First herpetological appraisal of the Parque Nacional de Banhine, Gaza Province, southern Mozambique

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The herpetofauna of Mozambique remains poorly documented despite recent surveys. We present here the first report on the herpetofauna occurring in Parque Nacional de Banhine in Gaza Province. Four chelonian, 13 snake, one amphisbaenid, 16 lizard and 15 frog species were recorded in the park, while an additional six snake, five lizard and two frog taxa have been recorded in close proximity and probably also occur in the park. Numerous range extensions are recorded, and these are discussed in the light of our present knowledge of the distribution of herpetofauna in Mozambique.

Keywords: Banhine National Park, Gaza Province, Mozambique, Reptiles, Amphibians.

INTRODUCTION

The herpetofauna of Mozambique remains poorly sampled and our knowledge of the distribution of most species is scant. Most of our knowledge on the Mozambique herpetofauna stems from *ad hoc* and often opportunistic sampling (Downs and Wirminghaus, 1997) and as such the distribution of reptiles along the coast, especially in areas attracting large numbers of tourists, is better known than the distribution of taxa inland. Broadley (1966, 1983) and Poynton and Broadley (1985*a,b*, 1987, 1988) provided initial distributions for the herpetofauna of Mozambique, while more recently Broadley (1990, 1992), Channing (2001) and Jacobsen *et al.* (2010) added to the slowly growing volume of literature. Northern and central Mozambique have received more attention than southern Mozambique in recent years, with a number of new taxa recently being described from the former regions (e.g., Branch *et al.*, 2005; Branch and Bayliss, 2009; Branch and Tolley, 2010).

A herpetological survey of Parque Nacional de Banhine was undertaken while one of the authors (EWP) was stationed there, with occasional visits by DWP. Additional unpublished records from an earlier collecting trip by WDH are also included.

Study site

Parque Nacional de Banhine (PNB) is a 700 000 ha national park situated in southern Mozambique's Gaza Province (Fig. 1). PNB was proclaimed in 1972 after representation by Ken Tinley to protect the vast numbers of game that roamed these plains. The park lies between latitudes 22°30′–23°20′S and longitudes 32°15′–33°25′E, and consists of near-pristine habitat. PNB is located in Gazaland, probably the driest province in Mozambique (Tinley, 1972), with mean annual rainfall ranging from 399 mm in the west to 427 mm in the east (Stalmans, 2003). The topography is predominantly flat, with a slight rise in elevation from 69 m above sea level (a.s.l.) in the southeast to 181 m a.s.l. in the northwest (Stalmans and Wishart, 2005; McNamara and Larsen, 2006). Geology consists of deep sandy soils overlying calcrete at a depth of *c.* 7 m (Stalmans and Wishart, 2005). Occasionally this calcrete reaches the surface and extends as intermittent calcrete bands for a few hundred metres (Stalmans and Wishart, 2005; DWP pers. obs.). Clayey sediments are present in the northeast of the park (Stalmans, 2003) and are largely associated with closed woodlands along the seasonal drainage lines and some of the mopane woodland communities (Stalmans and Wishart, 2005). The grasslands and main wetland also have a moderate to high clay content (Stalmans, 2003).

Using the Koppen classification system, the study area can be described as having a warm, dry climate with dry winters (van Rooyen *et al.*, 1981). Eleven plant communities have been identified in PNB, which can be further assigned to five major landscape types. These are (with their respective

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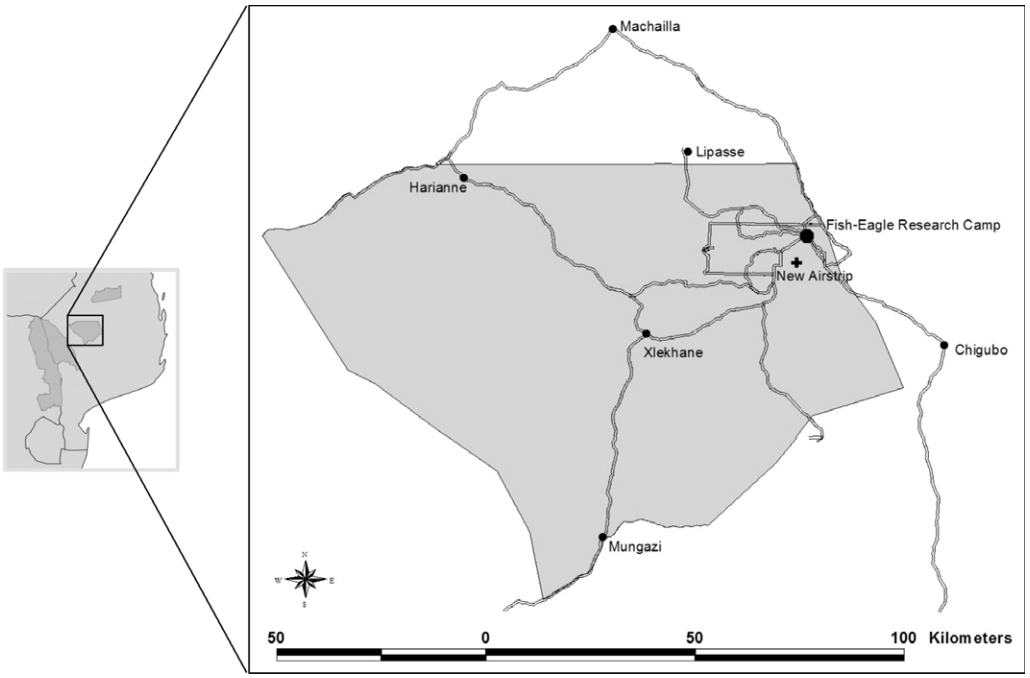

Fig. 1

Location of Parque Nacional de Banhine in Mozambique, and its geographic proximity to other major protected areas. Place names used in the text are indicated on the main map.

percentage area): wetland (1.1%), grassland (13.6%), mopane woodland (33.9%), sandveld (46.7%) and *Androstachys* forest (4.7%). A detailed vegetation map can be found in Stalmans and Wishart (2005). The main wetland is located in the northeast of the park and represents a seasonally flooded deltaic system with limited overflow. The water level is governed by an alluvial plug (fan) at the confluence of the main wetland and the Changane River, formed by sediment deposition by the Changane River during flooding events (McNamara and Larsen, 2006). A number of smaller, cut-off pools occur along the margins of the main wetland, and permanent to semi-permanent pools usually persist in portions of the wetland during dry spells. A number of temporary pans also form in the mopane woodlands after heavy rains. The grasslands form a large plain surrounding the wetland, and may also be seasonally inundated forming moist grassland. Sandveld is the dominant landscape and occurs in the western, south-central and eastern portions of the park, with some isolated pockets in the north as well. Mopane woodland is most prominent in the northern and central portions of the park, with isolated pockets of varying sizes scattered throughout the remainder of the park. *Androstachys* forests are present in the south and extreme northeast border areas of the park.

PNB forms part of the Gazaland Plain (Smithers and Tello, 1976). This plain most probably has its origins in fluvial deposits of the Zambezi, Save, and Limpopo Rivers, originating from headwater erosion together with marine depositions prior to the Plio-Pleistocene (Moore and Larkin, 2001). During the Plio-Pleistocene, major flexing occurred along the Ciskei-Swaziland flexure axis (du Toit, 1933; Partridge, 1998), resulting in the down-warping of the margins of the subcontinent (King, 1967; Moore and Larkin, 2001) and ultimately the raised marine terrace that today is the Gazaland plain.

MATERIAL AND METHODS

Observations were made on an *ad hoc* basis between November 2006 and May 2008. From November 2006 to December 2007, the main wetland was dry owing to a prolonged drought, and water remained only in a few scattered natural pans and man-made wells. In December 2007, the wetland flooded for the first time in five years, and remained inundated until at least May 2008.

Reptiles were actively searched for from a vehicle traversing roads by day and night, and by exploring various habitats on foot. All likely microhabitats were actively sampled in search of reptiles and amphibians. The old subterranean water tank at the Pio Cabral park headquarters acted as a *de facto*

pit-fall trap and was checked regularly. The clearing of vegetation for the new airstrip also provided opportunities to search for additional fossorial species. Frogs were actively searched for on a number of summer nights following rains. A search was also made of the herpetological records of the Ditsong National Museum of Natural History (formerly the Transvaal Museum), which houses material collected by WDH on a much earlier field trip to the Banhine swamps in 1964. Where taxonomic changes have been effected subsequent to this early collection trip specimens were re-examined to confirm their identity. Records were also gleaned from published sources.

The distributions of species recorded from PNB were compared to the distributions as currently depicted in major reference works (Broadley, 1983; Branch, 1998; du Preez and Carruthers, 2009). Nomenclature follows the most recent list available from Johan Marais (available online at www.reptileventures.com, downloaded on 5 June 2012), with the exception of the families Lamprophiidae and Acontiinae. For the former family, we follow the nomenclature of Vidal *et al.* (2008). Current Acontiinae nomenclature follows Lamb *et al.* (2010). However, the findings of Lamb *et al.* (*loc. cit.*) have been called into question by S. Daniels (pers. comm.) and D.W. Pietersen *et al.* (in prep.) and we therefore follow the former accepted nomenclature for this subfamily.

Most specimens collected were deposited in the Ditsong National Museum of Natural History (abbreviated TM) in Pretoria, South Africa. Some specimens were also deposited in the Eduardo Mondlane National Museum of Natural History (MHN) in Maputo, Mozambique, and in the National Museum Bloemfontein (NMB), South Africa. Accession numbers have been incorporated into the systematic account below. Photographs taken of reptiles and amphibians in PNB (species marked with a '*' in the species accounts) have been lodged online and can be accessed at http://www.facebook.com/darrenpietersen.herpetology/photos

Snout–vent length (SVL) was measured from the tip of the snout to the posterior border of the anal plate with a Vernier calliper to an accuracy of 0.02 mm, or with a material rule to an accuracy of 1 mm. Total length (TL) was measured with a Vernier calliper or material rule from the tip of the snout to the tip of the tail. Ventral scales were counted from the first scale posterior to the chin shields to the last scale bordering, but excluding, the anal plate. Subcaudal scales were counted from the first scale posterior to the cloacal opening to the tail tip. The number of upper labials (UL), lower labials (LL) and number of scale rows at midbody were recorded in some instances. Whenever lengths or scale counts were recorded, these have been included in the relevant species accounts.

SYSTEMATIC ACCOUNT

REPTILIA
TESTUDINES
CRYPTODIRA
TESTUDINIDAE

Stigmochelys pardalis* (Bell, 1828)

One individual was observed near Cantine on the eastern boundary of the park and another was noted on the edge of the main wetland to the west of the old Pio Cabral homestead. A carapace of this species is on display in the warden's caravan at the park headquarters. WDH collected a specimen at Chigubo (TM 29330).

Kinixys zombensis* (Gray, 1831)

A single individual was observed and photographed in sandveld after crossing the road between Xlekhane and Mungazi.

PLEURODIRA
PELOMEDUSIDAE

Pelomedusa subrufa* (Lacépède, 1788)

An individual was observed and photographed on the edge of the wetland east of Fish-Eagle Research Camp.

Pelusios subniger subniger (Lacépède, 1788)

A specimen was collected in the Banhine Swamp area by WDH in 1964 (TM 29316) and the anterior portion of a plastron was collected in front of Fish-Eagle Research Camp by DWP (TM 85585). These records are 200 km east of the populations known to occur in temporary pans in northeastern Kruger National Park (KNP) (Jacobsen, 1989) and 230 km southwest of the population on the San Sebastian Peninsula (Jacobsen *et al.*, 2010).

SQUAMATA
SERPENTES
TYPHLOPIDAE

Rhinotyphlops lalandei* (Schlegel, 1844)

A specimen was collected in mopane woodland during the construction of the new airstrip (TM 85595), while two other individuals that were captured at the same location were examined and released. TM 85595 has SVL: 226.0 mm, TL: 229.1 mm and 26 scale rows at midbody. All individuals were unearthed among the roots of trees that were being cleared for the airstrip. These records are 200 km east of the records in northeastern KNP (Jacobsen, 1989).

LEPTOTYPHLOPIDAE

Myriopholis longicauda (Peters, 1854)

WDH collected a specimen at Chigubo in 1964 (TM 29288). This record is *c*. 120 km east of the distribution for this species shown in Branch (1998), although within the distribution presented by Broadley (1983).

BOIDAE

Python natalensis A. Smith, 1840

Two large individuals were seen in the wetland during the aerial census in October 2004 (Stalmans, 2004). Three individuals were killed during 2007 by members of the local community who descended on the wetland to catch fish in the drying ponds (A. Guenya, pers. comm.). Owing to its large size and perceived threat to humans and livestock, together with it being a potential source of protein, this species may be less common in the park at present than it was historically.

LAMPROPHIIDAE
Atractaspidinae

Atractaspis bibronii A. Smith, 1849

A single individual believed to be referable to this species was observed crossing the road between Pio Cabral headquarters and Xlekhane. Broadley (1983) also recorded this species from the vicinity of the Banhine Swamps.

Amblyodipsas microphthalma microphthalma* (Bianconi, 1850)

Two individuals were unearthed while clearing tall mopane woodland on the new airstrip. One of these, an injured individual, was collected (TM 85596). This specimen (SVL: 363.5 mm, TL: 400 mm) has 15 scale rows at midbody, 144 ventrals, 31 paired subcaudals, anal scale divided, 5 UL and 6 LL. The released individual measured SVL 291 mm, TL 319.5 mm and was unearthed amongst the roots of a *Grewia bicolor*, about 40 cm below the soil surface.

The tail : total length ratio (10.96) and number of ventral scales indicate that TM 85596 is a female. The subcaudal count of TM 85596 is higher than previously recorded for this species: Broadley (1983) records subcaudal counts ranging from 18–26. Branch (1998) records the maximum SVL of this species to be 313 mm for a female and 320 mm for a male, while Broadley (1971*b*, 1983) gives maximum total lengths of 320 mm and 330 mm for males and females, respectively. These measurements are surpassed by TM 85596, with a total length of 400 mm (363.5 mm + 36.5 mm) and represents a new size record for this species. These records are 200 km east of the population in northeastern KNP (Jacobsen, 1989), and 230 km southwest of the population on the San Sebastian Peninsula (Jacobsen *et al.*, 2010).

Xenocalamus bicolor lineatus* Roux, 1907

Three individuals (two adults and a juvenile) were observed in tall mopane woodland at the new airstrip during bush-clearing activities. One adult was collected after being injured (TM 85594). This specimen has SVL: 467 mm, TL: 498 mm, 17 scale rows at midbody, 242 ventrals, 26 subcaudals, 6 UL and 6 LL.

Lamprophiinae

Boaedon capensis* (Duméril & Bibron, 1854)

Encountered fairly regularly in the park, especially around Fish-Eagle Research Camp and on the new airstrip. One of the individuals observed displayed the xanthic colour form.

Psammophiinae

Hemirhagerrhis nototaenia (Günther, 1864)

Broadley (1983) recorded this species in the vicinity of the Banhine Swamps. It is likely to occur in the extensive belts of mopane woodland *Colophospermum mopane*, a habitat that was not extensively covered during either of the survey periods.

Rhamphiophis rostratus* Peters, 1854

An adult was observed in sandveld on the road between Xlekhane and Mungazi and was also recorded in this area by Broadley (1983).

Psammophis subtaeniatus* (Peters, 1854)

Commonly encountered in sandveld around Pio Cabral Headquarters and Fish-Eagle Research Camp. One individual examined had 8 UL and 120 subcaudals. Although the UL count may be indicative of *P. orientalis*, the high subcaudal count and coloration confirm that it is *P. subtaeniatus*. Although these records are *c*. 100 km southeast of the distribution range indicated in Branch (1998), Broadley (1983) recorded this species in the vicinity of the Banhine swamps.

Psammophis mossambicus Peters, 1882

Individuals were seen foraging in the reeds at the edge of the wetland after it flooded.

COLUBRIDAE
Colubrinae

Dasypeltis scabra (Linnaeus, 1758)

A specimen was collected by WDH at Chigubo (TM 29286).

Telescopus semiannulatus semiannulatus A. Smith, 1849

This species was recorded from the vicinity of the Banhine Swamps by Broadley (1983).

Dispholidus typus typus (A. Smith, 1829)

An adult female was captured and examined 10 km south of Xlekhane in sandveld. This female displayed the typical brown colour pattern, and was readily identified by the large eyes and presence of rear fangs.

ELAPIDAE
Elapinae

Aspidelaps scutatus fulafula* (Bianconi, 1849)

This species occurs widely throughout the park. Individuals were observed in sandveld around Fish-Eagle Research Camp (TM 85620), in mopane woodland near the northwestern boundary of the park and in the grassland plains around Xlekhane. TM 85620 has 121 ventrals, 41 subcaudals and 23 scale rows at midbody.

Elapsoidea sundevallii longicauda* Broadley, 1971

An adult was captured and examined at Fish-Eagle Research Camp after being unearthed from a Yellow Golden Mole (*Calcochloris obtusirostris*) tunnel and a second individual was captured 16 km north of Mungazi after it crossed the road early in the morning. Morphological data for the research camp individual are: 180 ventrals, 30 subcaudals, 13 scale rows at midbody, SVL 655 mm, TL 714 mm. The Mungazi individual had 175 ventrals, 30 subcaudals, 13 scale rows at midbody, 7 UL, 6 LL, SVL 816 mm, TL 899 mm. Both individuals had white bellies, a buff stripe bordering the ventrals dorsally and a glossy black back. WDH also collected a specimen at Chigubo (TM 29287).

Note: Branch (1998: 106) confused the descriptions of *E. s. longicauda* and *E. s. decosteri*, erroneously indicating that *E. s. longicauda* has a lower number of ventrals compared to *E. s. decosteri* (see Broadley, 1971*a*).

Naja annulifera* Peters, 1854

A large male was captured in the research camp ablution section while additional individuals were observed in the buffer zones around the park.

Dendroaspis polylepis (Günther, 1864)

A single individual was observed about 20 km south of Chigubo. Although this record is extralimital, this species is likely to occur within the park.

VIPERIDAE

Bitis arietans arietans* (Merrem, 1820)

A common species observed in most vegetation types throughout the park. Individuals from PNB are pale in colour.

AMPHISBAENIA
AMPHISBAENIDAE

Monopeltis sphenorhynchus* Peters, 1879

Seven individuals were unearthed in mopane woodland during construction of the new airstrip, two of which were collected (TM 85590, TM 85591). TM 85590 has 28 dorsals and 19 ventrals per body annulus, 279 body annuli and 9 subcaudals; SVL: 248.73 mm, TL: 258.34 mm. TM 85591 has 28 dorsals and 16 ventrals per body annulus, 224 body annuli and 8 subcaudals; SVL: 83.28 mm, TL: 88.10 mm. This species is likely to occur throughout most of the park, but has been largely overlooked due to its fossorial habits. PNB records are 200 km east of the population in northeastern KNP (Jacobsen, 1989) and 230 km southwest of the population on the San Sebastian Peninsula and Bazaruto Archipelago (Broadley, 1992; Jacobsen *et al*., 2010).

SAURIA
SCINCIDAE
Acontiinae

Typhlosaurus **sp. nov.** Pietersen *et al.,* in prep.

TM 85604–12, NMB R8840–43, 1251/MHN/09 (five specimens). This new taxon is presently known only from PNB. Specimens were regularly encountered on the southern edge of the wetland in sandveld habitat, wetland-fringing vegetation, in bush clumps and in mopane woodland during the construction of the new airstrip, but may be more widespread in the park.

Lygosomatiinae

Mochlus sundevallii sundevallii (A. Smith, 1849)

Two specimens were collected near Chigubo by WDH (TM 29255, TM 29256).

Trachylepis depressa (Peters, 1854)

WDH collected a specimen 20 km southeast of Machailla (TM 29248) and another at Chigubo (TM 29280). This species was not observed during 2007 and 2008.

Trachylepis punctulata* (Bocage, 1872)

A fairly common species, encountered most frequently in mopane woodland in the northeast of the park, but likely to be more widespread. WDH collected seven specimens at the Banhine Swamps (TM 29306–12) and four at Chigubo (TM 29251, TM 29281, TM 29282, TM 31254). A single specimen was collected in mopane woodland to the north of Fish-Eagle Research Camp (TM 85582).

Trachylepis striata* (Peters, 1844)

This species was commonly observed throughout the park and was regularly encountered on build-

ings and large baobab trees (*Adansonia digitata*). WDH collected a specimen at the Banhine Swamps (TM 29313).

Trachylepis varia* (Peters, 1867)

An adult was observed foraging at the edge of the wetland in front of the research camp at 22:05. A juvenile and adult were subsequently observed in the research camp.

Afroablepharus walbergii* (A. Smith, 1849)

An uncommon species, but likely to occur throughout the park. WDH collected two specimens at the Banhine Swamps (TM 29304, TM 29305). One individual examined and photographed at Fish-Eagle Research Camp had five white spots between the ear opening and the armpit insertion, with scattered white spots continuing along the flank to the groin, as does TM 29304. These individuals did, however, also have a vermiculated belly and a white stripe bordering the dark lateral band ventrally, as is typical for *A. walbergii*.

LACERTIDAE

Heliobolus lugubris (A. Smith, 1838)

The most common lacertid in the park. Adults and juveniles were regularly observed in sandveld and mopane woodland throughout the north of the park. These records are approximately 100 km east of this species' distribution as plotted by Branch (1998).

Ichnotropis capensis (A. Smith, 1838)

A specimen was collected at Chigubo by WDH (TM 29272). This record is 230 km southeast of the nearest population in southeastern Zimbabwe (Branch, 1998) and 235 km southwest of the population on the San Sebastian Peninsula (Jacobsen *et al*., 2010).

Ichnotropis squamulosa* Peters, 1854

WDH collected a series of six specimens from the Banhine Swamps (TM 29319–TM 29324) and five from Chigubo (TM 29274–TM 29278). This species was encountered in summer and autumn virtually throughout the park. These records extend this species' range 150 km east (see Branch, 1998).

Nucras caesicaudata Broadley, 1972

Specimens were collected by WDH at the Banhine swamps (TM 29317, TM 29318) and at Chigubo (TM 29279). Observations of this species appear to be closely correlated with termite emergences following thunderstorms (Pienaar, 1978; Branch, 1998), which might explain the lack of subsequent observations.

GERRHOSAURIDAE

Gerrhosaurus nigrolineatus Hallowell, 1857

A single specimen was collected by WDH at Chigubo (TM 29326), but the species was not observed during the recent survey. TM 29326 has four supraciliaries, a robust appearance, and closely resembles other *G. nigrolineatus* material housed in the Ditsong Museum collection.

CORDYLIDAE

Cordylus jonesii* (Boulenger, 1891)

A specimen was collected at Chigubo by WDH (TM 29287), and a second individual was observed and photographed in sandveld on the road between Pio Cabral and Chigubo.

VARANIDAE

Varanus albigularis albigularis (Daudin, 1802)

Not observed during the recent observation period, although WDH collected a specimen at Chigubo (TM 29289).

AGAMIDAE

Agama armata* Peters, 1854

A common terrestrial agama occurring widely throughout the park. WDH collected two specimens at Chigubo (TM 29284, TM 29285) while a gravid female was collected in mopane woodland in the northwest of the park in January (TM 85583). TM 85583 (SVL 80.52 mm, TL: 182.86 mm) has 89 scale rows at midbody, 10 UL and 11 LL. The scales on the back are strongly keeled and directed obliquely inwards towards the backbone. There are six rows of enlarged, keeled spines along the body. The dorsal crest is small and the fifth toe does not extend as far as the first. This specimen corresponds well to other *A. armata* specimens in the Ditsong Museum collection, and is clearly distinct from the *A. mossambica* specimens housed in this collection.

CHAMAELEONIDAE

Chamaeleo dilepis* Leach, 1819

An adult was observed in tall wetland-fringing sandveld vegetation in the research camp during light rain, while WDH collected specimens at the Banhine Swamps (TM 29314, TM 29315) and at Chigubo (TM 29258, TM 29325). This species probably occurs widely throughout the park, but may be more common in sandveld habitat and in the vicinity of the wetland.

GEKKONIDAE

Chondrodactylus turneri* (Gray, 1864)

This species was commonly observed in Fish-Eagle Research Camp at night, often entering buildings.

Hemidactylus mabouia Morreau de Jonnes, 1818

Common on buildings and tents in the research camp and park headquarters. Also observed foraging along cement pathways at night. WDH collected specimens at the Banhine Swamps (TM 29301) and Chigubo (TM 29264, TM 29266–TM 29268).

Hemidactylus platycephalus Peters, 1854

WDH collected two specimens at both Chigubo (TM 29269, TM 29270) and the Banhine Swamps (TM 29302, TM 29303). A single individual was observed on the stem of a large nyala berry *Xanthocercis zambesiaca* tree near the edge of the wetland in the vicinity of the old Pio Cabral homestead. This species is likely to occur on large *Adansonia* and *Xanthocercis* trees throughout the northern portions of the park. These records are 235 km southwest of the nearest known population on the San Sebastian Peninsula (Jacobsen *et al.*, 2010).

Lygodactylus capensis capensis* (A. Smith, 1849)

A common dwarf gecko recorded on buildings and trees throughout the park. WDH collected specimens at the Banhine Swamps (TM 29292–TM 29299) and at Chigubo (TM 29271, TM 29273).

Pachydactylus punctatus* Peters, 1854

An uncommon species found under leaves and logs in sandveld vegetation at Fish-Eagle Research Camp and the new airstrip. WDH collected specimens at the Banhine Swamps (TM 29300) and at Chigubo (TM 29283, TM 29327, TM 29328). These records extend the known distribution of this species *c*. 100 km east (see Branch, 1998).

AMPHIBIA
ANURA
BREVICEPTIDAE

Breviceps adspersus adspersus Peters, 1882

Calling individuals in the vicinity of the research camp were considered referable to this species, but this requires confirmation.

Breviceps mossambicus Peters, 1854

Individuals presumably belonging to this species were heard calling in the vicinity of the research camp. This species requires confirmation.

BUFONIDAE

Amietophrynus garmani* Meek, 1897

Numerous individuals were seen between Fish-Eagle Research Camp and the salt pan to the east of the alluvial plug. Individuals were also observed in a sunken cement well in the north of the park, and WDH collected a specimen at Chigubo (TM 29549).

HEMISOTIDAE

Hemisus marmoratus (Peters, 1854)

WDH collected two specimens at Chigubo in February 1964 (TM 29547, TM 29548). This species is probably present in the park and may have been overlooked during the recent survey.

HYPEROLIIDAE

Hyperolius argus Peters, 1854

Individuals were observed on emergent vegetation in a small seasonal pan situated northeast of the research camp. This species probably occurs throughout the main wetland, as well as in seasonal pans with suitable emergent and waterside vegetation.

Hyperolius marmoratus marmoratus Rapp, 1842

WDH collected two specimens at Chigubo (TM 29547, TM 29548) where they occurred sympatrically with *H. m. taeniatus* (TM 29545). These records are much farther north than most reference books depict their distribution (Channing, 2001; Minter *et al.*, 2004; du Preez and Carruthers, 2009). However, Jacobsen *et al.* (2010) recorded both subspecies on the San Sebastian Peninsula, Vilanculos, together with what appears to be a hybrid individual and suggested that the peninsula may lie on a contact zone between the two subspecies. These records suggest that *H. m. marmoratus* is more widely distributed in southern Mozambique than presently appreciated, that *H. m. marmoratus* and *H. m. taeniatus* may occur sympatrically at some localities, and that these two taxa may therefore represent distinct species. Further surveys are required to assess the distribution and taxonomic status of these taxa.

Hyperolius marmoratus taeniatus Peters, 1854

Numerous individuals were seen and heard in the pan to the northeast of Fish-Eagle Research Camp, as well as in the main wetland between the research camp and the alluvial plug. WDH collected specimens at the Banhine Swamps (TM 29554–TM 29557) and at Chigubo (TM 29545). This subspecies is likely to be common in suitable habitat throughout the park.

Kassina maculata Duméril, 1853

This species was heard calling in the small wetland to the northeast of Fish-Eagle Research Camp.

Kassina senegalensis Duméril and Bibron, 1841

WDH collected a specimen at Chigubo (TM 29553). A single individual was observed in the research camp and others were heard calling in the vicinity. This species may occur in wet locations throughout the park.

MICROHYLIDAE

Phrynomantis bifasciatus Smith, 1847

A number of individuals were heard calling from the direction of the small wetland to the northeast of the research camp.

PHRYNOBATRACHIDAE

***Phrynobatrachus* sp.**

Puddle frogs were heard calling from the small pan to the northeast of the research camp, but we were unable to confirm which species were present.

PTYCHADENIDAE

Ptychadena mossambica Peters, 1854

Numerous froglets were observed in vegetation fringing the pan to the northeast of Fish-Eagle Research Camp and adults were also heard calling from fringe vegetation at night. Adults were also heard and observed between the research camp and the alluvial plug after the wetland flooded.

PYXICEPHALIDAE

Pyxicephalus edulis* Peters, 1854

Numerous individuals were observed in sandveld in the research camp, along the border of the wetland between the research camp and the alluvial plug and in mopane woodland on the new airstrip following the onset of rains in November. It is likely to be common throughout most of the park, but its presence may go unnoticed for many years owing to this species' habit of remaining dormant until suitable conditions prevail.

***Tomopterna* sp.** Beira* Dawood *et al.*, in prep.

A novel *Tomopterna* that was previously known only from the vicinity of Beira, but confirmed to be present in PNB through genetic characterization (Dawood, pers. comm.). Seven individuals were collected in sandveld in Fish-Eagle Research Camp (TM 85562–TM 85568). This species can be distinguished from all other southern African species by having two double proximal tubercles beneath the first finger and it is currently being described (Dawood, pers. comm.).

Tomopterna cryptotis Boulenger, 1907

A common species, collected at Chigubo (TM 29551, TM 29552) and at Fish-Eagle Research Camp (TM 85589).

Tomopterna krugerensis* Passmore and Carruthers, 1975

Specimens were collected in sandveld at Fish-Eagle Research Camp (TM 85588) and Chigubo (TM 29546, TM 29550, TM 29599, TM 29600). Specimens were identified by the presence of a double subarticular tubercle beneath the first finger, as well as call. Specimens were discerned from *Tomopterna* sp. Beira by the presence of one (not two) double subarticular tubercles beneath the first finger.

***Tomopterna* sp.** Banhine

Additional *Tomopterna* individuals were observed and photographed at Fish-Eagle Research Camp, but were not collected. These frogs had differing dorsal colour patterns and could not be positively assigned to any presently recognized taxa. They may represent undescribed species, or merely aberrant colour variations of described taxa. A description of the different forms follows:

*Form A**: Two individuals seen in sandveld at Fish-Eagle Research Camp in January 2007. Metallic green dorsally, with glandular elevations coloured gold (anteriorly) or yellow (medially) and enclosed by a broad black circle. A dark interorbital bar is present, broadest medially and directed backwards. Flanks mottled with black. Concealed surfaces pale blue. The first individual changed from metallic green to pale blue, especially laterally, while being photographed which may have been stress-induced. There is a glandular skin ridge present on the jaw-line, which continues to behind the tympanum. The tympanum is obscured. A dead female containing eggs was observed in Fish-Eagle Research Camp in January, but was too degraded to collect. Although it is possible that the observed colour change (metallic green to light blue) was induced by envenomation, it is unlikely that two individuals would be envenomated and not consumed at the same site and within four days of each other. The first individual also did not show any signs of envenomation (other than the colour change) while being photographed and hopped away upon release. The presence of two double proximal tubercles beneath the first finger suggests that this form may be referable to *Tomopterna* sp. Beira.

*Form B**: Seen in sandveld at Fish-Eagle Research Camp. This form is pale pinkish dorsally and white ventrally. The dorsal surface is largely smooth, but with scattered glandular elevations. The lateral glandular elevations are orange; the median elevations are elongated, reddish medially and surrounded by a narrow black circle. A dark interorbital bar is present, being broadest medially and pointing backwards, followed by a pale scapular patch. A glandular skin ridge is present on the jaw-line but is not pronounced, and extends approximately to the posterior border of the concealed tympanum. Small, conical orange elevations are present above the eyes.

*Form C**: Seen in sandveld at Fish-Eagle Research Camp. This individual is pale grey dorsally and laterally, and white ventrally. The dorsal surface is smooth to slightly granular, with a mosaic of slightly

darker patterns on the pale ground colour, including a darker inter-orbital bar that is broadest medially and points backwards, followed by a paler scapular patch. A pale glandular skin ridge is present but indistinct on the upper jaw, becoming distinct from behind the angle of the jaw and extending to the arm insertion. There is a darker patch behind the eye, extending across the concealed tympanum to the top of the arm insertion.

RHACOPHORIDAE

Chiromantis xerampelina* Peters, 1854

Nests of this species were seen above temporary pans throughout the park, including at Lipasse. WDH collected a specimen 30 km southeast of Machailla (TM 29544).

DISCUSSION

A total of four chelonian, 18 snake, one amphisbaenid, 21 lizard and 17 frog species were recorded from PNB, or in the areas immediately adjacent to the park. This herpetological diversity (61 species) is lower than the diversity in southeastern Zimbabwe (105), northeastern KNP (116) and the San Sebastian Peninsula and Bazaruto Archipelago (75), all of which are also on sandy substrates (Jacobsen, 1989; Broadley, 1990, 1992; Branch, 1998; Jacobsen *et al.*, 2010). The apparently lower diversity at the Mozambican sites might be due to less sampling having been done at these sites to date, but may also suggest that the habitat is less complex at these sites, which in turn translates to a lower herpetological diversity. Although the current list almost certainly does not represent the total herpetofaunal diversity of PNB, it does provide a baseline that future studies can build on.

Considering its geographic proximity, it is perhaps not surprising that PNB shows the closest herpetological affinities to the northeastern KNP and southeastern Zimbabwe. Of the 61 species recorded in PNB, 54 have also been recorded in northeastern KNP and/or southeastern Zimbabwe, while only 35 have been recorded on the San Sebastian Peninsula and/or Bazaruto Archipelago. There are also a number of common species that have been recorded at the other three locations, but not as yet in PNB, and which are expected to occur there as well.

Also of interest are the distribution patterns of various taxa. A number of taxa such as *Afrotyphlops fornasinii, Amblyodipsas m. microphthalma, Zygaspis vandami, Monopeltis sphenorhynchus, Typhlosaurus aurantiacus* species complex and *Ichnotropis capensis* exhibit apparently isolated populations in northern KwaZulu-Natal and southern Mozambique, but skip the Gazaland plain and then re-appear in northeastern South Africa or southeastern Zimbabwe. This apparent disjunct distribution may be an attribute of inadequate sampling rather than a true gap in distribution, an hypothesis that is lent support by the discovery of *A. m. microphthalma, M. sphenorhynchus, T. aurantiacus* species complex and *I. capensis* in PNB. Conversely, some taxa with a mainly western distribution extend eastwards along the sandy alluvium of northern South Africa, although few of these species have been recorded on the Gazaland plain as yet. The occurrence of *Monopeltis sphenorhynchus* and *Trachylepis punctulata* in PNB is therefore significant and may portend that other species such as *Chirindia l. langi, Monopeltis leonhardi, M. rhodesiana, M. decosteri, Zygaspis quadrifrons* and *Nucras intertexta* could occur here as well. The former species are all fossorial and their presence may only be noticed after many years of continuous fieldwork. The apparent lack of *Scelotes*, a genus that is well-represented in northeastern KNP, southeastern Zimbabwe and on the San Sebastian Peninsula and Bazaruto Archipelago, is surprising as this genus is usually located quite easily when searched for. Further fieldwork in all habitat types is required to ascertain whether this genus is truly absent, or whether it has merely been overlooked.

Three species of *Tomopterna* have already been recorded from PNB, although phenotypic traits suggest that there may be as many as three additional undescribed taxa. One of the species recorded in PNB was only recently discovered near Beira for the first time, and is still to be described. Ascertaining the total diversity of *Tomopterna* in PNB is likely to prove an interesting avenue of research.

The sympatric occurrence of *Hyperolius m. marmoratus* and *H. m. taeniatus* is interesting, as the former was considered to only occur further south and east (Channing, 2001; Minter *et al.*, 2004; du Preez and Carruthers, 2009; but see Jacobsen *et al.*, 2010). Although these subspecies are supposed to occur parapatrically only in the vicinity of St Lucia, KwaZulu-Natal, where intergrades have been recorded (Lambiris, 1989; Minter *et al.*, 2004), Jacobsen *et al.* (2010) found them together on the San Sebastian Peninsula, where an apparent hybrid was also collected. These PNB records are the second known instance of sympatry in southern Mozambique, indicating that sympatry may be more widespread than is currently believed. This suggests that *H. m. marmoratus* and *H. m. taeniatus* may represent distinct species rather than merely geographic variants although further research, including molecular characterization, is required to investigate this possibility. It is also believed that *H. m. marmoratus* is more widely distributed in

southern Mozambique than is currently appreciated.

The current survey of PNB, together with documentation of the long-overlooked specimens collected by WDH, has started to fill some gaps in the known distribution of a number of reptile and amphibian taxa in southern Mozambique. However, a great deal more sampling is required before we can deduce phylogeographic patterns. The species checklist for PNB would benefit from further surveys, especially surveys employing traps to increase sampling ability.

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Appendix

Gazetteer of localities in Parque Nacional de Banhine mentioned in the text.

Locality	Latitude	Longitude	Altitude
Alluvial Plug	22°39′35″S	33°18′53″E	70 m a.s.l.
Cantine	22°45′24″S	33°24′28″E	86 m a.s.l.
Chigubo	22°49′54″S	33°31′11″E	103 m a.s.l.
Fish-Eagle Research Camp	22°37′58″S	33°16′02″E	76 m a.s.l.
Lipasse	22°28′46″S	33°03′10″E	80 m a.s.l.
Machailla	22°15′14″S	32°54′56″E	113 m a.s.l.
Mungazi	23°10′50″S	32°53′51″E	100 m a.s.l.
New Airstrip	22°40′28″S	33°15′07″E	79 m a.s.l.
Old Pio Cabral Homestead	22°37′41″S	33°14′38″E	75 m a.s.l.
Pio Cabral Headquarters	22°38′04″S	33°15′46″E	86 m a.s.l.
Salt Pan	22°39′33″S	33°21′16″E	68 m a.s.l.
Xlekhane	22°44′46″S	32°57′11″E	81 m a.s.l.