

# PENGUINS OF ARGENTINA: A BIBLIOMETRIC ANALYSIS

JAVIER MENÉNDEZ-BLÁZQUEZ

Departamento Ecología Evolutiva, Museo Nacional de Ciencias Naturales, CSIC, C/José Gutiérrez Abascal,  
2, 28006 Madrid, Spain.  
jmenendezblazquez@gmail.com

**ABSTRACT.-** This study analyzes the scientific literature published on penguins in Argentina between 1985 and 2019. It examines the characteristics and the temporal variation in the number of publications, the total number of authors, the percentage of participation of Argentine researchers, the species and region of study, as well as the research topics they address. The results show a tendency towards an increase in papers and studies of these birds, the total number of authors, and the participation of researchers belonging to Argentine research centers during the period analyzed. The most studied penguin species was the Magellanic Penguin (*Spheniscus magellanicus*), followed by the Southern Rockhopper Penguin (*Eudyptes chrysocome*) and the Gentoo Penguin (*Pygoscelis papua*). The most addressed research topics were foraging and diet, followed by reproduction and reproductive success, conservation and wildlife management, population dynamics and physiology and histology, which were carried out mainly in the Patagonian region and in the Malvinas Islands. The results help to understand the past, present and future state of scientific literature, which will strengthen decision-making on future research on penguins.

**KEYWORDS:** *Authorship, Eudyptes chrysocome, Islas Malvinas, Patagonia, Pygoscelis papua, Spheniscus magellanicus, research topics, Tierra del Fuego.*

**RESUMEN.-** PINGÜINOS DE ARGENTINA: UN ANÁLISIS BIBLIOMÉTRICO. En este trabajo se analiza la literatura científica publicada sobre pingüinos en Argentina entre 1985 y 2019. Se examinaron las características y la variación temporal en el número de publicaciones, el número de autores totales, el porcentaje de participación de investigadores argentinos, las especies y región de estudio, así como la temática de investigación que abordan. Los resultados muestran una tendencia al incremento en la producción científica sobre este grupo de aves, el número de autores y la participación de investigadores pertenecientes a centros de investigación argentinos en el periodo de estudio. Las especies más estudiadas fueron el Pingüino de Magallanes (*Spheniscus magellanicus*), seguido del Pingüino Penacho Amarillo (*Eudyptes chrysocome*) y el Pingüino de Vincha (*Pygoscelis papua*). Los temas de investigación más abordados fueron alimentación y dieta, reproducción y éxito reproductivo, conservación y manejo de fauna, dinámica poblacional y fisiología e histología, los cuales se llevaron a cabo principalmente en la región patagónica y en el archipiélago de las Malvinas. Los resultados permiten comprender el estado pasado, presente y futuro de la literatura científica que fortalecerá la toma de decisiones sobre futuras investigaciones acerca de los pingüinos.

**PALABRAS CLAVE:** *Autoría, Eudyptes chrysocome, Islas Malvinas, Patagonia, Pygoscelis papua, Spheniscus magellanicus, Temas de investigación, Tierra del Fuego.*

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Bibliometry (Pritchard 1969) is the discipline that provides the methods for studying and analyzing information and the evolution of the scientific literature over time (Hood and Wilson 2001, Powell et al. 2010). There are even academic journals exclusively dedicated to the quantitative analysis of scientific research (Mingers and Leydesdorff 2015) such as *Scientometrics* and the *Journal of Informetrics*. This highlights the interest of many scientific journals to know the trajectory of their publications over the years in order to review their visibility, contents, authorship pattern, biases in their editorial process and even make future predictions. For this reason, bibliometric analysis has gained greater importance in older scientific disciplines that enjoy greater historical perspective and interest in their study - such as ornithology.

Despite the possibilities offered by new digital technologies (e.g., access to bibliographic databases) to be able to perform bibliometric analysis (Gordo 2014), there are still not many such studies on ornithological journals nowadays (Carrascal and Díaz 1998, Bautista and Pantoja 2000, Bibby 2003, Thomas et al. 2003, Barbosa and Moreno 2004, Yarwood et al. 2014, Vellaichamy and Jeyshankar 2020) or other studies of birds, like PhD theses (Barbosa 2000), which offer great information on the evolution of this particular scientific discipline. In South America, the number is even lower (Lazo and Silva 1993, Portflitt-Toro 2017) and only one bibliometric study has been carried out in Argentina (López de Casenave 2010). Despite the enormous number of publications on birds, the scarcity of this kind of analysis is surprising and, as

Portflitt-Toro (2017) points out, it may mean that the importance this type of analysis represents for the discipline has not been yet acknowledged or it may indicate the lack of interest in, or ignorance of, bibliometric analysis.

The bibliometric analysis carried out in ornithology (Lazo and Silva 1993, Carrascal and Díaz 1998, Barbosa 2000, Bautista and Pantoja 2000, Bibby 2003, Thomas et al. 2003, Barbosa and Moreno 2004, López de Casenave 2010, Gordo 2014, Yarwood et al. 2014, Portflitt-Toro 2017, Vellaichamy and Jeyshankar 2020) have not focused on specific taxonomic groups. However, to rectify that would mean taking a new approach from the current state of knowledge and its evolution at different temporal and spatial scales, one very different from that provided by traditional bibliographic reviews (Grant and Booth 2009). Indeed, this is especially necessary for taxonomic groups that have long been objects of study and have a considerable history of research on them like the Spheniscidae family. As seabirds, penguins are a key component of the maritime environment. They can be used as sentinels to monitor and evaluate the rate and nature of change of their austral marine ecosystems (Boersma 2008), such as the Argentine coast including Malvinas Islands, which are important nesting and life-cycle locations for a large number of species from the Spheniscidae family (Bingham 1998a, 1998b, Schiavini et al. 2005).

In spite of the great importance of these birds, a bibliometric study focusing on the Spheniscidae family has not been undertaken on a global or regional scale so far. Here, the first bibliometric analysis of the scientific literature published on penguins in Argentina in the last thirty-five years was carried out. The aim is to get a clear and simplified vision of what the temporal variations, productivity, and preferences have been in terms of research topics, species, number of publications, areas sampled, as well as the evolution of authorship and participation of Argentine researchers in the study of these birds. Evaluating the production and scientific literature on penguins is essential to understand the past and the current state of scientific research on these important birds for Argentina. This will allow a more careful choice on research topics, study areas and species to approach and to devote the efforts of future lines of research, especially important for young researchers (Bautista and Pantoja 2000). This review transcends the mere historical vision of literary information and its evolution and constitutes a good reference on the de-

velopment and general interests pursued in general research on penguins.

## METHODS

A bibliometric analysis was carried out on the scientific articles and publications about penguins made in Argentina over the last 35 years (1985 – 2019). Articles and publications were searched in the main global and regional coverage databases: Web of Science (all databases), Scopus, Plos One and Scientific Electronic Library Online (SciELO) as a main regional database on Ibero-American countries. The flow of information through the different phases of a systematic review collected in the PRISMA criterion proposed by Moher et al. (2009) was applied to the selection process for publication identification, screening, suitability, and the final inclusion in the bibliometric analysis. During the bibliographic search, key words and the following two search formulas required by the search engine were used in each database: “Penguin\*” AND “Argentina” and “Penguin\*” AND “Falklands”. The same words in Spanish were used in SciELO search formulas: “Pingüino\*” AND “Argentina” and “Pingüino\*” AND “Malvinas”. All the publications found were screened and their suitability for analysis was verified before becoming valid publications. Those publications that include penguin species as an object of study or penguins among other study species and that were carried out totally or partially within the Argentine territory were considered valid. Due to the low number found in the search, a sample-size calculator was not used to determine a representative subsample with a high level of confidence as in modern reviews (Roulier et al. 2020). Those scientific articles and conference presentations that were not accessible had been discarded. Repeated publications that appear in more than one database were counted once. The results of bibliographic search allow exploring the potential search-success (numbers of valid publications/numbers of total publications, shown as percentage) of the search engine of each database.

For each publication, available information was obtained on the following parameters: year of publication, number of authors, study area, penguin species, research topic, participation of Argentine authors (belonging to universities or research centers of Argentina) in the publications and whether they represented a majority among the authors (> 50% of Argentine authors). The participation of Argentine

authors was used to evaluate the temporal evolution in the participation (total number of publications with Argentine research/total number of publications) and activity of national researchers (number of publications with at least one Argentine author and number of publications with majority of Argentine researchers).

Since the penguins belong to the Mar Argentino eco-region (Litoral or Coastal Sub-Region), it is not possible to delimit Argentine territory in different regions based on eco-region criterion. For that reason, the coast of the Argentine Sea was divided into four regions to classify where each study was carried out: "Pampa", "Patagonia" "Tierra del Fuego" and "Islas Malvinas". These regions were delimited by the coast of the Argentine provinces: "Pampa" and "Patagonia" regions include the coast of Buenos Aires province and Rio Negro, Chubut, and Santa Cruz provinces respectively. "Tierra del Fuego" includes the entire Argentine territory south of the province of Santa Cruz (except part of the Atlantic Islands and Antarctica). "Islas Malvinas" corresponds to the territory included in this archipelago. I categorized another region, "Captivity", for the studies carried out in zoological or wildlife recovery centers of Argentina.

The species of study were grouped into the five penguin species that nest in Argentina study area (Bingham 1998a, Schiavini et al. 2005, BirdLife International 2020): Magellanic Penguin (*Spheniscus magellanicus*), Southern Rockhopper penguin (*Eudyptes chrysocome*), Gentoo penguin (*Pygoscelis papua*), King penguin (*Aptenodytes patagonicus*) and Macaroni penguin (*Eudyptes chrysolophus*). The Macaroni penguin species was left out of the statistical analyzes due to the low number of publications in which it was included. The fossil penguin species that appeared in paleontology studies were not counted, unless they referred to any of the aforementioned five species. The research topics were delimited following the topics defined by Bautista and Pantoja (2000) and used by Barbosa (2000). As a result, 16 research-topic categories were used: "Behaviour", "Biochemistry", "Breeding and reproductive successes", "Check-lists and Atlas", "Conservation and wildlife management", "Predation", "Evolution and systematic", "Foraging and diet", "Genetics", "Habitat selection", "Morphology and biometric", "Paleontology and zooarcheology", "Parasites and diseases", "Physiology and histology", "Pollution" and "Population dynamics". The information collected in the "Materials and Methods" and "Results" sections of each publication was used to

classify it in the different research-topic categories. All publications were revised by the same person to avoid biases or mistakes in its category classifications. Normality was evaluated with the Kolmogorov-Smirnov test. Based on this criterion, different correlation statistics were applied (Pearson and Spearman correlation as a parametric and non-parametric analysis respectively) which allow to evaluate the temporal trend of the variables described above correlating each of them with the years studied. Also, in the case of average numbers of authors per publication and year, a simple linear regression was applied to analyze its variation with the passing of time. The accepted level of significance was  $P < 0.05$  for the statistics analysis. The results are exposed as a mean  $\pm$  SE. As the same study can cover more than one species and geographical area in more than one research topic, the sum of the values of these variables is greater than the number of total publications considered in bibliometric analysis.

## RESULTS

A total of 933 publications were found as a result of the bibliographic search in all different databases. After applying the PRISMA criteria, 533 valid publications were obtained, which represents 57.13% of the total publications found. There are differences in the number of publications found in each database and the valid number of them. Web of Science had the highest number of valid results provided (291 publications) but was surpassed in search-success percentage by Scopus (73.80%). The less appropriate publications on penguins were found in SciELO (only eight valid publications) and the lowest success percentage was found in Plos One (7.87%) (Table 1). A total of 189 valid publications were discarded because they appear in more than one database.

As a result, 344 scientific publications have been published over the last 35 years (1985 – 2019) about penguins in Argentina. This supposes a rate of  $10.29 \pm 1.05$  publications per year, with a maximum of 21 in 2012 and a minimum of 2 in 1985, 1986, 1992, and 1993. There is a trend towards growth in the number of papers over the years of study (Pearson correlation,  $r = 0.83$ ,  $P < 0.01$ ; Fig. 1). In the first 15 years (1985-1998) the numbers of publications were low, 18.02% (62) of the total of publications in the last 35 years. This percentage increased in the next decade (1999-2008) to 31.98% (110), although the trend is negative in those years. But, in the last 10 years (2009-2019)

**Table 1.** Number of total publications found, valid publications and percentage of search success in each database in the bibliography search of studies on penguins in Argentina.

	Search Results	Valid Publications	% Search success
Web of Science	427	291	62.13%
Scopus	288	212	73.80%
SciELO	16	8	73.30%
Plos Ones	194	13	7.87%
<b>Total</b>	<b>933</b>	<b>533</b>	<b>57.13%</b>

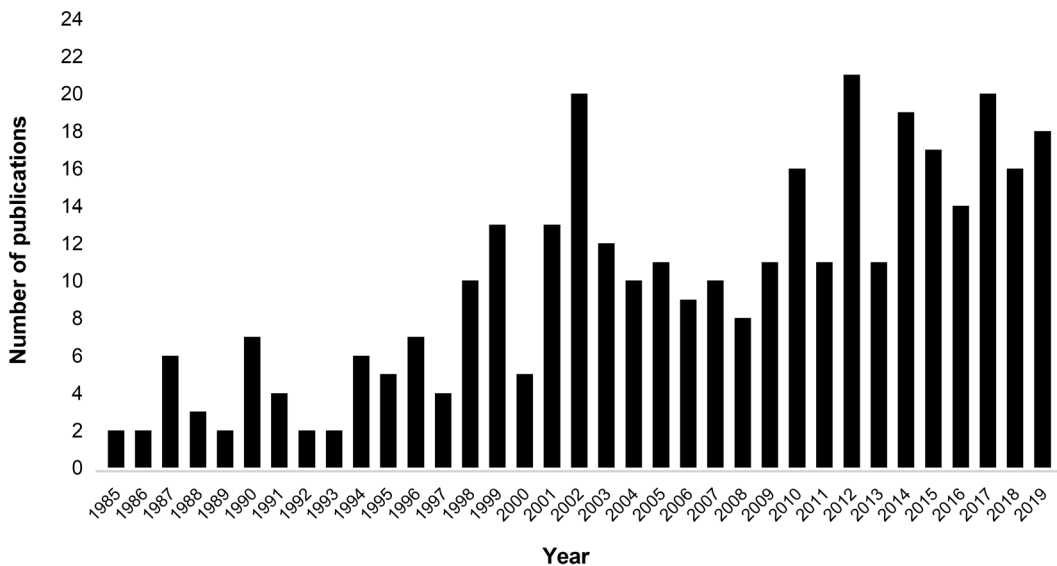
the trend is reversed and 50.00% of the studies (172) were published, increasing the number of publications by 18.02%.

In relation to the geographical distribution, it was observed that 58.14% (200) of the publications were carried out in “Patagonia”, while the “Malvinas” and “Tierra del Fuego” regions represent 29.07% (100) and 17.15% (59) respectively. Only 5.81% (20) of the publications were made in the “Pampa” region and 1.16% (4) represented research on captive penguins.

According to the authorship, there is a clear trend towards a growth in the number of authors per publication over the last 35 years ( $r = 0.77$ ,  $P < 0.001$ ; Fig. 2) (mean of authors per year =  $0.086 \cdot \text{year} - 168$ ,  $R^2 = 0.59$ ,  $P < 0.001$ ; Fig. 2) with  $3.36 \pm 0.20$  authors on average per publication, and a range of number of authors from 27 in the maximum to 1 in the minimum. Regarding Argentine participation, it was found that 55.23% (190 publications) of the total publications analyzed are signed by at least one Argentine researcher.

Of that percentage, 80.53% (44.48% of the total publications) of the studies present a majority - half or more - of Argentine authors. Throughout the years, there has been an increase (Spearman correlation,  $\rho = 0.87$ ,  $P < 0.001$ ) in the number of penguins studies involving at least one Argentine researcher and this increase is similar in studies that present a majority of authors belonging to an Argentine research institute ( $\rho = 0.82$ ,  $P < 0.001$ ). In terms of percentage of participation, there has been a slight increase ( $\rho = 0.48$ ,  $P = 0.004$ ) from 30.00% (period 1985-1989) to 63.12% in the last 5 years (period 2015-2019) in publications with at least one author belonging to an Argentine research institute (Fig. 3).

Regarding the relation of these results with scientific aspects, there are differences in the 16 research topics defined. There is a high incidence of publications focused on foraging and diet (23.26%), followed by breeding and reproductive successes (16.86%) and behaviour studies (15.70%). In contrast, the topics with the lowest incidence of study are predation



**Figure 1.** Number of publications on penguins per year in the last 35 years in Argentina.

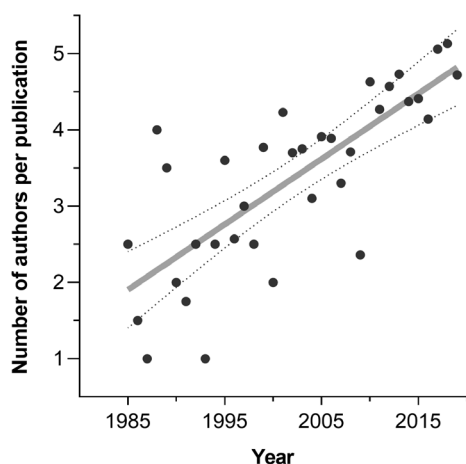
(1.16%), biochemistry (2.62%), and genetics (3.20%) (Fig. 4). There is a trend towards growth across the years for all of the research topics ( $P < 0.05$ ); with conservation and wildlife management showing the strongest increase ( $\rho = 0.70$ ,  $P < 0.01$ ) and predation presenting the weakest ( $\rho = 0.32$ ,  $P = 0.03$ ). Only four topics did not show a significant trend: biochemistry ( $\rho = 0.33$ ,  $P = 0.05$ ), population dynamics ( $\rho = 0.17$ ,  $P = 0.16$ ), pollution ( $\rho = 0.13$ ,  $P = 0.45$ ) and check-lists and atlas ( $\rho = 0.04$ ,  $P = 0.84$ ).

According to the study species, there is a strong bias towards the Magellanic Penguin (*S. magellanicus*) that covers 67.44% (232) of the studies. The Southern Rockhopper Penguin (*E. chrysocome*), Gentoo Penguin (*P. papua*) and King Penguin (*A. patagonicus*) represent 24.13% (83), 12.79% (44) and 6.40% (22) respectively, while the Macaroni Penguin (*E. chrysolophus*) is only present in 1.45% (5) of the publications. These proportions in the number of studies for study species are made evident in the different topics of research with the Magellanic Penguin boasting the highest incidence in them, except in check-lists and atlas topic (Fig. 4). Here again, the numbers of published works by species show a positive trend over time: Magellanic ( $r = 0.67$ ,  $P < 0.01$ ) and Southern Rockhopper ( $\rho = 0.65$ ,  $P < 0.01$ ) penguins show the strongest trend. King Penguin has a slightly higher positive trend ( $\rho = 0.40$ ,  $P = 0.02$ ) than Gentoo penguin ( $\rho = 0.35$ ,  $P = 0.04$ ). It should be noted that some found publications include the presence of two more species of penguins of the genus *Eudyptes*: Snares Penguin (*E. robustus*) and the Royal Penguin (*E. schlegeli*). These represent

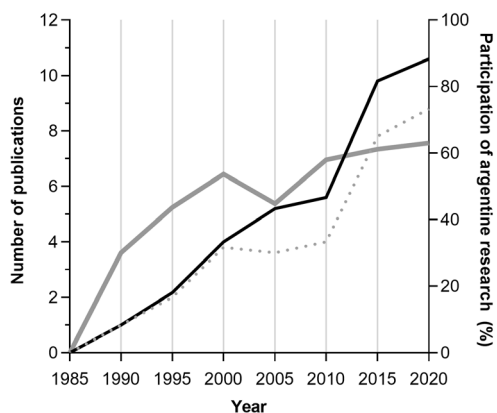
0.58% (2) and 0.29% (1) respectively for each species in the total of publications found.

## DISCUSSION

In the last 35 years, the scientific literature on penguin species in Argentina (except part of Atlantic Islands and Antarctica) has experienced a positive trend, accumulating a total of 344 publications in the main scientific bibliography databases (Web of Science, Scopus, Plos One and SciELO). The general increase has not been constant over the years, presenting a slight downward trend between 2002 and 2008. This trend reversed sharply in the last decade, in which, half of the published studies are concentrated (there are years with even more than 20 published studies) (Fig. 1). The upward trend is reflected in the growing interest in ornithology in recent decades (Barbosa and Moreno 2004, Bibby 2004, Gordo 2014, Yarwood et al. 2014, Vellaichamy and Jeyshankar 2020), particularly in Latin America (Portflitt-Toro 2017). This increase in the number of publications can be explained by the recognition of penguins as indicators of oceans health, and also by the characteristics of the species: e.g., their wide distribution, easy accessibility to breeding colonies, easy handling, capture, and monitoring of individuals, as well as the enormous number of them grouped together in a relatively small area. This allows to obtain a large amount of data and information in a short period of time, facilitating the work of researchers and the highest profitability, productivity and frequency of publication (Thomas et al. 2003). Together with a greater amount of human



**Figure 2.** Distribution of average numbers of authors per publication and year. The grey line shows the linear regression fit. Broken lines represent the 95% confidence interval of the fit line.



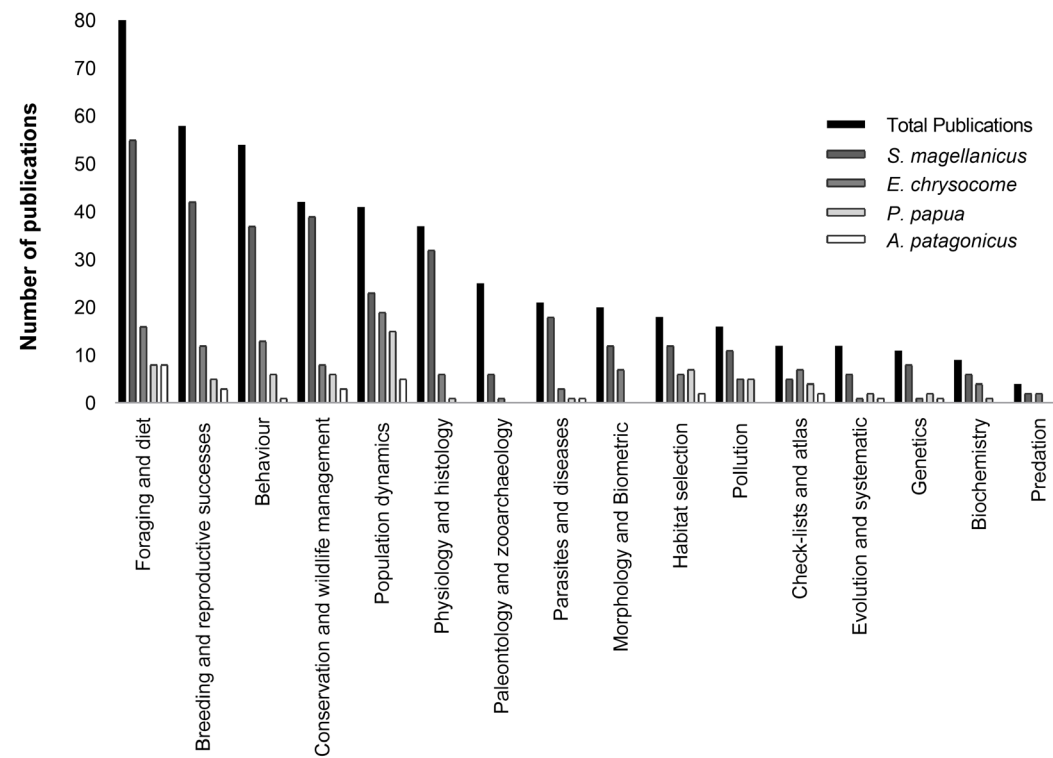
**Figure 3.** Evolution of authorship of researchers belonging to Argentine universities or research centers. The black line shows the number of publications per year with at least one Argentine researcher. The dotted grey line shows the number of publications with 50% or more of Argentine researchers per year. The grey line, associated with the axis on the right, shows the evolution of the percentage of publications with at least one Argentine researcher of total publications per year.

resources, these factors surely influenced and continue to influence the decisions of the researchers and their increasing interest on these seabirds. The general upward trend in studies of penguins contrasts with the one in seabirds (Barbosa and Moreno 2004, Gordo 2014) even in Latin America (Portflitt-Toro 2017). It would be interesting to analyze whether these described characteristics promote and facilitate one's research of other seabirds with which penguins may cohabit; however, such analysis transcends the aim of this article.

The use of publications that address more bird species than penguins and the indexing of small journals or repositories of scientific manuscripts (universities or research centers) to the databases is a key factor to take into account when interpreting the results published in this study. Only one doctoral dissertation (Carbajal 2017) and no master's or bachelor's thesis were included as scientific literature. This could be due to the fact that these types of studies are published in repositories or national and regional journals with a low impact factor and are not indexed in the databases used (which could be found in non-indexed databases like Google Scholar), which

could underestimate the results and make the bibliographic search more difficult. This could affect the total number of publications analyzed; however, it is expected that the preferences for the study species and the research topics will not vary since the doctoral theses (together with master's and bachelor's theses) are a reflection of the trends in ornithological research (Barbosa 2000).

Regarding the authorship, a positive trend towards an increase in the number of authors per manuscript was found. Most disciplines in ecology and zoology are becoming collaborative disciplines (Fitter 1999) and this is also widespread in the field of ornithology (Haffer 2001). Modern research is more extensive, covers a large amount of information and presents multiple approaches to the subjects of study. All this involves more numerous and multidisciplinary teams (Wuchty et al. 2007) that, in addition, work through international collaboration with researchers from other countries (Newman 2001). A positive trend is observed in the percentage of participation of Argentine researchers over the years, with an increase of more than 30% from the early 90s to 2020 in penguin studies. The publications involving



**Figure 4.** Number of total publications by research topic and number of total publications for each research topic in main penguin species in Argentina in the last 35 years.



a majority of Argentine researchers have increased in a similar way to the publications in which these researchers are present, indicating a greater weight of Argentine science in the study of penguins both in the continental territory and in its associated islands. This increase in Argentine researcher participation can be explained by a growth in human resources as it is mentioned above, and in the growing interest in the research of these birds in Argentina (where until the end of the 20th century foreign science predominated, Fig. 3). Also, it may be due to a greater growth in national inter-institutional collaboration to comply with multidisciplinary in the recent publications already commented and by the increase in investment in ACT (scientific-technological activities) and I+D (research and development) in Argentina from 2004 (Unzué and Emiliozzi 2017). Precisely, the greatest increase in the participation percentage coincides with the period in which the investment in Argentine science was greater.

The number of studies varies between the different geographical areas and this can be explained mainly by factors such as the extension of the territory, the number of breeding colonies, their individuals and species and their accessibility, which facilitates conducting observations and experiments in the development of different research projects (and to a large extent their financing). These reasons largely explain why Patagonia and the Islas Malvinas have the highest number of publications, followed by Tierra del Fuego. The lower incidence of studies is on the north coast of Argentina ("Pampa" region), which no longer corresponds to the nesting area of these birds. Publications carried out on the north coast of Argentina study penguins secondarily along with other birds during their migration to the northern wintering areas; the nesting areas define the study of these birds as the main object of research. On the other hand, a greater number of publications in continental Argentine territory was found compared to that of the Islas Malvinas. Only 20 publications were found covering both regions at the same time. This highlights the need for greater cooperation between institutions and researchers to work irrespectively of province borders, rather following the ecological borders of these austral regions (Southern Patagonia, Tierra del Fuego and Islas Malvinas) so important for the conservation of these birds.

The results show that the studies on foraging and diet, accompanied by breeding and reproductive successes and behavior studies were the most abundant,

followed by conservation and wildlife management, population dynamics and physiology, and histology. These topics coincide with those popular in ornithological research in general in recent years (Bautista and Pantoja 2000, Barbosa and Moreno 2004). The temporal distribution of the research topics resembles the evolution described for ornithological research (Barbosa and Moreno 2004, Bibby 2004, Gordo 2014, Yarwood et al. 2014), therefore, it is possible to identify that the scientific study on penguins in Argentina has passed the first stage of formation (where census and distribution studies predominate) and is in the second stage of maturity, in which the interest is focused on more complex aspects of their biology such as foraging and diet, behavior, reproduction, and physiology (Bijlsma et al. 2014). These topics coincide with those of greater emphasis in the current review on the state of knowledge and conservation of penguins in Argentina (Schiavini et al. 2005), except for studies related to pollution despite its negative effect on Argentine penguins and in the southern oceans in general (Underhill 2007, Brasso et al. 2015). Reproduction and reproductive success studies are very common in the study of species belonging to the Spheniscidae family because they are usually worked during the breeding season. On the other hand, the least addressed topics were predation, biochemistry, and genetics. The low number of studies on the last two topics may be due to several factors that are difficult to identify but could include, for example the application of new technologies, lack of interest and/or low profitability for researchers for this type of publication. Regarding the "predation" category, given the low number of articles found, it is recommended to delete this category or include it inside the "breeding and reproductive success" category for future bibliometric analyses. Due to the mortality of penguin chicks and predation of eggs, the selective pressure exerted during the reproductive stage frequently mentioned in these studies becomes clear.

Penguins are a very important tourist attraction for the Argentine coasts including Malvinas Islands (Ingham and Summers 2002, Boersma 2008). Since 2005, studies have been carried out in the Patagonian area in order to determine if tourism has negative effects on the health and population status of the colonies as mentioned by Carabajal (2017). This fact is clearly reflected in our results not only for the Patagonian region, but for the 73.17% of the works published on wildlife conservation and management carried out between 2005 and 2019, which has been the topic with the greatest upward trend over the years.

It is noteworthy that all the topics studied have presented an upward trend over the years except for four of them, among which population dynamics stands out, one of the topics with the largest number of total publications. *A priori*, it may seem negative that population dynamics studies do not show a positive or negative trend over the years. However, this is a good indicator of the constant effort put in these types of studies and that they will potentially become long-term studies on these species.

The most studied species is the Magellanic Penguin, which would be related to the number of publications in Patagonia (and in the Argentinean count) given its wide distribution and nesting area, as well as the number of individuals (Gandini et al. 1996, Schiavini et al. 2005): a quarter of its colonies are located on continental Patagonia, which facilitates their access by land means and has great implications for the conservation, management, and research of this species (Bertellotti 2013). The second most studied species, the Southern Rockhopper Penguin, did not show a large number of studies compared to the Magellanic Penguin, despite the fact that part of its distribution and nesting area is largely associated with the southern regions analyzed here. However, the number of colonies and individuals is low (Schiavini 2000, Schiavini et al. 2005) and the colonies are not as accessible by terrestrial means, which may be the most plausible explanation for the number of publications. It would be convenient to take into account the publications made in the southern territory of Chile to obtain a clearer image of the state of the current scientific bibliography of both species. A similar situation was found for the Gentoo and King Penguin. A lower number of studies on this species was found because they are more characteristic and predominant in sub-Antarctic and Antarctic regions (Pistorius et al. 2010, 2012) and appear in fewer numbers in the studied regions. Another species that appeared in the analysis was the Macaroni Penguin, present in only five studies (Lacy 1991, Bingham 1998b, Bingham and Mejias 1999, White and Clausen 2002, Crofts and Robson 2015) despite nesting in the Malvinas Islands (BirdLife International 2020). Furthermore, it is important to highlight the presence of two unusual species of penguin in neotropical regions such as Royal Penguin (Dehnhard et al. 2012) endemic from Australia's Macquarie Island, and Snares Penguin (Lamey 1990, Demongin et al. 2010) endemic from New Zealand. Both are species of occasional occurrence in the study area, but they have appeared in the bibliographic search carried out and therefore

it is necessary to mention them in our results. Despite the large differences in the number of publications between these species, all of them (except for the occasional occurrence of species) have presented a positive trend towards an increase over the years. This trend must be maintained in the future in order to obtain long-term data on the species that will eventually be used to diagnose environmental changes in their ecosystems and to recognize/analyze the health status of their populations.

It has been shown that the application of bibliometric analysis in specific taxonomic groups allows us to get an image about the current state of knowledge and its evolution at different temporal and spatial scales with a different approach than traditional bibliographic reviews. Therefore, analysis of this type should be included among the different types of recognized review studies (Grant and Booth 2009). It is necessary to highlight the importance of this type of analysis and to promote its use and application in the analysis of publications on different taxonomic groups. Evaluating the production and scientific literature on penguins is essential to understand the current and future state of scientific research. This will strengthen decision-making on future research and will fill gaps in knowledge about these species.

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