A note on polyvinyl chloride (PVC) pipe traps for sampling vegetation-dwelling frogs in South Africa

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INTRODUCTION

Vegetation-dwelling frogs are challenging to sample. They can climb out of traditional traps, and many are furtive (Pittman et al., 2008, Myers et al., 2007). PVC pipe traps, which mimic natural features frogs use for shelter, may provide a useful technique (e.g. Boughton et al., 2000). Pipe trapping has been used to sample treefrogs of the family Hylidae in the United States (e.g. Boughton et al., 2000, Farmer et al., 2009, Liner et al., 2008), but it is increasingly used elsewhere (e.g. Laurencio and Malone, 2009, Ferreira et al., 2012), even for non-Hylids (Coqui Frog Working Group, 2006).

African vegetation-dwelling frog genera, e.g. *Leptopelis, Afrixalus*, and *Hyperolius* (see du Preez and Carruthers, 2009, Channing, 2001), may be attracted to artificial refugia of PVC pipe traps. If so, pipe trapping would augment sampling techniques for African anurans, which are little studied (Trimble and Van Aarde, 2010, Trimble and van Aarde, 2012) despite conservation needs (Measey, 2011), and could facilitate sampling outside the breeding season, reduce observer and detection bias (see Willson and Gibbons, 2010, Bailey et al., 2004), and allow fundamental and applied ecological studies, e.g. habitat selection (e.g. Pittman et al., 2008, Johnson et al., 2007), migration/dispersal (e.g. Johnson, 2005), and management effects (e.g. Muenz et al., 2006, Rice et al., 2011). In this preliminary assessment, we provide the first evidence that it is possible to capture African frogs in PVC pipe traps in the field. However, capture success was low, so we encourage more research on alternate trap designs and in other habitats.

METHODS

Our study was conducted in the South African coastal forest within 2.3km of the east coast, along a 25km section between the Umlalazi River and Richards Bay Harbour. The area harbours a high species richness and concentration of threatened frogs (Measey, 2011, Maritz, 2007) (Table 1).

We installed 30 pipe trap arrays in terrestrial habitats ≥300m from water bodies and ≥500m from each other, divided evenly among five vegetation types: coastal forest, degraded forest, acacia woodland, eucalyptus woodlot, and sugar cane cultivation. We placed a further six arrays in coastal forest ≤30m from a water body and ≥50m apart. Each array consisted of four, 60-cm-long, white PVC pipes. We inserted two pipes (one of 16mm and 44mm internal diameter) 10cm into the ground near the base of a tree. We attached another of each diameter pipe together and affixed them vertically from their top at a height of 2m up the tree trunk. Caps on the bottom of these pipes allowed retention of standing water (added at installation), and a hole drilled 15cm from the bottom prevented flooding (Boughton et al., 2000). We installed

Table 1. Vegetation-dwelling frog species expected in the area, species incidentally recorded in the area during the survey (location of observation is denoted NW=near water, Tr=terrestrial, Tr/NW=terrestrial and near water), and inventory of captures in PVC pipe traps indicating array location (NW=near water, Tr=terrestrial), pipe diameter and location (G=ground, T=tree), Snout-urostyle length (SUL) of frog, and habitat type (AW=acacia woodland, DF=degraded forest, F=Forest).

Frog Atlas species [a]	**Incidentally recorded**	**Pipe trap captures**
Afrixalus delicates		
Afrixalus fornasinii	NW	NW (44mm G pipe, SUL=35mm, F)
		NW (44 mm T pipe, SUL=35mm, F)
Afrixalus spinifrons	Tr	Tr (44mm G pipe, SUL=23mm, DF)
Hyperolius argus	NW	
Hyperolius marmoratus	NW	NW (outside of T pipe, F)
Hyperolius poweri		
Hyperolius pickersgilli	NW	
Hyperolius pusillus	Tr/NW	
Hyperolius semidiscus		
Hyperolius tuberilinguis	Tr/NW	NW (44mm T pipe, SUL=27mm, F)
		Tr (44mm G pipe, SUL=29mm, AW)
Leptopelis mossambicus		
Leptopelis natalensis [b]	Tr/NW	

[a]The South African Frog Atlas Project recorded twelve species of *Leptopelis*, *Afrixalus*, and *Hyperolius* in the two quarter-degree squares spanned by our study area (ADU, 2011). Nomenclature follows du Preez and Carruthers (2009) except *Hyperolius poweri* (see Channing et al., 2013).

[b] *L. natalensis* was not captured in pipes despite occurring in the area. Worth noting, however, is that on two occasions we released incidentally caught *L. natalensis* individuals at the base of tree in which we had hung a set of pipes, and both frogs climbed the tree, went into a pipe, and remained there for some time.

pipes on a variety of tree species (e.g. White Stinkwood, *Celtis africana*; Horsewood, *Clausena anisata*; Sweet Thorn, *Acacia karroo*; and *Eucalyptus* sp.) with circumference at breast height of 10–200cm ($\bar{x}$=53.7cm, sd=41.2cm). At five sugar cane cultivation arrays there were no trees, so all four pipes were inserted into the ground.

Pipe traps were installed progressively from February 17 to March 21, 2012 (summer/rainy season); we monitored arrays for 14–34 days ($\bar{x}$=21.7, sd=7.3). As per agreements with landowners, arrays in cultivation and woodlots were removed after 14–15 days, while others remained for the study duration. We checked each array during daylight hours on an intermittent schedule as logistics allowed, i.e. 5–9 times per array at intervals of 1–9 days ($\bar{x}$=3.4, sd=0.7). We identified and measured frogs found in traps and released them ≥50m away. We also noted frogs observed incidentally (i.e. coincidentally or during casual searches) during the study period.

RESULTS AND DISCUSSION

We checked 36 arrays 219 times over 34 days (43 times for the six arrays near water and 176 for the 30 terrestrial arrays). We caught five frogs in pipes (Table 1), a trap success of 2.3% by array checking instances or 0.6% by pipe checking instances. One capture on the outside of a pipe was not included in calculations (Table1). Sparse captures prevented statistical analyses, but trap success appeared higher near water than away, 7% of array checking instances versus 1.1%. We incidentally observed eight species (Table 1). Trapping success was lower than reported in the Americas, e.g. 79% (Bartareau, 2004), 23% (Myers et al., 2007), 2.5-4.3% (Pittman et al., 2008), and 6% (Ferreira et al., 2012) (some of these studies included recaptures). Several factors might have contributed to our low trapping success.

(1) Pipes might not have provided attractive refugia. Frogs discriminate between refugia attributes (e.g. Boughton et al., 2000, Bartareau, 2004, Johnson et al., 2007, Johnson et al., 2008, Hoffmann et al., 2009). Many design factors have been investigated in relation to capture success (e.g. diameter, length, and colour); and while our 44mm diameter pipes appeared more effective than 16mm and ground and tree pipes both worked, other trap designs could be investigated. (see Boughton et al., 2000, Bartareau, 2004, Johnson et al., 2007, Myers et al., 2007, Pittman et al., 2008, Johnson et al., 2008, Ferreira et al., 2012).

(2) Natural refugia provided by plants may have outcompeted pipes (Hoffmann et al., 2009). *Dracaena aletriformis* and *Strelitzia nicolai* are prevalent in the undergrowth, and their leaf axils provide hiding places for frogs (du Preez and Carruthers, 2009).

(3) The sampling period may have been too short for frogs to find the pipes (Myers et al., 2007), which could have compounded the effects of competition with natural refugia.

In conclusion, we caught three species in PVC pipe traps and found an additional species on the outside of a pipe, demonstrating that the technique can be used to trap African frogs of the family Hyperoliidae. However, trap success was low, and we captured species also encountered incidentally. We encourage further assessment of PVC pipe trapping for African vegetation-dwelling frogs to support amphibian ecological studies. Altering trap design, using traps in areas with less abundant natural refugia, and installing traps a few months prior to sampling should be investigated to improve success. Further experiments could elucidate which trap designs work for which species.

ACKNOWLEDGEMENTS

We thank Richards Bay Minerals, Department of Trade & Industry, NSF GRFP, R. Guldemond, T. Lee, and A. Prins.

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