Chapter 16. The importance of field inventories and associated studies to understand biodiversity patterns: The case of the Beanka Forest, Melaky Region, western Madagascar

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Abstract

In a country such as Madagascar, with its extraordinary variation in climate and geology, associated vegetational variation, distinct biomes, and notable biotic heterogeneity, floristic and faunistic inventories over the past few decades have disclosed many hundreds of new species to science. Contrary to what might be anticipated given all of the inventory work conducted on the island, the level of discovery of previously unknown taxa continues at a largely unabated pace. Herein, using the Beanka Forest as an example, we present information on the importance of recent inventories in this previously unknown karst dry deciduous forest area, specifically in the discovery of numerous previously undescribed taxa and their importance to understand the conservation value of this site. Most of these discoveries have been made since large scale surveys commenced in 2009 and numerous other new taxa will be uncovered and described as taxonomists work through existing collections from the site and new material to be collected in other areas of the massif. These inventories have been important for 1) identifying the Beanka Massif as key biodiversity area, 2) understanding biotic patterns critical for allocating high priority status for conservation action at this site, 3) bringing to public attention the uniqueness of the area and different general conservation issues, and 4) collected data and specimens helping to resolve different aspects of the evolutionary history of locally occurring organisms.

Key words: biological inventories, species new to science, new distributional data, evolutionary history, conservation priorities, public attention

Résumé détaillé

L'île de Madagascar est connue pour présenter une variété climatique et géologique exceptionnelle, qui se traduit par une remarquable hétérogénéité biotique engendrant une diversité des biomes et des types de végétation. Les inventaires de flore et de faune qui y ont été menés dans les dernières dizaines d'années ont permis la découverte de centaines d'espèces nouvelles pour la science. Contrairement à ce à quoi on aurait pu s'attendre au vu de l'intensité du travail d'inventaire mené sur l'île, le taux de découvertes, d'un niveau sans précédent, se maintient. Dans ce chapitre basé sur les travaux récemment menés dans la forêt sèche décidue sur karst de Beanka (jusqu'alors à peine connue), nous discutons de l'importance de tels inventaires pour la découverte de nouveaux taxons ainsi que pour connaître la valeur de ce site en matière de conservation. La plupart de ces découvertes ont été réalisées depuis le début des inventaires qui y ont été menés sur une large échelle dès 2009. On s'attend encore à la description de nombreux autres taxons au fil de l'avancement du travail des taxonomistes sur le matériel accumulé au cours de ces inventaires ou qui pourra être collecté à l'avenir dans d'autres portions du massif. Jusqu'à présent les nouveaux taxons recensés sont :

- Plantes vasculaires: trois espèces décrites et quatre en cours de description ;
- Mollusques terrestres: sept nouvelles espèces décrites ;
- Araignées: deux nouvelles espèces décrites ;
- Fourmis : dix nouvelles espèces décrites ;
- Amphibiens : deux nouvelles espèces en cours de description ;
- Reptiles : une nouvelle espèce en cours de description et
- Oiseaux : une nouvelle espèce décrite.

L'importance des inventaires menés dans la forêt de Beanka peut se décliner de la manière suivante :

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1) Contribuer à une meilleure connaissance de ce site unique et des espèces qui le peuplent. Les nouveaux taxons découverts y contribuent directement, mais également toutes les nouvelles données de distribution des espèces déjà connues, qui permettent de mieux comprendre leur biogéographie.
2) En se basant sur ces travaux, démontrer l'importance de Beanka comme *Zone d'Importance Capitale* pour les actions de conservation à Madagascar. La promouvoir et l'inclure au sein du réseau national d'aires protégées. Trouver des moyens financiers pour contribuer au développement des communautés limitrophes et lancer un programme de conservation proactif.
3) Communiquer à l'attention d'un public non spécialisé afin de le rendre conscient de l'importance de ce site unique et de le sensibiliser aux défis de la conservation. A ce titre, une couverture médiatique importante a été réalisée autour de la découverte en 2011 de *Mentocrex beankaensis*, la nouvelle espèce d'oiseau. Une telle découverte est un évènement rare au niveau mondial. Le public international et malgache a pu à cette occasion partager l'importance de cette découverte et être rendu attentif au sort tragique des forêts sèches.
4) Apporter des éléments manquants à la compréhension de l'histoire évolutive des organismes rencontrés. Les résultats obtenus à partir des spécimens récoltés au cours des inventaires font partie intégrante de l'accumulation du savoir. Ils soulignent l'importance de ces études fondamentales et de recherches plus intégratives dans des pays comme Madagascar.

Mots clés : inventaires biologiques, nouvelles espèces pour la science, nouvelles données sur la répartition, histoire de l'évolution, priorités de conservation, attention du public

Introduction

Across many areas of the tropics, continued biological exploration of natural habitats has revealed an extraordinary range of species and higher taxa previously unknown to scientists. These species span the gamut from those that when first handled in the field were clearly new to science to those that only based on morphological or genetic studies revealed that they were undescribed cryptic taxa. These types of findings are important to augment knowledge of the world's biodiversity, particularly in light of on going habitat destruction of most remaining natural habitats, but also in certain cases these new taxa provide critical information into the evolutionary history of different groups.

Madagascar is well known for its unique and endemic biota. Over the past decades a considerable number of new species and to a lesser extent genera and families of plants and animals have been described from the island, indicating that a measurable portion of its biodiversity still remains unknown to science. The question can be asked if the exploration of the biological richness of the island and the era of discovery is approaching a plateau. On the basis of recent fieldwork in a scientifically poorly known or better put unknown region such as the Beanka Forest in western central Madagascar, which is the subject of this monograph, we can address this question. Below we present a list of species that have been discovered and in most cases described based on material collected in recent years from the Beanka Forest. Amongst these new taxa, few are microendemics to the Beanka Forest. A few forms are listed as undescribed, but remain to be formally named by scientist.

List of species discovered and described based on material from the Beanka Forest

Vascular plants

1. *Aloe beankaensis* Letsara, Rakotoarisoa & Almeda – holotype from Beanka (Letsara *et al.*, 2012) (Figure 16-1).
2. *Memecylon* nov. sp. R. D. Stone, ined. – holotype to be proposed from Beanka.
3. *Coffea* nov. sp. 1 – based on initial analysis and comparisons apparently an undescribed species (Andriamihajarivo *et al*., 2010).
4. *Coffea* nov. sp. 2 – based on initial analysis and comparisons apparently an undescribed species (Andriamihajarivo *et al*., 2010).
5. *Pandanus tsingycola* Callmander & Nusbaumer – holotype from Beanka (Callmander *et al*., 2013) (Figure 16-2).
6. *Uvaria lombardii* Gautier & Deroin – holotype from Beanka (Gautier & Deroin, 2013) (Figure 16-3).
7. Aristolochiaceae indet., Luino & Gautier, comm. pers. – based on initial analysis and comparisons this taxon represents an undescribed species of this family.

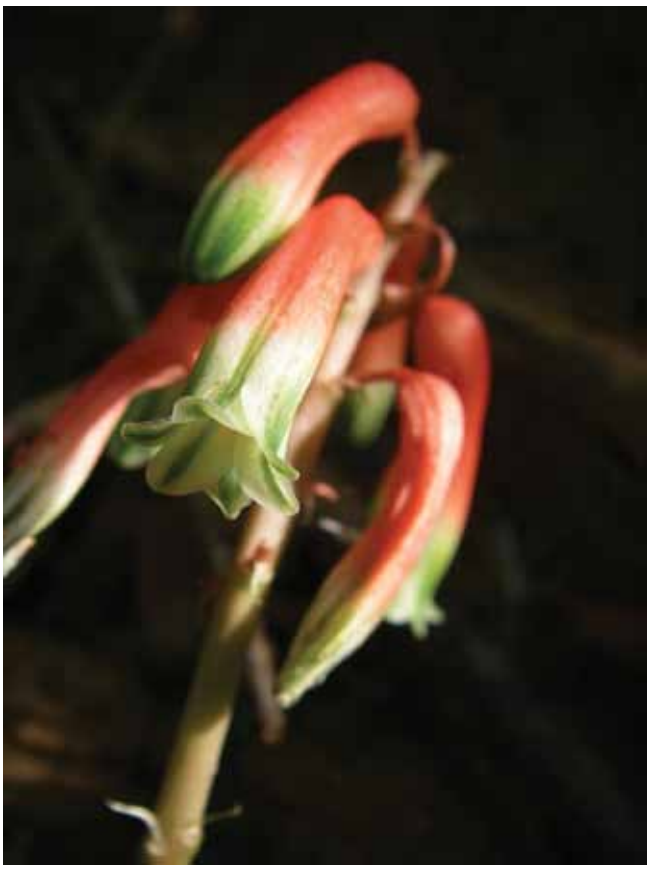

Figure 16-1. *Aloe beankaensis* Letsara, Rakotoarisoa & Almeda. (Photograph taken by L. Gautier.)

Figure 16-2. *Pandanus tsingycola* Callm. & Nusb. (Photograph taken by R. M. Hanitrarivo.)

Figure 16-3. *Uvaria lombardii* L. Gaut. & Deroin. (Photograph taken by L. Gautier.)

Platyhelminthes

1. *Ophiotaenia lapata* Rambeloson, Ranaivoson & Chambrier – holotype from Beanka and the host is the snake *Madagascarophis* (Rambeloson *et al.*, 2012).

Freshwater snails

1. *Madagasikara vivipara* Köhler & Glaubrecht – paratype from Beanka (Köhler & Glaubrecht, 2010).

Land snails

1. *Ampelita andriamamonjyi* Griffiths & Herbert – holotype from Beanka (Griffiths & Herbert, 2013) (Figure 16-4).
2. *Ampelita beanka* Griffiths & Herbert – holotype from Beanka (Griffiths & Herbert, 2013).
3. *Ampelita lindae* Griffiths & Herbert – holotype from Beanka (Griffiths & Herbert, 2013) (Figure 16-5).
4. *Conulinus randalanai* Griffiths & Herbert – holotype from Beanka (Griffiths & Herbert, 2013).
5. *Kalidos maryannae* Griffiths & Herbert – holotype from Beanka (Griffiths & Herbert, 2013).
6. *Tropidophora humbug* Griffiths & Herbert – holotype from Beanka (Griffiths & Herbert, 2013) (Figure 8-2b).
7. *Tropidophora sericea* Griffiths & Herbert – holotype from Beanka (Griffiths & Herbert, 2013).

Spiders

1. *Noideattella amboa* Álvarez-Padilla, Ubick & Griswold – material from Beanka part of type series (Álvarez-Padilla *et al.*, 2012).
2. *Noideattella mamba* Álvarez-Padilla, Ubick & Griswold – material from Beanka part of type series (Álvarez-Padilla *et al.*, 2012).

Ants

1. *Crematogaster tsisitsilo* Blaimer & Fisher – material from Beanka part of type series (Blaimer & Fisher, 2013a) (Figure 16-6).
2. *Crematogaster maina* Blaimer & Fisher – material from Beanka part of type series (Blaimer & Fisher, 2013b).
3. *Crematogaster masokely* Blaimer & Fisher – material from Beanka part of type series (Blaimer & Fisher, 2013a).

Figure 16-4. *Ampelita andriamamonjyi* Griffiths & Herbert, 2013, holotype, maximum diameter 29.3 mm, height 15.1 mm. (Photograph by D. G. Herbert.)

Figure 16-5. *Ampelita lindae* Griffiths & Herbert, 2013, holotype, maximum diameter 30.5 mm, height 12.6 mm. (Photograph by D. G. Herbert.)

Figure 16-6. *Crematogaster tsisitsilo* was recently described by Blaimer & Fisher (2013a) based in part on specimens from Beanka. (Image downloaded from http://www.antweb.org, accessed 18 December 2013.)

Figure 16-7. *Tetramorium malagasy* was recently described by Hita Garcia & Fisher (2012) based in part on specimens from Beanka. (Image downloaded from http://www.antweb.org, accessed 18 December 2013.)

4. *Crematogaster ramamy* Blaimer & Fisher – material from Beanka part of type series (Blaimer & Fisher, 2013a).
5. *Tanipone scelesta* Bolton & Fisher – material from Beanka part of type series (Bolton & Fisher, 2012).
6. *Tetramorium malagasy* Hita Garcia & Fisher – material from Beanka part of type series (Hita Garcia & Fisher, 2012) (Figure 16-7).
7. *Tetramorium popell* Hita Garcia & Fisher – material from Beanka part of type series (Hita Garcia & Fisher, 2012).
8. *Tetramorium sada* Hita Garcia & Fisher – material from Beanka part of type series (Hita Garcia & Fisher, 2012).
9. *Pachycondyla vazimba* Rakotonirina & Fisher – material from Beanka part of type series (Rakotonirina & Fisher, 2013).
10. *Ravavy miafina* Fisher – material from Beanka part of type series (Fisher, 2009).

Amphibians

1. *Rhombophryne* nov. sp. A. P. Raselimanana, ined. – this species is known from Beanka and remains to be described (Raselimanana, 2013).
2. *Stumpffia* nov. sp. A. P. Raselimanana, ined. – this species is known from Beanka and remains to be described (Raselimanana, 2013).

Reptiles

1. *Liophidium* nov. sp. A. P. Raselimanana, ined. – this species is known from Beanka and remains to be described (Raselimanana, 2013).

Birds

1. *Mentocrex beankaensis* Goodman, Raherilalao & Block – holotype from Beanka (Goodman *et al.*, 2011) (Figure 16-8).

Figure 16-8. One of the more news worthy species described from the Beanka Forest in recent years was the Tsingy Wood Rail, *Mentocrex beankaensis*. This species was differentiated from other members of this genus based on size, plumage coloration patterns, and molecular genetics. Color illustrations of the heads, upper backs, and breasts are presented (from left to right) of *M. beankaensis* from the Beanka Forest, *M. k. kioloides* collected near Maroantsetra, and *M. k. berliozi* obtained south of Anaborano. (Illustration by Velizar A. Simeonovski.)

Discussion

As we have presented above, a considerable number of plant and animal species have been discovered and described from the Beanka Forest in a few short years. These findings have implications in at least four different manners, which in certain cases are interrelated:

1) Underlying the importance of the Beanka Forest as a *Key Biodiversity Area*.
2) New biogeographic information on local occurring organisms and providing a foundation to augment the *conservation priority* status of the site.
3) Bringing to *public attention* discoveries at the site, its importance for preservation, and more generalized aspects associated with conservation.
4) Contributing with new specimens to the resolution of questions in the *evolutionary history* of different organisms occurring on Madagascar.

Key Biodiversity Area

The recent inventory work on plants and animals conducted in the Beanka Forest indicates that this massif is of key interest with regards to its biodiversity. This consideration is associated with different aspects, including the notably high species richness for different biotic groups covered in this monograph with respect to other regional dry deciduous forest sites (e.g. Gautier *et al.*, 2013; Ravelomanana & Fisher, 2013), as well as a notably high number of recently described taxa. From a vegetation perspective, the Beanka Forest shows considerably heterogeneity (Chatelain *et al*., 2013; Rakotozafy *et al*., 2013), often associated with underlying soil types and hydrological aspects, which in turn might explain the rather varied animal fauna occurring within these different habitats. The presence in Beanka of several humid forest species also brings attention to the existence of microhabitats suited for the survival of these relict taxa, which presumably had broader distributions on the island during more humid episodes in the recent geological past.

Conservation priority

Another critical aspect is that given the low human populations living around the periphery of the park, local pressures on forest resources are relatively low. Excluding certain aspects associated with the burning of grasslands that impact the forest-grassland ecotone and some hunting of forest-dwelling animals (Andriamamonjy *et al*., 2013; Randriandimbimahazo, 2013), the existing anthropogenic pressures on the native forest ecosystems is relatively reduced. Given that the Beanka Forest is amongst the key biodiversity areas of Madagascar, combined with the critical aspect that the level of threat to this site is relatively reduced in comparison to many other areas of dry deciduous forest in central western Madagascar, indicates that the active protection currently being conducted by Biodiversity Conservation Madagascar (BCM) has a real chance of preserving the remaining forest habitat (Andriamamonjy *et al*., 2013). The BCM program can be considered proactive, commencing to conserve the regional biota associated with local community involvement and before problems are too overwhelming to correctly advance the intended actions. This is a rather unique situation for any western dry forest area on Madagascar and the opportunity should be seized by BCM, in collaboration with the Malagasy governmental partners and non-governmental institutions, to advance a variety of actions to conserve this important forest block.

Public attention

While different taxa have been named in recent years from the Beanka Forest, one species stands out as being particularly important from the perspective of public attention via different forms of media coverage. The description of an undescribed species of bird to science anywhere in the world is news worthy and on Madagascar only four new birds have been described since 1972 (Raherilalao & Goodman, 2011). The most recent of these was named in 2011 by Goodman *et al.* (2011) as the Tsingy Wood Rail, *Mentocrex beankaensis* (Figure 16-8). The type specimen is from the Beanka Forest and other populations are known to the immediate south in the Bemaraha complex.

The publication of this new species brought considerable attention across the world to Madagascar ornithology via different sorts of media coverage, including newspapers, magazines such as National Geographic France, and numerous internet sources. Hence, this discovery brought the Beanka Forest into public view. While the dissemination to the public of information on the island's biodiversity is important, within these different forms of media coverage, critical messages on the massive reduction of Malagasy dry deciduous forests in recent decades associated with human pressures and the plight of these unique ecosystems were underlined. These types of messages are important for the local, regional, and international communities interested in

the preservation of dwindling natural habitat in the tropical areas of the world.

Evolutionary history

During the course of different studies associated with biotic diversity, ranging from biogeographic studies, where new presence and absence data are critical to discern different patterns, to molecular genetic studies, where analyzed material brings different perspectives, biological inventories and the specimens they provide are fundamental steps in providing a better understanding of evolutionary history. Many examples can be cited for these aspects amongst the new taxa described based on specimens collected at Beanka. However, rather than repeating or expanding on details presented above, we will provide a different type of example.

Throughout the literature on the mammals of Madagascar, the small species of shrew, *Suncus madagascariensis*, has been considered endemic to Madagascar (e.g., Goodman *et al*., 2008). This was considered slightly enigmatic, as the other species of shrew occurring on the island, *S*. *murinus*, is known to have been introduced. A recent molecular study examining the phylogeny of Asian members of this genus included samples of *S*. *madagascariensis* from the Beanka Forest (Omar *et al*., 2011). To a considerable surprise, the results indicate that the Madagascar populations are nested within those of Asian *S*. *etruscus*. Hence, the best manner to interpret these results is that "*S*. *madagascariensis*" is almost certainly introduced to the island and the correct species identification is *S*. *etruscus*. Perhaps of even greater interest and a direct extension of the Omar *et al*. (2011) study, is that *S*. *etruscus* may have been introduced to Madagascar by early sea-voyagers that traveled from southeastern Asia. Hence, a detailed phylogeographic of Asian and Malagasy populations of this shrew might provide a proxy to understand the origin or passage route of some of the early human colonizers of the island.

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