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The continuing lack of ornithological research capacity in almost all of West Africa

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West Africa has high bird diversity and is a crucial non-breeding area for over one-third of European breeding species, yet local capacity for ornithological research and so targeted bird conservation is perceived to be limited. I reviewed all the published literature on Web of Science classified as “ornithology” with accompanying key word of a country’s name, over the last three decades, from the 16 countries within West Africa and compared them to 16 Western European countries. Inclusion of the country’s name as a search term identified any papers produced by local authors, and so should provide an index of local ornithological capacity. Overall only 129 papers were produced from 1987 – 2016 with West African authors (range 0 Burkina Faso to 45 Nigeria), significantly fewer compared to 12,380 with European authors (range 71 Greece to 2,745 England). The number of papers produced increased significantly at similar rates over the three decade period in both continents. The number of papers produced by local authors in West Africa and Europe approximately doubled each decade, but variation between countries was large, particularly in West Africa. The results are broadly the same when paper output is adjusted for the population of each country. Of the three West African countries that showed a consistent increase in numbers of locally authored ornithological papers only Nigeria showed a highly significant increase and this increase was down to a single ornithological research institute established there in 2002. The results confirm that there is little local ornithological capacity in West Africa and this is not changing except in Nigeria, where even a single new research institute can make a significant difference because of the very low baseline.

West Africa has high bird diversity (Borrow and Demey, 2001) and is a crucial non-breeding area for over one-third of European breeding species (Moreau, 1972, Grimmett, 1987, Jones, 1995). Despite this importance for avian diversity, ornithological research is relatively limited. This applies within both pure ornithology (Brito and Oprea, 2009), and wider related areas such as biodiversity research (Liu et al., 2011), environmental monitoring (Yevide et al., 2016) and conservation (Fazey et al., 2005, Wilson et al., 2016). Research in all of these subject areas within developing countries then leads to effective conservation: from the presence of research programs and researchers actually acting directly promoting local area conservation (Laurance, 2013), through to local monitoring and ringing schemes increasing local awareness of conservation and sustainability issues (e.g. Latta and Faaborg, 2009, Sekercioglu, 2012) through to more traditional research-led management of protected areas (e.g. Caro et al., 2013).

The relatively limited amount of research (and so effective conservation) carried out in developing tropical regions such as West Africa is largely through external institutions, mostly based in Europe and the United States of America (Fazey et al., 2005). One of the reasons for this is the limited local within-country capacity for scientific research within the tropics, whether in terms of resources and infrastructure (e.g. Kabuye, 2001), lack of well-trained people (e.g. Latta, 2012, Caro and Davenport, 2016) and effective training institutions (Bawa et al., 2008). Capacity for research with tropical regions is clearly perceived to be lacking and a problem to be solved, but although there has been an increase in local research output in recent years, this has been relatively small (Griffiths and Dos Santos, 2012) and indeed the proportion of research originating from developing countries has actually decreased (Mammides et al., 2016). Fundamental to this may be the lack of appropriate post-graduate training institutions within the region (Fazey et al., 2005, Bawa et al., 2008), for example, there is only one dedicated ornithological research institute within West Africa, the AP Leventis Ornithological Research Institute (APLORI), at the University of Jos Nigeria, set up in 2002 (Vickery and Jones, 2002).

Here I determine how much ornithological research capacity there is within West Africa and how this might have changed over the last 30 years. I survey how much published literature in the Web of Science database is classified as “ornithology” with accompanying key word of a country’s name, over the last three decades, from the 16 major countries within the West of Africa and compare them to 16 major countries in the West of Europe. Inclusion of the country’s name as a search term will identify

any papers produced, at least in part, by local authors, and so should provide an index of local ornithological capacity. Three main perceptions arising from the conservation literature were tested, that:

1. The number of ornithological papers published with at least one of its authors being based in a West African country will be substantially fewer than the number of papers published where at least one of its authors are based in a European country.
2. There will be a greater rate of increase in the number of papers with a West African based author over the last thirty years compared to papers with European authors, reflecting an increase in local capacity from a low baseline in West Africa compared to a relatively static, already developed capacity in Europe, but this increase is likely to be small.
3. Local institutions can make a significant difference to local research capacity. There should be a change in ornithological research output within Nigeria after the establishment of the AP Leventis Ornithological Research Institute, within the University of Jos, Nigeria.

Methods

Papers were searched for on the Web of Science Core collection using the subject category of "Ornithology", the name of one of 16 West African countries (Liberia, Sierra Leone, Gambia, Burkina Faso, Mali, Niger, Ghana, Senegal, Cameroon, Nigeria, Guinea, Mauritania, Benin, Togo, Guinea-Bissau and Côte d'Ivoire) or one of 16 Western European countries (Greece, Netherlands, Sweden, Poland, Italy, Germany, France, England (because this is listed as a country rather than the UK on Web of Science), Spain, Portugal, Switzerland, Austria, Hungary, Norway, Denmark and Belgium). Choice of country in West Africa was inclusive of all mainland countries, but including Mauritania and Cameroon because these are perceived to be ornithologically active countries and are adjacent to the region. Choice of the 16 countries in Europe was entirely arbitrary, but with the intention to approximately match population size and to cover most of the region of Western Europe. Searches were carried out covering the last 30 years split into three decades (1987 – 1996, 1997 – 2006, 2007 – 2016). For example, "CU = Mauritania and WC=ORNITHOLOGY and PY= (2007-2016)": note that the CU term searches only the address field for country. The assumption was that if a paper was listed in the search results, there would be at least one author on the paper reflecting local ornithological capacity for that country: in all of 25 randomly chosen West African papers checked in

detail this was true. The searches resulted in 12,130 papers being listed, split across 32 countries (Appendix Table 1), in two continents and three decades (e.g. a data file with 96 rows and 4 columns). A further column was added for each of the 32 countries of their population size in 2017 from World Population Meters (http://www.worldometers.info/world-population/ accessed July 2017).

It is important to note that biases and pseudoreplication were present in the sampling protocol: these were tested by individually scrutinising the number of authors and their country affiliations from the first two papers listed for every country for the most recent decade. Where no papers were produced as in some West African countries, I randomly sampled from other West African countries until 30 papers were sampled (13 countries provides samples). If a paper had already been sampled then I moved onto the next paper so that 30 different papers were sampled in total. I then repeated the sampling across European countries for a matched sample of 30 papers.

First, if there were several authors from a country listed for a paper, then the paper only counts once: therefore a paper with 5 authors from a country counts the same as one with only one author, underestimating the capacity involved in the first paper. There were 2.1 (+/- 0.48 SE) West African authors per paper for West African papers and 4.8 (+/- 0.68 SE) European authors per paper for the European papers; this difference was significant ($t_{1,58} = 4.0$, $P < 0.001$). Therefore the analyses in this paper underestimate the number of European authors relative to West African authors.

Second, there is a potential bias if papers in Europe have more authors spread across countries compared to West Africa. For example, a European paper with 5 authors across 5 countries would add 5 to the total and a Nigerian paper with 5 Nigerian authors would only add a total of 1. There was, however, no significant difference ($t_{1,58} = 0.1$, $P = 0.93$) in the number of different countries in a region that feature in the address list per paper: 1.5 (+/- 0.25 SE) countries on average with a West African author listed within the West African region, and 1.5 (+/- 0.35 SE) countries on average with a European author listed within the European region. Therefore although the count underestimates the number of authors (for example, the same ornithological paper could appear in each of 5 countries total if it had authors from 5 different countries), the degree to which this double counting of papers happens is the same in the two regions.

Third, some authors have several affiliations including authors that may have affiliations across countries and even in both regions, further increasing the amount of double counting of papers. There

were 2 papers with affiliations across countries within West Africa, 3 papers with affiliations across countries within Europe and 12 papers with affiliations across the two regions. This means that about 7% (2/30) of the total of West African papers were double counted, about 10% (3/30) of the total of European papers were double counted and 40% (12/30) of the West African region papers would also have been attributed to various countries in Europe. Therefore any bias due to multiple affiliations affects both continents broadly to the same degree and approximately 40% of the total number of papers identified with West African authors also contribute to the European total.

Analyses were carried out using R 3.2.3 (R Development Core Team 2014). The difference in the total number of papers published in the two regions and whether this has changed with time was tested using the model:

Log(no. of papers +1) ~ continent (factor, Africa, Europe) + decade (continuous variable, 1-3)

Models were repeated adjusting the number of papers published by the population size of the country at the end of the survey period.

Log[(number of papers + 1)/(population/10,000,000)] ~ continent (factor, Africa, Europe) + decade (continuous variable, 1-3)

The number of papers in all models was transformed with a log transformation to obtain reasonably normally distributed residuals from final models, and models that overall that did not violate GLM assumptions when examined visually as diagnostic plots (Crawley 2007). All models which used decade as a 3-level factor had AIC scores that were much greater than 2 AIC points compared to the same models that included decade as a continuous variable, and so decade was only considered as a continuous variable in all models detailed here on the basis of parsimony. The interaction between continent and decade was included in both models to test whether rates of change with decade differed between the two continents. Mean values from the models are presented as the mean predicted value followed by the 95% confidence interval in all cases.

Results

Overall only 129 papers were produced from 1987 – 2016 with West African authors (range 0 Burkina Faso to 45 Nigeria), significantly fewer compared to 12,380 with European authors (range 71 Greece to 2,745 England): Figure 1. Comparing just the most recent decade (2007 – 2016) there were 2.0

(0.8 to 4.1 95% CI) papers produced per country in West Africa compared to 238.1 (142.2 to 398.1 95% CI) in Europe ($t_{1,30}$ = 12.1, P < 0.001, adjusted R^2 = 0.82). The change in number of papers produced over the decades was significant, there were significantly many more papers produced in Europe and the rate of increase in both continents over the period was the same (Figure 2, Table 1).

The results are broadly the same when paper output was adjusted for the population of each country. Overall only 4.4 papers per 10 million population were produced from 1987 – 2016 with West African authors (range 0 Burkina Faso to 16.4 Mauritania), significantly fewer compared to 368.3 with European authors (range 65.2 Greece to 1009.2 Norway): Figure 2. Comparing just the most recent decade (2007 – 2016) there were only on average 2.2 (0.8 to 4.5 95% CI) papers per 10 million population produced per country in West Africa compared to 238.0 (137.5 to 411.5 95% CI) in Europe ($t_{1,30}$ = 11.2, P < 0.001, adjusted R^2 = 0.80). The change in number of papers produced per 10 million population over the decades was significant (0.5 $\pm$ 0.1, $t_{1,93}$ = 3.9, P < 0.001) and there were significantly more papers produced in Europe (4.3 $\pm$ 0.2, $t_{1,93}$ = 20.1, P < 0.001) and the rate of increase in both continents over the period was the same (interaction between decade and continent (0.1 $\pm$ 0.3, $t_{1,92}$ = 0.5, P = 0.61): model format as Table 1 but predicting number of papers adjusted for population size, overall R^2 for the model without interaction = 0.81: Figure 2.

Of the three West African countries that showed a consistent increase in numbers of locally authored ornithological papers (Ghana total N = 17 papers, χ^2_2 = 3.3, P = 0.19; Senegal total N = 18 papers, χ^2_2 = 5.3, P = 0.07) only Nigeria (total N = 61 papers, χ^2_2 = 48.4, P < 0.0001) showed a highly significant increase (tests were whether the frequency had changed across the decades, and in Nigeria's case this was a clear increase). This increase was almost entirely due to a single ornithological research institute (the AP Leventis Ornithological Research Institute at the University of Jos) established there in 2002 (Figure 3).

Discussion

The results of this publication review confirm the three general perceptions of low local research capacity in West Africa: there is little local ornithological capacity in West Africa and this is not changing except perhaps in Nigeria, where even a single new research institute can make a significant difference because of the very low baseline. But perhaps most importantly the results show just how low the baseline is with some West African countries having no ornithological expertise at the

level to publish in international, peer-reviewed scientific journals (e.g. Burkina Faso and Côte d'Ivoire, both with reasonably large populations producing no local ornithological papers over the last 30 years – see Appendix Table 1). Although the analysis has biases and effects of double counts, they make very little difference to the main conclusion because of the magnitude and direction of the difference between European and West African ornithological publication rates. For example, although 40% of West African papers also feature as European papers, if 52 papers (40% of the total 129 West African papers identified here) are removed from the European total, it remains as a very large number (12,328) relative to the West African total.

There are limitations in this review because not all publications will be identified and the Web of Science is not comprehensive in its inclusion of journals, particularly low impact and non-established "grey literature" sources. Therefore, numbers of papers here represent an index rather than the absolute number of publications, but this applies to all countries considered here. But there may also be inclusion biases apply that favour European countries that are more able to publish successfully in traditional journals (Fazey et al., 2005, Meijaard et al., 2015). These would lead to an underestimate of the capacity for research and conservation within West African countries, although it seems unlikely that any underestimate would cause the two orders of magnitude difference identified in this study. It is also worth noting that research capacity does not necessarily equate to published papers: important local expertise outside scientific publishing may exist (e.g. Elbroch et al., 2011).

Despite the potential shortcomings of this study, there is clearly a fundamental need for increased capacity building for ornithology in West Africa. One major issue is the lack of any consistent post-doctoral training in most African universities: there is also a need for continued mentoring and training of West African academics beyond PhD level. There is also an issue that many existing lecturers are over-burdened with teaching from post-doc level, and lack resources or incentive for research in terms of promotion. Similarly those ornithologists that end up working for conservation NGOs can rarely prioritise publication of reports in the scientific literature. It is important for scientists and conservation managers within developing countries not just to harvest information or talented people from developing countries, but to allow people to develop within their country within an environment that provides a long-term career in ornithological and conservation research.

Ornithological research capacity is a function of education and training, and a culture that values the monitoring and conservation management of ecosystem services such as biodiversity. There is a

continuum of education and training from citizen science initiatives to higher degrees such as Masters in conservation biology or PhDs in ornithology that can be implemented effectively in local situations (e.g. Trewhella et al., 2005), and most have demonstrably positive outcomes for conservation (Sekercioglu, 2012, Caro et al., 2013), although measuring success itself is problematic (Chapman et al., 2016). Research collaborations need to skewed in favour of positive training outcomes for West African scientists rather than those from developed, European countries where capacity may have already been reached (Habel et al., 2014). Effective research institutions are needed (Bawa et al., 2008) and where they occur, such as with APLORI, then relative increases in capacity may be substantial. Research capacity in ornithology and similar biological sciences can produce positive conservation outcomes in Africa, albeit alongside many other important factors (Tranquilli et al., 2014) but it is essential that scientists from developing countries acknowledge the need for and carry out training and capacity building as a fundamental part of their research if this is to happen (Strigl, 2003). Clearly, despite widespread acknowledgement of the problem, there are few scientists that actually do this.

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Table 1: Results of a GLM of number of papers published with Continent (Africa set to the intercept) and Decade (1987 – 1996, 1997 – 2006, 2007 – 2016, coded as a continuous variable 1-3 respectively). Number of papers + 1 was log transformed to give a normal distribution of residuals. Overall model adjusted R^2 = 0.84, $F_{2, 93}$ = 259.7, P < 0.0001. The interaction of Continent * Decade was removed from the model (0.15 $\pm$ 0.23, t = 0.6, p = 0.53; adjusted R^2 = 0.84, ΔAIC = - 1.6 on removal of the interaction).

	Est.	SE	t value	P value
(Intercept)	-0.28	0.27	-1.0	0.31
Decade	0.49	0.11	4.2	<0.0001
Continent (Europe)	4.3	0.19	22.4	<0.0001

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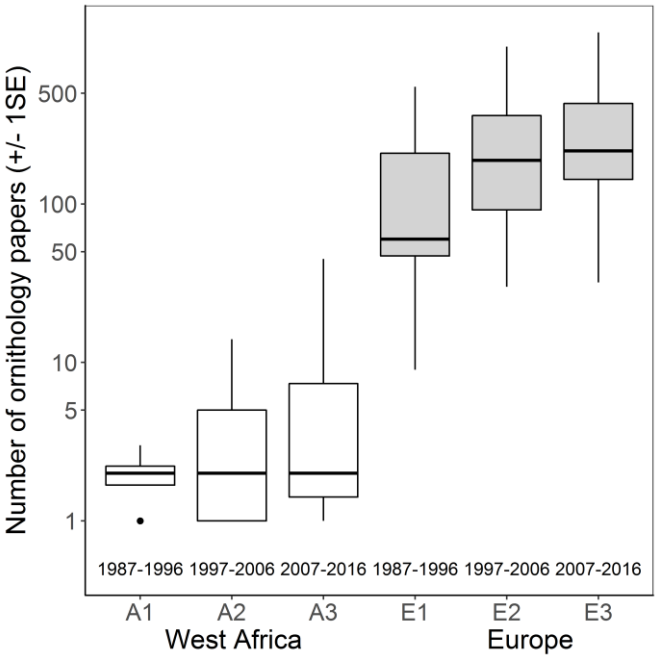
Figure legends

Figure 1: Boxplot of the number of ornithological papers (± 1 SE) produced by West African and European countries over three recent decades. Note y axis is on a logarithmic scale.

Figure 2: The number of ornithological papers produced by individual West African and European countries over three recent decades (left panel) and the same data plotted on a logarithmic y scale (middle panel) to show detail for West Africa. The actual number of papers produced by West African and European countries per 10 million population of each country in 2017 over three recent decades (right panel). Top lines and circles are European countries and bottom lines and squares are West African countries in all panels.

Figure 3: The number of ornithological papers produced by Nigerian authors based in Nigeria over three recent decades. The total number of papers is plotted as a solid line, the number produced by a single research institute, APLORI, founded in 2002 is plotted as a dashed line and the remainder of the total as a dotted line.

Figure 1:


Number of ornithology papers (+/- 1SE)
500
100
50
10
5
1
1987-1996 1997-2006 2007-2016 1987-1996 1997-2006 2007-2016
A1
A2
A3
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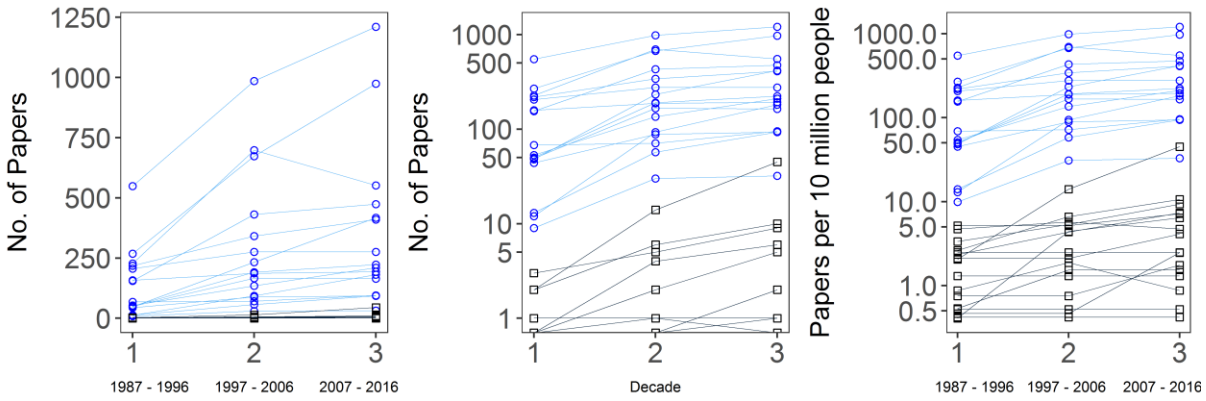
West Africa
Europe

Figure 2:


No. of Papers
1250
1000
750
500
250
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1987 - 1996
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No. of Papers
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Decade
Papers per 10 million people
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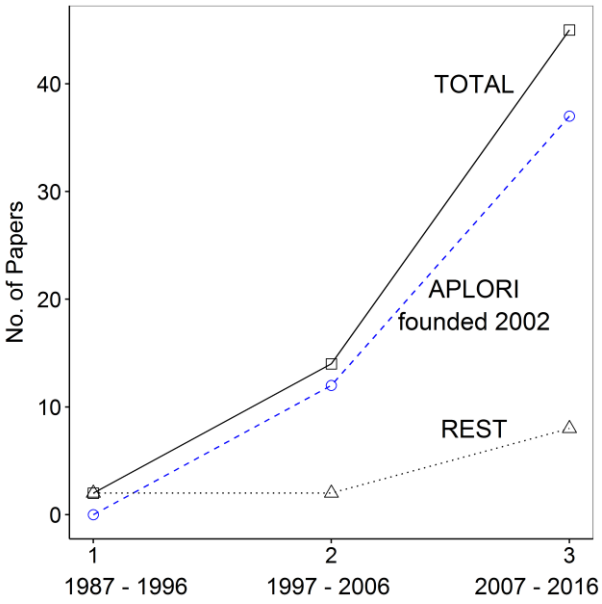
Figure 3:


No. of Papers
40
30
20
10
0
TOTAL
APLORI
founded 2002
REST
1
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Appendix Table 1: Number of ornithological papers produced with at least one local author in West African and European countries over the last 30 years.

Population millions	Country	Period	1 1987 - 1996	2 1997 - 2006	3 2007 - 2016	Total 1987 - 2016
4.7	Liberia		0	0	2	2
6.7	Sierra Leone		1	1	1	3
2.1	Gambia		0	1	0	1
19.2	Burkina Faso		0	0	0	0
18.7	Mali		0	1	1	2
21.6	Niger		0	0	2	2
28.7	Ghana		3	5	9	17
16.1	Senegal		2	6	10	18
24.5	Cameroon		0	4	6	10
191.8	Nigeria		2	14	45	61
13.3	Guinea		3	0	0	3
4.3	Mauritania		0	2	5	7
11.5	Benin		0	1	0	1
7.7	Togo		0	0	0	0
1.9	Guinea-Bissau		0	0	2	2
23.8	Côte d'Ivoire		0	0	0	0
10.9	Greece		9	30	32	71
17.0	Netherlands		218	341	410	969
9.9	Sweden		206	276	276	758
38.6	Poland		48	233	417	698
59.8	Italy		50	191	223	464
80.6	Germany		227	698	552	1477
64.9	France		155	431	474	1060
65.5	England		549	985	1211	2745
46.1	Spain		268	673	974	1915
10.3	Portugal		12	93	181	286
8.5	Switzerland		53	135	210	398
8.6	Austria		44	88	93	225
9.8	Hungary		13	57	93	163
5.3	Norway		158	187	193	538
11.4	Belgium		68	71	95	234
5.7	Denmark		49	166	164	379
TOTALS	W Africa		11	35	83	129
	Europe		2127	4655	5598	12380
	% W African		0.5	0.7	1.4	1.2