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Comparative geographical distribution and abundance of Xenopus species AND Hymenochirus species in a secondary swamp forest, Okpara Inland, Delta State, Niger Delta Region, Nigeria

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ABSTRACT

The distribution and abundance of Xenopus sp and Hymenochirus sp were investigated in a secondary swamp forest at Okpara Inland, Nigeria. Due to the fact that they are two of the most dominant species inhabiting the water potholes and remanant puddles, this would give an adequate representation of the distribution of species inhabiting these habitats. The total study area was about 1,600m2 having a matrix of cassava, oil palm and yam farms. Sampling was carried out during the dry season and at the advent of the wet season in which three methods were used namely; sweep netting, pitfall traps and visual encounter. Most anuran (332 individuals) were collected using the sweep netting method of which 284 individuals were Hymenochirus sp. There were more Xenopus sp (63 individuals) were collected in the pitfall traps than the Hymenochirus sp (31individuals). The visual encounter method had the least (25 individuals). However, there was no significant difference (F1.3,9.6, df=2, P=0.37781) between the different collection methods. Overall, the results indicated that most of the anuran species were collected in the aquatic habitat than the terrestrial habitat. Both the SVL (snouth-vent-length) and the weight of the two anuran species were significantly different at (F1.2,4.7, df=1, P<0.05) and (F0.6,4.4, df=1, P<0.05) respectively. The study suggests that Hymenochirus sp was the more abundant species, but Xenopus sp seems to be more distributed in this human-modified landscape.

Keywords: Hymenochirus sp, Xenopus sp, anuran, human-modified, landscape

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1. INTRODUCTION

Nigeria is situated between West and Central Africa, and hence between the biodiversity hotspots of the Upper and Lower Guinea forest. Therefore the country is expected to harbor high biological diversity composed of West and Central African species alike (Bakarr et al., 2004). The country also has a great variety of ecosystems comprising varied landscapes which determines to some extent the spatial and temporal distributions of anuran species. This is evident in the Niger Delta region. The wet and dry seasons have a profound effect on the composition and distribution of anuran species which is exacerbated by the different land use types, mainly agricultural.

Anurans are paramount for wetlands and aquatic habitats because they provide key ecological functions, especially in tropical regions (Gibbons et al., 2006, Hocking and Babbitt, 2014). As a result of climatic change, invasive species and diseases (Beebee, 1995, Cheng et al., 2011), and especially by habitat loss, amphibian diversity worldwide is threatened (Butchart et al., 2010, Wake and Vredenburg, (2008).

In the Niger Delta region in Nigeria, inhabitants of many communities in an effort to secure food, have degraded most of the primary vegetation into cultivated lands. Native forest conversion to human-modified landscapes reduces and brings about fragmentations to natural habitats which is a major driver of biodiversity loss at multiple scales (Collins and Crump 2009, Newbold et al., 2015). Anthropogenic land-cover change, such as deforestation and conversion into farmland, is a major driver of species loss (Butchart et al., 2010, McGill et al., 2015), with severe impacts on global biodiversity (Bradshaw et al., 2009, Newbold et al., 2015). This leads to loss of biodiversity which has severe negative impacts on ecosystems functioning which, in turn, poses a threat to human well-being (Loreau et al., 2001, Johnson et al., 2017). Forest reserves are increasingly becoming islands as a result of the matrix of human-modified habitats due to various land use types (Rathod & Rathod, 2013). These are now forming a significant part of the landscape pattern in the Niger Delta region which has a profound effect on anuran assemblages.

According to Gomez-Rodrigue et al., 2010, they believed that ecological theory implicitly assumes that environmental variables determines, at least in part, species distributions across space and thereby promotes the existence of different species assemblages along environmental gradient. Different habitats are occupied by different anuran species both on a larger scale eg. forest and smaller scale eg breeding pond (Rodel 2000, Amiet 1989 & Lamotte 1983) and these are expressed by differences in their temporal appearance and or spatial distribution (Begon et al., 1990).

Here in this study due to interference by anthrogenic activities, I examined the temporal and spatial distribution and abundance of two prominent species (Xenopus and Hymenochirus spp) along microhabitats within varied landscapes patterns in the Niger Delta town of Okpara Inland in Delta State. Due to the fact that they are two of the most dominant species and the occupy similar habitats (temporary and permanent water potholes),this would give an adequate representation of the distribution of the herpetofauna species living in similar ecological niches during the dry season and at the advent of the rainy season. During the wet season, the entire locality is submerged under water and hence sampling is not possible. This study was done in cojunction with project researching the taxonomy, diversity and molecular characterization of anuran species in the Niger Delta Region, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted as part of the Central Research Committee, University of Lagos Research Grant, a research project investigating the taxonomy, diversity and molecular characterization of anuran species of the Niger Delta Region, Nigeria.

For this survey, studies were undertaken around Okpara Inland, Warri, Delta State that were characterized mainly by swamp forest with segments of secondary and pristine lowland forest with leaf litter habitats.

The total study area was about 1,600m2 having a matrix of cassava, oil palm and yam farms in small scale farming especially during the dry season. The central coordinate of the entire study area was N 05 o 37' 865'' E 005 o 59' 677''.

Majority of the study area gets submerged when the rain comes in (Plate 1). During the rainy season, about 80% are submerged under water and these areas are also used as fishing grounds where fishes, reptiles and even amphibians (mainly Hoplobatrachus occipitalis) are caught.

However, these sites are completely dry during the dry season with the exception of few puddles of water (see Plate 2). These puddles also entirely disappear but for a few during extremely dry conditions.

Plate 1. Part of the study area during the advent of the rainy season

Plate 2. Part of the study area during the dry season

2.1.1Anuran Sampling

Two anuran species, namely Xenopus and Hymenochirus spp (Plates 3&4) were sampled due to the uniqueness of their niche habitats. Both species occur within the West African subregion with Hymenochirus sp observed from Southern Guinea-Bissau to the Democratic Republic of Congo inhabiting lowland rainforests, small pools and puddles near slow flowing rivers and shaded agricultural lands Hymenochirus sp observed from Southern Guinea-Bissau to the Democratic Republic of Congo inhabiting lowland rainforests, small pools and puddles near slow flowing rivers and shaded agricultural lands.

Xenopus sp are observed from Senegal to the Democratic Republic of Congo inhabiting rainforest, degraded forest, savanna, and in temporary and permanent puddles (Channing and Rodel, 2019). The both species are usually found located in similar habitats especially during the dry season. During previous surveys, they were observed mostly submerged in remenant puddles (potholes) of water (Plates 5 and 6).

Plate 3. *Hymenochirus sp*

Plate 4. *Xenopus sp.*

Plate 5. Remenant puddles within site. **Plate 6. Water potholes during the dry season.**

2.2 Sampling Methods

The sampling of the anuran species took place during the dry season of years 2022 (November and December) and 2023 (January and February). Also, sampling was carried out at the advent of the wet season 2023 (April 15th-May 15th). The study area was visited fortnightly and the methods used to collect the species were sweep netting, pitfall trapping and visual encounter.

Sweep nets of mesh size (0.2 x 0.2mm) were used to scoop water and sediment samples from within water potholes located in the study area. Five sweep nets samples each were taken fortnightly from six water potholes that were randomly chosen to cover the study area. Anuran species were collected, counted and recorded with some preserved as voucher specimens. The rest were released after the end of the sampling.

The pitfall traps were also set randomly to cover different environmental conditions
The analysis of variance (ANOVA) was utilized to ascertain if significant difference of the anuran species population existed between the different methods of collection. The snout vent length (SVL) and the weight of both anuran species were tested by the same statistical method to ascertain if significant differences existed between both of these morphological parameters. The similarities or differences resulting thereof could show the resultant effect on physiological differences which could affect distribution patterns.

(vegetation, farmlands and areas around water potholes in the swamp) in the study area. The pitfall traps consisted of 15-litre buckets (250 cm deep and 270 cm diameter) sunk to ground level. There were 2 unconnected lines of 10 buckets spaced approximately 3 m apart, with a drift fence formed by a continuous rubber sheet which directed anuran specimens towards the traps. The traps were checked every morning for 2 weeks.

Anuran specimens were located opportunistically in the entire study location using the VES (visual encounter survey) methods (Rodel & Ernst, 2004). They were also opportunistically located by examining carefully suspected refuges and hiding places such as under fallen wood, stones, panels, plastics and amongst leaf litter. Specimens caught were identified, photographed and released.

2.3 Statistical Analysis

3. RESULTS

The numbers of Xenopus sp and Hymenochirus sp collected by the three methods are presented in Table1. In total 451 anurans, 323 Hymenochirus sp, 128 Xenopus sp were collected.

Most anuran individuals were collected using the sweep netting method from remaining water potholes. 332 individuals were collected using this method of which 284 individuals were Hymenochirus sp.

The visual encounter method had the least (25 individuals) collection recorded of which eight specimens of Hymenochirus sp were observed.

More Xenopus sp (63) were collected in the pitfall traps than the Hymenochirus sp (31). Overall, the results indicated that most of the anuran species were collected in the aquatic habitat than the terrestrial habitat.

However statistically, there was no significant difference (F1.3,9.6, df=2, P=0.37781) between the different collection methods.

Morphometrically as observed in Figures 1 and 2 respectively, the snout vent length (SVL) and the body mass (weight) of Xenopus sp are much larger than that of the Hymenochirus

Table 1. Numbers of individuals of two species of anurans collected by three different methods

Species	Collection method			Totals
	Sweep netting	Pitfall	Visual encounter	
Hymenochirus sp	284	31	8	323
Xenopus sp	48	63	17	128
Totals	332	94	25	451

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Overall, the results indicated that most of the anuran species were collected in the aquatic habitat than the terrestrial habitat. However statistically, there was no significant difference (F1.3,9.6, df=2, P=0.37781) between the different collection methods. Morphometrically as observed in Figures 1 and 2 respectively, the snout vent length (SVL) and the body mass (weight) of Xenopus sp are much larger than that of the Hymenochirus sp.

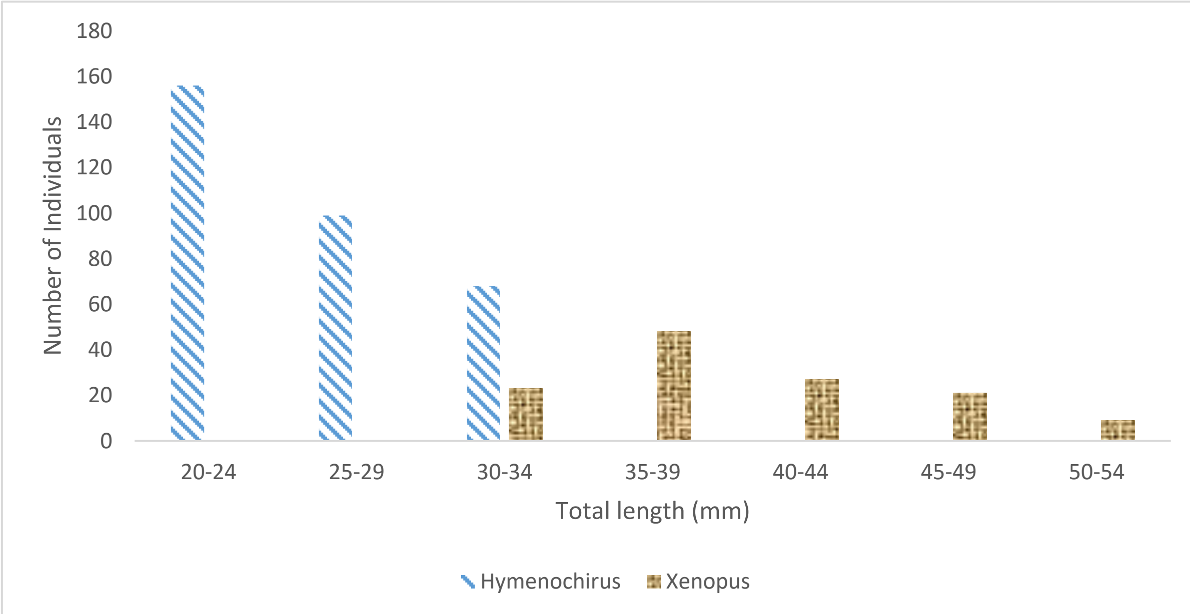

Fig.1. Frequency distribution of the snout vent length (SVL) anuran species collected.

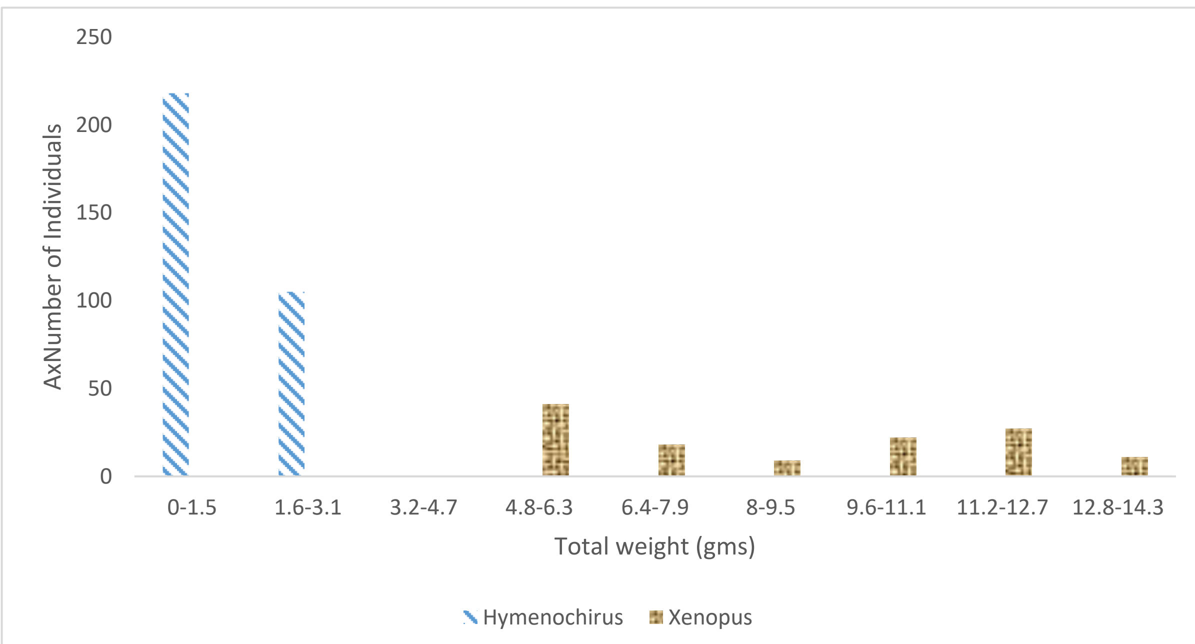

Fig.2. Frequency distribution of the weight of anuran species collected.

The range of the SVL of Xenopus sp collected was 31.51mm to 53.24mm while that of Hymenochirus sp was 23.33mm to 30.12mm. the SVL of Xenopus sp was greater than that of Hymenochirus sp. The weight range of both species of Xenopus sp and Hymenochirus sp were 4.18g to 14.25g and 0.61g to 1.67g respectively. Both the SVL and the weight of the two anuran species were significantly different at (F1.2,4.7, df=1, P<0.05) and (F0.6,4.4, df=1, P<0.05) respectively.

4. DISCUSSION

Taking a face value, the collection data suggests that Hymenochirus sp is more abundant than Xenopus sp in the study location. However, Xenopus sp seems to be the more distributed in the study habitat consisting of mainly swamp forest with patches of secondary and pristine lowland forest. According to Laurie et al, 2010, they observed that all pipids are aquatic frogs, occurring in a variety of habitats, usually still or slow-moving water among vegetation and Xenopus seemingly occurs in every freshwater habitat south of the Sahara, including road side puddles.

Significantly, more Hymenochirus sp individuals were collected in the sweep net than Xenopus sp. This may be due to the fact that they are more restricted to the aquatic habitat than the Xenopus sp. They may possess naturally a higher population density than Xenopus due to their smaller morphological size. Also, it was revealed that the males of Hymenochirus sp mate throughout the year and amplexus at night and can last for several hours (Deban, 2002). This could be another possible reason for its greater collection. An alternative explanation for this data could be that this collection method could be a bias to the collection of Xenopus sp. For example Xenopus sp maybe larger and faster, hence maybe able to easily escape the sweep net. They maybe more sensible to danger, making them more environmentally aware than the Hymenochirus sp.

The visual encounter and pitfall trap methods were used to sample individuals of the species that spend at least some time in the terrestrial environment. There were more Xenopus sp observed visually than the Hymenochirus sp. This indicates that Xenopus sp has demonstrated the ability to occupy modified environments. Similar observations were made in Mexico on the leopard frog, Lithobates neovolcanicus and some treefrogs that showed a positive response in occupancy probability with the increasing of crop land proportion (Oropeza-Sanchez et al., 2022). This shows that the Xenopus sp are highly mobile and invasive. Among amphibians, Xenopus sp have one of the highest recorded impacts of all invasive amphibians (Measey et al., 2016; Kumschick et al., 2017). The species was originally distributed for pregnancy test and laboratory use (Van Sittert and Measey, 2016), and today large number are exported as pets (Herrel and van der Meijden, 2014). Xenopus sp has been used as a laboratory animal for a long time in different areas of research (Sater et al., 2017; Robert, 2020; Boswald et al., 2024). Consequently, invasive populations have been established on the four continents (Measey et al., 2012). Lesser Hymenochirus sp were recorded which may be due to the fact that they may have been less conspicuous in the environment (among leaf litter) or they may emerge when visual encounter was less likely eg. at night.

There were also more Xenopus sp observed in the pitfall trap. As discussed previously, Xenopus may have a higher mobility rate. They are the first of the two species to be observed at the advent of the rainy season in small puddles in farmlands.

This indicates that the Xenopus sp immediately starts to move out of permanent puddles formed during the dry season to newer puddles being formed when the rains begin to come in. According to Measey, 2016 evidence overwhelmingly shows that both native and invasive populations of Xenopus spp move overland during migration processes. Distances of over 40m to 2 km were reported with no apparent difference between native and invasive ranges. This phenomenon increases the distribution potential of the Xenopus sp.

Hymenochirus sp may begin to migrate to newer puddles or bodies of water at a later period, hence the lesser individual numbers observed in the pitfall traps. The Hymenochirus sp may also be patchily distributed when compared to the Xenopus sp in the study area. This may be due to the fact that Hymenochirus sp may not be well adapted to different landscapes due to different land uses. Similar observation was made by Mechkarska et al., 2012, who revealed that there was a declination of Hymenochirus sp because of habitat modification from deforestation. Observing their behavior and breeding ability, it was also revealed that Hymenochirus sp was less distributed due to the fact that they are a sexually dimorphic species, in which females usually present a larger oval-shaped body, whereas males present a large obiculated tympanum and a lateral postaxillary subdermal gland that increase in size and vascularity during sexual activity (Rabb, 2010).

The two species differ substantially morphologically in their snout-vent-length (SVL) and weight. Data from this study showed that the range of SVL of Hymenochirus sp and Xenopus sp were 23.33-30.11mm and 31.51-53.24mm respectively while their weights were 0.61-1.67gm and 4.18-14.25gm respectively. Observations made by Laurie and Janalix, 2009, revealed that adult SVL size of Hymenochirus sp and Xenopus sp were variable, ranging from 25-33mm and 60-130mm respectively.

The differences in the size, length and weight may also have been contributing factors to their distribution. Xenopus was found to be more evenly distributed among the three sampling methods employed in this study. This could be as a result of larger body size that enable the species greater mobility hence enabling more distribution. Invariably Hymenochirus sp with smaller body size had over 90% of individuals located beneath large puddles surveyed. Very few individuals were observed visually or caught in pitfall traps. The ability to disperse in the environment could be due to their small size which hindered their dispersal ability. As a result, they congregate in drying up puddles and even remain there at the advent of the rainy season not dispersing to newer puddles being formed. However both species share similar habitat and it might be hypothesized that both species share similar environmental and nutritional requirements.

5. CONCLUSION

The environs of Okpara Inland in Delta State, Nigeria supports a high diversity of herpetofauna communities. These anuran species were observed in various microhabitats and ecological niches. Two prominent species observed were Xenops sp and Hymenochirus sp. These two species were among the dominant members of the herpetofauna communities studied and in this habitat and it was observed that they were mainly restricted to water potholes and remanant puddles.

Despite inhabiting similar habitats, these two species exhibited different distribution patterns. It was revealed from the sampling methods that the dispersal of these species varied. This coud be due to the behaviour and possibly the morphological differences of the organisms. This gives credence to the fact that the distribution and abundance of any species is based partially on its behaviour and morphological features. It is imperative that some of these locations be set aside to conserve the diversity of these organisms. Continual human interference leading to the modification of these landscapes maybe detrimental to the thriving exixtence of these species.

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