Diversity and abundance variations of anurans with habitat strata across Amani swamp, East Usambara Mountains, Tanzania.

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Abstract

A comparative study to investigate diversity and abundance of anurans in habitat strata was conducted from 16–27 September, 2005 at Amani swamp within the Amani Nature Reserve. Anurans were studied in three habitat types using both acoustic and visual 50m × 10m strip transects. Habitat types were classified according to the vegetation types. Anuran assemblages were highest in fern complex, followed by *Cyperus* reeds, while Myriophyllum ranked last. The Shannon Wiener index strikingly showed that species diversity was higher in Cyperus reed (H'= 1.25) than in Myriophyllum (H'= 1.20) and in the fern complex (H'= 1.05).

Key words: Diversity, abundance, anurans, habitat strata, Amani swamp.

INTRODUCTION

The East Usambara Mountain ranges are an important habitat for amphibians supporting about 46 amphibian species, 27% of which are endemic (Hamilton and Bensted-Smith, 1989). The amphibians occupy diverse habitats and are universally threatened as a result of human activities. Anurans represent an ubiquitous group of organisms that play a pivotal role in aquatic food webs but may also be used for observing long-term trends in community change in wetland ecosystems (Adamus, 1995). Amphibians frequently respond differently to habitat gradients (Heyer *et al*., 1993). It is therefore important to understand how they use their habitats and how this affects their diversity and abundance.

Amphibians are interesting subjects for conservation biology. Their responses to different landscapes or natural habitat transitions in the face of land use changes makes them highly suitable for indicating habitat quality. This could be an aid to managers in selecting or prioritizing areas for management and conservation. However, of all the vertebrates little attention has been given to amphibians, especially compared to that

given to birds and mammals. The aim of this study is to investigate anuran diversity and abundance variations in different habitat types of the swamp. The Amani swamp has been silting up in recent years that the response of anurans to habitat strata could provide important information for decision-making for management of the swamp as an asset of Amani Nature Reserve. Results of this study will allow us to address the question of whether a particular habitat should be promoted or removed for better ecological integrity.

OBJECTIVES

a) To compare variations in anuran diversity and abundance between different habitats of the Amani swamp.
b) To recommend conservation and management options.

METHODS

Study Area

The study area for this research project is the Amani swamp located near the IUCN hostel in Amani Nature Reserve. The study area lies at 910m above sea level in the East Usambara Mountains which is part of the Eastern Arc Mountains. The swamp has an area of approximately 4,100m^2 (TBA, 2000) and was artificially created at the turn of the century when a dam was built in Dodwe River (Anon, 1995). Three different habitats were studied in the swamp. The selection of habitats was based on vegetation types. Habitat 1 is fern complex (20% of the pond area) dominated by *Asplenium* spp and *Antigonum* spp. with some patches of *Myriophyllum aquaticum.* Habitat 2 was Cyperus reed bed (14% of the pond area) characterized by *Cyperus exaltatus*. Habitat 3 was myriophyllum monoculture (63% of the pond area) dominated by *Myriophyllum aquaticum*, an invasive species.

Data collection and species identification

A combination of both acoustic and visual strip transect sampling techniques were employed in this study (adopted from Heyer *et al*., 1994). Two transects at 10m distance, were systematically allocated to each habitat. Each transect consisted of 5 sampling points (flag marks) at 10m intervals. Data collection took place at each point for 2

minutes whereby all individuals calling within an area 10m perpendicular to the transect were recorded. After 2 minutes, anurans were thoroughly tracked along the transect to the next point. Data were uniformly collected three times a day in early mornings, mid-day and after sunset at 6, 14 and 18hrs respectively for three days form 16th to 18th September 2005. Species identification was carried out for the next two days from 20th to 21st September 2005 using similar transects, whereby all species seen or heard were identified using a field guide and recorded on a pre-prepared data sheet.

Data analysis

a) Estimating species diversity

The Shannon–Wiener index, H' was used to specify degree of diversity for anurans in each habitat type and was calculated as follows (Kent and Coker, 1992):

$$H' = \left| \sum_{i=1}^{s} p_i \ln p_i \right|$$

Where H' = is the Shannon-Wiener index of diversity;

p_i = is the proportion of total number of individuals represented by i^{th} species.

Therefore, the higher the index, the more diverse is the habitat and vise versa is also true.

b) Comparing anuran abundance among different habitats

A one-way ANOVA (Unpaired t-test) was used to test for differences in anuran abundance among habitat types.

RESULTS

Species richness

A total of six species representing two families (Hyperoliidae and Ranidae) including one near endemic frog species *(Hyperolius mariae)* were recorded across three different habitat types (Figure 1). The fern complex had higher species richness than *Myriophyllum* monoculture and *Cyperus* reeds. Over 83% of all the species recorded were aquatic dependant.

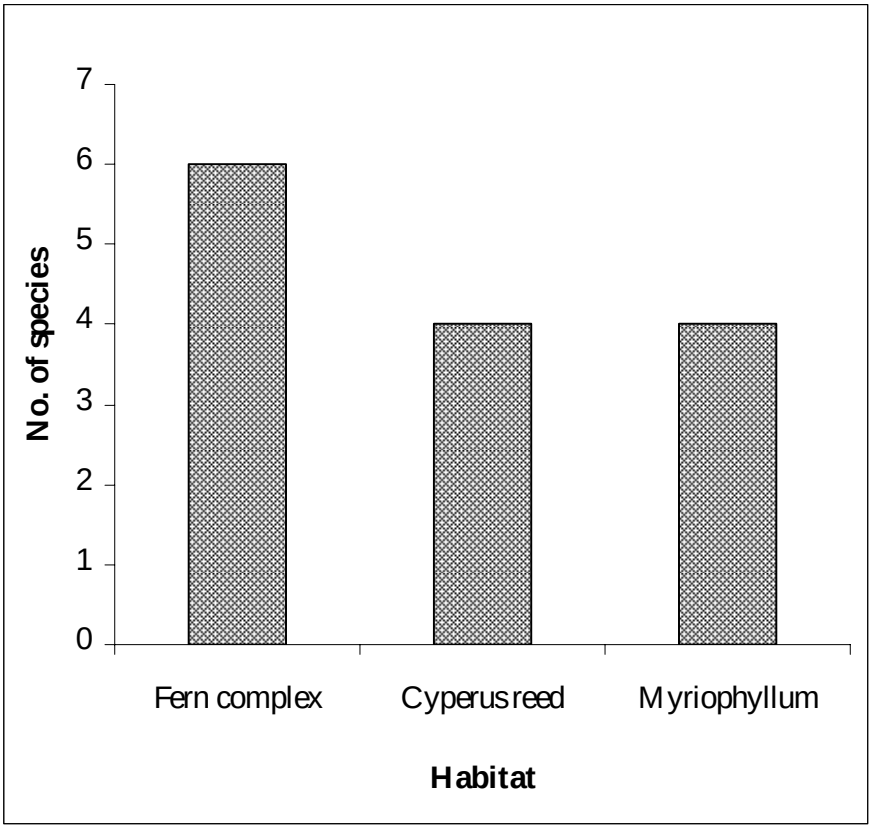

Figure 1: Species richness of anurans in different habitat types in the Amani swamp

Distribution of species across habitats

Four species of the six species recorded were present throughout the three habitat types (Table 1). These were *Hyperolius puncticulatus, H. mariae, H. mitchelli* and *Leptopelis flavomaculatus.* The remaining two species, *H. spinigularis* and *Rana angolensis,* were only found in the fern complex.

Table 1: Distribution of species recorded per habitat type in Amani pond

S/N	**Species**	**Family**	**Habitat**		
			fern complex	*Cyperus*	*Myriophyllum*
1.	*Hyperolius puncticulatus*	Hyperoliidae	×	×	×
2.	*H. mariae*	Hyperoliidae	×	×	×
3.	*H. mitchelli*	Hyperoliidae	×	×	×
4.	*H. spinigularis*	Hyperoliidae	×		
5.	*Leptopelis flavomaculatus*	Hyperoliidae	×	×	×
6.	*Rana angolensis*	Ranidae	×		

Note: × = species presence

Species diversity

Species diversity between the three habitat strata was pronounced. *Cyperus* reed bed showed the highest species diversity while the fern complex ranked the lowest. The Shannon-Wiener index of diversity was 1.25 for the *Cyperus* reed bed, 1.20 for *Myriophyllum* monoculture and 1.05 for the fern complex (Figure 2).

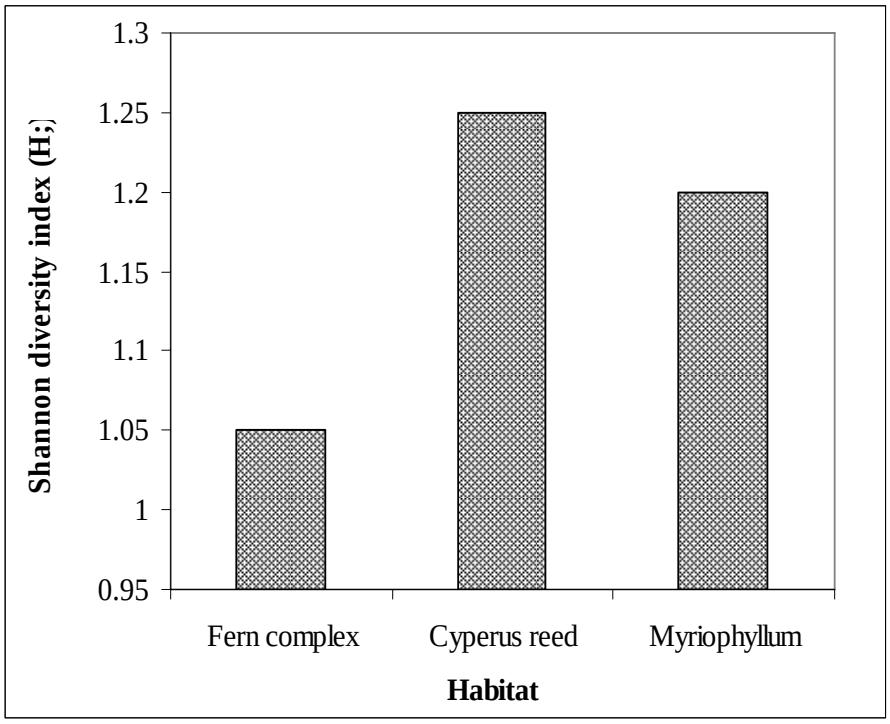

Figure 2: Species diversity of anurans in different habitat types in Amani swamp.

Anuran abundance in different habitat types

A total of 632 individuals were recorded at the Amani swamp. The fern complex ranked the highest in adult anurans abundance with 128 individuals, followed by *Cyperus* reeds with 44 individuals and *Myriophyllum* monoculture the lowest with 33 individuals (Figure 3). In contrast, *Cyperus* reeds ranked the highest in juvenile abundance with 173 individuals. *Myriophyllum* monoculture had 151, while only 101 individuals were recorded in the fern complex (Figure 3). It was also found that anuran activity varied with time. There were more male calling activities in the evening that the rest of the day (Figure 4 (a)). Like wise afternoon was suitable for recording juveniles (Figure 4(b)).

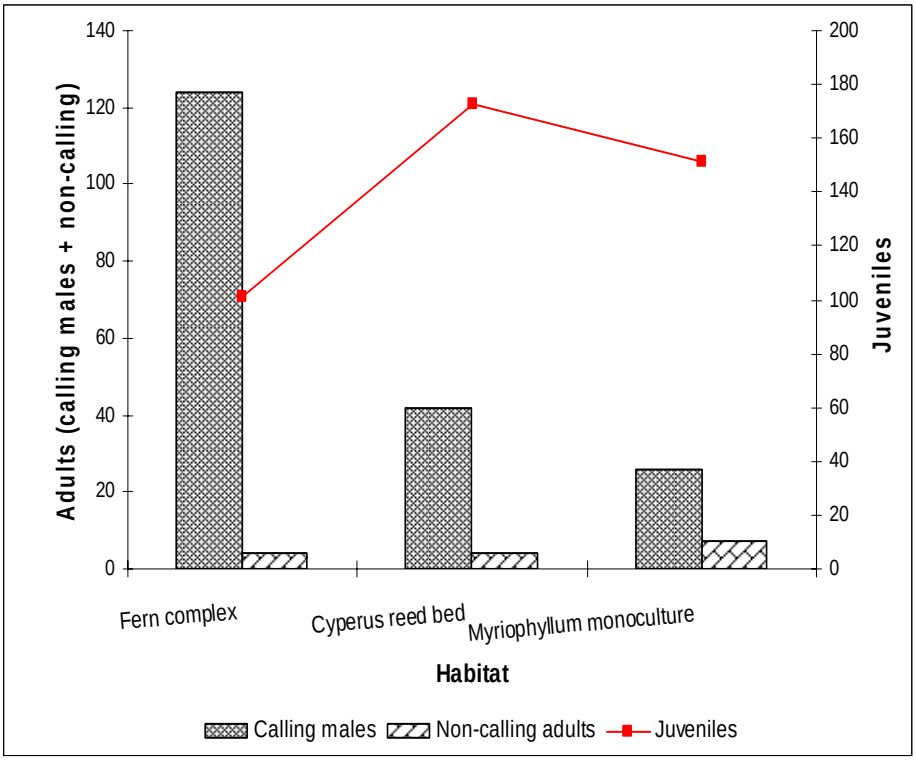

Figure 3: Anuran assemblages in different habitat type

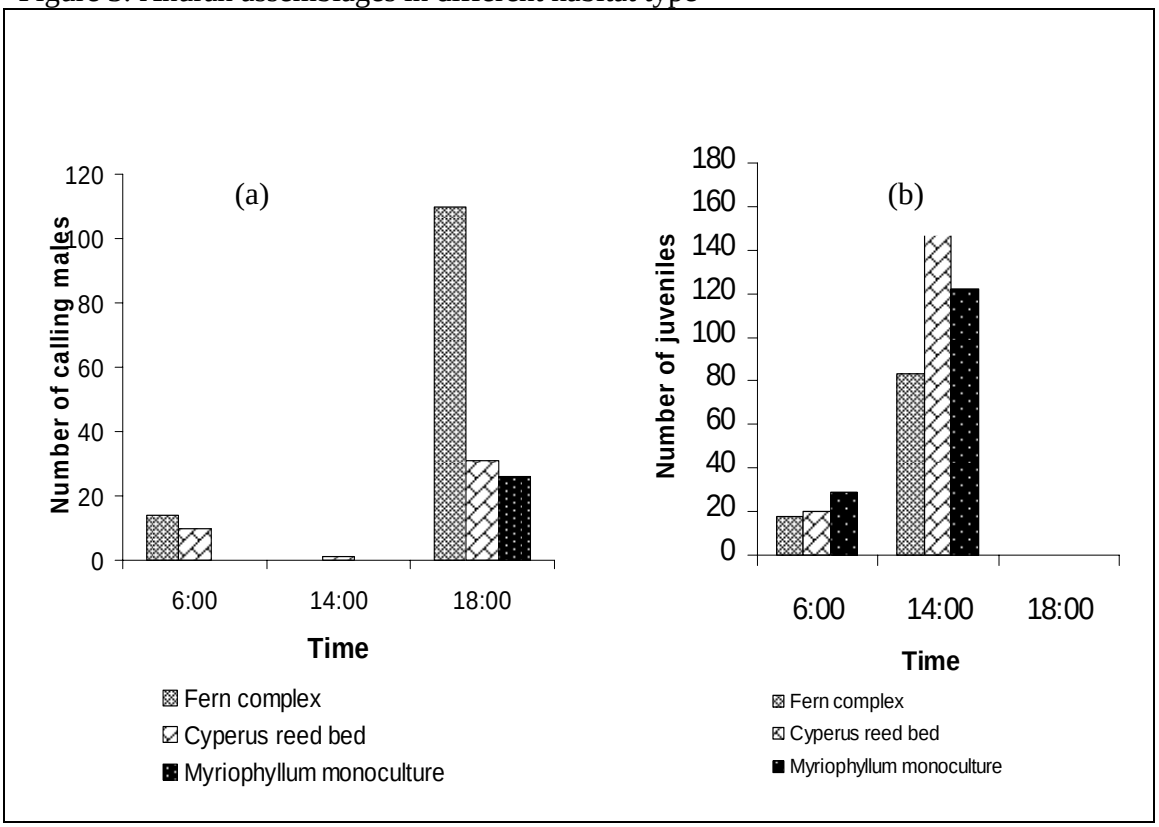

Figure 4: Population variations with time for calling males (a) and juveniles (b)

Comparisons of calling males abundance among habitat strata

A t-test on calling males abundance between habitat groups during different sampling periods showed a significant difference between *Cyperus* reeds and *M. aquaticum* monoculture ($t_{0.05\ (2),\ 22} = 2.283$, $p<0.05$, Table 2) at 06 HRS. There was a highly significant difference between the fern complex and *Cyperus* reeds ($t_{0.05\ (2),\ 22} = 6.985$, $p<0.001$, Table 2) and between the fern complex and *M. aquaticum* ($t_{0.05\ (2),\ 22} = 6.242$, $p<0.001$, Table 2) at 18HRS.

Table 2: Results of Unpaired t-test for calling males abundance between habitat groups

Time	Habitat groups	t-value	P-value	Significance
06 HRS	fern, Cyperus reeds	0.321	0.7515	ns
	fern, myriophyllum	2.069	0.5050	ns
	Cyperus reeds, myriophyllum	2.283	0.0325	*
14 HRS	fern, Cyperus reeds	-0.348	0.7314	ns
	fern, myriophyllum	-0.728	0.4745	ns
	Cyperus, myriophyllum	-0.453	0.6547	ns
18 HRS	fern, Cyperus reeds	6.985	<0.0001	**
	fern, myriophyllum	6.242	<0.0001	**
	Cyperus reeds, myriophyllum	0.323	0.7500	ns

Note: ns = Non- significant ($p>0.1$); * = significant ($p<0.05$), ** = highly significant ($p<0.001$)

DISCUSSION

Anuran abundance among habitats

It was observed that the abundance of calling males in the *Myriophyllum aquaticum* was low compared to the abundance in the fern complex and in the *Cyperus* reeds bed in the swamp. There are a number of possible reasons for this difference: the *M. aquaticum* is a homogeneous monoculture with a uniform height throughout, in contrast to the heterogeneous vertical and horizontal structure of the fern complex and the *Cyperus* reed bed. This may be particularly important in providing elevated resting point for calling males (Schiotz, 1999) and at night many more calling males were observed in the fern complex and *Cyperus* reed beds than in the *M. aquaticum.* It is notable that the less rigid leaves of *M. aquaticum* do not provide the same support as the reed beds do so that large frogs are rarely found perched on them. This observation is supported by the results of TBA (1998) which showed a far higher abundance of calling males in fern complex and

Cyperus reeds than in *M. aquaticum.* The heterogeneity of fern complex and *Cyperus* reed beds may also provide more refuges from predation.

Species richness and diversity

The species richness seems to be higher in the fern complex than in either *Cyperus* reeds or in *Myriophyllum* monoculture. However, the Shannon index (H') results showed that the fern complex ranked lowest in species diversity of the three habitats. This is probably because the fern complex had a more even distribution of individuals of the six species compared with the abundance of individuals of the four species found in *Cyperus* reeds and in the *Myriophyllum*. This result is supported by Heyer *et al*. (1993) that a habitat have higher richness but that each such species has on average, proportionally fewer individuals than habitats with fewer species it.

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The native fern complex supports more species than the other habitats yet it is becoming severely degraded. It is under threat by local communities around Amani Nature Reserve who frequently harvest grass to feed their livestock. The *M. aquaticum* seems to spread over native habitat. This may perhaps lead into ecological imbalance and fewer frogs in future.

CONCLUSION

In conclusion, this study found that native habitats host a very large abundance and richness of frogs compared to *M. aquaticum* dominated habitats. Nevertheless, *Cyperus* reeds and *M. aquaticum* supported more juveniles, perhaps because the habitats were more open than fern complex making the juvenile anurans easier to observe. Therefore, the native habitats can be considered as important habitats for frogs in Amani pond. Although the pond is an artificial ecosystem, more active management could possibly enhance its biotic diversity and consequently its value as a scientific and ecotourism resource.

RECOMMENDATIONS

In the light of the results from this study, management strategies would be toward increasing diversity of native habitat in the Amani swamp by probably removing part of the *M. aquaticum.* Trail monitoring plots would be established to assess habitat transitions in the course of *M. aquaticum* replacement. Further studies should be carried out to investigate this comparison and explore whether this invasive species is creating ecologically havoc or having mainly a benign impact before any restoration activities are put in place.

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