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PLATINUM OPEN ACCESS

Complementary bat (Mammalia: Chiroptera) survey techniques uncover two new country records for Nigeria

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Abstract: Knowledge of the bat fauna in Nigeria is limited due to use of outdated collection techniques, and infrequent sampling effort. To advance knowledge of bat diversity in the country, a survey of bats from three localities:—Emu, Okomu National Park (ONP), and Ososo—in southern Nigeria was conducted using mist nets set at canopy and at ground level from February–September 2011. During 28 capture nights involving a total of 202.7 mist net/nights, 239 individuals belonging to 27 bat species in eight families (Emballonuridae, Hipposideridae, Megadermatidae, Molossidae, Nycteridae, Pteropodidae, Rhinolophidae, and Vespertilionidae) were recorded. A total of 130, 64, 45 individuals of 8, 13 and 11 species were recorded from Emu, Okomu, and Ososo, respectively. Two new country records, *Casinycteris campomaanensis* and *Chaerephon aloysiisabaudiae,* both collected from Okomu National Park, are reported for Nigeria. Whereas the former species was collected in a canopy high stacked mist net setup, the latter was collected in a ground level mist net, demonstrating the value of employing contemporary and complementary sampling techniques especially in such understudied regions of Africa.

Keywords: Bats, *Casinycteris campomaanensis, Chaerephon aloysiisabaudiae*, Guinean Forest of western Africa.

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Competing interests: The authors declare no competing interests.

Author details: Iroro Tanshi is interested in Afrotropical bat diversity patterns across the Lower Guinean Forest of West Africa and assemblage structure along elevational gradients. She is keen to develop mammal conservation infrastructure of the Afrotropics. Iroro also co-founded and runs a non-profit Small Mammal Conservation Organisation, that is focused on evidence-based conservation of small and medium sized mammals, ecological research and capacity building of local students in Nigeria and across West Africa. Anthony Ekata Ogbeibu is a Hydrobiologist working at the interface of biodiversity, ecology and human disturbance across fresh and brackish water systems across Nigeria. Dedicated to capacity building over the past three decades, he has trained several postgraduate students, with a publication record on the ecology of aquatic fauna and the impact of pollution on aquatic and terrestrial systems. Paul J.J. Bates trained as a small mammal/bat taxonomist. He has published extensively on the diversity, distribution and ecology of bats and rodents in Asia, Arabia and Africa. Through a series of internationally funded projects, he has promoted capacity building, academic supervision and postgraduate training of young scientists and conservationists in the Old World tropics. Today, he works with a new generation of in-country staff and students to preserve and protect wildlife and the environment in Africa and Asia.

Author contribution: IT conducted the field survey, preliminary identification (for some members of Pteropodidae) and wrote the manuscript. AEB supervised the project and contributed to manuscript writing. PJJB contributed to taxonomic notes and manuscript writing.

Ethics statement: The authors affirm that animals were handled following the guidelines of the American Society of Mammalogists for the use of wild mammals in research (Sikes et al 2011).

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INTRODUCTION

Africa holds over a fifth of the global diversity of 1,411 bat species (Simmons & Cirranello 2019), but many countries on the continent remain relatively under-surveyed. A recent species distribution model of bats across Africa detected a huge Wallacean shortfall—limited occurrence data primarily due to inadequate sampling (Herkt et al. 2016). To effectively document bat species occurrence and distribution patterns, intensive sampling across multiple localities and habitat types have been suggested (Fahr & Kalko 2011). Over 90% of bat captures in Nigeria were reported prior to the 1980s, showing limited sampling effort in the last four decades (I. Tanshi unpubl. data). Similar reports of limited surveys in recent decades are known from other countries in Africa (Bates et al. 2013; Kangoyé et al. 2015).

Beyond sampling effort, limited knowledge of the fauna in Nigeria is due to inadequate capture techniques employed in previous studies. Elsewhere in the tropics, improvement and implementation of contemporary capture techniques has led to an increase in species discoveries and new distributional records (Francis 1989; Kingston 2010). Employing appropriate sampling techniques in bat surveys is important for local checklists because different trapping methods are optimized for each of the three major bat foraging groups: clutter, edge and aerial, including pteropodids (Kingston 2016). Therefore, inventory completeness relies on appropriate, contemporary and complementary sampling techniques (Meyer et al. 2011). In Nigeria, most bats have been collected by employing inappropriate methods, such as shotguns that are ineffective relative to contemporary techniques like mist nets (Bradley & Dowler 2019) in providing a true insight into a country's bat diversity.

The largest diversity hotspot for bats in Africa is predicted to occur on the easternmost part of the Guinean Forests of West Africa (GFWA) (Herkt et al. 2016). The GFWA is comprised of two blocks – Upper and Lower GFWA, which are separated by the Dahomey gap (Bakarr et al. 2004). Furthermore, the Lower GFWA spans eastern Benin Republic, through southern Nigeria to southwestern Cameroon, with Nigeria holding the largest portion of this forest block. In southern Nigeria the two largest ecoregions are the Nigerian lowland forests and Guinean forest-savanna mosaic. This Guinea savanna area, a heterogeneous transition between forest and savanna, has been demonstrated as a center for high bat diversity in Africa (Fahr & Kalko 2011), making it an important target for bat surveys. Moreover, Nigeria holds 12 terrestrial ecoregions, making it the most ecologically diverse country in western Africa (Olson et al. 2001). Despite being ecologically diverse, the bat fauna of ecoregions across Nigeria is poorly understood, primarily due to limited sampling efforts and the use of outdated sampling techniques.

To improve knowledge of the bat fauna in Nigeria, bat surveys were conducted at three localities across two ecoregions using mist nets installed at ground and canopy level. We report new records for Okomu National Park (ONP) and Nigeria. This is the first study to employ a contemporary survey technique (stacked canopy nets), complemented by ground mist netting in Nigeria.

MATERIALS AND METHODS

Study localities

Three localities were surveyed, Emu, Okomu National Park (ONP), and Ososo (Figure 1), all within Edo State, a landlocked area in southern Nigeria. The Nigerian National Park Service granted permission to conduct surveys in ONP. Community members and individual land owners granted permission for surveys in Emu and Ososo. Vegetation in the state spans lowland rainforest to the south and Guinea savanna to its northern most point. At each locality, bat trapping was conducted at two sites. Sites were selected to represent different vegetation structures or presence of water, in order to capture variability within localities.

Site description

Emu Village

This is a predominantly agricultural landscape with patches of regenerating or degraded forest and farm/bushland fallows. Although on the edge of the lowland forest zone, large scale clearings for farmlands together with the use of fire to clear ground for agriculture have led to the development of a savanna-like landscape. The presence of single-standing tall rainforest tree species, however, indicates a historic lowland forest vegetation in the area.

Site A1: Lat/long (6.558, 6.470): The dominant rainforest tree was *Irvingia gabonensis*, harvested for its edible fruits and nuts, this tree is often left untouched during forest clearing for farming. Other trees include *Hevea brasiliensis* (rubber) and *Bambusa* sp. (bamboo) in addition to *Musa* sp. (banana) and several unidentified grass species.

Site A2: Lat/long (6.559, 6.476): This site was a hilltop with a few tall trees and shrubs interspersed by grasses.

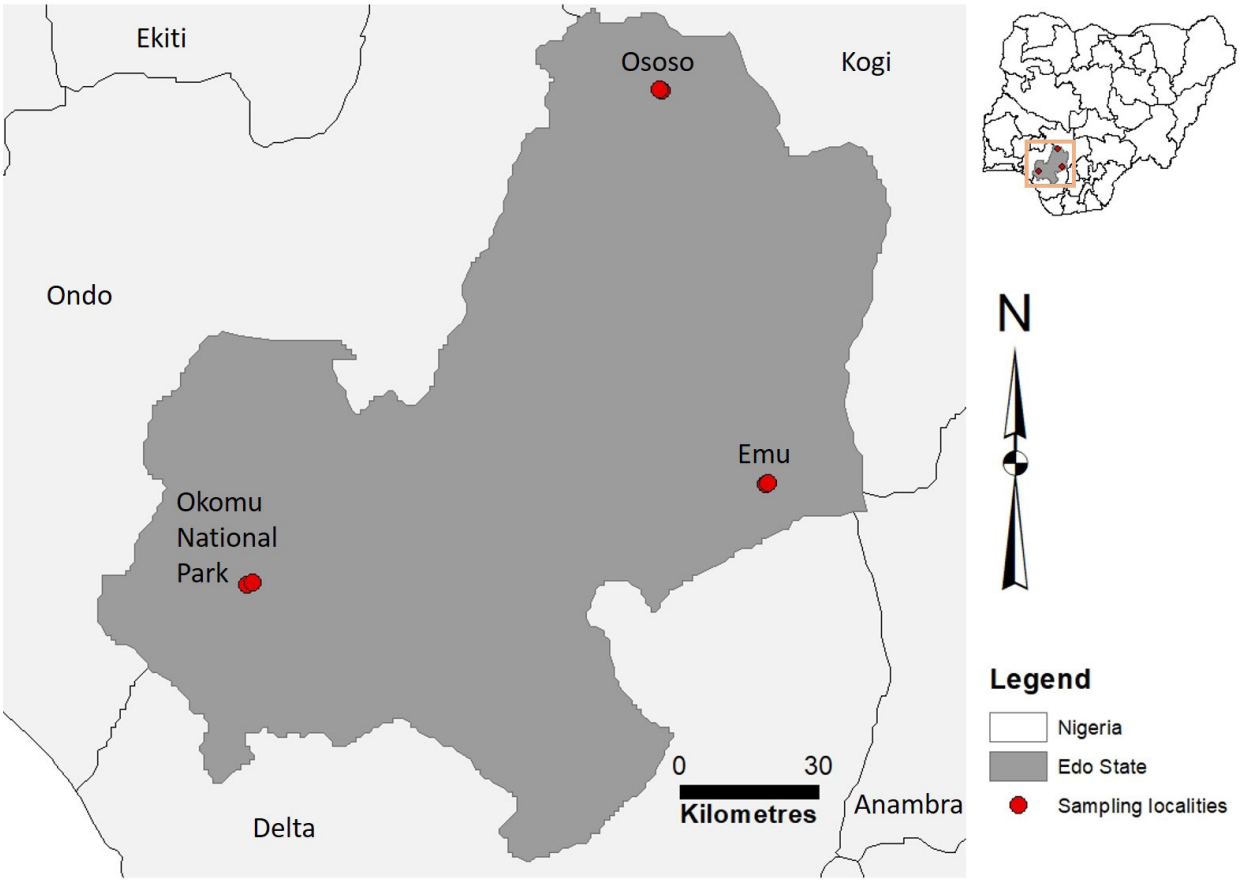

Figure 1. Study localities. Insert: Nigeria, showing spatial extent of surveyed sites.

Okomu National Park

ONP lies 45km west of Benin City adjacent to the larger Okomu Forest Reserve where timber is selectively logged. Annual rainfall ranges 1,524–2,540 mm (Aremu et al. 2012). It falls within the Nigerian Lowland Forest ecoregion (Olson et al. 2001), which is part of the Lower Guinean Forest (Bakarr et al. 2004). Previously known as Okomu Wildlife Sanctuary, ONP is the smallest of the seven national parks in the country with an approximate size of 181km^2. It, however, holds one of the country's last remaining stands of mature lowland forest west of the river Niger. The park is protected for its unique wildlife including the endangered *Cercopithecus erythrogaster* (White-throated Monkey).

Site C1: Lat/long (6.340, 5.345): This site is a seasonal lake (Lake 54), with the dominant tree being *Ceiba pentadra* (Silk cotton tree). During the rainy season, the lake overflows, but is dry in the dry season, during which the lake bed is covered by forbs, tree saplings and grasses, growing up to 0.5m height.

Site C2: Lat/long (6.345, 5.358): This site is just by a vehicle track, next to the park generator house. With the exception of a single individual of *Tectona* sp. the vegetation is closed forest.

Ososo Town

Characteristic of the Guinean forest-savanna mosaic, this is a transition zone between forest to the south and Sahel savanna to the north. The landscape is a wooded savanna vegetation, gallery forests, bare rock surfaces and farms. The terrain is hilly with a network of cave-like habitats formed from granitic boulders. The village is set within the valley of the surrounding Ososo Hills, some of which still hold patches of native vegetation, fragmented by farmland on gentle slopes and at the foot of hills.

Site B1: Lat/long (7.410, 6.244): This site is a fallow farmland vegetation with the dominant tree being few *Parkia biglobosa* surrounded by grasses.

Site B2: Lat/long (7.414, 6.240): This site is a hilltop, forested with dense understory clutter. In addition to *Parkia biglobosa*, other dominant trees were *Cola nitida* (cola nut).

Bat capturing

Bats were captured bimonthly in two 100m^2 plots (sites) per locality between February–September 2011 using 12 x 3 m mist nets with four or five shelves, 16mm mesh, 2 x 70 denier netting. Each sampling plot included eight ground nets and one canopy net. Ground nets were erected using bamboo poles with the lowest point of each net reaching the forest floor or grass layer. Canopy nets comprised of three or four mist nets stacked one above the other and attached to a rope pulley system, which was hoisted between two trees. Canopy net height varied depending on the height of trees at a given plot. Capture efforts varied between localities (Table 1).

Bats were captured between 18.30–06.00 h, and nets checked regularly throughout the night. Bats were retrieved from nets and placed in individual holding bags prior to processing. Routine biometric data were collected from each individual; forearm length (mm) using a Vernier caliper 0.05 precision, body mass (g) using a Pesola spring scale, sex, age and reproductive status (Brunet-Rossinni & Wilkinson 2009; Racey 2009). Identified individuals were released immediately after measurements. We followed Hayman & Hill (1971) and Rosevear (1965) in the identification of captured bats. Handling of captured animals followed Gannon & Sikes (2007). Taxonomy followed Simmons (2005) and where required, supported, by recent revisions. Voucher specimens were collected for all bat species. Skull extraction and measurements used in identification and confirmation of field IDs was performed by Jakob Fahr prior to deposition at the Professor A.B.M. Egborge Museum of the University of Benin City. A handheld GPS (Garmin Etrex) was used to obtain geographical coordinates of sample plots.

RESULTS

We report two new country records *Casinycteris campomaanensis* and *Chaerephon aloysiisabaudiae*. A total of 239 individuals belonging to 27 species and eight families (Emballonuridae, Hipposideridae, Megadermatidae, Molossidae, Nycteridae, Pteropodidae, Rhinolophidae and Vespertillionidae) were recorded from the three localities (Table 1). Of the 27 species, 11 were fruit bats belonging to the single family Pteropodidae with 189 individuals, while 16 were insectivorous bats belonging to seven families of which a total of 50 individuals were captured. Each locality had a unique species composition with only two species (*Eidolon helvum* and *Micropteropus pusillus*) shared between Ososo and Emu, while three species (*Epomops franqueti*, *Megaloglossus woermanni* and *Mops condylurus)* were shared between Emu and Okomu. Table 2 displays forearm length and body mass of species captured during the survey.

Species accounts

New records and material (voucher specimens) are presented, and previous localities for captured species were extracted from published literature. The current IUCN Red List category for each species is also provided (IUCN 2019). Where available, noteworthy ecological or taxonomic details are discussed under notes.

Pteropodidae

***Eidolon helvum* (Kerr, 1792)**

Near Threatened

New records: Emu and Ososo.

Previous records from Nigeria: Yola (Dollman 1908), Panyam (Thomas 1911), Abuehi, Asaba and Gombi (Andersen 1912), Lagos Island (Boulger & Porterfield 1958), University of Ile Ife (Halstead 1977; Okon 1974; Ogunbiyi & Okon 1976; Caxton-Martins 1977; Okon 1980; Aladetuyi 1984; Cole & Marquis 1985; Okon & Ogunbiyi 1997; Nwoha 2000; Agboola et al. 2003; Oke 2004), Abuja (Monath et al. 1974), Ijan Ekiti, Iyin Ekiti, Idanre, Oyo, Okitipukpa (Funmilayo 1978), Ibadan (Funmilayo 1978; Happold & Happold 1978b), Otari and Buguma (Angelici et al. 2000), northern Nigeria (Dzikwi et al. 2010), Oshogbo and New Bussa (Happold & Happold 1978b). The closest reported locality is near Benin by Rosevear (1953).

***Epomops franqueti* (Tomes, 1860)**

Least Concern

New records: Emu and Okomu National Park (Image 1).

New material: Two individuals were collected from Emu Village (F-N^o 62, 73).

Previous records from Nigeria: Old Calabar (Thomas 1880), Asaba (Andersen 1912; Rosevear 1965), Abonuema, Lagos, Oban (Andersen 1912), Umuahia (Rosevear 1965), Ibadan (Caxton-Martins 1977; Happold & Happold 1978b; Bergmans 1982), Olokomeji Forest Reserve, Nikrowa, Sapoba Forest Reserve, Igbo-Oloyin, Omo Forest Reserve (Happold & Happold 1978b), Agege, Calabar, Ife, Odukpani (Bergmans 1982), Leinde Fadali (Hutterer et al. 1992), Otari, Buguma, Orashi and Peterside (Angelici et al. 2000), northern Nigeria (Odebiyi et al. 2004).

Notes: This is a new record for Okomu National Park.

Table 1. Capture effort and the number of individuals of the 27 bat species captured from the three survey localities

		Emu		Okomu		Ososo		
		A1	A2	C1	C2	B1	B2	Total
		Canopy mist net/nights						
		27.4	5	8	17.3	22	1.5	81.2
		Ground mist net/nights						
Family/Species		42.5	-	34	20	25	-	121.5
Pteropodidae	*Eidolon helvum*	19	2			7		28
	Epomophorus gambianus	-	-			1		1
	Epomops franqueti	17	1	4				22
	Hypsignathus monstrosus	-	-	3				3
	Myonycteris angolensis smithii	-	-			4	3	7
	Megaloglossus cf. *woermanni*	1	1	9	1			12
	Micropteropus pusillus	51	4			15		70
	Myonycteris leptodon			29	3			32
	Rousettus aegyptiacus					7	1	8
	Casinycteris campomaanensis				1			1
	Scotonycteris cf. *zenkeri*			4	1			5
Hipposideridae	*Hipposideros* cf. *ruber*					1		1
Rhinolophidae	*Rhinolophus aff. darlingi*					2		2
Megadermatidae	*Lavia frons*			1				1
Nycteridae	*Nycteris arge*				1			1
	Nycteris grandis				2			2
	Nycteris macrotis					1		1
Vespertilionidae	*Glauconycteris beatrix*			1				1
	Mimetillus moloneyi	1						1
	Scotophilus dinganii					1		1
	Scotophilus leucogaster	2						2
	Scotophilus nigrita					1		1
Molossidae	*Chaerephon aloysiisabaudiae*				2			2
	Chaerephon pumilus	1						1
	Mops condylurus	30			1			31
Emballonuridae	*Saccolaimus peli*				1			1
	Taphozous nudiventris					1		1

***Epomophorus gambianus* (Ogilby, 1835)**

Least Concern

New record: Ososo (Image 2).

Previous records from Nigeria: Benin, Gombe (Andersen, 1912), Kabwir (Thomas 1912), Jebba (Andersen 1912; Bræ strup 1933), Nupeko (Monath et al. 1974), Otari, Buguma, Orashi and Peterside (Angelici et al. 2000), northern Nigeria (Dzikwi et al. 2010), near Jebba (Rosevear 1953), Ibadan, Shaffini, Ejigbo, Upper Ogun Game Reserve, Borgu Game Reserve (Oli river), Shagunu (Happold & Happold 1978b).

***Hypsignathus monstrosus* Allen, 1862**

Least Concern

New record: Okomu National Park.

New material: One individual was collected from Okomu NP (F-N^{o} 209).

Previous records from Nigeria: Old Calabar (Murray 1862; Andersen 1912), Kwa and Oban (Andersen 1912), Ibadan and Topo Island (Happold & Happold 1978b), Buguma and Orashi (Angelici et al. 2000), Calabar (Lameed & Ayodele 2008). The closest reported locality is Benin (Rosevear 1953).

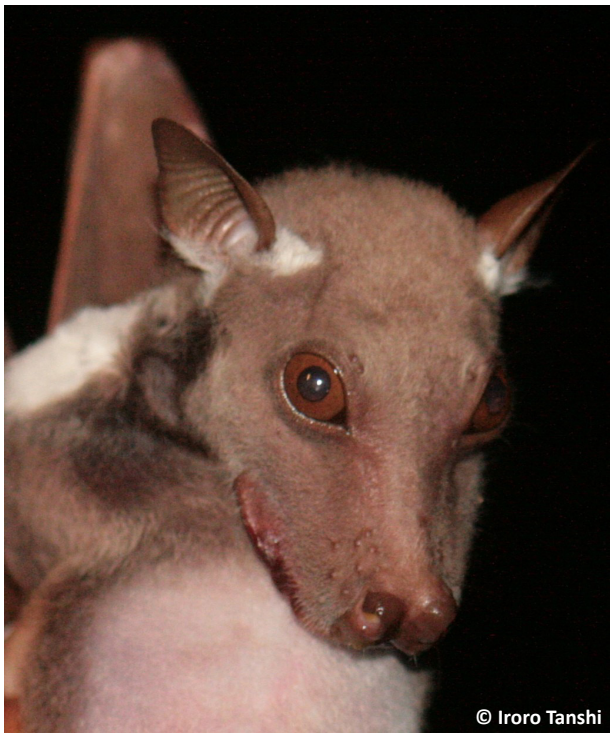

Image 1. *Epomops franqueti* (Tomes, 1860).

Notes: This is a new record for Okomu National Park.

***Megaloglossus* cf. *woermanni* Pagenstecher, 1885**

Least Concern

New records: Emu village and Okomu NP.

Previous records from Nigeria: Okomu National Park (Nikrowa), Shasha Forest Reserve, Gambari Forest Reserve, Sapoba Forest Reserve, Ibadan - International Institute for Tropical Agriculture (Happold & Happold 1978), southeastern Nigeria (Luiselli & Angelici 1998), Orashi and Peterside (Angelici et al. 2000).

Notes: Based on molecular data, Nesi et al. (2013) separated eastern populations of *Megaloglossus* from western African ones, and the taxonomic status of specimens Nigeria remain unresolved. Therefore, the status of our collection remains unclear.

***Micropteropus pusillus* (Peters, 1868)**

Least Concern

New record: Emu village (Image 3).

New material: One individual was collected from Ososo (F-N° 58).

Previous records from Nigeria: Nupeko (Monath et al. 1974), Borgu Game Reserve (Oli river), Shaffini, Egbe, Olokomeji Forest Reserve, Upper Ogun Game Reserve, Ibadan (Happold & Happold 1978b), Calabar (Lameed & Ayodele 2008), northern Nigeria (Dzikwi et al. 2010).

Image 2. *Epomophorus gambianus* (Ogilby, 1835) with pup.

Rosevear 1953 lists the species, but no specific localities are provided.

***Myonycteris angolensis smithii* (Bocage, 1898)**

Least Concern

New record: Ososo Town.

New material: One specimen was collected from Ososo Town (F-N° 174)

Previous records from Nigeria: Ipole near Illesha (Happold & Happold 1978b), Filele (GBIF 2018), Idere (HZM), Igbo-Ora (GBIF 2018), Obudu (BM), Odukpani (GBIF 2018), Sapoba, Kagoro (Happold 1987), and Leinde Fadali (Hutterer et al. 1992).

Notes: We follow the suggestion of Nesi et al. (2013) to treat the taxon as a subspecies, with populations in western Nigeria now referred to *M. a. smithii*.

Image 3. *Micropteropus pusillus* (Peters, 1868).

***Myonycteris leptodon* Dobson, 1878**

Least Concern

New record: Okomu National Park.

New material: Three specimens were collected from Okomu NP (F-N° 98, 104, 120).

Previous records from Nigeria: Ibadan (Bergmans 1976) and Sapoba FR (Happold 1987).

Notes: This is a new record for Okomu National Park. Specimens from both localities were previously identified as *M. torquata*. Specimens west of the river Niger, however, have been assigned to *M. leptodon* that was recently elevated to species rank, with *M. torquata* now restricted to localities east of the river (Nesi et al. 2013).

***Rousettus aegyptiacus* (Geoffrey, 1810)**

Least Concern

New record: Ososo Town (Image 4).

Previous records from Nigeria: Oban (Rosevear 1965), Jos, Kagaro and Kano (Bergmans 1994), Otari, Orashi and Peterside (Angelici et al. 2000).

***Casinycteris campomaanensis* Hassanin, 2014**

Data Deficient

New record: Okomu National Park (Image 5).

New material: One sexually immature individual was collected from Okomu NP (F-N° 103).

Image 4. *Rousettus aegyptiacus* (Geoffrey 1810).

Previous localities: The species is not previously known from Nigeria.

Notes: This individual was captured in a ground net at about 1.2m from ground level, and close to a dry seasonal lake. This specimen represents the first record of the species for the country. The species was only recently described from a specimen caught in 2007 from its type locality - Village of Nkoe´lon-Mvini, Campo-Ma'an area, South Region, Cameroon (Hassanin 2014). The current specimen is only the second collection known for the species and is deposited in the personal collection of Jakob Fahr, awaiting transfer to the Prof. A.BM. Egborge Zoological Museum, University of Benin, Benin City.

***Scotonycteris* cf. *zenkeri* Matschie, 1894**

Unassessed

New record: Okomu National Park (Image 6).

New material: One individual was collected at Okomu NP (F-N° 102).

Previous localities: Gambari, Oban, Omo Forest Reserve, Shasha and Sapoba Forest Reserves (Happold & Happold 1978b), Orashi and Peterside (Angelici et al. 2000).

Notes: Based on molecular data, this cryptic species complex was recently resolved across the Guineo-Congolian forest range, but specimens from southwestern Nigeria remain unassessed (Hassanin et al. 2015). Therefore, pending the taxonomic resolution of specimens from southwestern Nigerian, the taxonomic status of our specimen remains unclear and awaits

Image 5. *Casinycteris campomaanensis* Hassanin, 2014, a new record for Nigeria.

Image 6. *Scotonycteris* cf. *zenkeri* Matschie, 1894.

molecular analysis. *Scotonycteris zenkeri* is suggested to occur in Okomu National Park (Anonymous, Okomu NP mammal list). This specimen confirms the presence of a *Scotonycteris* sp. in the park.

Rhinolophidae

***Rhinolophus* aff. *darlingi* Andersen, 1905**

Least Concern

New record: Ososo.

New material: Two individuals were collected at Ososo (F-N° 90, 175).

Previous localities: Kagoro (Hill et al. 1988), specimens reported for Chappal Waddi, Gangirwal as *R. simulator* by Hutterer et al. (1992) have been reidentified by Jakob Fahr (unpubl. data, January 2014).

Hipposideridae

***Hipposideros* cf. *ruber* (Noack, 1893)**

Least Concern

New records: Ososo.

New material: One individual was collected from Ososo (F-N° 89).

Previous localities: Umuahia (Cozens & Marchant 1952), Calabar, Ibadan, Kagoro, Kamuku Game Reserve, Naraguta Forest Reserve, Yankari Game Reserve (Happold 1987), Chappal Waddi, Gangirwal, (Hutterer et al. 1992).

Notes: Based on molecular analysis supported by echolocation data, Vallo et al. (2008) and Monadjem et al. (2013) demonstrated that *H.* cf. *ruber* contained at least eight lineages. As no specimens were examined from Nigeria by both of these studies, the taxonomic status of our specimen remains unclear. Similarly, the taxonomic status of other specimens reported from previous localities in Nigeria remain unclear. Based on echolocation data obtained from specimens collected recently in southeastern Nigeria (I. Tanshi unpubl. data), specimens from the country may belong to C1 and E1 lineages after Monadjem et al. (2013).

Emballonuridae

***Saccolaimus peli* (Temminck, 1853)**

Least Concern

New records: Okomu National Park

New material: One individual was collected from Okomu NP (F-N° 105).

Previous localities: Lagos (Rosevear 1953) as *Taphozous peli*, Oban (Happold 1987) as *Taphozous peli*, Orashi (Angelici et al. 2000).

Notes: This is a new record for Okomu National Park.

***Taphozous nudiventris* Cretzschmar, 1830**

Least Concern

New records: Ososo.

New material: One specimen was collected from

Table 2. Forearm length and body mass of 27 bat species captured during the survey. Values represent mean, range, standard deviation, and count.

Family	Species	Forearm (mm)	Body mass (g)
Pteropodidae	*Eidolon helvum*	118.43,96.2–131,8.7,28	242.96,135–380,55.1,28
	Epomophorus gambianus	86.9,1	148,1
	Epomops franqueti	87.08,77–96.4,4.7,22	101.05,68–143,22.3,22
	Hypsignathus monstrosus	112.87,106.1–122.2,8.4,3	148.33,102–182,41.5,3
	Myonycteris angolensis smithii	50.36,37.6–58,3.3,70	25.21,13–47,6.1,71
	Megaloglossus cf. *woermanni*	73.31,69.8–78.1,3.2,7	61.71,54–72,6.2,7
	Micropteropus pusillus	41.97,39.8–44.3,1.4,12	16.08,11–26,4.5,12
	Myonycteris leptodon	58.5,51.1–64.6,3.5,33	35.63,20–47,7.1,33
	Rousettus aegyptiacus	93.54,80.3–101.8,7.5,8	135.25,85–166,32.1,8
	Casinycteris campomaanensis	67.8,1	36,1
	Scotonycteris cf. *zenkeri*	51.58,48.8–55,2.4,5	24.6,19–35,6.4,5
Hipposideridae	*Hipposideros* cf. *ruber*	51.1,1	12,1
Rhinolophidae	*Rhinolophus* aff. *darlingi*	47.55,47.3–47.8,0.4,2	12.5,12–13,0.7,2
Megadermatidae	*Lavia frons*	54.2,1	22,1
Nycteridae	*Nycteris arge*	38.6,1	8,1
	Nycteris grandis	62.8,61.5–64.1,1.8,2	32.5,31–34,2.1,2
	Nycteris macrotis	49.9,1	15,1
Vespertilionidae	*Glauconycteris* spp.	37.2,1	6,1
	Mimetillus moloneyi	28.4,1	8.5,1
	Scotophilus dinganii	56.6,1	23,1
	Scotophilus leucogaster	52.9,52–53.8,1.3,2	19.5,18–21,2.1,2
	Scotophilus nigrita	89.2,1	79,1
Molossidae	*Chaerephon aloysiisabaudiae*	51.3,51.3–51.3,0,2	25,25–25,0,2
	Chaerephon pumilus	35.6,1	9,1
	Mops condylurus	48.5,45.9–51,1.3,31	23.03,18–35,4.5,31
Emballonuridae	*Saccolaimus peli*	88.4,1	90,1
	Taphozous nudiventris	71.3,1	44,1

Ososo (F-N° 94)

Previous localities: Gomlar, Kabwir (Rosevear 1965), Wase Rock (Dunger 1965).

Nycteridae

***Nycteris arge* Thomas, 1903**

Least Concern

New records: Okomu National Park.

New material: One individual was collected from Okomu NP (F-N° 96).

Previous localities: Akpada, Afon, Kudu (Happold 1987), Orashi (Angelici et al. 2000) Umuahia (Cozens & Marchant 1952), Akpaka Forest Reserve (Bergmans 1977), Calabar (Lameed & Ayodele 2008).

Notes: Unpublished records suggest that this species occurs in Oban (ACR 2017), Nikrowa Forest Reserve (GBIF 2018), Okomu Forest Reserve (GBIF 2018).

***Nycteris macrotis* Dobson 1876**

Least Concern

New records: Ososo (Image 7).

New records: One individual was collected from Ososo (F-N° 55).

Previous localities: Umuahia (Cozens & Marchant 1952), Nasarawa (Rosevear 1965), Akpaka Forest Reserve, Dada, Fanisau (Happold 1987), Shaguna (Bergmans 1977).

***Nycteris grandis* Peters, 1865**

Least Concern

New records : Okomu National Park (Image 8).

New material: Two individuals were collected from Okomu NP (F-N° 241, 243).

Previous localities: Calabar (Thomas 1880), Kagoro, Nikrowa, (Bergmans 1977; Happold 1987).

Image 7. *Nycteris macrotis* Dobson, 1876.

Image 8. *Nycteris grandis* Peters, 1865.

Notes: Nikrowa refers to a village near Okomu National Park. A section of the park is also referred to as Nikrowa by the park rangers. Thus, it is unclear whether the previous record for Nikrowa falls within Okomu NP in the absence of geographical coordinates for this record.

Megadermatidae

***Lavia frons* (Geoffroy, 1810)**

Least Concern

New record: Okomu National Park.

New material: One individual was collected from Okomu NP (F-N° 118).

Previous localities: Yola (Dollman 1908), Ilorin (Rosevear 1953), Pandam (Bergmans 1977), Dikwa, Kainji Lake National Park, Malamfatori, Shaguna (Happold 1987). Omo Forest Reserve is not listed here as a previous locality, because the only known report of the species from that forest represents an incorrect identification (I. Tanshi, pers. obs.) and reported on a bogus species list (Tanshi, 2019).

Vespertilionidae

***Glauconycteris beatrix* Thomas, 1901**

Least Concern

New records: Okomu National Park.

New material: One specimen was collected from Okomu NP (F-N° 240).

Previous localities: The specimen is suspected to be *G. beatrix*, which is listed for Okomu Forest Reserve (Happold 1987). Rosevear (1953) includes *Chalinolobus beatrix*, but no localities are listed.

***Mimetillus moloneyi* (Thomas, 1891)**

Least Concern

New record: Emu (Image 9).

New material: One individual was collected from Emu (F-N° 122).

Previous localities: Lagos as *Vesperugo moloneyi* (Thomas, 1891), as *Eptesicus moloneyi* reported for Lagos (Rosevear 1953; Happold 1987).

***Scotophilus leucogaster* (Cretzschmar, 1830)**

Least Concern

New record: Emu.

New materials: Two individuals were collected from Emu (F-N° 1, 16)

Previously localities: Fika (Happold 1987), Pandam Game Reserve (Bergmans 1977), Maiduguri (Harrison & Brownlow 1978), Bichi, Ibadan, Illorin, Kaduna, Kainji Lake National Park, Kamuku Game Reserve, Mokwa, Panyam, Samaru, Yankari Game Reserve, Zaria (Happold 1987).

Image 9. *Mimetillus moloneyi* (Thomas, 1891).

Image 10. *Chaerephon aloysiisabaudiae* (Festa, 1907), a new record for Nigeria.

***Scotophilus dinganii* (Smith, 1833)**

Least Concern

New record: Ososo.

New material: One individual was collected from Ososo (F-N° 176).

Previous localities: Zaria (Happold 1987), Agege, Darazo, Ibadan, Ife, Jos, Pandam Game Reserve (Bergmans 1977), Kainji Lake National Park, Kamuku Game Reserve, Lagos, Panyam and Shagunu (Happold 1987).

Molossidae

***Chaerephon aloysiisabaudiae* (Festa, 1907)**

Least Concern

New record: Okomu National Park (Image 10).

New material: Two individuals were collected from Okomu NP (F-N° 97, 101).

Previous localities: The species is not previously known from Nigeria.

Notes: This is the first record for the country. Both specimens were caught in canopy nets over a dry seasonal lake (often flooded in the rainy season). One was a lactating female. It is unsurprising that the species occurs in Nigeria, as it is previously known from countries to the east (Cameroon) and west (Ghana). Other countries include Côte d'Ivoire, Gabon, Central African Republic, Democratic Republic of Congo, Sudan, and Uganda (Fahr 2013).

***Chaerephon pumilus* (Cetzschmar, 1830)**

Least Concern

New record: Emu.

New material: One individual was collected from Emu.

Previous localities: Yola as *Chaerephon websteri* (Dollman 1908) *Tadarida websteri* (Rosevear 1953), Maiduguri (Harrison 1958), Pandam, Zawan as *T. gambiana* (Bergmans 1977), Ogbunike cave (Gugnani et al. 1994), Nguru as *T. gambiana* (Lekunze et al. 2001) Calabar as *T. pumila* (Lameed & Ayodele 2008)

Notes: *T. gambiana* was treated as a junior synonym of *Mops pumilus* by Hayman & Hill (1971).

***Mops condylurus* (Smith, 1833)**

Least Concern

New records: Emu and Okomu National Park.

New material: Four individuals were collected from Emu (F-N° 9, 23 and 29) and Okomu NP (F-N° 100)

Previous localities: Umuahia (Cozens & Marchant 1952), Lagos (Rosevear 1953) as *Tadarida angolensis*, Aguleri, Ajaokuta Forest Reserve, Asaba, Enugu, Igbetti, Lokoja, Oyo, Shagunu, Yankari Game Reserve, Zungeru (Happold 1987), Okene, Ajaokuta Forest Reserve, Lokoja, Shaguna (Bergmans 1977), Calabar (Lameed & Ayodele 2008).

Notes: This is a new record for Okomu National Park.

DISCUSSION AND CONCLUSION

This study recorded 239 individuals of 27 bat species belonging to eight families. Of the three sampled localities, only ONP had been previously reported in the literature (Happold 1987), making these first locality records for Emu and Ososo. In addition, at ONP nine species were first time records. Of these, five species (*Chaerephon aloysiisabaudiae, Hypsignathus monstrosus, Lavia frons*, *Mops condylurus*, and *Saccolaimus peli*), all of which are known edge bats or known to forage in the forest canopy, were collected exclusively in canopy net installations. Thus, a survey based on only ground mist nets will likely miss these species, demonstrating the value of complementary capture techniques. Furthermore, the new park records are important because ONP is the last remaining federally protected area holding mature secondary forest west of the river Niger in southern Nigeria. Unlike state-protected forest and game reserves, federal protection for national parks allows paramilitary trained ranger patrols that minimize poaching and encroachment. Recognized as part of the Key Biodiversity Areas (KBA) network, this park is home to some endemic species like the white throated monkey *Cercopithecus erythrogaster* and the site of recent records (across taxa) new to the country and science. It is therefore not surprising that the new country records reported from this survey were both collected at ONP.

Our capture results are similar to findings of other comparable surveys reported elsewhere in West Africa (Decher et al. 2015; Fahr & Ebigbo 2003). Decher et al. (2015) reported 312 individuals of 26 species belonging to eight families, whereas Fahr & Ebigbo (2003) reported 276 bats of 21 species belonging to six families. On the other hand, surveys with fewer captures report fewer bat species (Angelici et al. 2000; Decher & Fahr 2007; Monadjem, Fahr & Allee 2007; Denys et al. 2013). Surveys with higher sampling effort, however, report greater number of species (Fahr & Kalko 2011; Monadjem et al. 2016). Both studies in West Africa that reported higher species richness than the current study employed complementary and contemporary capture techniques (harp traps, canopy and ground mist nets and roost search) over a longer time span. Given the differential detectability of different bat ensembles, this disparity in our captures versus previous reports demonstrates the value of employing diverse capture techniques in bat survey, supporting previous recommendations (Meyer et al. 2011).

In conclusion, our survey improves knowledge of species distribution in this poorly studied part of Africa, by filling geographical gaps. Furthermore, we report new records for a Key Biodiversity Area in southern Nigeria and our capture of two new country records suggests the potential for more species discoveries in this poorly studied but ecologically diverse region of Africa.

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