Biodiversity Change: Preliminary Monitoring of Anura Species in Selected Vegetation Sites in Southwestern Nigeria

A. B. Onadeko[1*], R. I. Egonmwan[1] and J. K. Saliu[1]
[1]*Department of Zoology, University of Lagos, Akoka, Lagos, Nigeria*
**Corresponding author; Email: onadeko2002@yahoo.com*

Abstract

Four study sites with different vegetation structures in southwest Nigeria were selected and monitored for anuran species between 2007–2009 applying the transect sampling method. These study sites were located at Ijede (06° 34' 072'' N 003° 35' 030'' E), Ijebu Oru (06° 56' 493'' N 003° 56' 792'' E), Onidundun (07° 37' 313'' N 003° 55' 258'' E) and Ibapon Oyewole (08° 05' 129'' N 004° 11' 132'' E), all in southwest Nigeria. The study sites of Ijebu Oru (forests/abandoned farmlands) and Ibapon Oyewole (savanna) had a mean number of species and individuals of 21 and 14, and 236 ± 5 and 108 ± 7.9, respectively. However, at Ijede (swamps/forests), there was 18% reduction (6% in 2008; 12% in 2009) of the initial number of species recorded in 2007 due to shifting agricultural practices. *Hylarana albolabris, Aubria subsigillata* and *Ptychadena aequiplicata* were no longer accounted for in 2009 surveys. At Onidundun (derived savanna/forests), there was a 17% reduction of anuran species (*Ptychadena mascareniensis, Hyperolius f. burtoni* and *Arthroleptis* sp.) in 2008, but 12% of these species (*Hyperolius f. burtoni* and *Ptychadena mascareniensis*) were again seen in 2009 after substantial amount of vegetation growth had occurred. The mean number of species and individuals at the study sites of Ijede and Onidundun were 16.67 ± 1.5 and 16.67 ± 1.5; and 203.67 ± 6.7 and 169.67 ± 8.3, respectively. In general, fewer number of amphibian species were observed during the dry season at the four study sites. Habitat destruction and modification are key causes of habitat loss of anuran species observed in this study. Biomonitoring procedures should be applied regularly to detect changes (increase/decrease) in the diversity and abundance of anuran species within a specified study area of interest over time.

Introduction

In recent years, scientists and conservationists have reported the alarming rate at which anuran species are declining and disappearing. Of the estimated 5918 known species of anurans, about 1856 species are listed as endangered, threatened or vulnerable on the International Union for the Conservation of Nature (IUCN) red list (IUCN, 2008).

Fewer amphibian species population and individuals are on earth today than were present in the last century, primarily because most species no longer have as much of their requisite habitat as they did a century ago, a decade ago, or even a year ago (Halliday, 2005). Disease, pollution, invasive species, over collecting, global changes and other causes have been documented or proposed to be responsible for particular or widespread amphibian declines (Fahrig *et al.*, 1995; Collins & Storfer, 2003; Muths *et al.*, 2003; Weldon *et al.*, 2004; Blaustein & Bancroft, 2007).

Throughout the history of civilization, human activities have been detrimental to the natural biota, which is particularly evident in the clearing of the forest that houses the greatest diversity of anurans (Duellman & Treub, 1986). For nine out of every 10 amphibian species that are classified as threatened, habitat loss is a key threat (Baillie *et al.*, 2004). Habitat loss is primarily caused by expanding agriculture, logging, mining and infrastructural developments (for example industrialization, road building, dam construction and housing developments). Due to the growing human population and its demand for food, shelter, energy and consumer goods will continue to drive the destruction of habitats throughout the hemisphere. This will place additional burdens on our natural resources, and amphibians and other wildlife will be pushed further to the margins of their existence (Young *et al.,* 2004).

The economic value of losses due to forest destruction in Nigeria has been put at $750 million annually. If this current rate of deforestation is allowed to continue unchecked, the remaining forest in Nigeria may disappear by 2020 (FAO, 2006), which would have a disastrous effect on amphibian existence. Except for the Congo basin, West Africa's frontier forests have largely been destroyed primarily by loggers and by farmers clearing land for agriculture. In West Africa, nearly 90% of the original moist forests have gone and what remains is heavily fragmented or degraded. Today, West Africa frontiers are restricted to one patch in Cote d'Ivoire (Taï National Park) and another along the border between Cameroon (Korup National Park) and Nigeria (Cross River National Park) (Kio *et al.,* 1989; Udo *et al.,* 1993).

Appreciating the importance of amphibians in our environment and the fast and unprecedented rate of their decline (Blaustein & Wake, 1990; Stuart *et al.*, 2004; Lips *et al.*, 2005; Pounds *et al.*, 2006), one cannot overemphasize the need for its conservation. As crucial components of both aquatic and terrestrial communities, anthropogenic factors that negatively affect them may, therefore, influence the entire ecosystem (Hopkins, 2007). It is critical that not only high quality ecosystems persist, but also that associated terrestrial habitats are protected. The need to create protected areas and conservation sites with optimal thriving conditions for amphibian species must be a priority.

But, in order to achieve this cause, adequate monitoring procedures must be emphasized. Standardized methods of amphibian assessments and measurements will guarantee comparability between different studies as well as enhance the power of prediction resulting there from (Rodel & Ernst, 2004; Heyer *et al.,* 1994). The study tries to employ adequate monitoring procedures so as to ascertain the diversity and abundance of amphibian species within the selected vegetation sites of southwest Nigeria, and to investigate factors that may affect their seasonal (rainy and dry) abundance. The preliminary data gathered from this study is expected to provide base-line information to help evolve management plans to protect and improve biological diversity. This will go a long way in establishing the fact of amphibian decline, when results are compared to future monitoring surveys in similar sites.

Materials and methods

Study area

The study area is situated in the tropical zone. It is covered by two vegetations types; forests (where there is significant tree cover), which is humid, and the savanna (insignificant tree cover, with grasses and flowers located between trees), which is drier (Udo, 1970). The sites selected for the study were located in Oyo, Ogun and Lagos states in southwestern Nigeria (Fig. 1). Four study sites of different vegetation characteristics were selected within these states which were located at Ijede, (secondary forests with swampy areas), Ijebu Oru (primary/ secondary forests and large areas of abandoned farmlands at different degrees of

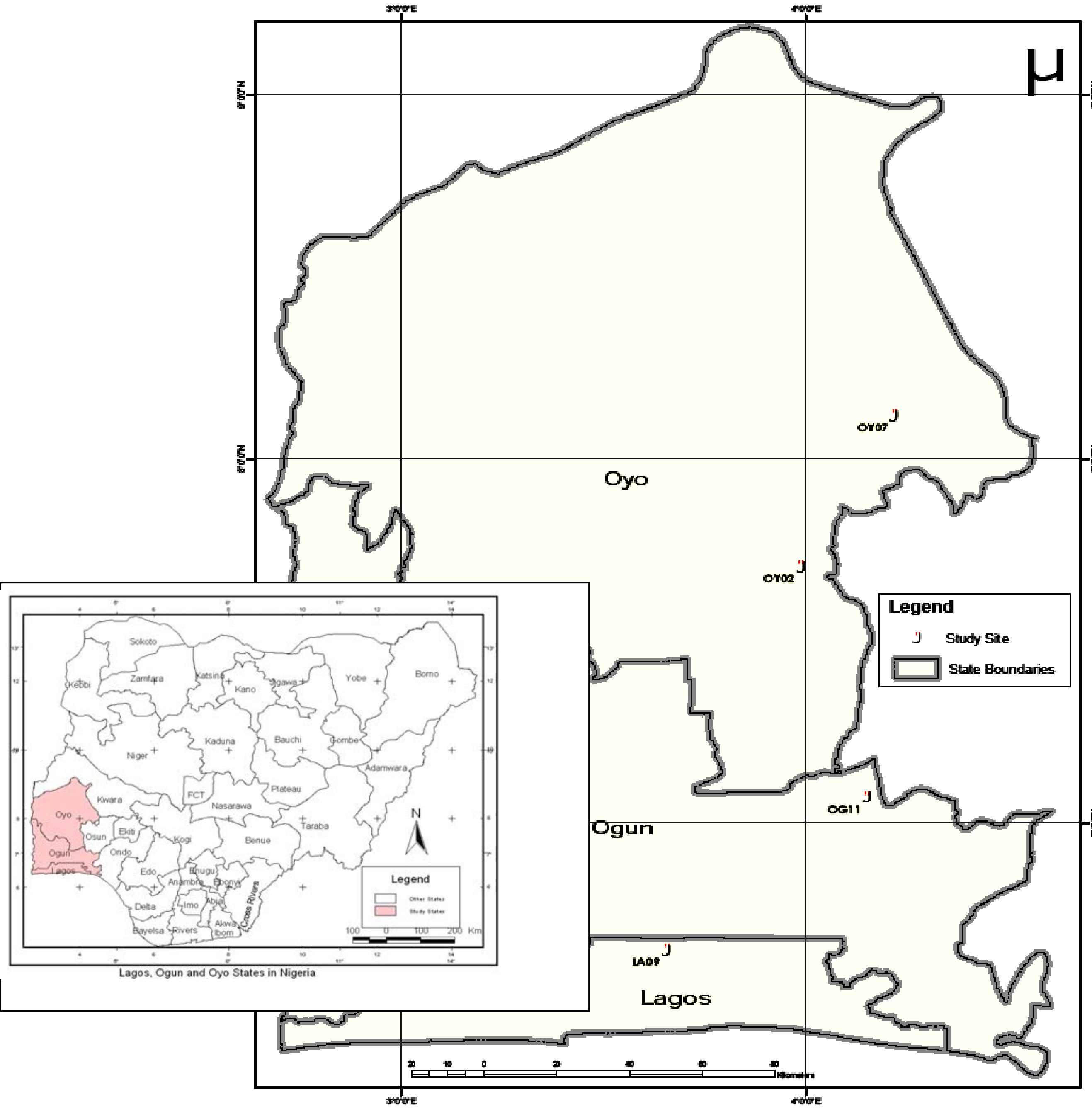

Fig. 1. Nigeria showing states of Lagos, Ogun and Oyo and study sites located at Ijede (LA 09), Ijebu Oru (OG 11), Onidundun (OY 02) and Ibapon Oyewole (OY 07). (LA = Lagos State; OG = Ogun State and OY = Oyo State)

growth, e.g. quaternary or tertiary), Onidundun (mostly of tertiary vegetation in the derived savanna and a small area of secondary forest) and Ibapon Oyewole (savanna). Each site had an approximate area of about 400 m^2, and their position taken by the Global Position System (G.P.S.). The choice of these sites was made to cover the existing ecosystems (forest to savanna zones).

Sampling method and design

Sampling at each study site took place twice a year from 2007 to 2009 during the rainy and dry seasons. Samplings were undertaken for 10 days each in June at Ijede and Ijebu Oru; 10 days each in July for Onidundun and Ibapon Oyewole that covered the rainy season. This was done again in December at Ijede and Ijebu Oru and January at Onidundun and Ibapon Oyewole that covered the dry season.

The standardized transect method was employed in the study of the anuran community. Five transects, each of length 200 m and width 5 m, were distributed between microhabitats types in each study area. The sampling methods used include the standardized visual transect sampling (SVTS), standardized acoustical transect sampling (SATS) and pitfall traps (Rodel & Ernst, 2004; Veith *et al.*, 2004). The SVTS method was employed to observe anuran species along the transects. The SATS sampling technique was used to detect calling individuals along these transects. This technique allows recording of cryptic species that despite their potential abundance may be underestimated when using visual techniques.

The pitfall traps were used as a supplementary method. They were installed using plastic buckets of diameter 35 cm and height of 40 cm, which were placed in the ground with the rims of the buckets leveled with the ground surface. A trap was installed every 100 m of these transects and checked once every morning.

Sampling surveys were performed day and night, independent of the prevailing weather condition. These transects were patrolled intensively (about 0.30–0.35 m/s), and all individuals on the main path, and those present in a band of 100 cm in either side were recorded. To avoid duplicate recordings, the fingers of captured individuals were clipped. For aquatic and terrestrial species, the second finger was clipped whereas for arboreal species, the second toe was clipped. The scissors used in clipping the digits were sterilized with alcohol and antifugal or antibiotics cream were applied to the cut digits following the methods of Donnelly *et al.* (1994). This was done to prevent infection. Opportunistic surveys were also done away from the transects among amphibian species inhabiting areas not more than 300 m away from the transects.

Specimens were identified by Prof. Mark Rodel from the Natural Museum of Herpetology, Berlin. The tree frogs were identified courtesy of Dr Arne Schiotz. Identification was also carried out using literature by Schiotz (1963, 1967, 1999) and Rodel (2000). Differences of anuran taxa's distribution and abundance in the four study sites were tested for, using the one-way analysis of variance (ANOVA).

Climatic data

The climatic data (rainfall, humidity and temperature) were obtained from the Nigerian Meterological Station at Oshodi, Lagos, which supervises the field stations at Ikeja, Ijebu Ode, Ibadan and Ilorin. These stations cover the study areas of Ijede, Ijebu Oru, Onidundun and Ibapon Oyewole, respectively, in southwest Nigeria.

Results

The climatic data recorded at the Ijebu Ode, Ikeja, Ibadan and Ilorin field stations in 2002 and 2003 are shown in Fig. 2–4.

A total of 12 anuran species were recorded on the transects at the Ijede study site (Fig. 5). There were seven species observed in the family Ranidae while two species (*Afrixalus dorsalis* and *Hyperolius f. burtoni)* were seen in the family Hyperoliidae. *Arthroleptis variabilis* was the only leaf litter species recorded while *Amietophrynus regularis* and *A. maculatus* were terrestrial species observed from the family Bufonidae.

At Ijebu Oru, the greatest number (14) of species was observed on the transects. *Afrixalus dorsalis* was observed on the transects while the other two members of the Hyperoliidae (*Hyperolius f. burtoni* and *H. concolor ibadanensis*) were outside the transects (Fig. 6). There were eight species observed in the family Ranidae which accounted for the greatest number of species recorded in a single family. The aquatic species *Xenopus muelleri* was recorded nocturnally in temporary bodies of water and diurnally in the pitfall traps. Leaf litter frogs, *Arthroleptis poecilonotus* and *A. variabilis*, were also recorded. The terrestrial frogs, *Amietophrynus maculatus* and *A. regularis*, were abundant in terms of individual numbers. Most of the species recorded in the pitfall traps were also observed on the transects.

The greatest number of arboreal species (family Hyperoliidae) was observed on the transects at the study site of Onidundun (Fig. 7). Most leaf litter species were absent and only an *Arthroleptis* sp. was observed. Semi-aquatic species were represented by *Ptychadena mascareniensis*, *P. taenioscelis*, *Phrynobatrachus auritus* and *P. accraensis*. At Ibapon, Oyewole recorded the least number (8) of species was recorded; four species of Ranidae, two species of Hyperoliidae (*Leptopelis hyloides* and *Hyperolius c. ibadanensis)* and two of Bufonidae (*Amietophrynus regularis* and *A. maculatus)* (Fig. 8). There were no records of leaf litter species.

Table 1 summarizes the number of individuals and species collected in the four study sites where sampling was carried out in 2007, 2008 and 2009. In 2007, the highest number of species and individuals were recorded at the study area in Ijebu Oru. Equal numbers of species (18 each) were recorded at Ijede and Onidundun but the individuals at Ijede (211) were higher than that of Onidundun (179). The study area at Ibapon Oyewole recorded the lowest number of both species and individual numbers.

In 2008, there were reductions in the number of species and individuals at Ijede (from 18 to 17) and Onidundun (from 18 to 15). This amounted to 6% and 17% decreases at Ijede and Onidundun, respectively. The species not seen at Ijede was *Hylarana albolabris* and the three species not observed at Onidundun were *Ptychadena mascareniensis, Hyperolius f. burtoni* and *Arthroleptis* sp.The other two study areas retained similar number of species but there were differences in their individual numbers.

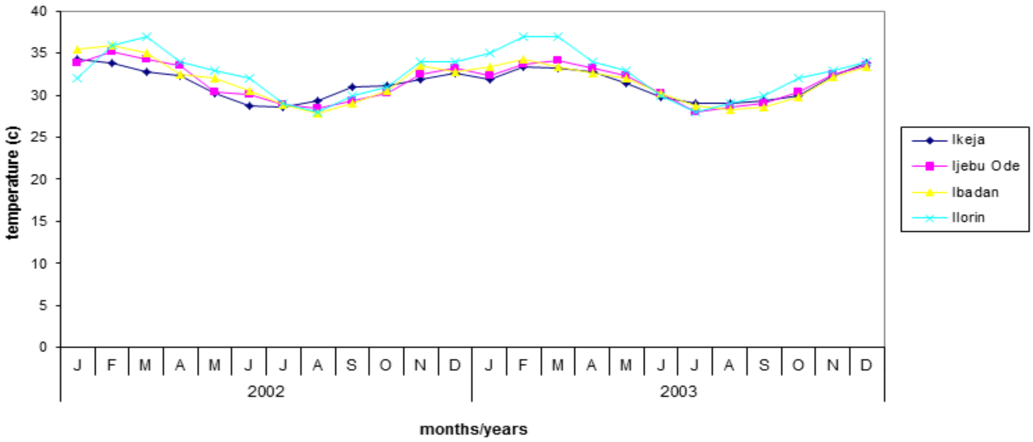

Fig. 2. Variation in the maximum temperature patterns in southwest Nigeria

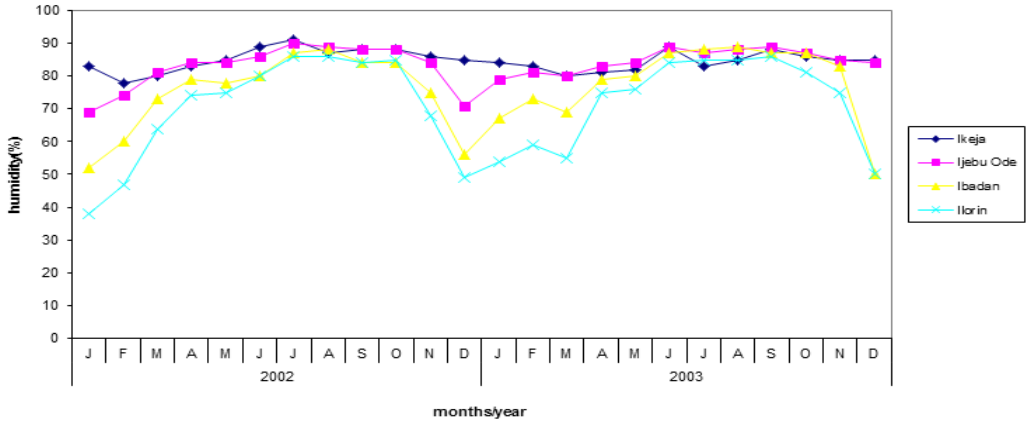

Fig. 3. Variation in the relative humidity in southwest Nigeria

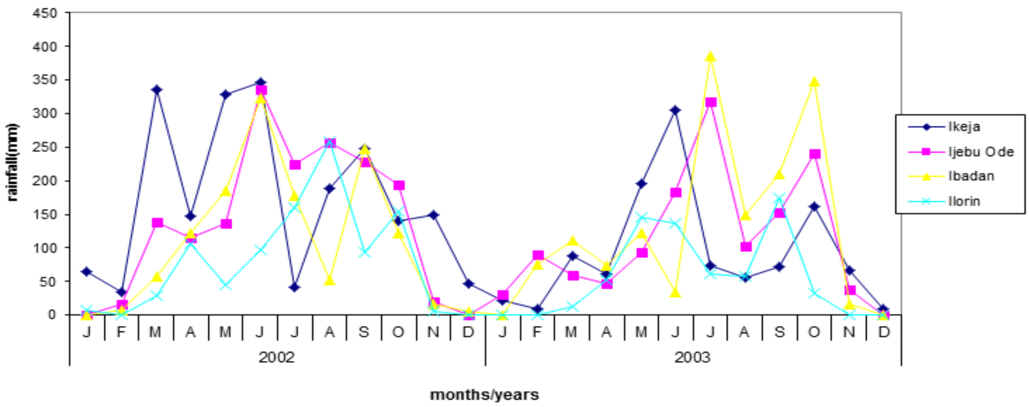

Fig. 4. Seasonal variation in the rainfall patterns in southwest Nigeria

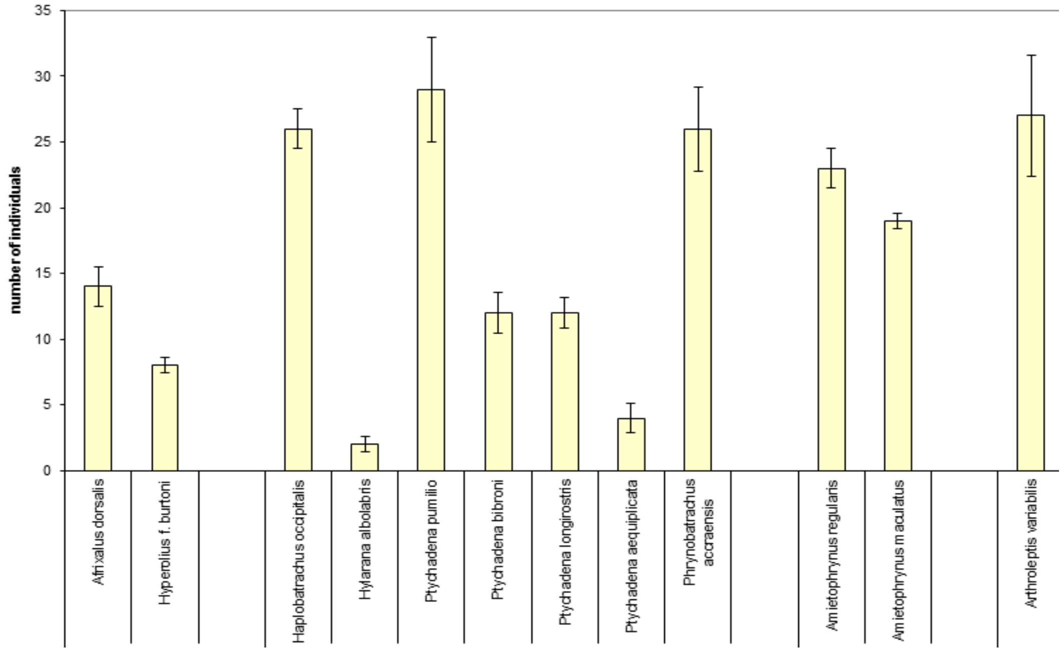

Fig. 5. Total mean number of species encountered on the transects at Ijede study site in 2007–2009

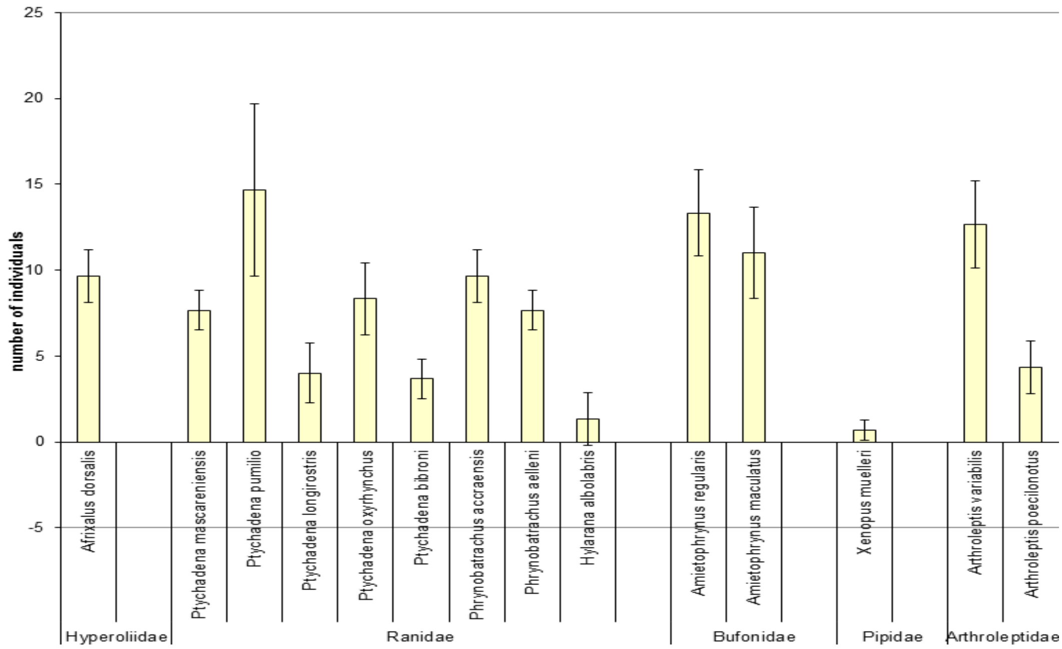

Fig. 6. Total mean number of species encountered on the transects at Ijebu Oru study site in 2007–2009

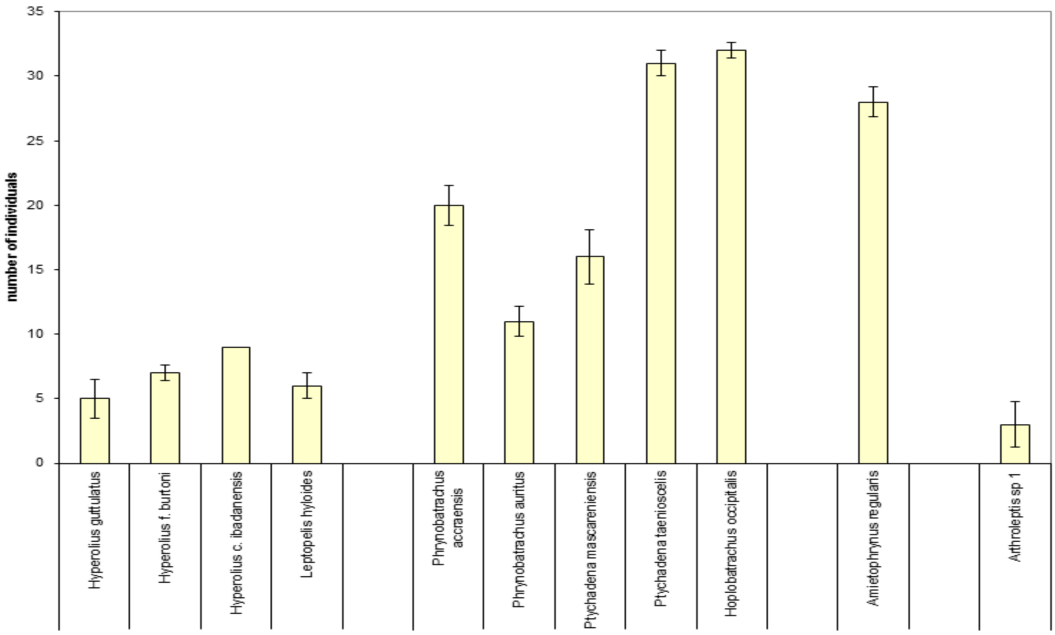

Fig. 7. Total mean number of species encountered on the transects at Onidundun study site in 2007–2009

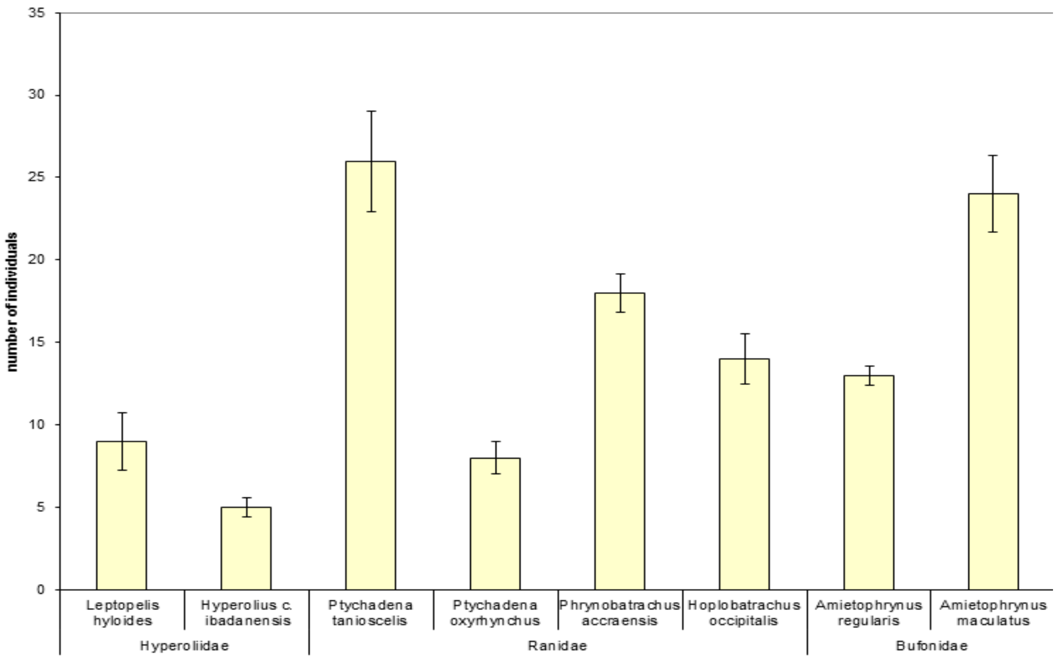

Fig. 8. Total mean number of species encountered on the transects at Ibapon Oyewole study site in 2007–2009

TABLE 1

Observed number of anuran species for four transect study sites (2007-2009).

Year/Study sites	*N-counts*	*Days$_o$*	*N-campaign*	*S_{obs}*	*N_{indiv}*
2007					
Ijede	20	1	18	12	211
Ijebu Oru	20	0	21	14	236
Onidundun	20	2	18	11	179
Ibapon Oyewole	20	6	14	8	117
2008					
Ijede	20	0	17(-6%)	12	198
Ijebu Oru	20	1	21	13	241
Onidundun	20	2	15(-17%)	11	163
Ibapon Oyewole	20	5	14	8	105
2009					
Ijede	20	1	15(-12%)	11	202
Ijebu Oru	20	2	21	14	231
Onidundun	20	1	17(+12%)	11	167
Ibapon Oyewole	20	3	14	6	102

Where, N-counts = number of transects walks; Days$_o$ = days with no anuran species record; N-campaign = total number of species observed on and around the transect sites during opportunistic surveys not more than 300 m away from the transects; S_{obs} = number of species observed on the transects; N_{indiv} = number of individuals observed on the transect (-) or (+) = percentage decrease or increase

Recordings at the various study sites in 2009 revealed a further decrease of anuran species at Ijede and an increase of species at Onidundun. The two species not observed at Ijede were *Aubria subsigillata* and *Ptychadena aequiplicata.* This led to further decrease of anuran species at that site by 12%. At Onidundun, two of the three species not observed in 2008 were again seen; *Hyperolius f. burtoni* and *Ptychadena mascareniensis,* which led to an increase of 12%. The other sites still retained their original number of species. The mean number of individuals and species recorded at the various study sites are shown on Table 2.

TABLE 2

Mean number of individuals and species at the various study sites.

Study sites	*Number of species*	*Number of individuals*
Ijede	16.67 ± 1.5	203.67 ± 6.7
Ijebu Oru	21 ± 0	236 ± 5.0
Onidundun	16.67 ± 1.5	169.67 ± 8.3
Ibapon Oyewole	14 ± 0	108 ± 7.9

Comparison of the anuran taxa among the study sites revealed no significant difference using the one-way analysis of variance (ANOVA) at (df = 3, P < 0.05%). See

Appendix for the multi comparisons of means among the study sites.

Seasonal abundance

The cumulative number of anuran species recorded at each monitoring survey site during the rainy (June and July) and dry (December and January) seasons of 2007, 2008 and 2009 are shown on Fig. 9–12.

Observations made in the year 2007 revealed that at Ijede there were 18 anuran species recorded during the rainy season. Less than half (7) of these species were recorded during the dry season (Fig. 9). At Ijebu Oru, 21 species were recorded in the rainy season while 12 were recorded in the dry season (Fig. 10). Less than half (8) of the anuran species were recorded during the dry season at the study site at Onidundun, while during the rains a total of 18 species were recorded (Fig. 11). Similar results were obtained at Ibapon Oyewole in which 14 species were recorded during the rainy season as against six in the dry season (Fig. 12). Similarly, in years 2008 and 2009 there were significantly lesser number of species and individuals collected during the dry season than the rainy season.

Discussion

From the preliminary monitoring results in 2007, the total number of species observed at Ijede and Onidundun were 18 each. In 2008, the number had reduced to 17 at Ijede and 15 at Onidundun. Human activities have been implicated as one of the reasons for the decline in anuran population. The inhabitants were found to have cultivated in and around the vicinities of both study sites which adversely affected the anuran population. Farming activity was maintained at Ijede, which further decreased the number of species and individuals collected in 2009. This led to the local extinction of *Hylarana albolabris, Aubria subigillata* and *Ptychadena aequiplicata* at the site due to the destruction and degradation of their habitat, which supported either their special feeding or breeding activities when compared to other species that were still observed.

Ash (1997) reported that for species with complex habitat requirements (such as those using separate breeding or foraging sites), it only takes one crucial habitat feature, a breeding pond, for example, to be lost to precipitate the eventual, if not immediate loss of the population. But at Onidundun, the farm was abandoned in 2008, this allowed the vegetation to grow and, as a result, the number of species observed in 2009 increased. It is evident that some species re-established themselves as a result of vegetation growth. These species were able to migrate to areas where re-grown vegetal cover was adequate enough for their existence. Dupuis (1997) observed that clear cut logging is immensely destructive in the short term for both terrestrial and aquatic breeding amphibians, but with forest re-growth, amphibian populations will re-establish themselves in second-growth forest as long as sources of immigrants remain. This might have been the case of *Hyperolius f. bourtoni* and *Ptychadena maascareniensis* that were again observed in 2009 surveys at Onidundun. Since only their sink population was destroyed, this made their local extinction temporary (inconsequential) and when conditions ameliorated they disperse from surrounding undisturbed environment and recolonized. However, *Arthroleptis* sp. was not observed after substantial re-growth, which may be due to the low population of individuals or power of dispersal. Dispersal

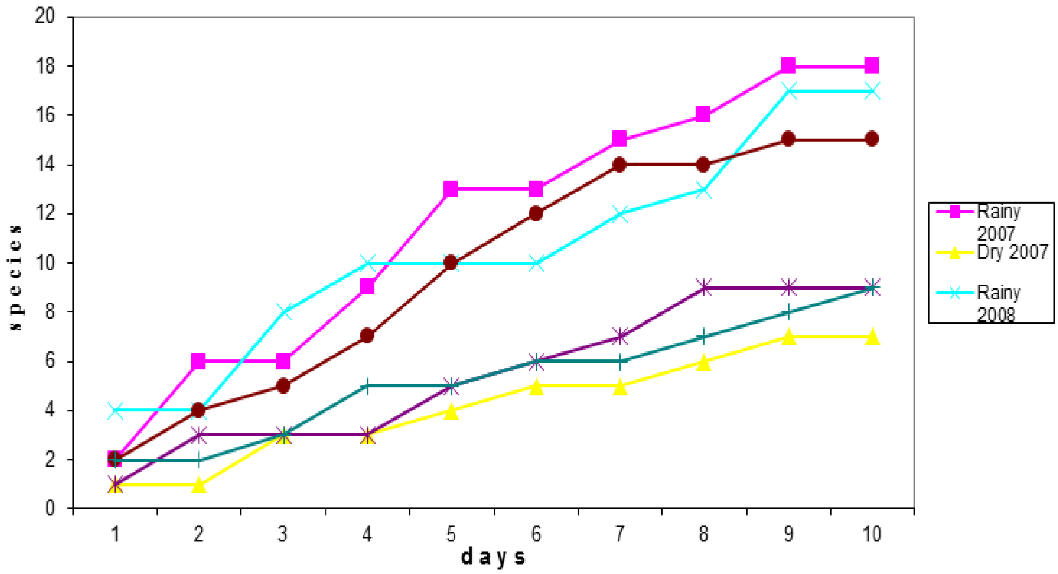

Fig. 9. Cummulative number of species observed at Ijede during the rainy and dry seasons of 2007, 2008 and 2009

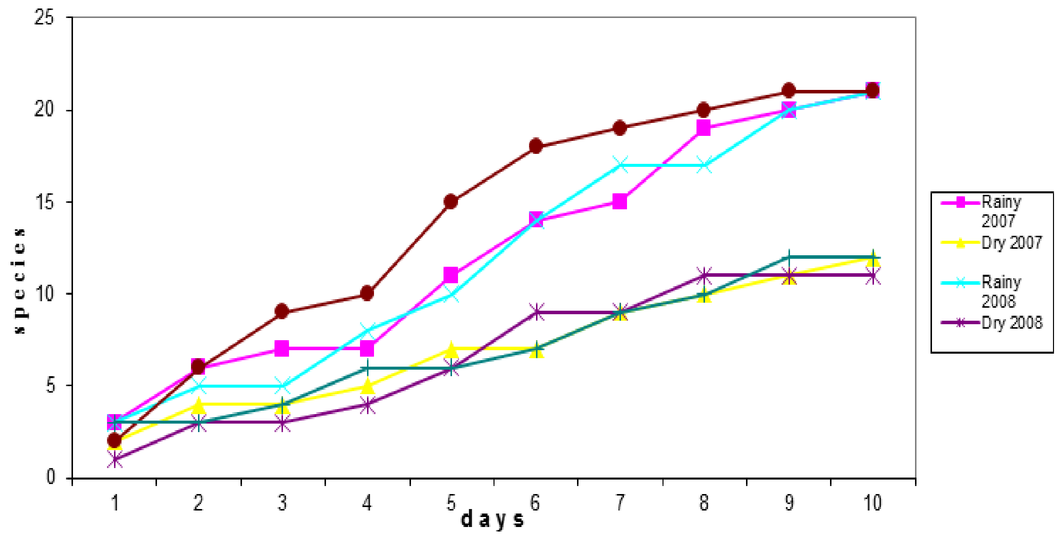

Fig. 10. Cummulative number of species observed at Ijebu Oru during the rainy and dry seasons of 2007, 2008 and 2009

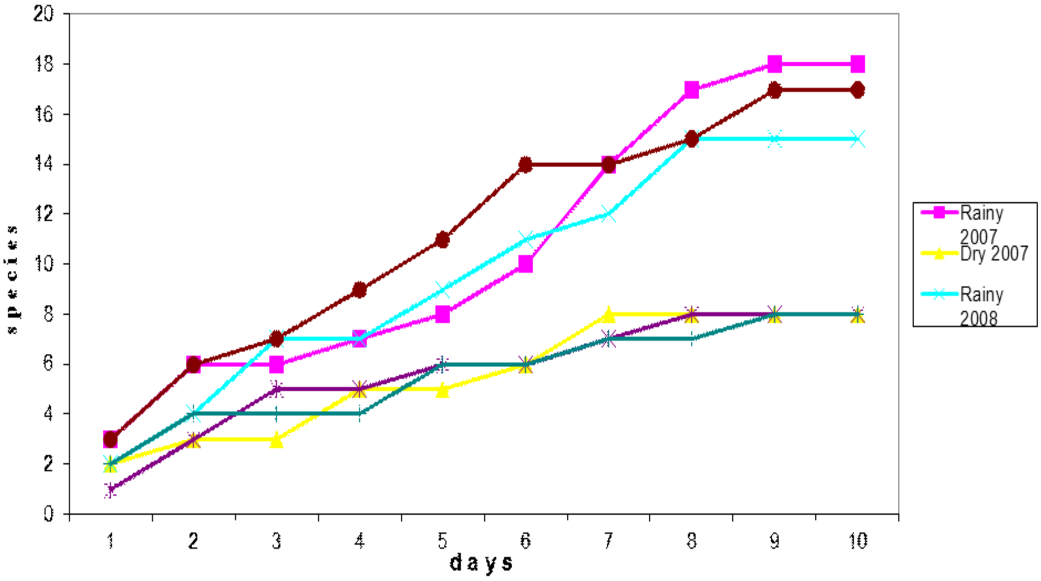

Fig. 11. Cummulative number of species observed at Onidundun during the rainy and dry seasons of 2007, 2008 and 2009

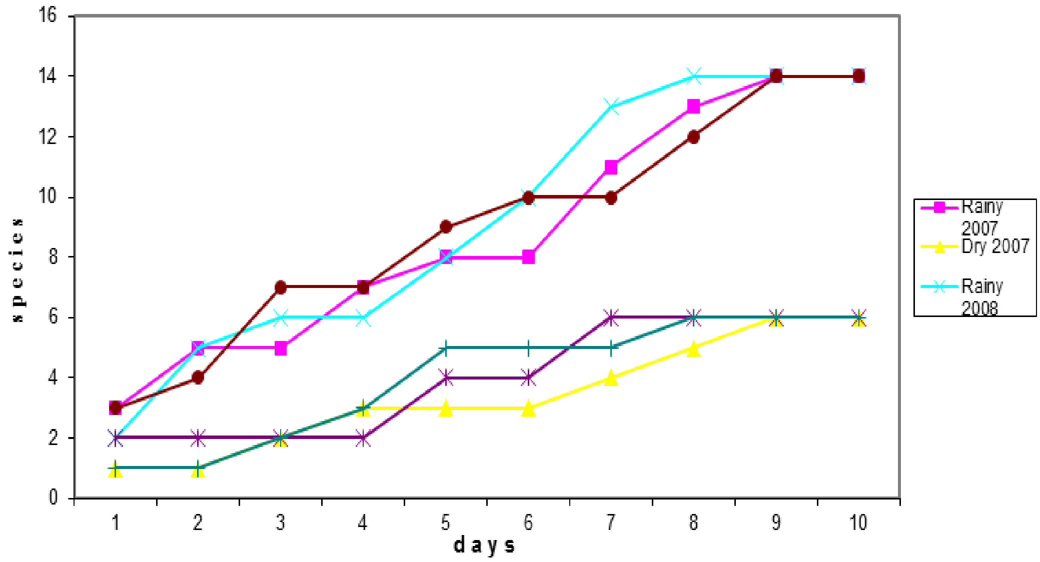

Fig. 12. Cummulative number of species observed at Ibapon Oyewole during the rainy and dry seasons of 2007, 2008 and 2009

has been shown to be important in maintaining population, and Lannoo (2005) observed that not widely dispersing species risk increased possibility of extinction in any habitat alteration that severs or attenuates the connection between local populations.

The study shows that the main cause of amphibian decline both in diversity and number of individuals is due mainly to anthropogenic activities, such as the practice of shifting cultivation, which results in the loss of primary/secondary vegetation in the forest regions, thereby, destroying the once conducive habitat of the anuran species. Sodhi *et al.* (2008) observed that elevated habitat loss and human densities contributed to the decline of 2454 anuran species between 1980 and 2004, compared to 1545 species that were stable and population of 28 species that had increased. The continuous destruction of this rain forest is giving way to the spread of the savanna ecosystem, which does not support a wide diversity of anurans compare to the forest ecosystem.

From the preliminary results of monitoring, the highest number of species was recorded at Ijebu Oru site followed by Ijede, both in the forest/fallowed farmland region, and lowest number recorded at Ibapon Oyewole in the savanna region, which was statistically not significant. This reveals in this study that there are probably higher numbers of species in the forest/ fallowed farmland regions than in the savanna, which signifies unequal number of amphibian species and individuals inhabiting the different ecosystems, which is influenced mainly by climatic conditions. The lowest number of species was recorded in the savanna that had the lowest mean rainfall and humidity but highest mean temperature. Higher number of species was observed in the forest and fallowed farmland that has a greater amount of rainfall and humidity, which favour the thriving conditions of the anurans unlike the savanna, which has a lower rainfall and humidity coupled with lower density and variety of vegetations.

It is also evident that climatic conditions have a great influence on the diversity and distribution of anurans as observed by Schiotz (1963). Major deforestation could change the local weather pattern such that a given area experiences reduced rainfall (Lannoo, 2005). It is also abundantly clear that the Earth's climate is changing in response to anthropogenic green-house gas emission. This change has been recognized as a potential problem for amphibian population and can cause potential shift in geographical range (Raxworthy *et al.*, 2008).

Also pertaining to seasonal conditions, anurans thrive in conditions where there are higher rainfall, more humid conditions and lower temperature. These conditions are available during the rainy season and may have contributed to their high abundance during this period. However, during the dry season these conditions are not available, thereby, significantly reducing their number. Akani *et al*. (2004) has observed similar trend in the forest swamp of the River Niger delta in southeastern Nigeria, greater number of anuran species and individuals were captured in the rainy season than the dry season.

During the dry season most anuran move away from temporary pools of water that would have dried and become restricted to large and permanent bodies of water, e.g. *Hoplobatrachus occipitalis* and *Ptychadena oxyrhynchus.* In this study, some anurans hibernate under leaves of the forest floor, under fallen trees or dig holes, e.g.

Amietophrynus regularis and *Hylarana albolabris*, in the dry season. Some dig into shallow burrows close to the banks of large streams or rivers, e.g. *Silurana tropicalis, Xenopus muelleri* and *Hemisus marmoratus*. Campbell (1999) also observed that during the dry season, other amphibians such as caecilians were found mainly in the soil, but in the rainy season they were detected in epigeic microhabitats (leaf litter or rotten vegetation).

The necessity of biomonitoring can not be overemphasize especially in this present state of amphibian decline and climate change. Amphibians are sensitive to and respond strongly to changes and variability in air and water temperatures, precipitation and hydro periods of their environment (Carey & Alexander, 2003). Global and regional climate change models predict climate warming and increased variability in the timing and type of precipitation (Walter *et al.*, 2002). As temperature warms and the availability of water in aquatic habitats becomes more variable, amphibians are likely to experience lower rates of survival (Gibbons *et al.*, 2000). With these preliminary data and looking at future biomonitoring plans coupled with statistical and modeling procedures, there is great possibility to advance the phenomenon of conservation in Nigeria, which is a major responsibility of man himself.

Conclusion

It has become imperative to monitor the anuran communities to ascertain whether its population is declining in southwest Nigeria and, if it is, what factors are contributing to this phenomenon. Sites once monitored can again be revisited in subsequent years (in 2, 3, 5,10 years) to evaluate species abundance and diversity in relation to past evaluations. This will go a long way in detecting changes in the anuran population and diversity status in Nigeria, which will eventually lead to the advancement of conservation efforts of these brilliant gems.

Acknowledgement

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APPENDIX I

Transect species list at the various study sites

Ijede site:

A) Twelve species observed along the transects were *Amietophrynus regularis, A. maculatus, Hoplobatrachus occipitalis, Afrixalus dorsalis, Hyperolius f. burtoni, Hylarana albolabris, Ptychadena pumilio, P. bibroni, P. longirostris, P. aequiplicata, Phrynobatrachus accreansis* and *Arthroleptis variabilis*).

B) Six species outside but close to the transects (100cm on both sides). These were *Phrynobatrachus francisci, P. alleni, Leptopelis viridis, Arthroleptis sp 1, Hylarana albolabris* and *Aubria subsigillata*.

C) Seven species were caught in the pitfall traps and these were *Ptychadena bibroni, P. pumilio, Hoplobatrachus occipitalis, Amietophrynus regularis, A. maculatus, Phrynobatrachus accraensis* and *Silurana tropicalis*.

Ijebu Oru site:

A) Fourteen species observed along the transects were *Amietophrynus regularis, A. maculatus, Ptychadena mascareniensis, P. pumilio, P. longirostris, P. oxyrhynchus, P. bibroni, Phrynobatrachus accreansis, P. alleni, Hylarana albolabris, Xenopus muelleri, Arthroleptis variabilis, A. poecilonotus* and *Afrixalus dorsalis..*

B) Six species outside but close to the transects (100cm on both sides). These were : *Hyperolius f. burtoni, H. c. ibadanensis, Hoplobatrachus occipitalis, Leptopelis hyloides, Arthroleptis sp 1* and *Silurana tropicalis.*

C) Six species were caught in the pitfall traps and these were *Xenopus muelleri, Amietophrynus regularis, Ptychadena mascareniensis, P. taenioscelis, Hylarana albolabris* and *Phrynobatrachus accraensis*

Onidundun site:

A) Eleven species observed along the transects were *Phrynobatrachus accraensis, P. alleni Ptychadena mascareniensis, P. taenioscelis, Hyperolius guttulatus, H. f. burtoni, H. c. ibadanensis, Hoplobatrachus occipitalis, Leptopelis hyloides, Arthroleptis* sp. *1,* and *Amietophrynus maculatus.*

B) Four species outside but close to the transects (100cm on both sides). These were *Leptopelis viridis, Phrynobatrachus francisci, Aubria subsigillata* and *Afrixalus dorsalis.*

C) Five species were caught in the pitfall traps and these were *Silurana tropicalis, Xenopus muelleri, Phrynobatrachus alleni, Ptychadena oxyrhynchus* and *P. taenioscelis.*

Ibapon Oyewole:

A) Eight species observed along the transect were *Amietophrynus regularis, A. maculatus, Leptopelis hyloides, Ptychadena taenioscelis, P. oxyrhynchus, Hyperolius c. ibadanensis, Ptrynobatrachus accraensis* and *Hoplobatrachus occipitalis.*

B) Four species outside but close to the transects (100cm on both sides). These were *Hyperolius nitidulus*, *Kassina senegalensis*, *Leptopelis viridis* and *Pthchadena bibroni*.

C) Three species were caught in the pitfall traps and these were *Hemisus marmoratus*, *Xenopus muelleri* and *Ptychadena taenioscelis*.

APPENDIX 2

Multiple Comparisons of Means

(I) Study sites	*(J) Study sites*	*Mean difference (I-J)*	*Std error*	*Sig.*	*95% Confidence interval*	
					Lower bound	*Upper bound*
Ijede	Ijebu-Oru	1.369	3.566	.703	-5.83	8.57
	Onidundun	1.311	3.784	.731	-6.33	8.95
	Ibapon-Oyewole	2.958	4.138	.479	-5.40	11.31
Ijebu-Oru	Ijede	-1.369	3.566	.703	-8.57	5.83
	Onidundun	-.058	3.652	.987	-7.43	7.32
	Ibapon-Oyewole	1.589	4.018	.694	-6.52	9.70
Onidundun	Ijede	-1.311	3.784	.731	-8.95	6.33
	Ijebu-Oru	.058	3.652	.987	-7.32	7.43
	Ibapon-Oyewole	1.648	4.212	.698	-6.86	10.15
Ibapon-Oyewole	Ijede	-2.958	4.138	.479	-11.31	5.40
	Ijebu-Oru	-1.589	4.018	.694	-9.70	6.52
	Onidundun	-1.648	4.212	.698	-10.15	6.86