Kapisen

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The roles of animals in habitat rehabilitation

The Roles of Animals in Habitat Rehabilitation

Dear Kapisen readers,

In Seychelles we have long been aware that rehabilitation of habitats should serve both plants and animals. Rehabilitation projects on small islands, such as the one on North Island (p. 16), aim to create an ark for endemic plants and for animals such as the Seychelles White-eye. Less discussed are the roles that animals may play *for* habitat rehabilitation. Animals can greatly help us in this endeavour – or pose additional challenges…

An obvious example of animal involvement is that of birds and fruit bats transporting fruits and thereby dispersing seeds. It has been calculated that Seychelles Bulbuls may carry around several 100 tons of fruit mass per year on Mahé alone! Research reported on page 3 indicates that Bulbuls effectively disperse both native and invasive plants however, so they can be a crucial factor for the reestablishment of native vegetation, or bring the worst invasive species to a freshly restored site…

Transport of pollen is even more important for successful plant reproduction. If a plant is not pollinated, it cannot produce viable seeds or offspring: a fact that was experienced by Seychellois who had to hand-pollinate Vanilla flowers in order to obtain the valuable seed pods (p. 13). Pollen is often transported by animals such as insects or – particularly on oceanic islands – lizards. Dennis Hansen shows in his article (p. 4), that rare endemic plants profit from growing close to Vakwa shrubs (*Pandanus* spp.), because that is where Phelsuma geckos hide from their predator – the Kestrel. However, not only the presence of certain species but also the overall vegetation structure can influence the activities of animal pollinators, which may have important implications for vegetation rehabilitation, as demonstrated by Christopher Kaiser on page 6.

Rats are known to affect vegetation in Seychelles – both on the granitic islands (p. 12) and on Aldabra (p. 10). However, even rat impacts on vegetation can be rather complex. Christa Mulder presents on page 9 an example where the most relevant rat impacts may be indirect, through impacts on seabird colonies. In her example rats may also have both positive and negative direct impacts, predating both native and invasive species. This dual role was also observed in Seychelles (p. 12) and mirrors that of the seed dispersing birds mentioned before. The issue of rat impacts on vegetation is very relevant to the ongoing North Island Rehabilitation Project, where rats have been successfully eradicated for over a year now (p. 16).

Last but not least, we report from major advances in a core field of PCA: the conservation of endemic plants in Seychelles. A Red Data assessment of all endemic woody plants has just been completed (p. 15); and using the case of the unique endemic Jellyfish tree PCA member Denis Matatiken shows in his MSc thesis how detailed conservation biology studies can complement the information of a Red Data assessment for supporting concrete conservation action of the most threatened plants (p. 14).

In 2007 PCA will celebrate its 5th anniversary: It will be a year to look back on achievements and to plan future actions! We are looking forward to another successful year for plant conservation in Seychelles!

Meyer ve pou lannen 2007!

Eva Schumacher, Katy Beaver & Christoph Kueffer

Editors

The electronic version of Kapisen can be ordered from boga@seychelles.net or downloaded from www.plantecology.ethz.ch/publications/books/kapisen

Photo front cover:
Plants & Geckos in Mauritius:
A male *Phelsuma cepediana* gecko approaching a flower of *Trochetia blackburniana* (Malvaceae) by climbing down its long, thin stalk (D Hansen).

Content

Bulbuls Love Food Imports From Overseas

By Christoph KUEFFER[1], Lilian KRONAUER[1*], Perley CONSTANCE[2], Rodney FANCHETTE[2], James MOUGAL[2], Gérard ROCAMORA[3]

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Seed dispersal is vital for the survival of plants. Often juveniles have a lower survival chance close to their parents because competition with the mother plant or siblings is high or the mother plant is a source of pathogens and herbivores that may attack nearby juveniles. And, of course, only through dispersal can plants colonize new areas. This is especially important for rare plants after major habitat destruction, as has been the case for the endemic plants of the Seychelles. Many of them survived only in small pockets – for instance on inselbergs, locally called 'glacis'. Only through effective dispersal will they be able to enlarge their growing areas and their population sizes again. Similarly, effective dispersal enables invasive plants to invade the forests of the Seychelles. For instance, the recently introduced Fo Watouk (*Clidemia hirta*) is spreading very fast even into remote areas such as the mountain forest of Congo Rouge because it is dispersed by birds.

In Seychelles, the majority of plant species is dispersed by animals; today mainly by two endemic and one alien bird and one endemic fruit bat species. While Blue Pigeons, Indian Mynah and Fruit Bats are probably important in dispersing seeds over longer distances, it is particularly the Seychelles Bulbul (see Fig. 1) that disperses seeds within forest patches and from the inselbergs to the surrounding forest. Bulbuls probably disperse seeds over relatively short distances. In an experiment described below, it took a seed eaten by a Bulbul an average of only 15 minutes from the ingestion to the moment it was dropped. Seychelles White-eyes are also good seed dispersers over short distances (Rocamora & François, 2000), but they are currently very rare.

We were interested to investigate how the Seychelles Bulbul may influence the composition of the vegetation. If they preferentially eat (and disperse) fruits of certain species, these species might benefit. If Bulbuls mainly eat local food (i.e. native species) it is good news for habitat rehabilitation, but if they prefer imported food (i.e. invasive species) it might be bad news. To investigate our question we compared the characteristics of fruits of a number of native and invasive woody species, and fed them to Seychelles Bulbul in captivity (Kronauer 2005, Kronauer & Kueffer 2004).

The fruit analysis showed that invasive species produce fruits of higher nutritional quality than the native species of the Seychelles. This was mainly due to a lower water content, resulting in a higher relative content of valuable dry fruit flesh per total fruit weight (so called relative yield), and they had also a higher energy content, and a tendency for higher sugar and fat contents. Cinnamon produces fruits of particularly high fat and protein content. The fat content was about 30-times higher in Cinnamon fruits than a fruit of a typical endemic species. It was therefore no surpirse to observe that in the food selection experiment in which individuals of the Bulbul were presented with a choice of fruits (see Fig. 2), the fruits of Cinnamon were preferred over those of all native trees except one (Bwa rouz, *Dillenia ferruginea*). So, Bulbuls seem to prefer imported fruits over local food. For the same reason, many humans love Burgers and Ice-Cream: fat and sugar… More research will have to show why Bulbuls love some native trees such as Bwa rouz.

Fig. 1 Seychelles Bulbul (*Hypsipetes crassirostris*) in captivity (L Kronauer).

Perhaps because it is abundant and the birds know it? And we will need to check the preference for native species in the field. For instance, Bwa merl (*Aphloia theiformis*) is often eaten by Bulbul in the field (as the name suggests), but was not liked in the experiment. Maybe, the fruit quality was not good enough after transportation from the field to the cage. In any case, these favoured native fruit species may be a

first priority for replanting in rehabilitation projects because of their effective dispersal and utility for the native birds.

The presence of high quality fruits of invasive species in the forests of Seychelles can have both negative and positive impacts on native plant populations (Kueffer 2006). If the native plants are in competition

Fig. 2 The setup of the food selection experiment with a Cinnamon fruit on the left and a Bwa rouz fruit on the right. (L Kronauer)

with invasive species for seed dispersers, i.e. if the Bulbuls eat and disperse mainly invasive species, then the native species could suffer from reduced seed dispersal. On the other hand, by permitting higher densities of frugivore species, the fruit production of invasive species may also promote dispersal of native plants and assure the survival of frugivorous endemic birds. By the early 19th century, much of the granitic Seychelles was deforested. At that time, probably the fruit production of Cinnamon and other alien fruit trees, that were quickly invading the deforested land and were planted in gardens, acted as alternative food sources and assured the survival of the endemic frugivorous species. Without Cinnamon, Guava, Jambrosa, Ylang Ylang and other imported fruits, the Blue Pigeons, Bulbuls and Fruit Bats might have become very rare like many other endemic birds in Seychelles…

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Plants and Geckos – and How They Interact

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The islands of the western Indian Ocean are famous for their rich endemic biodiversity. Including Madagascar, there are thousands of plant species found nowhere else. Also, there has been a radiation of endemic diurnal geckos of the genus *Phelsuma*, which comprises some 35–40 species. We are aware that these beautiful and colourful geckos interact with plants by crawling on them, feeding on insects hiding between the leaves, laying their eggs in hollow stems, and generally by making the plants their home. However, are there any other ways in which plants and geckos interact?

A recent study documented that lizards on islands (often) feed on nectar and fruits much more than lizards on mainlands (Olesen & Valido 2003). This could be because there are less insects on islands than on mainlands, so the otherwise insectivorous lizards have to broaden their diet to survive – or may be because there are less pollinating animals around, leaving the nectar unharvested and available for alternative flower visitors. Or, of course, it could be due to a combination of different reasons.

This suggests that on some Indian Ocean islands, *Phelsuma* geckos may be important pollinators or seed dispersers. Pollination and seed dispersal are two very important ecosystem processes, without which many tropical forests would slowly die. Many plants depend on animals to transfer pollen so that fruits can set, and once the fruits are ripe they often need to be dispersed away from the mother tree before the seeds can germinate. Most *Phelsuma* species are relatively small, which limits the size of fruits they can eat, and thereby limits which seeds they can disperse. However, the incredible climbing skill of geckos enables them to visit all kinds of flowers for nectar, even if the flowers are at the end of a long stalk (Fig. 1). Therefore, they are potentially good pollinators of many different flowering plants, and

Fig. 1 A male *Phelsuma cepediana* gecko visiting a flower of *Trochetia blackburniana* (Malvaceae) (D Hansen).

their rough scales are indeed well-suited to transport pollen grains from flower to flower. However, unlike many other pollinating animals (e.g. bats, bees, birds, butterflies), geckos cannot fly. Thus, their efficiency as pollinators is likely to be constrained to relatively smaller distances within the ecosystem.

One of the main focuses of my PhD was to study gecko pollination and seed dispersal of several endemic plants in Mauritius. After observing the plants and geckos for many hours, I realised that the geckos were not evenly distributed within a habitat. Just like you and me, they like to have a good, secure home. I found that dense patches of spiky *Pandanus* plants – also called Pandans or Vacoas – were much preferred by the geckos, and many more individuals were found in such places than anywhere else. Pandans probably offer several advantages compared to other vegetation types: firstly, the

Fig. 2 A male *Phelsuma cepediana* gecko hiding between the spiky *Pandanus* leaves (D Hansen).

geckos' main predator, the Mauritius kestrel, will probably not want to fly into the tangled mess of spiky leaves – and the geckos are thus safer there than anywhere else (Fig. 2). Secondly, the rich mosaic of sun and shade within a patch of Pandans facilitates easy thermoregulation for the geckos – if they are too hot, they only need to move a few centimetres to be in the shade and vice versa. Thirdly, the densely packed rosettes of leaves offers a superb egg-laying site for the geckos, and I have often found their eggs glued into the very narrow leaf axils – where even the omnipresent rats cannot get to them!

Pandans therefore offer the geckos a good home – from which the geckos might not want to stray too far. In turn, this could mean that gecko-pollinated plants which are growing *close* to Pandan patches may be visited more often, and so receive more pollen and

Fig. 3 A male *Phelsuma cepediana* gecko licking the sweet nectar of *Roussea simplex* (Rousseaceae), thereby pollinating it (D Hansen).

therefore get a higher fruit set. But how far away from Pandans would this positive effect extend? On Ile aux Aigrettes, a small islet off the south-east coast of Mauritius, a recent study showed that within one day, *Phelsuma ornata* geckos were observed at different places up to 80 metres apart, but that the vast majority of geckos were observed at spots no more than 5 to 10 metres apart (Nyhagen et al. 2001).

We could therefore expect gecko-pollinated plants to do better in terms of fruit set if they grow within 5-10 metres of Pandan patches. This is indeed what I found for two gecko-pollinated endangered endemic plants in the upland heath areas in Mauritius – *Trochetia blackburniana* (Malvaceae) (Fig. 1) and

Roussea simplex (Rousseaceae) (Fig. 3) (Hansen 2006, Hansen et al. in press). Both plant species received far more visits by geckos if they grew within 10 metres of Pandan patches, than if they grew more than 20 metres away. Consequently, the plants that grew close to Pandans had a much higher fruit set than plants growing far from Pandans.

These results highlight that indirect interactions between plants via pollinators are just as important as the direct interactions between a plant and its pollinator. Furthermore, these results demonstrate that Pandans are important in structuring ecological interactions by being favoured microhabitats for day geckos – and that we need to understand and preserve the *interactions* between species just as much as the species themselves.

Acknowledgements

I want to thank the Mauritius National Parks and Conservation Service and the Mauritian Wildlife Foundation, and my supervisor Christine Müller and my colleague Chris Kaiser, for help, support and friendship during the last many years!

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Habitat Restoration in Mauritius: Adding Pollinators to the Equation

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The unique fauna and flora of Mauritius have been subject to a wave of extinctions since human colonisation about 400 years ago. To counteract the continuous degradation of native habitat and to preserve the highly endangered flora of the island, the governmental National Parks and Conservation Service (NPCS) and a local NGO, the Mauritian Wildlife Foundation (MWF) restore the native habitat by hand-weeding invasive alien plant species within 11 fenced plots (Conservation Management Areas, CMAs), totalling an area of approximately 44 ha. Recent surveys have reported a slow but gradual regeneration of native plant species in these areas (Mauremootoo *et al.* in press). However, as habitat restoration in Mauritius aims to restore whole ecosystems, it is crucial to understand whether, by restoring the original flora, native animals and their interactions will also find their way back into these areas. In particular, pollination and seed dispersal are essential for natural plant regeneration but, so far, there is little information on the effect of the restoration management on such plant–animal interactions in Mauritius and elsewhere (Fig. 1).

At Pétrin, a 6-ha CMA harbours a part of the remnants of highly diverse heathland-type habitat, which was formerly widespread in the uplands of Mauritius. About 40% of plant species in the CMA are either endangered or critically endangered. Regular weeding of invasive plants within the CMA has created a habitat structure which is highly distinct from the surrounding degraded plant assemblages (Fig 2). Invasive species form an impenetrable thicket with a uniform, dense vegetation structure, which dominates the unrestored area despite having a similar native plant species composition to the restored area. However, it is unclear whether such differences in habitat structure also affect pollinator diversity. If so, does the latter result in increased plant reproduction? Are all animals and their interactions affected equally? And finally, because we are interested in restoring native communities, are the pollinators native or introduced to Mauritius?

To understand these processes, I observed pollinators of all flowering plant species in Pétrin CMA and in

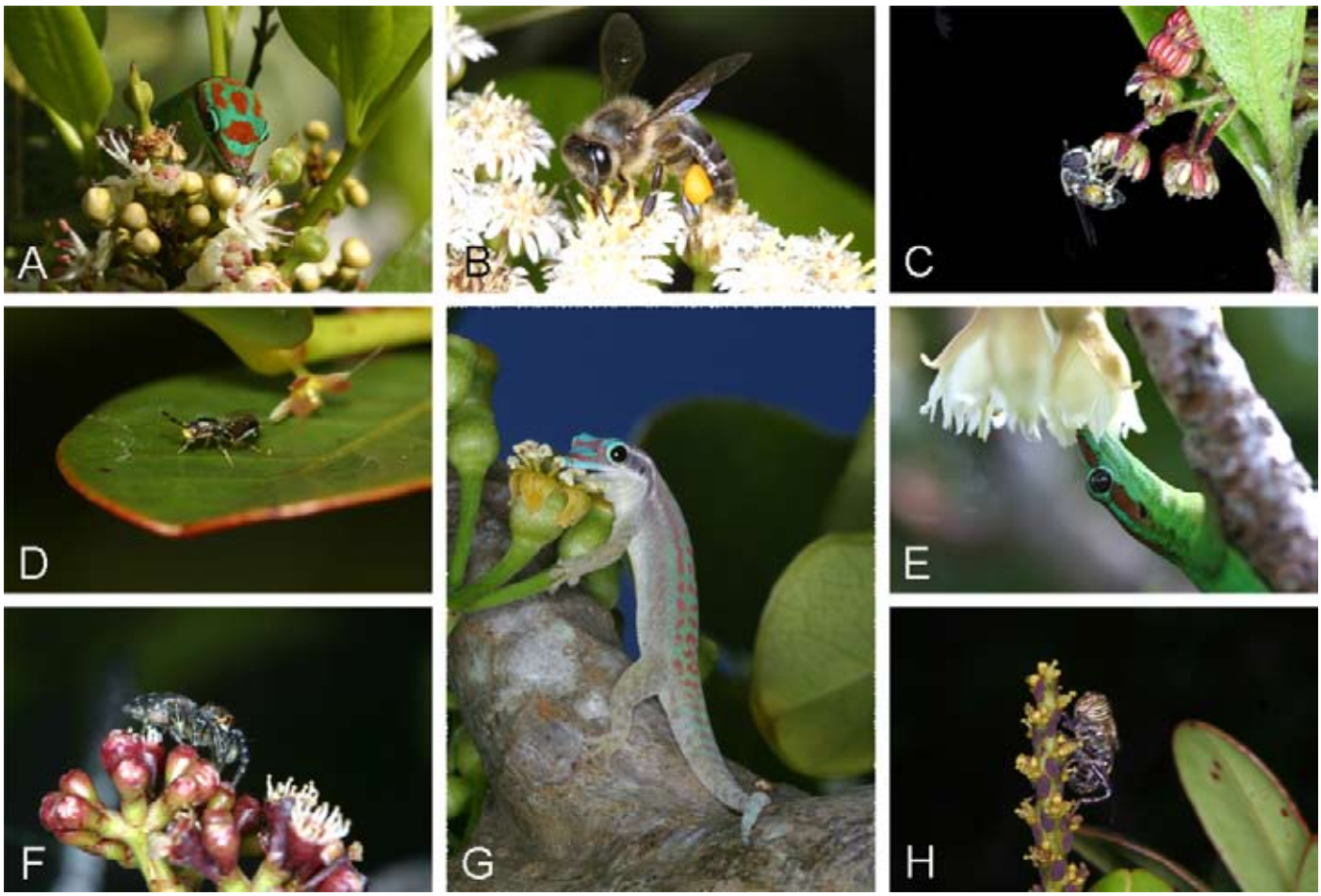

Fig. 1 Flower visitors of native plant species in Mauritius, primarily in Pétrin CMA. A: *Phelsuma cepediana*, blue-tailed day gecko, on *Molinaea alternifolia* (Sapindaceae); B: *Apis mellifera*, honey bee, on *Psiadia terebinthina* (Asteraceae); C: *Paragus borbonicus*, hover fly, on *Dodonaea viscosa*; D: *Eurytonidae sp 1*, parasitic wasp, on *Phyllanthus phillyreifolius* (Euphorbiaceae) E: *Phelsuma cepediana* on *Labourdonnaisia calophylloides* (Sapotaceae, photograph by D. Hansen) F: Spider on *Syzygium coriaceum* (Myrtaceae) G: *Phelsuma ornata*, ornate day-gecko, on *Gastonia mauritiana* (Araliaceae, on Ile aux Aigrettes) H: *Eristalinus flaveolus* (Syrphidae) on *Stillingia lineata* (Euphorbiaceae) (C. Kaiser).

a neighbouring invaded area. Pollinator species richness was 25% higher in the restored habitat and the number of interactions between pollinators and flowering plants was almost double that of the unrestored area. Of several common plant species in both sites, 57% performed better in the restored site, suggesting that habitat restoration improved reproductive success, possibly partly due to an increase in pollination quantity and quality.

We found a few very common pollinators and many relatively rare ones, i.e. approximately half of the pollinator species visited less than two flowers. This pattern was even more prominent when comparing the two sites. For example, the endemic day gecko *Phelsuma cepediana* was a frequent flower visitor in the CMA (Fig. 1A, C), but visited only a total of five flowers of three plant species in the unrestored area. This was also the case for introduced species: the invasive yellow-footed ant *Technomyrmex albipes* visited flowers of twice as many plant species in the restored compared to the unrestored area (Kaiser 2006).

Overall, the vast majority of common pollinator species observed in our study are not native to Mauritius. Species introductions have occurred both deliberately, for example the honey bee *Apis mellifera*, or accidentally, such as the widespread fly *Stomorhina lunata*. What are the implications of our finding for the native plant and pollinator community of Mauritius? The lack of co-evolved adaptation between native plants and introduced pollinators may result in less effective pollination. In addition, introduced flower visitors which successfully compete with native pollinators for floral resources may cause their displacement to lower quality resources and ultimately their extinction.

Mutualistic partners benefit from each other. For example pollinators act as pollen carrier between flowers and, in return, receive floral resources, such as pollen and nectar, as reward. Similarly,

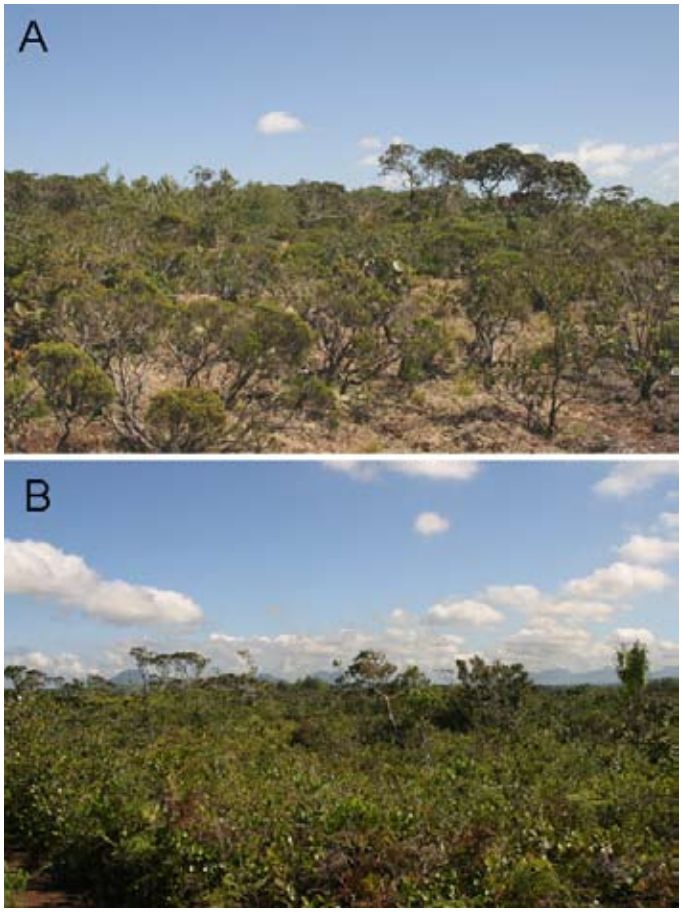

Fig. 2 Heathland habitat in (A) Pétrin Conservation Management Area (CMA) without invasive plant species, and (B) adjacent to Pétrin CMA, heavily degraded by invasive plants. Note the open structure in the CMA and the dense thicket of mainly *Psidium cattleianum* in the unrestored habitat (C. Kaiser).

avian seed dispersers feed on fruits and seeds and transport them away from the mother tree either in their beaks or guts, allowing the plant to disperse propagules over a large distance. Both processes ensure natural plant reproduction and maintain viable plant population size. However, the role of pollinators and other mutualists, such as seed dispersers, in habitat restoration has been largely neglected. The results of this study suggest that restoration schemes may act on several levels: first, through reducing direct competition for natural resources between native and invasive plants, and second, through reducing indirect competition for pollinators between neighbouring plants. Flowers of invasive plants can be very attractive to pollinators, which can result in fewer visits of the same pollinators to flowers of neighbouring native plants (Chittka & Schürkens 2001). By eradicating invasive plants, the risk of such competition between plant species is reduced and natural regeneration of native plants is likely to increase. Consequently, conservationists have to account for such interactions and have to consider the possibility that introduced animals may substitute now extinct native pollinators. Much more effort is required into habitat restoration in Mauritius, preferably into restoration schemes which preserve habitat structure to sustain high levels of pollinator diversity. Finally, the success of such restoration schemes can only be assessed by monitoring species diversity of both plant and animal species and by ensuring the long term sustainability of ecological interactions.

Acknowledgements

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After the Sweep: Will Removing Rats from Islands Result in Restoration?

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Rats have been and continue to be extremely effective invaders of oceanic islands. Over the past two decades there has been an enormous increase in the number of islands on which introduced predators, particularly rats, have been eradicated. These successful eradications give rise to hope that such islands can be restored to a state resembling that prior to invasion – but is that realistic? Our study of seabird islands in New Zealand focuses on detecting the effects of rats on island vegetation and soil processes, including what happens when rats are removed. Here I describe what we have discovered to date about the role that rats play in changing island ecosystems. We took advantage of the fact that New Zealand has a very large number of offshore islands; on some of these rats have never been present, on some they are still found, and on some they have been eradicated (usually in the past decade) or are being controlled and maintained at low densities. In total we included 21 islands in the study, all located off the east coast of the north island of New Zealand.

Fig. 1 Impacts of seabirds on Middle Island, an island with very high seabird densities and no history of rats. The exclosure on the left shows high densities of seedlings when seabirds are kept out. The structure on the right is a control plot with access to seabirds (notice the wire does not reach the ground) and no seedlings (N. Grant-Hoffman).

The islands we work on are or were home to populations of burrowing seabirds such as petrels, and shearwaters. These birds feed at sea and then come back to the islands in the evening during the nesting season to build burrows, lay eggs and raise chicks. While digging burrows to lay their eggs in, they completely mix up the soil, incorporating litter and any seeds into the soil down to 30 cm. They also deposit vast quantities of guano, as well as leaving behind feathers, regurgitated food, eggshells and dead eggs and chicks. Having millions of seabirds (literally!) running over the soil surface makes it pretty difficult for any little seedlings to survive. Figure 1 shows what happens when you prevent seabirds from trampling: a small forest of seedlings emerges!

Fig. 2 Destruction of *Pittosporum crassifolium* fruits by rats (C. Mulder).

It is well known that rats, particularly the larger species (*Rattus rattus*, the ship rat, and *Rattus norvegicus*, the Norway rat) kill seabirds as eggs, chicks, and sometimes adults, resulting in a reduction of their populations or their local extinction. We expected many of the effects of rats to be “indirect” – i.e. the result of lower seabird populations. But we also expected that rats might impact vegetation directly by eating seeds and seedlings (Fig. 2), by moving seeds about, and by eating larger invertebrates such as snails and caterpillars that in turn consume plants or detritus. We wanted to know which of the rat effects were direct and which were indirect (through seabirds) because that tells us something about what is likely to happen to islands when rats are removed but seabirds have not returned (yet).

In general, most of the effects of rats were indeed due to seabirds. For example, seabird density (rather than rat presence *per se*) explained what happened with soil and plant nutrient content and invertebrate populations. However, the results weren’t exactly

what we had expected. Belowground (in the soil and litter), rats had mostly negative impacts: when they were present and seabirds were absent, soils had much lower nutrient content (particularly nitrogen and phosphorus) and much lower populations of litter- and soil-dwelling invertebrates such as herbivorous nematodes, minute land snails, and collembolans. However, effects of rats on vegetation and animals living on the vegetation were mostly positive or neutral: islands with rats had higher tree biomass and shrubs produced more leaves, while average seedling density and diversity and damage levels by invertebrate herbivores were not different between islands with rats and those which never had rats. We are still trying to figure out why we don't see the much higher productivity that we saw below ground reflected in the vegetation and associated fauna, but it may be that for plants the damaging effects of burrowing outweigh the advantages of having more nutrients in the soil.

So what happens when rats are removed? Well, it depends on what we look at. For soils and adult plants the answer is: "Not much!". We couldn't tell the difference between islands with rats and those where rats had recently been removed for soil structure and nutrient content. However, there was one aspect of the vegetation that was affected strongly by rat removal: seedling populations. Islands with rats removed or controlled had more than twice as many seedlings per m^2 as islands with rats or those which had never had any rats, but most of the seedlings were of only one or two species, so that diversity was actually lower on these islands. Whether this difference will be maintained as the seedlings age is unclear.

What does this mean for restoration? Without the return of seabird colonies it is unlikely that islands from which rats are removed will return to a pre-rat state, since most of the impacts of rats are really the result of reductions in seabird populations. However, plant composition will probably change following rat eradication; whether it will eventually become more similar to that of seabird (non-rat) islands or whether the composition will be very different from either rat or seabird islands is still unclear. We also have some worrisome observations suggesting that invasive plant species, uncommon on islands with seabirds or rats, may be becoming more common on islands where rats have been removed, possibly because they are no longer being trampled or consumed. While we can't yet predict exactly what will happen, one thing is clear: without the restoration of the seabird colonies on these islands, the legacy of rat invasions on these islands will persist for a very long time.

This project is a collaboration between the University of Alaska Fairbanks (Christa Mulder, Nikki Grant-Hoffman and Mel Durrett), Landcare Research in New Zealand (David Wardle, Peter Bellingham, Tad Fukami and others) and the New Zealand Dept. of Conservation (Dave Towns); see http://users.iab.uaf.edu/~christa_mulder/RASP%20webpage.htm.

We established a Research Conservation Network on impacts of introduced predators and their removal on seabird islands. If you are interested in finding out more about the project or network, please contact Christa Mulder.

The Impact of Rats on the Vegetation of Aldabra

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The vegetation on Aldabra atoll (Republic of Seychelles) evolved in the absence of rodents, until the relatively recent introduction of rats by visiting ships, probably in the 19th century. These rats may therefore have a negative impact on the unique vegetation communities on Aldabra.

I carried out a general survey to identify plant species being targeted by rats and document the impact of rats on these species. Being fairly new to Aldabra, I started by questioning the staff to find out whether they knew of or had encountered any plant species that are being affected by rats. Throughout this exercise I drafted a list of these plants to facilitate my field observation. Then, one day in September (during the dry season) I walked from the Research Station on Picard to the Main Channel (Grande Passe) keeping along the coast. During the observation I was assisted by another ranger, Catherina Onezia. Photos were taken to illustrate the impact being inflicted on several species.

Species being affected varied along the path depending on their abundance and life stage. Most of

Fig. 1 Affected stem of bwa santal (*Acalypha claoxyloides)* (C. Onezia).

the plants being chewed were young or the growing shoots of mature plants. Rats were seen in broad daylight eating flowers of *Cocos nucifera* and also immature fruits were found perforated. *Acalypha claoxyloides* and *Colubrina asiatica* were seen to be the most affected around the Old Settlement. In some cases the protective outer epidermis was peeled off exposing the vascular bundles which conduct water, sugar and other substances around the plant. In other cases the stem itself was chewed (Fig. 1 & 3). Several species were coppiced, including *Pandanus* (Fig 2). Close inspection of damaged branches revealed that rats had almost certainly inflicted the damage as there were bite marks, so that it was unlikely that crabs, birds or insects had produced the effects.

We found rat damage on the following plant species:

Cocos nucifera (coconut), *Acalypha claoxyloides* (bwa santal), *Casuarina equisetifolia* (sed), *Apodytes dimidiata* (bwa none), *Moringa oleifera* (bred mouroung), *Pandanus sp.* (vakwa), *Colubrina asiatica* (bwa savon), *Terminalia catappa* (bodanmyen)

Fig. 2 Vakwa (*Pandanus tectorius*) damaged by rats (C. Onezia).

Catharanthus roseus (roz anmer), *Solanum aldabrense* (zangiv), *Stachytarpheta jamaicensis* (zepi ble), *Pisonia grandis* (mapou), *Guettarda speciosa* (bwa kasan), *Cordia subcordata* (porse), *Maytenus senegalensis* (tir bonnen), *Polysphaeria multiflora* (pti kafe maron), *Hibiscus tiliaceus* (var), *Scaevola sericea* (vouloutye).

Water has a vital role to play in the survival of fauna and flora in any ecosystem. During the dry season, the only rodent, *Rattus rattus,* present on Aldabra, may struggle to find water. Maybe through the peeling off of the epidermis rats are able to maintain their water intake throughout the dry season, but affecting the plant at the same time. In some cases the whole stem is cut off which probably makes them lose water unless they are able to seal the gap. If plants are continuously affected in this way it will have an effect on their regeneration or might kill them completely.

Fig. 3 Affected branch of bwa savon (*Colubrina asiatica*) (C. Onezia).

At the moment we are not sure if the rats are having the same effect in the rainy season. If they are using plants for water we would expect less damage in the rainy season. As rodent teeth are continually growing, it is also possible that rats could be chewing on vegetation to wear down their teeth. If this hypothesis is correct the rats would need to continuously gnaw on plants year round, including in the wet season. As rats are clearly having a significant impact on the vegetation of Aldabra, which is of management concern, I plan to extend the observations into a rigorous seasonal sampling protocol, and search for other signs that rats are indeed the culprits by looking for droppings beneath affected trees and by examining stomach contents from trapped rats.

Acknowledgements

Catherina Onezia for photos provided and field assistance. Sam Bostock and Pierre Pistorius, Research Officer, for help in compiling the report.

Notes from the Field

A. Negative effects of rats in Seychelles

In a seed sowing experiment with Cinnamon (kannel) in the montane forest of Congo Rouge, Christoph Kueffer found that in 4 out of 6 positions, 100% of several 100 seeds where removed or showed signs of rat predation within a week. In this case, the impact of rats may be positive because the regeneration capacity of an invasive species is reduced, but it indicates that seed predation may also be very high for the rare endemic plants in the mountain forests of the Seychelles.

Willy Andre had a similar experience during the 1960s on Curieuse, where Cocoplum (Prindfrans) was being planted to stop soil erosion. Rats ate the germinating seeds of this shrub, thus reducing the efficacy of the erosion control programme. It took 5 years to get rid of the rats using poisoned Coconut. The fact that Cocoplum is now considered invasive is beside the point – at the time Cocoplum was a very effective tool for erosion reduction.

Both of the above examples are introduced species but such observations are backed up by Brendon Grimshaw, who says rats will take freshly planted seeds of native plants from the soil (presumably chewing them up so that they will then not germinate). On the other hand, he says Tourtrel dezil (Turtle doves) also take newly planted seeds, but in this case it is possible that the seeds can pass through the gut so that these birds actually help to disperse plants…

Several PCA members have reported endemic species affected by rat damage in the forest, for example Latannyen oban (*Roscheria*), Palmis (*Deckenia*) and Bwa bannann (*Gastonia spp.*) but several other species are known to be affected in forest areas on Mahé (e.g. Congo Rouge, Mare aux Cochons) and in the firebreaks on Praslin. The growing tips of plants are eaten and the rats chew the base of palm leaves to get sap, so that the leaves fall or dead leaves are left hanging on the plant. Rats may even gnaw through the growing heart so that the palm dies. The liquid-containing pitchers of pitcher plants (potao) are sometimes found with large irregular holes at the base, indicating rats have learned that these also are a source of moisture.

In the past, when the economically important coconut industry was vital for Seychelles, rats were an enormous problem for plantation owners because they ate the young coconuts on the trees. Not only did the owners put pieces of slippery metal around the coconut trunks to prevent rats from climbing the trees, they also sometimes planted a variety of 'wild' pineapple that can grow in poor soil and waste areas in the hope that the rats would be attracted away from the coconut plantations. However, the main form of removing rats in the old days was by trapping, using a trap called a 'lasonmwar' made from bamboo and native shrub species. According to Willy Andre, these were used by the hundreds, laid out in long lines and checked every day. In the 1960s, the government offered 10c per rat tail, later increased to SR1. The photos on page 13 illustrate the making of a 'lasonmwar' using bamboo, 'bwa dir' and string (maker = Lindsay Chong- Seng) and shows how effective it can be at catching rats!

Another animal that affects native vegetation in the wild is the introduced Tenrec (Tang), a small animal similar in appearance to a European hedgehog, which digs into loose soil looking for invertebrates and plant material to eat. According to Willy Andre, tenrecs caused much disturbance to seedlings of Takamaka and Mahogany planted out in forestry plantations, so for vegetation rehabilitation projects they might also produce negative effects and reduce the effectiveness of the rehabilitation.

Lindsay Chong-Seng making a 'lasonmwar' rat trap using bamboo, 'bwa dir' and string and it shows how effective it can be at catching rats (K. Beaver).

B. Positive interactions between plants and animals in Seychelles

In the days of the first settlement of the granitic Seychelles, giant tortoises were abundant and as their digestive process is rather inefficient, seeds from many species would have been dispersed in the faeces. On Aldabra Atoll this still happens and a research project in the 1970s showed that at least 28 plant species can be germinated from tortoise faeces. In fact, as Brendon Grimshaw says, tortoises not only spread the seeds but provide a nice package of fertilizer for the growing seedlings at the same time! In his rehabilitation project on Moyenne Island he uses tortoise manure when planting out native seedlings.

Fruit bats are important to native plants in two ways – as dispersers of seeds (e.g. Kapisen, Takamaka, Bwa-d-nat, Vakwa maron, Bwa sousouri) and also as pollinators (e.g. Bonnen kare bordmer and Bonnen kare larivyer, Mangliye fler). Of course, fruit bats also spread seeds of introduced species, such as Mango, Cashew and Ponm gouvernman, as well as pollinating their flowers (e.g. Bwa ber, Kapok, Zanbroza).

Insects are essential for the pollination of very many plant species and it is surprising how little we know about the species involved in the pollination of Seychelles' native species. James Mougal and others have reported the destructive effects of a native hawkmoth caterpillar on a very rare plant – Benzamen sovaz – but it is probably the same species that also pollinates the long-spurred flowers! The importance of such specific relationships is illustrated by the case of Vanilla, a plant which was once important as an economic crop in Seychelles. In its native habitat, vanilla is pollinated by a particular moth. No other insect can do this job, so wherever in the world vanilla is cultivated for the flavoured vanilla pods, the flowers have to be artificially pollinated. In Seychelles, a 'zig' is used to lift the flower's top lip and the flower is pressed vertically with the fingers to bring the pollen into contact with the stigma. Marcel Rosalie commented that when he was a boy he remembers that this has to be done early in the morning when the flower is fresh. Very occasionally Willy Andre has found a vanilla pod in the forest, possibly after a lizard by chance pollinated the flower.

Katy Beaver made a special effort recently to observe the insects visiting an endemic species planted in her home garden - Bwa sagay, the small flowers of which have a beautiful but delicate perfume. She reports that many honey bees visited the flowers and also a number of small native bees, various wasp species and a hover fly. Some ants were also crawling over a few flowers. These kinds of observations are needed for **all** of our native plant species – we still know so little about the relationships between our native insects and native plants, and also about the role of geckos as pollinators.

Using Population Studies to Set Conservation Priorities: A Case Study in Seychelles Using the Critically Endangered Bwa mediz (*Medusagyne oppositifolia*)

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Plants can be naturally rare or have rarities imposed upon them. *Medusagyne oppositifolia* (Bwa mediz or Jellyfish tree) is a naturally rare endemic plant of the Seychelles, restricted to four small populations at intermediate altitude on the granitic island of Mahé. The populations have been said to consist of no more than 50 mature individual trees, with no natural regeneration recorded in the wild. Molecular studies by Fay et al. (1997) showed that *Medusagyne* is a very distinct species, the sole member of its family. Hence, it has been identified as a relict of Gondwanaland flora that should be considered a priority for conservation (Vane-Wright et al., 1991) – a flagship species for Seychelles in fact - and currently listed as critically endangered.

As part of my MSc studies sponsored by the British Council, I carried out a field survey of *Medusagyne* at Bernica, Copolia, Mont Jasmin and Mont Sebert to establish the demography (population size, range and population structure) and distribution of *Medusagyne* in order to use these for prioritising conservation of the species. The glacis areas where this species grows are often difficult to access, full of large boulders and not easy to explore, so the study proved quite adventurous!

The results of my detailed field survey showed that the population of *Medusagyne* was larger than had been thought, with more than 80 mature trees and a large number of seedlings. But of the four sub-populations, only that at Bernica was apparently regenerating. In the other three places there were a few mature flowering trees but with no regeneration at all. Moreover, even at Bernica most of the seedlings were around 20 cm with very few seedlings reaching 1 metre, so there is no guarantee that any will reach maturity.

In addition, I collected information on where in the world (Botanic Gardens) the species was being grown *ex situ* and also the methods used for its propagation. It turns out that plants in *ex situ* collections were mostly derived from the population at Bernica and propagation by seeds was most successful, although many plants failed to survive beyond the seedling stage.

The categorisations used by IUCN for classifying how endangered a plant species is (see p. 15) are now very sophisticated, but what do they tell us about the conservation of a species? Basic demographic knowledge is needed for the categorisation but once we have this information, is it enough to **know** that a species is for example critically endangered? Can it help us to actually conserve the species? Since resources for conservation are always limited can detailed demographic studies help us prioritise?

Bwa mediz tree (L. Kronauer) and immature fruits (inset, E. Schumacher).

I believe that this study has shown us that demographic studies can indicate where we need to put our efforts in terms of conservation, in this case of *Medusagyne oppositifolia.* The population of Bernica is more likely to survive without any human influence than are the much smaller populations at higher altitude which have no natural regeneration and no specimens *ex situ*. These tiny sub-populations are more vulnerable to extinction and should be prioritised for conservation. *Ex situ* conservation in the case of *Medusagyne* may be the only way to conserve the genetic diversity of the whole population.

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Suggested IUCN Red List Status for the Endemic Woody Plants of the Inner Seychelles

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For the Seychelles, no recently updated Red List for flowering plants exists.The assessment for Seychelles registered at the moment with IUCN is not very differentiated, i.e. most of the species are classified as 'vulnerable' due to their restricted range and a few species are not assessed at all. The most comprehensive, but not officially acknowledged, Red Lists of Seychelles were compiled by Procter in 1971 and by Carlström in 1996. Therefore, the preparation and publication of a new Red List was stated as sub-target 2b in the National Strategy for Plant Conservation 2005-2010 (see p. 18). Already in 2004, PCA started a project with the aim to produce such an updated Red Data assessment of all flowering plants with the scientific support of the Institute of Integrative Biology (ETH Zurich, former Geobotanical Institute) (see Bollier & Tanner 2004). In this project, thus far, data on the abundance of endemic woody plants had been collected from understudied areas (Bollier & Tanner 2004), and a database was prepared that is in line with the IUCN assessment methodology (Burger et al. 2005).

For the third phase of the Red List project, we stayed in Seychelles from May until August 2006 to do our master thesis in environmental sciences at ETH Zurich. In our study, the 55 woody species endemic to the inner Seychelles were classified based on the available information and knowledge (applying IUCN Red List criteria Version 3.1). Accurate data on the endemic plants of Seychelles useful for a quantitative assessment was scarce. The perfect assessment should certainly be based on recent field data. However, a research project for the determination of the threat categories for all the endemic plants of Seychelles based on new field data would need a huge amount of resources. Therefore available information for each plant was compiled and analysed. Reports on plants and vegetation, back to 1877, were incorporated in this study. Because the data used was often out of date, the processed information for the assessment had to be verified and updated. A very effective way of improving and updating information was the incorporation of expert knowledge with a workshop held in August 2006 and with interviews. This evaluation revealed for instance that the presence of *Campnosperma* on Praslin reported in the literature is improbable.

For one species, Bwa de Fer (*Vateriopsis seychellarum*), we conducted a population survey. This was the first entire survey of this extremely rare and evolutionary unique species. The survey revealed that the species is still present in a higher number of individuals and in more sites than has previously been thought. In total 58 trees (diameter at breast height > 10 cm), 59 saplings (height > 50 cm) and 385 seedlings (height < 50 cm) were recorded in nine sites on Mahé.

As a result of our project, for each species a fact sheet was prepared in which the five IUCN criteria are discussed. Of the 55 endemic woody species, two were classified as 'extinct', 14 as 'critically endangered', six as 'endangered', 22 as 'vulnerable', and ten species as 'near threatened' or 'least concern'. One species has to be regarded as 'data deficient' (for the details of the assessment see Huber & Ismail 2006). It is important to note that many endemic species apparently occur only on one island (e.g. Mahé or Silhouette), and only some coastal species such as Vakwa bord-d-mer (*Pandanus balfourii*) and Lafous pti fey (*Ficus reflexa)* are widespread also on the small islands.

A young leaf of Bwa de Fer (*Vateriopsis seychellarum)* (S. Ismail).

Compared with the present IUCN Red List for Seychelles, this classification represents an improvement for the woody endemic species of the inner Seychelles, because the assessment was made with enhanced differentiation. Additionally, species that are missing on the present official IUCN Red List were also assessed. In summary, we compiled the

data necessary for the submission of a new Red List assessment to IUCN. Although such a submission would be a great step for plant conservation efforts in Seychelles, one has to keep in mind that the IUCN Red List is based on a methodology for assessing the extinction risk of a species from a global point of view. That means that the classification is quite coarse. On a national level the IUCN Red List could serve as a rough orientation to focus conservation efforts on the most threatened plants, but, additionally, more detailed studies are needed on the most threatened species (see p. 14).

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Link for the IUCN questionnaire:
http://app.iucn.org/webfiles/doc/SSC/RedList/Red_List_Assessment_Datasheet.doc

North Island Vegetation Rehabilitation Update

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After the purchase of North Island by Wilderness Safaris in 1997, and a thorough initial impact assessment, North Island initiated a vegetation rehabilitation programme in 2003. Several experts were actively consulted for advice on how to take the process forward. Considerable progress was made in 2005 when the island joined the ICS-led FFEM project on Rehabilitation of Island Ecosystems, in which PCA has an active advisory role (Kapisen 4, p. 6). During 2006, another two masters students (Martin Hertach and Claudia Farrér, from PCA partner Institute of Integrative Biology, ETH Zurich) spent 11 weeks on the island carrying out the second annual monitoring, improving the monitoring protocols set in place by their predecessors in 2005, and devising a new methodology for monitoring the freshwater wetlands. They also worked on the island's digital herbarium, increasing the number of species represented to 110.

Meanwhile the Environment and Landscape teams on the island were hard at work in 2005, along with ICS personnel and other experts, ridding the island of rats. Intensive post-eradication monitoring from September 2005 to September 2006 has confirmed that the island has now been rat-free for well over one year. However, the island has to continue preventing any re-introductions of alien invaders to maintain its rat-free status, a demanding task with boat arrivals on a daily basis. Protocols are in place and actively adhered to for ensuring that rats do not return or other alien invaders enter. Removal of rats is good news for all the native plants that have been planted as part of the vegetation rehabilitation on the island. More than 9 ha have now been rehabilitated, with continuing maintenance and extra planting as necessary. Much of the restored area

Removal of coconut trees (L. Vanherck).

is on the western plateau, together with an area along the saddle between the west beach and the eastern plateau. Hundreds of alien species have been removed, particularly invasive species such as Vyey fiy (*Lantana*) and Pok Pok (*Passiflora foetida*), small Kalis dipap (*Tabebuia*), Bwa zonn (*Alstonia*) and Rousay (*Eugenia uniflora*), and also many coconut seedlings. Many of the coconut palms on North Island are now old, the remains of extensive plantations that were once very productive, and

many of these will gradually be removed in selected areas. In the place of the alien species, almost 3000 native trees and shrubs have already been planted and the North Island nursery still has plenty more ready to plant out. This all represents a great deal of work and dedication, including support from the Biodiversity Centre on Mahé via the supplying of seeds and cuttings.

Planting of endemic plants on North Island (L. Vanherck).

A major step forward will be the finalisation of the Vegetation Management Plan 2007-2011, with PCA and North Island collaborating, along with ICS input. A holistic ecosystem approach is being taken, acknowledging that vegetation is not only important in its own right but also forms the basis of any island ecosystem and creates habitats for the island's animals. Indeed we cannot just remove all alien species without taking into consideration for example the effect such a drastic intervention might have on animals, which now use them for roosts and nesting sites. When choosing the native plant species most suitable for the particular conditions on North Island, it is also necessary to plan for the future introduction of animal species such as the Seychelles White-eye and Seychelles terrapins. It is also necessary for the management plan to take into consideration insect pests and diseases that are on the island.

PCA NEWS

Firstly we are very proud to report that two more PCA members have achieved further qualifications. **Denis Matatiken** has completed a Masters degree (with distinction) in Botanical Conservation at Plymouth University (UK) (see p. 14), and **Eva Schumacher** a Doctorate in Plant Ecology at ETH Zurich, Switzerland. Congratulations to them both!

Lindsay Chong-Seng and **Didier Dogley** have recently returned from a short trip to **Aldabra** where they were able to initiate some vegetation monitoring. Monitoring of some of the most common plant species will help to reveal environmental changes that may result from global climate fluctuations, and known populations of a few rare species will also be monitored. A search for several plants that had been recorded in specific areas by Fosberg and Renvoize in their Flora of Aldabra was unsuccessful. However, Lindsay and Didier did find 5 new populations of ***Angraecum eburneum*** **orchid** in a location where only one population had previously been recorded – and these were found in a period of only 20 minutes, so further searching could turn up more. Didier also returned with more seeds to grow in the Aldabra section of the Biodiversity Centre on Mahé, which will enable people to get to know the very different vegetation of the Aldabra group of islands.

Terrence Mahoune showing *Angraecum eburneum* on Aldabra (L. Chong-Seng).

Another **booklet** is to be published very soon, this time by the Botanical Garden. A colourful and interesting guide to the Garden itself, it will help to focus attention on the many uses of plants in our lives as well as their beauty, at a location, which is visited by tourists and locals alike.

Last but not least, a new project collaboration is being initiated between Professor **Jaboury Ghazoul** and **Christopher Kaiser** at ETH Zurich/Imperial College London and Didier Dogley and Denis Matatiken (Ministry of Environment and Natural Resources) and several members of the PCA. Christopher did his PhD in Mauritius (see p. 6) and will contribute with this experience to the project. The aim of this collaboration is to understand some of the ecological and genetic barriers to regeneration and viability of some of the fascinating but rare plant species endemic to Mahé. In due course, the work will include education and outreach, and restoration of some inselberg plant populations with the help of experts from the Eden Project, UK.

Seychelles National Strategy for Plant Conservation 2005-2010

Any individual or organisation wanting a copy should contact James Mougal at Botanical Gardens:
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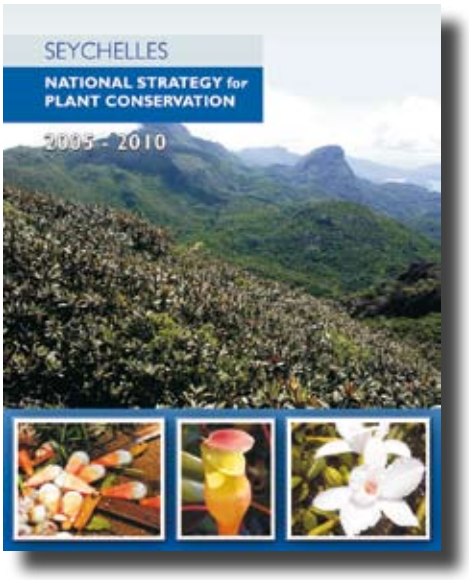


Guide to Endemic Palms and Screwpines of the Seychelles Granitic Islands

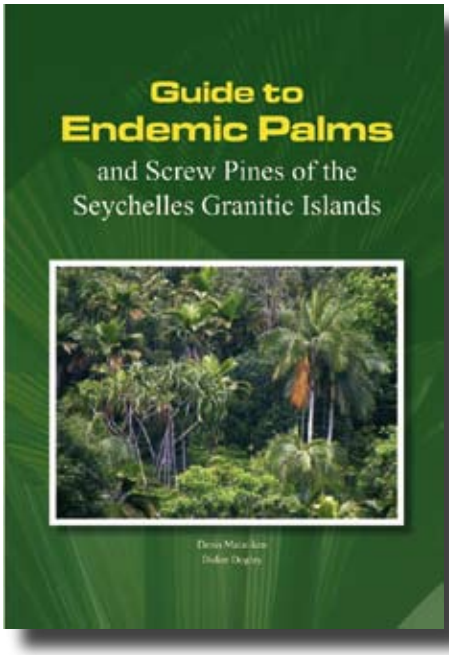
by Denis Matatiken and Didier Dogley

Published by the Plant Conservation Action group (PCA)

This printed guide gives you all the information and photographs you need to identify the six endemic palms and four endemic vakwa (pandans) of the granitic Seychelles. It is the first in a series of booklets to be published on the endemic and indigenous species of the Seychelles granitic islands.

The paperback is on sale at Antigone bookshop, Victoria and Vallee de Mai shop, Praslin and other outlets at a price of SR 75.

Overseas orders: Now available on the Natural History Book Service website http://www.nhbs.com



Join PCA!

Any person interested in plant conservation in the Seychelles, either from the Seychelles or somewhere else in the world, is invited to join the Plant Conservation Action group (PCA). As a member you support plant conservation in the Seychelles, get Kapisen - the PCA newsletter - twice a year sent to you by e-Mail, and get regular invitations to events and field excursions.

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