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Full Length Research Article

DISTRIBUTIONAL ECOLOGY OF *SCLEROPHRYS MACULATA* (NORTHERN FLAT-BACKED TOAD) AND *PTYCHADENA MASCARENIENSIS* (MASCARENE GRASS FROG) ON THE LIBERIAN REFUGEE CAMP, IJEBU- ORU, NIGERIA

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ABSTRACT
Sclerophrys maculata (toad) and *Ptychadena mascareniensis* (frog) are widely distributed anuran genera across West Africa to even other regions of Africa. Their distributional ecology and comparative abundance were studied on the Liberian refugee camp in Ijebu-Oru, Ogun State. Applying the visual encounter survey (VES) and acoustical encounter survey (AES) sampling methods, both genera were searched for opportunistically in the study area that was delimitated into four sub study sites (SSA, SSB, SSC and SSD). The highest number of individuals of both *S. maculata* and *P. mascareniensis* were observed in SSB during the dry season while the least observed in SSD. In the wet season, the highest number observed was in SSC while the least in SSD. During the dry season, there was a mean adult population of thirty-two (32) *Sclerophrys* sp while that of *Ptychadena* sp was 9.5 which was significantly different (P< 0.05). However during the wet season, greater number of adult *Ptychadena* sp (76.6) was observed than the *Sclerophrys* sp (65.4), but not significantly different (P> 0.05). During the wet season, the greatest mean number of adult individuals for *Sclerophrys* sp (29.9) and *Ptychadena* sp (31.5) were recorded at site SSC. The lowest; *Sclerophrys* sp (6.6) and *Ptychadena* sp (6.5) were recorded at site SSD. During the dry season, the greatest mean number for *Seclerophrys* sp (11.5) and *Ptychadena* sp (4.1) were recorded at site SSB and the lowest; *Sclerophrys* sp (4.4) and *Ptychadena* sp (1.4) were recorded at site SSD. Higher mean numbers of *Sclerophrys* sp were recorded within the first ten meters compare to the *Ptychadena* sp while further towards the swamp (21-30m), greater mean number of *Ptychadena* sp was observed compared to *Sclerophrys* sp. *Ptychadena* sp with its soft moist skin finds it more suitable not dwelling in vicinities far away from aquatic sources of water. Therefore evolutionarily speaking, the development of tough warty skin by the toads have conferred on them better adaptation for terrestrial existence as compared to the frogs that is still relying more on very moist and aquatic environments for their optimal existence.

Keywords: *Sclerophrys* sp, *Ptychadena* sp, Distribution, Ecology, Abundance, Evolutionary.

INTRODUCTION
Distributional variation of amphibian species maybe as a result of heterogeneous habitats associated with the tropical regions. According to McAuthur (1984) and Mesquita and Colli (2003), they hypothesized that when populations are subjected to different environmental pressures, they may respond by evolving different characteristics or strategies which are more adapted to the environmental conditions they experienced. This is true concerning many assemblages of amphibian species. Ecological aspects such as life-history traits, diet, microhabitat use and thermoregulation maybe influenced by the climate or the physical aspect of the environment (Albuqurque *et al.*, 2018). Also the cold-warm seasonality (temperate region) and the wet-dry seasonality (tropical region) effects are more evident on the reproductive activities of organisms (Mesquita and Colli, 2010; Mesquita *et al.*, 2016).

Unnatural habitat heterogeneity created by anthropogenic disturbances also has a huge effect on the abundance of amphibian species. These habitats created from the natural ones may not be conducive for the optimal existence of the species. Habitat specialist species are particularly more susceptible than generalist species in this situation. According to Travis (2003) and Munday (2004), specialists have greater population declines when faced with habitat loss and tend to be less resilient to the effect of climate change when compared with generalists.

Sclerophrys maculata (toad) and *Ptychadena mascareniensis* (frog) are widely distributed genera across West Africa to even other regions of Africa. Channing and Rodel (2019) reported that these genera inhabited wide range habitats. Onadeko and Rodel (2009) also reported on the distribution and abundance of *S. maculata* and *P. mascareniensis* in the three states (Lagos, Ogun and Oyo) in Nigeria. *Sclerophrys maculata* inhabits mostly degraded forests to humid savanna and seen in settlements. They are also found on farmlands, forest edges, along river edges, ponds and puddles. *Ptychadena mascareniensis* occurs in the wooded savanna, grassland, temporary and permanent and stagnant waters, and in rice puddles.

In this study, we attempt to further highlight the distributional ecology of these genera by observing their abundance in the various habitats on the Liberian Refugee Camp in Ijebu Oru, Ogun State. The camp is a model habitat for study because it has heterogeneity of habitats which these species occur at certain duration of time throughout the year (wet-dry seasons). We therefore describe and compare the microhabitat use, number of individuals, tadpoles and sub adults at four (4) selected sites at the camp.

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MATERIALS AND METHODS

Study Area

The general study site was the Liberian Refugee Camp (06^0 56' 493" 0030 56' 792") located on the outskirt of Ijebu Oru in Ogun State. This was the settlement used by the Nigerian government to host Liberian refugees fleeing the civil war in Liberia. It is a large lowland settlement (300 x 300m) with heavy vegetation and water present on almost 15-35% of the ground throughout the year depending on the season. There are two (2) large shallow ponds having banana (*Musa* sp) trees around their periphery. There is a small river bordered by cultivated farmland and secondary forest growths.

Delimitation of Study Site

The study site was delimitated to four sub study areas (Table 1)

Table 1. Brief description and size of sub study areas

Sub Study Areas	Total Size	Brief Description Of Area
SSA	≈ 19, 480 m²	Secondary forest with a small river flowing through.
SSB	≈ 27, 140 m²	Swampy region with tertiary vegetation. Ponds located within and totally green due to heavy presence of algae.
SSC	≈ 24, 610 m²	Swampy region bordering dry land. Several housing units within the location.
SSD	≈ 18, 760 m²	Cultivated land, gardens and small patches of fallowed farmlands.

Data Collection

Both genera (*Sclerophrys* and *Ptychadena*) were searched for opportunistically using the visual encounter survey (VES) and acoustical encounter survey (AES) methods (Rodel and Ernest, 2004) in two consecutive years encompassing both dry (January-March 2016/2017) and wet (May-July 2016/2017) seasons

Plate 1. *Sclerophrys maculate* *Ptychadena mascareniensis*

Sampling was done monthly consisting of 5 nightly consecutive visits (1900-2300h) made by two investigators, the principal investigator and the field assistant. Each sub study area had survey duration of one hour each night, totaling four hours each night. This gave a total of 20 survey hours monthly, 60 hours for each season and 120 hours yearly. For each sampling occasion, we recorded the total number of individuals and stages of development (adults, sub adults and tadpoles).

Microhabitat Surveys

Surveys of the aquatic habitats (ponds both temporary and permanent, river side) were thoroughly done so as not to create a bias against the terrestrial ones. Sweep nets of mesh size (0.2 x 0.2mm) were used to take water samples within and along the sides of aquatic habitats to ensure sub adults and tadpoles were adequately recorded. This was done especially during the wet season when the emergence of large temporary ponds was numerous.

The tadpoles were identified according to Rodel, (2000). The tadpoles of *S. maculata* were brown to usually deep black color. The body is covered by a transparent layer and the short muscular tail axis bears an almost symmetrical tail fin that shows no marking. The eyes are arranged laterally, but almost on top of the head. The tadpoles of *P. mascareniensis* have its dorsum scattered with bright brownish spots with a metallic glimmer. The tail length is three times its height and three times the body length and it is very pointed.

Proximity of Species to Human Habitation

The species proximity and activities around three buildings inhabited by humans were taken into consideration. Each building had a ground surface area of about 32m X 21m giving a total area of 672m^2. The locality of the individual species was classified within the interval distances of 0-10m, 11-20m and 21-30m towards the swamp from the buildings. Observations and recording were done fortnightly for two hours (6-8pm) during the wet season in the months of June and July. Only the adults and sub adults were recorded.

Data Analysis

Data were analyzed using the one way analysis of variance (ANOVA) with the SPSS version 18.0 (SPSS, 2008). This was used to ascertain if the populations of the species differ significantly among the study sites seasonally. Variations between the adult anuran species were also tested each (wet and dry) seasonally to ascertain if significant difference existed.

RESULTS

The result of the mean population distribution of *Sclerophrys maculata* and *Ptychadena mascareniensis* observed in the various study sites are shown in Figure 1. There was significant difference ($P< 0.05$) between the population of these species during the wet and dry seasons. Far greater number of individuals of adults, sub adults and tadpoles were recorded during the wet season. In the wet season, there were greater populations of *Sclerophrys* sp observed in site SSA while greater amount of *Ptychadena* sp seen in site SSB).

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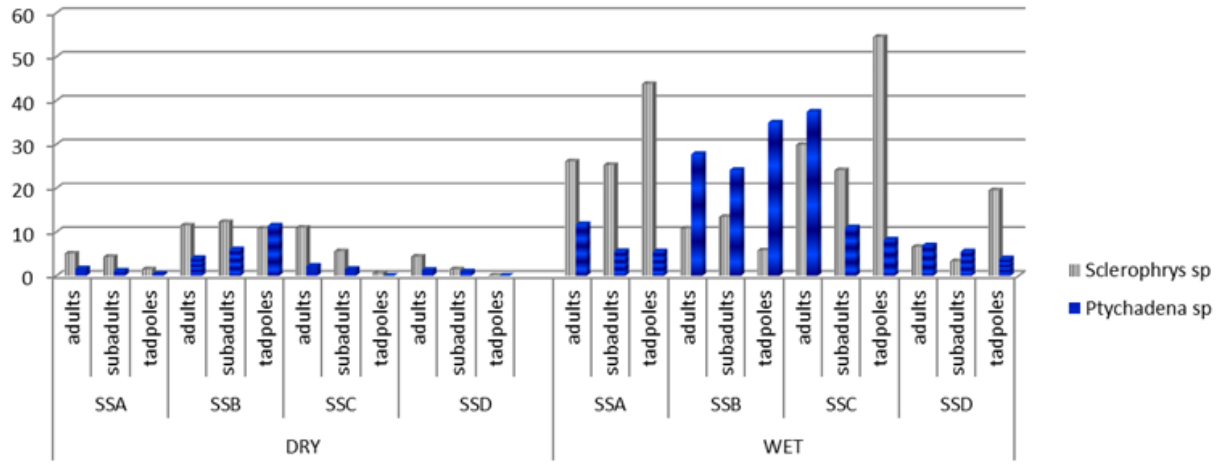

Fig. 1. Mean population of *Sclerophrys maculata* and *Ptychadena mascareniensis* observed in the various study sites during the wet and dry season

There were more tadpoles recorded in the wet season than adults and sub adults while in contradiction, the tadpoles were the least observed during the dry season. Figure 1 also reveals that the highest number of individuals of both *S. maculata* and *P. mascareniensis* were observed in SSB during the dry season while the least observed in SSD. In the wet season, the highest number observed was in SSC while the least in SSD.

In Figure 2, the mean population of adult *S. maculata* and *P. mascareniensis* observed at the study sites during the wet and dry seasons are shown. During the dry season, there was a mean total of 32 *Sclerophrys* sp while that of *Ptychadena* sp was 9.5 which was significantly different (P< 0.05). However during the wet season, greater mean number of adult *Ptychadena* sp (76.6) was observed than the *Sclerophrys* sp (65.4), but not significantly different (P> 0.05).

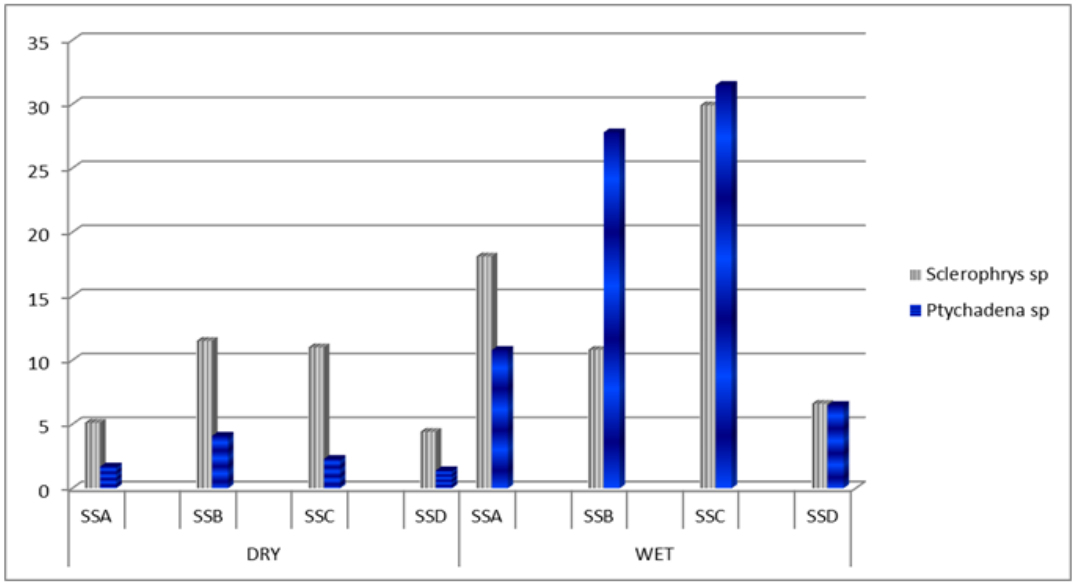

Fig. 2. Mean population of adults *Sclerophrys* sp and *Ptychadena* sp observed in the study sites during the wet and dry seasons

During the wet season, the greatest mean number of adult individuals for *Sclerophrys* sp (29.9) and *Ptychadena* sp (31.5) were recorded at site SSC. The lowest; *Sclerophrys* sp (6.6) and *Ptychadena* sp (6.5) were recorded at site SSD. During the dry season, the greatest mean number for *Sclerophrys* sp (11.5) and *Ptychadena* sp (4.1) were recorded at site SSB and similarly the lowest; *Sclerophrys* sp (4.4) and *Ptychadena* sp (1.4) were recorded at site SSD.

The distribution and abundance of *Sclerophrys* sp and *Ptychadena* sp were observed between the housing units and the swamp (Fig. 3). According to the distance intervals, higher mean numbers of *Sclerophrys* sp were recorded within the first ten meters compared to the *Ptychadena* sp. Within further distance (11-20m) slightly higher mean number of *Ptychadena* sp were recorded. Further towards the swamp (21-30m), greater mean number of *Ptychadena* sp (31) was observed compared to *Sclerophrys* sp (8).

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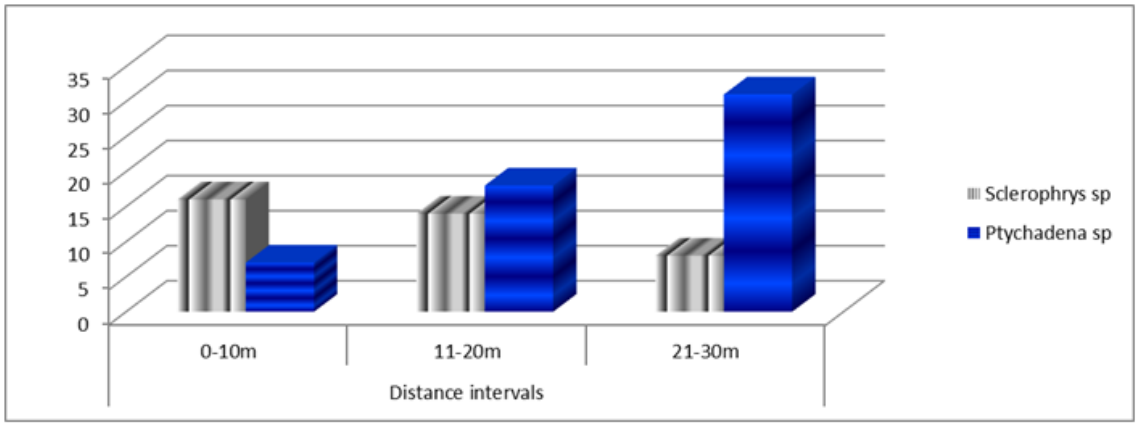

Fig. 3. Mean number of *Sclerophrys* sp and *Ptychadena* sp observed at the distance intervals between the housing units and swamp

Short notes were made on microhabitat activities and positions of adult *Sclerophrys* sp and *Ptychadena* sp at distance intervals between the housing units and the swamp (Table 2).

Table 2. Observation made on microhabitat activities and positions of adult *Sclerophrys* sp and *Ptychadena* sp at distance intervals between the housing units and swamp.

Distance intervals	*Sclerophrys maculata*	*Ptychadena mascareniensis*
0-10m	1. Some are found half buried in the sand/soil near the house bases during the day 2. Feed on insects flying around light bulbs at night 3. Eat flies on or near leftover food for pets	1. Very few seen near human habitation, if seen probably for nutritional needs
11-20m	1. Seen mostly around garbage waste disposal area feeding on flies and other insects/worms	1. Mostly seen among grasses feeding on insects 2. Few observed in amplexus in shallow pools
21-30m	1. Found in shallow temporary pools for reproductive purposes	1. Many located among half submerged vegetation in small puddle of water 2. Males call among vegetation to initiate reproductive activities

Plate 2. Sclerophrys sp hiding between toilet pipe and wall and half buried beside a house foundation

DISCUSSION

There has always been a marked difference in anuran population between the wet and dry seasons. Many authors (Duellman, 1995; Onadeko *et al.,* 2013; Onadeko, 2015 and Vonesh, 2001) have indicated this fact due to the presence of available water in the wet season which favours the thriving conditions of the species. In this study, apart from the reproductive potentials the wet season brings about, it was observed that species acquired temporal niches which helped in the acquisition of more food. Hence this increased the population of anurans in areas that were void of their presence during the dry season.

These niches acquired by both species (*Sclerophrys* sp and *Ptychadena* sp) during the wet season increased their distribution and abundance. Therefore it was observed that there was no significant difference between these species during the wet season. Both anuran species took advantage of the wet environmental conditions to maximize their nutritional needs and reproductive activities. These two anuran species may have been living in the same environment but their diets may not have entirely been the same. Protazio (2015) studying the diet composition and morphology in an assemblage of fifteen anuran species occupying temporary ponds revealed that closely related species use the same microhabitats, although at different proportions and show a high diet niche overlap. However, more individuals of *Ptychadena* sp were recorded in and around the ponds compared to that of *Sclerophrys* sp. Reasons could be that *Ptychadena* sp are semi-aquatic in nature and hence more associated with the aquatic or very moist terrestrial environments. More toads were seen in the secondary forests which corroborates Channing and Rodel, (2019) that they inhabit very highly degraded forest to humid savanna. Perhaps due to their integumentary morphology and composition, they are able to wander further away from aquatic or very moist terrestrial sources and into the forest.

Despite the low population of individuals observed during the dry season, there was still significant difference between the toad and frog population. This may be due to the fact that the frog (*Ptychadena* sp) has smooth and moist skin which doesn't permit them to move far away from moist or aquatic environments. The dry weather or terrain could easily subject them to dehydration which is detrimental to their existence. The toad (*Sclerophrys* sp) that had the higher population has tougher rough warty skin which could be advantageous to their dispersal in the dry conditions. This could be an evolutionary adaptation that could help withstand dehydration. This was one of the morphological adaptations the reptiles possessed in conjunction with dry scaly skin that made them better adapted for terrestrial existence (Hickman *et al.,* 2001). Therefore the higher populations of toad observed during the dry season might be due to the occurrence of tough, dry warty skin which prevented dehydration thus enabling them to disperse more than the frogs.

The highest occurrence of tadpoles during the wet season buttresses the point that the wet season is a conducive time for reproductive activities (Akani *et al*., 2004; Onadeko *et al.*, 2013). Most anuran species start their reproduction at the advent of the rainy season, hence the observance of more tadpoles than sub adults and adults. Contrastingly, the lowest occurrence of tadpoles compared to the sub adults and adults was observed in the dry season. This simply indicates that the dry conditions coupled with the scarcity or lack of water did not favour the reproductive activities of both species. Anurans still have to result in using the aquatic environment to complete their life cycle. Therefore evolutionarily speaking, some anurans have not completely conquered the existence of life on land.

Individuals of the toad and frog species were most populated in the swampy region bordering the dry land where some housing units (Site SSC) were located during the wet season. Water accumulates in the large pond during the wet season, therefore anuran species congregate at the side and close regions of the pond searching for food. According to Hopkins (2007), anurans play a very important role in the ecosystem as secondary consumers in many food chains as carnivores. This is the reason why most of their individuals were observed located in this region during the wet season. But however, during the dry season the highest population of anurans species were observed in the swampy region where the ponds were located (Site SSB). The species had now congregated around the almost dried up ponds where there were adequate and conducive conditions for their optimal survival. As noted, the surrounding conditions extending from this site was totally dry and devoid of water which made the other habitats less populated.
The lowest population of anuran species recorded at Site SSD both during the wet and dry seasons was as a result of degraded vegetation resulting from fallowed farmlands. Deforestation due to these human-induced activities adversely affects biodiversity, which in turn is expected to result in species decline and an increase in species extinction (Sodhi *et al*, 2010). Decena (2020) also confirmed that habitat alteration affected the assemblage of leaf-litter and semi-aquatic amphibians. The cultivated farmlands engage in monocropping activities which also reduces the abundance and diversity of animal species existing within these sites.

Sclerophrys maculata showed greater proximity to human habitation than *Ptychadena mascareniensis*. They were seen eating flies on and around left over dog's food, half buried beside building's edges during the day, neatly resting between pipes and mostly noted around garbage waste disposal sites. Those half buried during the day came out at night to eat flying insects around light bulbs at night. It can be deduced that due to the tough warty skin of *Sclerophrys maculata*, they are able to survive further distance from aquatic sources than the *Ptychadena* sp. For this reason they are found closer and around human establishments which are further away from natural aquatic sources. However within 11-20m towards the swamp, both *Sclerophrys* and *Ptychadena* sp*p* were not significantly different in populations though the latter being higher. *Ptychadena* sp population grew significantly higher as from above 20m into the swamp away from the housing units. This species with its soft moist skin finds it more suitable not dwelling in vicinities far away from aquatic sources of water. Therefore evolutionarily speaking, the development of tough warty skin by the toads have conferred on them better adaptation for terrestrial existence as compared to the frogs that is still relying more on very moist and aquatic environments for their optimal existence.

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