

## Diversity and Species Composition of Amphibians of the Aripo Savannas Scientific Reserve, Trinidad, West Indies

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**ABSTRACT.**—Information on amphibian diversity in Neotropical savannas and in protected areas in the Caribbean is lacking. We evaluated amphibian diversity and species composition in the Aripo Savannas Scientific Reserve in Trinidad, in relation to the two major habitat types, savanna and marsh forest. Thirty 200-m-long transects were sampled visually and aurally in 4 periods (total 120 samples), with 10 transects in savanna, and 20 in marsh forest (10 along trails and 10 off trails), at night in the wet season from June to December 2015. We recorded 895 individuals representing 16 species, 11 genera, and 7 families, with greater counts and diversity of amphibians in marsh forest compared to savanna. The three species recorded in savanna (*Leptodactylus fuscus*, *Scinax ruber*, and *Rhinella beebei*) were also found in marsh forest, with no separate savanna amphibian community. Audio detection was more effective at sampling most species, and there were greater counts along trails compared to transects off trails.

The Neotropics (including South America, Central America, southern Texas and Florida of the United States, and the Caribbean), currently has over half of all known amphibian species (Stuart et al., 2008). Although amphibian declines are occurring globally, the proportion declining in the Neotropics (40%) is greater than the global average (Stuart et al., 2008) and also is higher than all other biogeographical realms (Stuart et al., 2004). These declines are attributed to various factors, including habitat alteration, global climatic change, introduced species, commercial overexploitation, and infectious diseases, particularly the chytrid fungus *Batrachochytrium dendrobatidis* (Collins and Storer, 2003). Other factors that contribute to declining amphibian populations and increase their susceptibility to extinction include relatively low dispersal rates (Bowne and Bowers, 2004), vulnerabilities to movement across roads (Glista et al., 2008), narrow habitat tolerances (Houlahan and Findlay, 2003), and vulnerability to pollution (Stuart et al., 2004). Habitat alteration contributes to all these factors and is thus considered the major threat to amphibians (Cushman, 2006). Better information on how amphibians use habitats and factors that affect habitat suitability can be used to help conserve amphibian species (Babbitt et al., 2010; Searcy et al., 2013).

Savannas are an important but understudied habitat for amphibians in the Neotropics, with large areas in Venezuela and Brazil; some species are specialized for this habitat type, despite its generally lower amphibian diversity (Stuart et al., 2004). The Aripo Savannas Scientific Reserve (hereafter ASSR) comprises one of the last remaining natural savannas in Trinidad and Tobago and is of conservation importance (Environmental Management Authority [EMA], 2008; Hailey and Cazabon-Mannette, 2011). The vegetation there is unique, comprised of endemic species found nowhere else on the island; most of the other areas in the country that once had savanna have been lost to anthropogenic development (Comeau, 1990). The savanna habitat within the ASSR is surrounded by marsh forest; these together cover the majority of the reserve. Marsh forest is also unique to the ASSR in Trinidad and Tobago and comprises woody vegetation adapted for waterlogged conditions (Beard, 1946). Although the ASSR is legally protected, it is under threat from habitat alteration as a consequence of quarrying, squat-

ting, and fire (EMA, 2008; Bisram Singh and Oatham, 2011). The vegetation within the ASSR is well documented (Beard, 1946; Richardson, 1963; Comeau, 1990; Federman et al., 2014), but there have been few studies on the fauna (Sewlal, 2013), especially regarding counts and habitat preferences (Schwab, 1988). In particular, there has been no detailed study of the amphibian community within the ASSR. A checklist of 9 amphibian species for the ASSR (Schwab, 1988) was later updated to include 19 species (Auguste et al., 2015). No assessment of amphibian counts or species diversity has been made for the ASSR, or its habitat types. Such research is imperative because it can be used to identify and track future declines in populations (Beebe and Griffiths, 2005).

We investigated the diversity and species composition of amphibians in the ASSR, both the savanna habitat itself, and the associated marsh forest. The ASSR overall is a relatively small area (~18 km<sup>2</sup>) compared to savannas in South America, which may cover thousands of square kilometers, and the savanna habitat makes up only a small part (~2.5 km<sup>2</sup>) of the total area. The predictions were therefore that amphibian diversity would be lower in savanna compared to that of marsh forest, and that there would not be a specialist savanna amphibian fauna in the ASSR, unlike larger savannas (e.g., Searcy et al., 2013), but only generalist species adapted to open or disturbed areas. We also investigated whether the potential disturbance caused by man-made trails influenced counts of amphibians in marsh forest habitat, where trails formed clear discontinuities in the vegetation. Trails in the savanna habitat were not clearly distinct from the rest of this open habitat type. Trails in natural areas are known to have variable effects on amphibians (Flemming et al., 2011). The prediction was that trails in marsh forest would have lower counts, be restricted to generalist species of open or disturbed areas, and be more similar to the adjoining savanna habitat. This study also provides essential baseline data for future monitoring of amphibians in the ASSR, especially given its vulnerability to anthropogenic pressures, because such protected areas represent a conservation management tool to safeguard critical habitats and species (DeFries et al., 2005).

### MATERIALS AND METHODS

*Study Area.*—The ASSR is located in the east-central region of the northern basin of Trinidad (10.60° latitude, –61.19° longitude;

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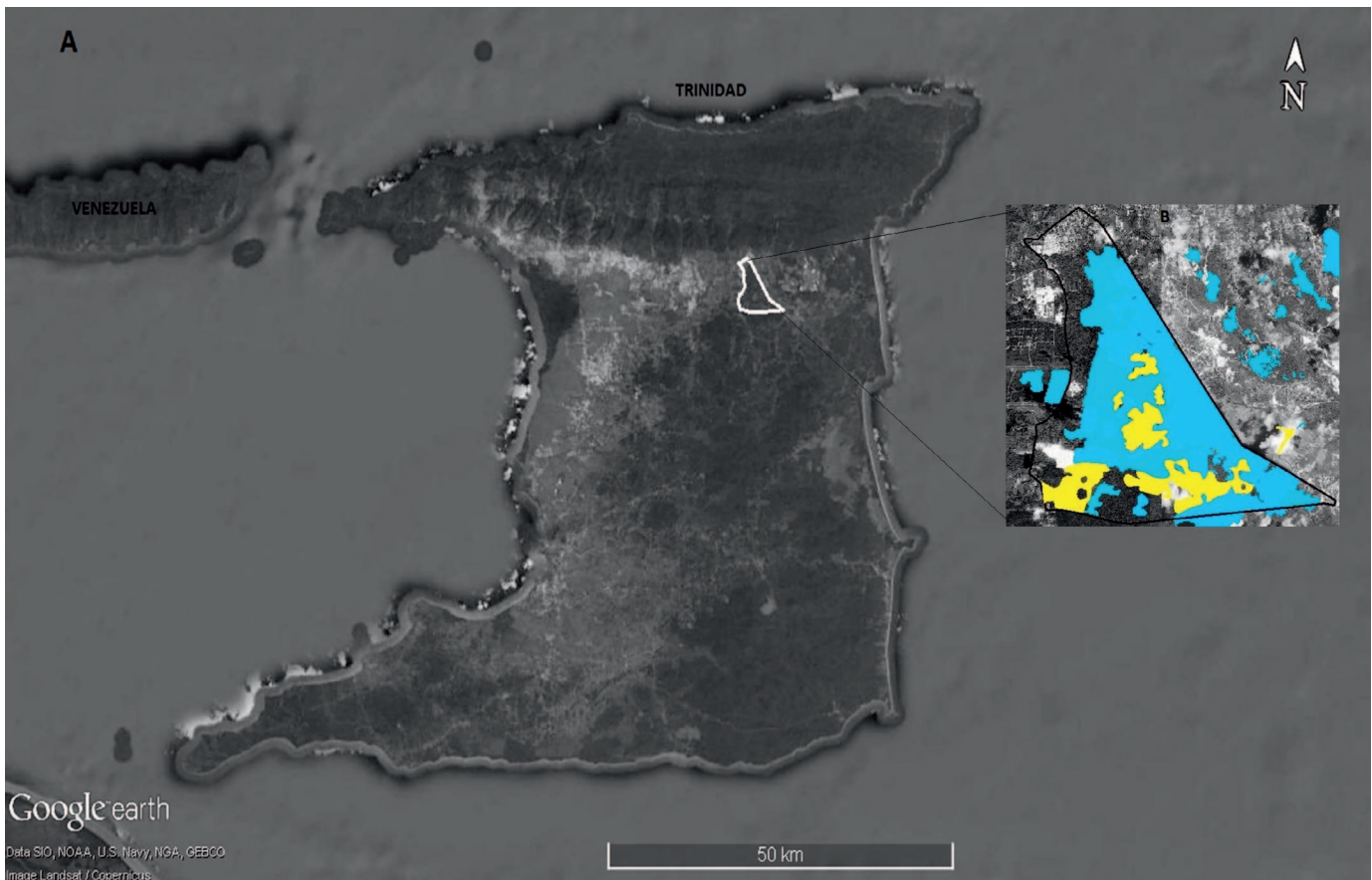


FIG. 1. (A) The Aripo Savannas Scientific Reserve's (ASSR) location within Trinidad. (B) The two dominant habitat types within the ASSR; savanna (yellow) and marsh forest (blue).

datum = WGS84; Fig. 1A). Elevation is relatively flat, peaking at 45 m above sea level (Richardson, 1963). The ASSR has sandy topsoils that overlay impervious subsoil horizons (Panton, 1953). The soil type influences the vegetation, resulting in a mosaic of different habitat types, including natural (edaphic) savanna interspersed with marsh forest (Beard, 1946; Richardson, 1963; Fig. 1B). The reserve is in close proximity to urban development, and there is also some disturbance within the reserve, including trails within the marsh forest. These trails vary in width from 1 to 10 m and typically are flat, depending on the terrain. Most are dirt trails with vegetation such as grasses, shrubs and/or sedges found on and along them. Most trails also are flanked by trees >10 m in height. Some of the trails are used by the Forestry Division of Trinidad and Tobago to patrol the reserve. They also are used for educational purposes, such as school field trips and ecotourism. Annual rainfall in the ASSR is typically 2,500–2,800 mm. There is pronounced seasonality, with very dry conditions during the dry season (January to May) and waterlogged areas during the wet season (June to December). Average monthly maximum temperature may reach 32°C in May, whereas the average monthly minimum drops to about 20°C in February, and relative humidity has reached 100% at night (Richardson, 1963).

**Sampling.**—We obtained permission to sample and collect voucher specimens within the ASSR from the Wildlife Section of the Forestry Division of Trinidad and Tobago. We conducted sampling in four periods in the wet season 2015: Period 1: 20 June–15 August; Period 2: 4 September–2 October; Period 3: 11 October–11 November; Period 4: 8 November–4 December. Periods 3 and 4 overlapped because of the need to complete

specific transects in widely spread parts of the ASSR, using available transport. We used transect sampling, an effective method for surveying amphibians across different habitat types in the tropics (Heyer et al., 1994; Rödel and Ernst, 2004). Other sampling methods such as pitfall and funnel traps were not considered feasible, as the ASSR is prone to waterlogging during the wet season. We sampled the same thirty 200-m-long numbered transects in each period (total 120 samples), with 10 transects in savanna (after finding them to be less variable) and 20 transects in marsh forest. Transect sites were positioned parallel and perpendicular to each other, with a minimum separation of 50 m in savanna and 25 m in marsh forest. To evaluate whether man-made trails influenced amphibian counts, we established 10 transects along man-made trails greater than 2 m in width and 10 transects at least 5 m off trails in marsh forest. We established and marked each transect with flagging tape at least 2 wk prior to sampling to reduce any effects of disturbance, and recorded the start and end point of each transect with the use of a handheld GPS (GPSMAP 62S, Garmin). Transects were generally straight, depending on the terrain of the habitat, and were at least 100 m from the edge of each habitat to retain habitat-type consistency.

We restricted sampling to between 1800 and 2100 h to reduce bias from sampling times. Nocturnal surveys are considered efficient and productive for sampling amphibians in the tropics (Pearman, 1997). Further, Trinidad's only day-active frog (*Mannophryne trinitatis* Garman, 1888) is not known from the ASSR and is restricted to higher elevations across the island (Murphy, 1997; Auguste et al., 2015). Sampling typically

TABLE 1. The number of individuals of each amphibian species recorded in marsh forest and savanna habitats in the Aripo Savannas Scientific Reserve (ASSR), Trinidad, over four sample periods from June to December 2015.

| Family          | Scientific name               | Total individuals | Marsh forest |          |         | Detection method |       |
|-----------------|-------------------------------|-------------------|--------------|----------|---------|------------------|-------|
|                 |                               |                   | Off trail    | On trail | Savanna | Seen             | Heard |
| Bufonidae       | <i>R. beebei</i>              | 24                | 6            | 15       | 3       | 19               | 5     |
|                 | <i>Rhinella marina</i>        | 11                | 3            | 8        | 0       | 11               | 0     |
| Hemiphractidae  | <i>F. fitzgeraldi</i>         | 60                | 21           | 39       | 0       | 1                | 59    |
| Hylidae         | <i>Dendropsophus goughi</i>   | 73                | 42           | 31       | 0       | 20               | 53    |
|                 | <i>D. microcephalus</i>       | 31                | 11           | 20       | 0       | 2                | 29    |
|                 | <i>H. boans</i>               | 5                 | 5            | 0        | 0       | 0                | 5     |
|                 | <i>Hypsiboas punctatus</i>    | 34                | 1            | 33       | 0       | 2                | 32    |
|                 | <i>P. paradoxa</i>            | 3                 | 0            | 3        | 0       | 0                | 3     |
| Phyllomedusidae | <i>S. ruber</i>               | 120               | 9            | 88       | 23      | 9                | 111   |
|                 | <i>P. trinitatis</i>          | 4                 | 4            | 0        | 0       | 0                | 4     |
| Leptodactylidae | <i>Engystomops pustulosus</i> | 30                | 6            | 24       | 0       | 24               | 6     |
|                 | <i>L. fuscus</i>              | 203               | 4            | 27       | 172     | 168              | 35    |
|                 | <i>L. cf. hylaedactylus</i>   | 1                 | 0            | 1        | 0       | 1                | 0     |
|                 | <i>Leptodactylus validus</i>  | 42                | 17           | 25       | 0       | 4                | 38    |
| Microhylidae    | <i>E. ovalis</i>              | 4                 | 2            | 2        | 0       | 2                | 2     |
| Craugastoridae  | <i>P. urichi</i>              | 250               | 135          | 115      | 0       | 1                | 249   |

involved RJA and AH or RJA and a field assistant, with all detections and species confirmations made by the authors only. We walked along transects, stopped and searched microhabitats, and recorded species and number of individuals seen 1 m either side by 2 m high and heard 10 m either side by 5 m high. These dimensions were estimated and represent a restriction in our ability to detect amphibians, and not a specified true cutoff (Jongsma et al., 2014). Savanna and on trail marsh forest transects typically took about 30 min, whereas we took ~45 to 60 min to complete each off trail marsh forest transect. We learned calls from listening to recordings by Morley Read, supplemented with at least 3 yr of practical experience listening to calls. Each species of frog on Trinidad has a distinctive call unlikely to be confused with another. We did not sample on nights with heavy rainfall, which may have impaired our ability to detect frog calls. We collected voucher specimens (up to two individuals per species), humanely euthanized these with the use of sodium pentobarbitone (60 mg/mL), fixed and stored them in 70% ethanol, and catalogued and lodged them at the University of the West Indies Zoology Museum (UWIZM). We recorded the microhabitats (substrate types) in which each species was observed. We used a handheld weather meter (Ambient Weather WM-3, Ambient LLC) to record air temperature, relative humidity, and wind speed at the start and end of each transect and used their means as representative for each sample. In addition, we obtained rainfall data from the nearest meteorological station (roughly 15 km away) from the Trinidad and Tobago Meteorological Office (TTMO). We noted reproductive activity and/or advertisement calls of amphibians observed along transects, as surveys were undertaken during the wet season in which peak reproductive and calling activity are exhibited by most amphibians in Trinidad (Murphy, 1997). We noted species that were represented by calling males, adults in amplexus, adults with eggs and/or tadpoles, and foam nests. We also noted the method of detection for each individual (seen and/or heard).

**Analysis and Statistics.**—We used Species Diversity and Richness (SDR 4) v4.1.2 (Pisces Conservation Ltd., <http://pisces-conservation.com/>) to calculate Shannon's ( $H'$ ) and Simpson's ( $D$ ) diversity indices. We calculated Simpson index in its reciprocal form with the use of  $D = 1/y$ , where  $y = \sum [n_i(n_i - 1)/N(N - 1)]$ , to produce a measure directly related to

diversity as recommended by Magurran (2004). We used both  $H'$  and  $D$  to describe diversity to include species richness, counts, and evenness (Dodd, 2010). We constructed rank abundance curves in SDR4 based on the summed sample periods to compare count patterns and species evenness between habitats.

We used the Tinn-R program (Version 3.0.1; R Core Team, 2013) for statistical analyses, and tested the data for normality with the use of the Shapiro-Wilk test, and log-transformed data where necessary. We used repeated-measures ANOVA to compare the mean counts of amphibians in marsh forest samples (80 total) to those in savanna (40 total), and  $t$ -tests to compare amphibian counts along trails and off trails in marsh forest. We constructed cluster dendrograms based on transformed Bray-Curtis Similarity Index values to illustrate the similarity among amphibian species and sampling sites within the ASSR (Dodd, 2010). We used repeated-measures ANOVA to assess whether there was significant variation of amphibian counts through the four sample periods, and simple linear regression to assess whether rainfall was a significant predictor of counts on each night of sampling ( $n = 32$ ). We used multiple linear regression to assess whether other abiotic variables (air temperature, relative humidity, and wind speed) were significant predictors of counts in each sample ( $n = 120$ ), with sample period as a factor. After we found temperature to be normally distributed, we log-transformed the nonnormally distributed data for counts and relative humidity, whereas wind-speed values were used as a factor of 0 (for all 0 recordings) or 1 (for all recordings that were not 0), before conducting regression analyses to more closely approximate the linear assumptions of the model. We used a chi-squared test of association to assess whether there was any significant variation among species in the detection method.

## RESULTS

We recorded 895 individuals during the 4 sample periods representing 16 species, 11 genera, and 7 families (Table 1). *Pristimantis urichi* Boettger, 1894 was the most abundant species recorded, followed by *Leptodactylus fuscus* Schneider, 1799 and *Scinax ruber* Laurenti, 1768, which together comprised more than half of the total individuals observed, whereas *Leptodactylus cf. hylaedactylus* Cope, 1868 (= *Adenomera hylaedactyla*) was

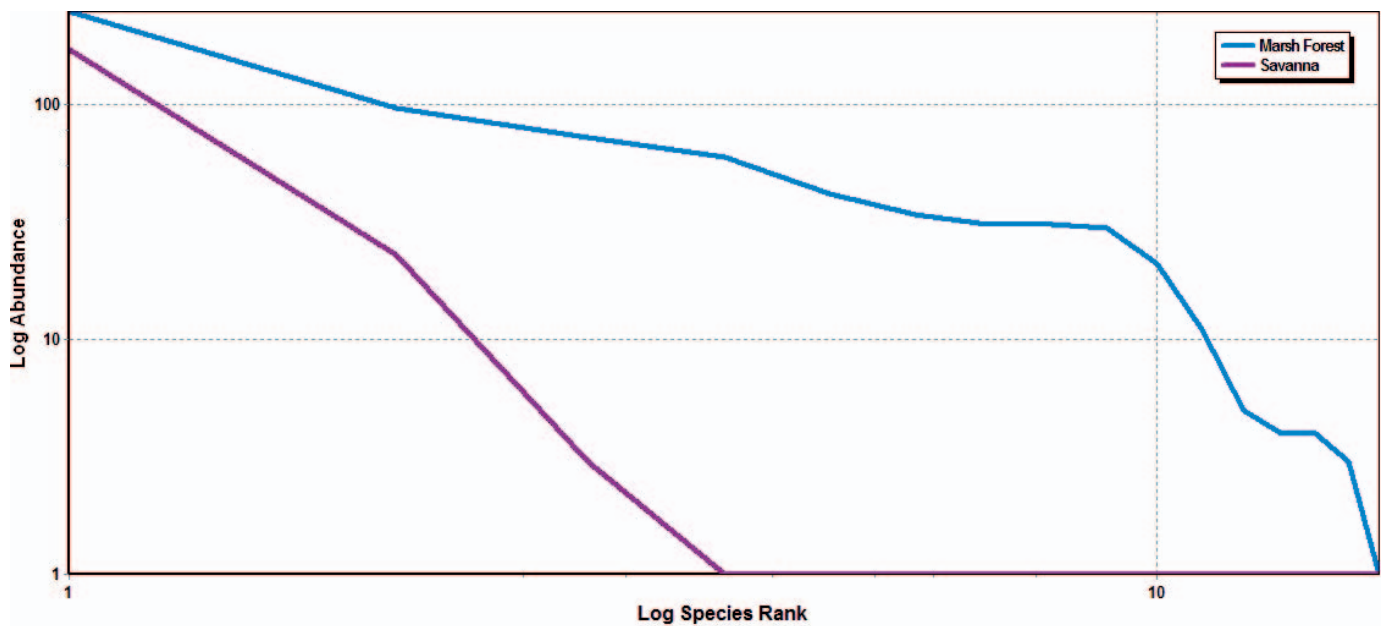


FIG. 2. Rank abundance curves showing that marsh forest had greater diversity (species richness, evenness, and counts) than savanna in the Aripo Savannas Scientific Reserve during four sample periods between June and December 2015.

least encountered (one individual) (Table 1). Five individuals of *Hypsiboas boans* Linnaeus, 1758 represent a new species record for the ASSR. The other 15 species have previously been documented for the reserve (Auguste et al., 2015). This takes the new total number of amphibian species for the ASSR to 20, which represents roughly two-thirds of the known amphibian species for Trinidad (Murphy, 1997). We found four sampling periods to be adequate, as we found no new species after we recorded three sampling periods; however, we did not observe some species previously documented for the ASSR (see Auguste et al., 2015).

**Species Diversity.**—We recorded 16 species in marsh forest and 3 species in savanna (Table 1). Of these, only *L. fuscus* was recorded most frequently in savanna. Further, we recorded greater counts of amphibians in marsh forest (697 individuals; 8.71 per transect sample) compared to savanna (198 individuals; 4.95 per transect sample) (Table 1; Fig. 2), and with the use of a repeated-measures ANOVA we found that mean counts were significantly different between marsh forest and savanna ( $F_{1,118} = 6.94$ ,  $P = 0.0096$ ). The diversity of amphibians was greater in marsh forest ( $H' = 2.12$ ) than savanna ( $H' = 0.44$ ), and the species were more even in marsh forest ( $D = 2.86$ ) than savanna ( $D = 2.33$ ).

We recorded the same number of species of amphibians along trails ( $n = 14$ ) as off trails ( $n = 14$ ) in marsh forest, with 12 species found both along trails and off trails (Table 1). *Pseudis paradoxa* Linnaeus, 1758 and *L. cf. hylaedactylus* were recorded only along trails of marsh forest, and *H. boans*, and *Phyllomedusa trinitatis* Mertens, 1926 were recorded only off trails. These 4 species appeared to have had specific microhabitat requirements (Auguste, 2016) and may also have been more cryptic both aurally and visually during the time of our sampling, given the lower number of individuals observed compared to the other 12 species (Table 1). We recorded greater counts of amphibians along trails (434 individuals over 4 sample periods, 43.4 per transect location) compared to those off trails (263 individuals over 4 sample periods, 26.3 per transect location) in marsh forest (Table 1), a significant difference ( $t$ -test,  $t_{19} = 9.21$ ,  $P < 0.001$ ).

**Species Composition.**—The cluster dendrogram of the 16 species (Fig. 3A) showed that 5 species (*L. cf. hylaedactylus*, *P. paradoxa*, *H. boans*, *P. trinitatis*, and *Elachistocleis ovalis* Schneider, 1799) were clustered distinctly from the other 11; these species were associated mainly with water. The three species found in savanna (*L. fuscus*, *S. ruber*, and *Rhinella beebei* Gallardo, 1965), which were also recorded in marsh forest, did not form a distinct cluster (Fig. 3A), and therefore were just a subset of those found in the marsh forest, and not a separate identifiable savanna community. The cluster dendrogram of transect sites showed similar results, whereby the 10 savanna transects were mixed among a group of 12 marsh forest transects (to the right in Fig. 3B). The 8 marsh forest transects to the left in Figure 3B appeared separate from the other 22 transects in the ASSR; most of these were associated with the 5 species to the left in Figure 3A. The off-trail and on-trail transects in marsh forest did not form distinct clusters (Auguste, 2016).

**Ecology.**—Amphibian counts were highest during the first sample period, which took place upon the onset of the rainy season, and reduced with every sample period (Fig. 4). We found a significant difference among the sample periods with the use of a repeated-measures ANOVA ( $F_{3,116} = 7.43$ ,  $P < 0.001$ ). We used simple linear regression and found that rainfall recorded each night of sampling ( $n = 32$ ) was not a significant predictor of amphibian counts ( $F_{1,30} = 2.47$ ,  $P = 0.13$ ). We used multiple linear regression and found that none of the three abiotic variables measured for each transect sample ( $n = 120$ ) were significant predictors of amphibian counts ( $F_{3,116} = 0.75$ ,  $P = 0.53$ ); air temperature ( $t_{116} = -1.12$ ,  $P = 0.27$ ), relative humidity ( $t_{116} = 0.62$ ,  $P = 0.54$ ), and wind speed ( $t_{116} = -0.31$ ,  $P = 0.75$ ).

**Reproductive Activity.**—We observed reproductive activity and/or advertisement calls for 14 of the 16 amphibian species over the 4 sample periods (Table 2). Not all species were observed calling or being reproductively active across all sample periods. We only observed *E. ovalis* calling or being reproductively active during Sample Period 1 (Table 2), whereas some species exhibited calling or reproductive activity only in sample periods with greater rainfall. For instance, *R. beebei* was not observed calling or being reproductively active during Sample Period 2, which had the



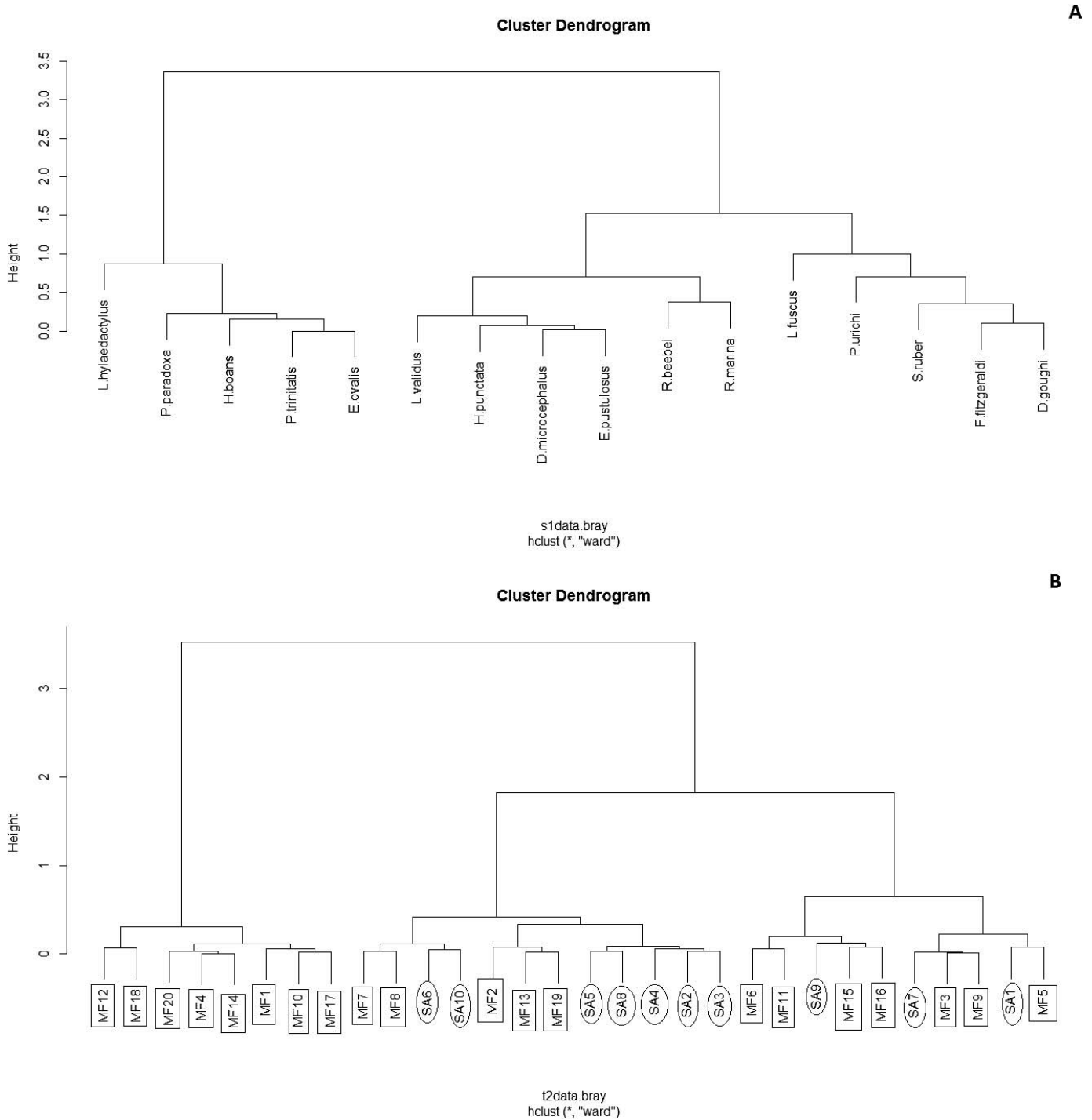


FIG. 3. Cluster dendrogram of species (A). The 5 species on the left were distinct from the other 11 species and were associated with water. Cluster dendrogram of transects (B). The savanna transects highlighted in purple (SA1–SA10) were not distinct from the marsh forest transects (MF1–MF20) highlighted in blue.

lowest mean rainfall recorded (1.43 mm/day, compared to 3.35–12.45 mm/day for Periods 1, 3, and 4; Auguste, 2016).

*Species Detectability.*—We visually detected ~30% of the 895 individuals and the other 70% were detected aurally (Table 1). After omitting species that had  $\leq 5$  recordings (Table 1), we found significant association between detection method and species ( $\chi^2_{10} = 537.35$ ,  $P < 0.001$ ). Most of the species we detected by sound belonged to the family Hylidae, whereas most of the species visually detected belonged to the families Bufonidae and Leptodactylidae (Table 1).

## DISCUSSION

*Species Diversity.*—We recorded more species of amphibians and higher counts of individuals in marsh forest compared to savanna in the ASSR. Similar results were recorded for amphibians in Brazil's Amazonian savannas and surrounding forests (Neckel-Oliveira et al., 2000). We also recorded greater diversity ( $H'$  and  $D$ ) in marsh forest compared to savanna. Habitat type is known to influence amphibian diversity (Jongsma et al., 2014), and several environmental factors related to habitat

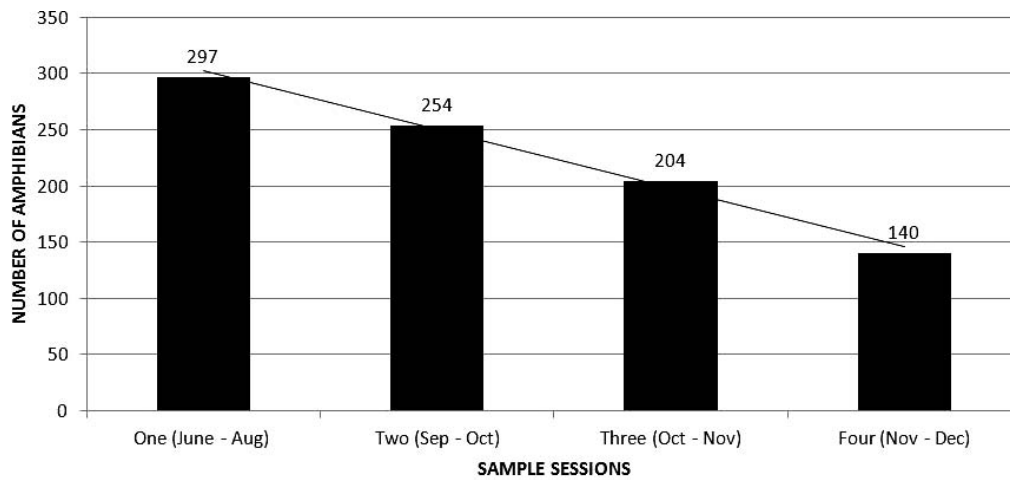


FIG. 4. Amphibian counts recorded during each sample period, showing a continuous decline after Period 1.

structure are important for counts and richness of anurans in the tropics (Pearman, 1997). The greater diversity observed within marsh forest during our study was likely attributed to greater variability in resources for foraging, reproduction, and cover from predators, which typically may influence habitat selection by amphibians (Babbitt et al., 2010).

Some studies have found that amphibian counts are greater in less disturbed areas (Pearman, 1997), others have noted the contrary effect (Urbina-Cardona et al., 2006). Our results were more aligned with the latter, as we recorded greater counts of amphibians along trails (visually and aurally) in marsh forest compared to transects off trails, contrary to our original prediction. Microhabitat variability was likely greater along trails, and greater counts may also have been due to increased movement patterns (Garner et al., 2008), and increased visibility along trails cannot be ruled out as a contributing factor.

**Species Composition.**—The five species clustered in Figure 3A are known to be closely associated with and dependent on water (Murphy, 1997). This may have conservation implications, as populations of these species may be more vulnerable to threats

such as habitat desiccation and fragmentation in the ASSR. The 3 species we found in savanna were also observed in marsh forest, and all 10 savanna transects were dispersed among the larger group of marsh forest transects in the cluster diagram (Fig. 3B). In some taxa (mammals and reptiles), species found in savanna are not subsets of those found in nearby forest (Bond and Parr, 2010). The different pattern seen in the ASSR may have been the result of the combined area of the ASSR savanna (~2.5 km<sup>2</sup>) and/or the close proximity to marsh forest (Fig. 1B). The Cerrados in Brazil is ~2 million km<sup>2</sup>, with 209 species of amphibians, only a small proportion of which are widespread, also using adjacent habitats (Valdujo et al., 2012). A study on frogs from the Llanos savanna in Venezuela recorded some of the same species documented at the ASSR; *R. beebei*, *Dendropsophus microcephalus* Cope, 1886, *P. paradoxa*, *L. fuscus*, and *E. ovalis*. These species occurred in various habitat types within the Llanos, such as near forests, and were not specialized to open savannas (Tárano, 2010), and were therefore more similar to the pattern in the ASSR.

**Ecology.**—The onset of the rainy season typically acts as a cue for reproductive activity for most frog species in Trinidad,

TABLE 2. Reproductive activity and/or advertisement calls observed for amphibians over the four sample periods along marsh forest transects (MF1–MF20) and savanna transects (SA1–SA10) in the Aripo Savannas Scientific Reserve from June to December 2015.

| Species                     | Reproductive activity/calls                    | Period  | Transects  |
|-----------------------------|--|---------|--|
| <i>R. beebei</i>            | Males calling                                  | 1, 3, 4 | SA7, MF4   |
| <i>R. marina</i>            | Not observed                                   | –       | –  |
| <i>F. fitzgeraldi</i>       | Female with eggs on her back; males calling    | 1–4     | MF9, MF4, MF5, MF7, MF11, MF13, MF14, MF15, MF17, MF18, MF19, MF20 |
| <i>D. goughi</i>            | Males calling; metamorphosed juveniles         | 1–4     | MF4, MF14, MF16, MF18, M20   |
| <i>D. microcephalus</i>     | Males calling                                  | 1–4     | MF4, MF13, MF14, MF15, MF18, MF20                                  |
| <i>H. boans</i>             | Males calling                                  | 2, 3, 4 | MF15, MF19   |
| <i>H. punctatus</i>         | Males calling                                  | 1, 2    | MF10, MF11, MF12, MF18   |
| <i>P. trinitatis</i>        | Males calling                                  | 3, 4    | MF19, MF20   |
| <i>P. paradoxa</i>          | Males calling                                  | 1, 2, 3 | MF18   |
| <i>S. ruber</i>             | Males calling                                  | 1–4     | SA7, SA8, SA9, SA10, MF10, MF11, MF12, MF14, MF16, MF18            |
| <i>E. pustulosus</i>        | Males calling; amplexus pairs and foam nests   | 1, 2, 4 | MF15, MF4  |
| <i>L. fuscus</i>            | Males calling; tadpoles in waterlogged savanna | 1–4     | All 10 SA transects, and MF10, MF11, MF12, S2, S3, and S4          |
| <i>L. cf. hylaedactylus</i> | Not observed                                   | –       | –  |
| <i>L. validus</i>           | Males calling; female brooding tadpoles        | 1–4     | MF17, MF4  |
| <i>E. ovalis</i>            | Males calling; amplexus pair                   | 1       | MF15, MF5  |
| <i>P. urichi</i>            | Males calling                                  | 1–4     | All 20 MF transects  |

particularly explosive breeders (Murphy, 1997). Seasonality is known to influence call patterns and detection in anurans (Saenz et al., 2006; Pittman et al., 2008). This may have contributed to greater counts of amphibians observed during Sample Period 1, which took place upon the onset of the rainy season. The continuous drop in counts of amphibians recorded during the sample periods may have resulted from fewer individuals being reproductively active, therefore reducing the chance of their detection, particularly aurally.

**Detection.**—We detected more amphibian individuals by sound compared to visual observation along our transects. Hylidae, the most species-rich family we recorded (Table 1), consists of species that are generally well hidden in their microhabitats, making detection difficult (Pittman et al., 2008), and these species were more often heard than seen (Table 1). Detectability by sound varies among species, and depends on their calling characteristics (de Solla et al., 2005). Some species exhibit a short period of calling activity, e.g., *E. ovalis* (Murphy, 1997) whereas others tend to call sporadically and/or at a relatively low volume (de Solla et al., 2005), e.g., *P. trinitatis* (Kenny, 1969), which may have contributed to their low acoustic detection. Terrestrial species as well as habitat generalists are more likely to be visually encountered, such as some Leptodactylidae and Bufonidae species, because they generally use open areas on the ground (Murphy, 1997). For example, *L. fuscus* prefers open areas, such as savannas, that are suitable for building burrows (Lucas et al., 2008).

**Conservation.**—Two of the 16 species we recorded in the ASSR are of particular conservation concern: *P. urichi*, and *Flectonotus fitzgeraldi* Parker, 1933, both listed as Endangered in the IUCN Red List (Hardy et al., 2004; La Marca et al., 2004). *Pristimantis urichi* is currently considered endemic to Trinidad and Tobago, whereas *F. fitzgeraldi* occurs in Trinidad, Tobago, and Venezuela (Murphy, 1997). Our study provides the first assessment of their counts for this protected area. Given the relatively high counts recorded for each species, particularly *P. urichi* (Table 1), the ASSR represents a critical area for their preservation in Trinidad and further highlights its conservation importance for these and other amphibian species. *Leptodactylus fuscus*, the most abundantly recorded species in the savannas of the ASSR, potentially represents an important component of the savanna ecosystem, though not currently considered threatened with extinction (Reynolds et al., 2004).

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