ravines of the northern side of Mont Dauban.

Pisonia sechallarum can probably be regarded as a "montane" species, with the Mont Dauban stand being at its lower elevation limit. It is known that a number of montane species can occur at lower elevation in ravines (Senterre et al. 2009). The genetic identity of the geographically widely separated and morphologically varied Seychelles and Mayotte populations need to be investigated.

Red List status

Pisonia sechellarum is currently listed on the IUCN Red List as Endangered on the basis of criterion D (population size estimated to number fewer than 250 mature

individuals) and threatened by invasive plant species. At the time of the Red List assessment only the main population was known. Although the new data result in dramatic increases in the known range (Area of Occupancy from 0.05–5 km^2 and Extent of Occurrence from 0.05–20,000 km^2), they do not significantly change the threat status of the species, with a Seychelles population of around 200–300 individuals and an unknown number on Mayotte. The population structure is precarious with only six populations (with at least one probably not being viable) and there is a decline in habitat quality in most sites due to the impacts of invasive species. This would qualify the species for Endangered status on the basis of restricted range B2 (small Area of Occupancy) subcriteria a (only five viable subpopulations) and b(iii) (deteriorating habitat): Accordingly *P. sechellarum* should be regarded as Endangered (B2 a, b(iii)).

Conservation needs

Conservation of *P. sechellarum* requires the continued protection of the known populations (all are within protected areas and are currently safe from any development or logging threats) and control of invasive species. Invasive species are not causing significant problems to the main population at present but do need control in the other four sites. Wider invasive species management and habitat restoration is also needed as the populations are isolated by a combination of natural restriction due to their association with boulder fields and by areas of heavily degraded habitat.

The limited recruitment of the species should be investigated; predation by the Seychelles endemic *Epicroesa* moth is a natural process and does not completely prevent set of viable seed in the *Pisonia* forest, but it is not known whether this contributes to the lack of significant recruitment elsewhere. As many of the mature trees appear to have grown from suckers or from fallen branches, and this growth strategy is known in other *Pisonia* tree species it should be relatively easy to propagate for ex situ conservation and augmentation of the more restricted populations. There is an urgent need to create a viable population on Mahé near the single Morne Blanc tree. This could be supplemented by cuttings from Silhouette but should be preceded by thorough searches of the remaining unexplored sites on Mahé in order to maintain any genetic distinction between the island populations. Genetic research into the distinctiveness of the Mahé, Silhouette and Mayotte populations should also be undertaken, including an analysis of genetic diversity within the populations.

Appendix I. List of plant species recorded in the *Pisonia* forest on Silhouette

Native species
Acanthaceae: *Pseuderanthemum subviscosum* (C.B. Clarke) Stapf.
Araliaceae: *Schefflera procumbens* (Hemsl.) F.Friedmann
Asclepiadaceae: *Tylophora coriacea* Marais
Begoniaceae: *Begonia sechellensis* Hemsl.
Convolvulaceae: *Merremia peltata* (L.) Merr.
Flacourtiaceae: *Ludia mauritiana* Gmelin
Flagellariaceae: *Flagellaria indica* L.
Hypoxidiaceae: *Hypoxidia rhizophylla* (Baker) F.Friedmann
Labiatae: *Achyrospermum sechellarum* Baker
Mimosaceae: *Acacia pennata* Willd.
Moraceae: *Ficus bojeri* Baker
Ficus reflexa Thunb.
Ficus lutea Vahl
Trilepisium madagascariense DC.
Nyctaginaceae: *Pisonia sechellarum* F. Friedmann
Orchidaceae: *Goodyeria sechellarum* (S. Moore) Omerod
Arecaceae: *Phoenicophorium borsigianum* (K.Koch) Stuntz
Verschaffeltia splendid H. Wendl
Pandanaceae: *Pandanus sechellarum* Balf.f.
Passifloraceae: *Adenia gummifera* (Harv.) Harms
Piperaceae: *Piper seychellarum* J. Gerlach
Rubiaceae: *Amaracarpus pubescens* Blume
Psychotria pervillei Baker
Psychotria silhouettae F. Friedmann
Pyrostria bibracteata (Baker) Cavaco
Tarenna sechellensis (Baker) Summerh.
Sapindaceae: *Allophylus pervillei* Blume
Sapotaceae: *Northia seychellana* Hook.f.
Stemonuraceae: *Grisollea thomasseti* Hemsl
Ulmaceae: *Trema orientalis* (L.) Blume
Urticaceae: *Pellionia latifolia* (Blume) Boerl.

Pteridophyta:
Aspleniaceae: *Asplenium herpetopteris* Baker
Asplenium nidus L.
Asplenium pellucidum Lam.
Asplenium tenerum G.Forst
Asplenium unilateralae Lam.
Cyatheaceae: *Cyathea sechellarum* Mett.
Davalliaceae: *Nephrolepis biserrata* (Sw.) Schott
Hymenophyllacae: *Hymenophyllum fumarioides* Willd.
Hymenophyllum hygrometricum (Poir.) Desv.
Marattiaceae: *Angiopteris evecta* (G. Forst.) Hoffm.
Tectariaceae: *Tectaria pleiotoma* C. Chr.
Thelypteridaceae: *Thelypteris cruciata* (Willd.) Tardieu
Thelypteris tomentosa (Thouars) Tardieu

Bryophyta: Musci
Acanthorrhynchium decolor (Besch.) M. Fleisch.
Aerobryidium subpiligerum (Hampe) Cardot
Aerobryopsis wallichii (Brid.) M. Fleisch.
Pelodictyon vallis-gratiae (Hampe ex Müll. Hal.) Kuntze
Distichophyllum mascarenicum Besch.
Leucomium strumosum (Hornsch.) Mitt.
Leucophanes angustifolium Renauld & Cardot
Porotrichum elongatum (Welw. & Duby) A. Gepp

Invasive species
Begoniaceae: *Begonia ulmifolia* Willd.
Fabaceae: *Falcataria moluccana* (Miq.) Barneby & J.W.Grimes
Labiatae: *Pogostemon heyneanus* Benth.
Lauraceae: *Cinnamomum verum* Presl
Myrtaceae: *Syzygium aromaticum* (L.) Merr. & L.M.Perry.
Melastomataceae: *Clidemia hirta* (L.) D. Don

REFERENCES

Barthelat, F. & V. Boullet (2005). Index de la flore vasculaire de Mayotte - Version 2005-1, pp. 103–197. In: Rolland, R. & V. Boullet (coord.). *Mayotte, Biodiversité et évaluation patrimoniale, Contribution à la mise en œuvre de l'inventaire ZNIEFF*. Document DAF - CDM, Mamoudzou et CBNM, Saint-Leu.

Barthelat F., M. M'changama & B.A. Sifari (2007). Atlas de la flore protégée. DAF de Mayotte, 51pp.

Floater, G.J. (1995). Seed predation and flower visiting by *Epicroesa* sp. (Lepidoptera: Heliodinidae) on a rare Seychelles tree. *Phelsuma* 3: 31–40.

Friedmann, F. (1986). Flowers and Trees of Seychelles. Editions Delroisse forest Department of Finance, Seychelles

Friedmann, F. (1994). Flore des Seychelles: Dicotylédones. Editions de l'Orstom, Paris

Ismail, S., M.J. Huber & J. Mougal (2011). *Pisonia sechellarum*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>. Downloaded on 30 April 2012.

OUSE (1990). Oxford University Silhouette Expedition 1990. Final Report, Unpublished.

Senterre, B., J. Gerlach, J. Mougal & D. Matatiken (2009). Old growth mature forest types and their floristic composition along the altitudinal gradient on Silhouette island (Seychelles) - the telescoping effect on a continental mid-oceanic island. *Phytocoenologia* 39(2): 157–174; http://dx.doi.org/10.1127/0340-269X/2009/0039-0157