

FISH REPRODUCTION: BIBLIOMETRIC ANALYSIS OF WORLDWIDE AND BRAZILIAN PUBLICATIONS IN SCOPUS DATABASE.

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RESUMO

A reprodução é uma parte fundamental da vida, e estudos relacionados à reprodução de peixes tem sido muito acessados. O objetivo deste estudo foi realizar uma análise bibliométrica na intenção de identificar as tendências neste tipo de publicação. Em junho de 2013, foram realizadas pesquisas em banco de dados *Scopus* usando o termo "reprodução de peixes", que foi compilado e apresentou informações relacionadas com o número de publicações por ano, número de publicações por país, publicações por autor, por periódico, por instituição e palavras-chave mais usadas. Com base no estudo, foi possível obter os seguintes resultados: o Brasil ocupa uma posição de destaque no número de artigos publicados, sendo que a participação brasileira em relação à produção mundial na base *Scopus* teve um aumento exponencial; foi observada uma elevada concentração de artigos nos 10 principais autores e nas 10 principais instituições no que se refere aos resultados para o Brasil. O presente estudo permitiu verificar que o termo "reprodução de peixes" tem sido foco de muitos artigos científicos, sendo que no Brasil existe um esforço de pesquisa especial relacionado a este assunto, especialmente nos últimos anos. A contribuição principal refere-se à utilização de métodos bibliométricos para descrever o crescimento e concentração de pesquisas na área de produção e reprodução de peixes.

Palavras-chave: Peixes, reprodução, pesquisa, bibliometria.

ABSTRACT

Reproduction is a fundamental part of life being and studies related to fish reproduction have been much accessed. The aim of this study was to perform a bibliometric analysis in intend to identify trends in this kind of publication. During June 2013, were performed searches on Scopus Database, using the term "fish reproduction", being compiled and presented information related to the number of publications per year, number of publications by country, publications by author, by journal, by institution and most used keywords. Based on the study, it was possible to obtain the following results: Brazil occupies a highlight position in number of papers, being that the Brazilian participation compared to worldwide publishing production is having an exponential increase; in Brazil, there is a high concentration of articles when concerning the top 10 authors and institutions. The present study allows verifying that the term "fish reproduction" has been focused by many scientific papers, being that in Brazil there is a special research effort related to this subject, especially in the last few years. The main contribution concerns to the use of bibliometric methods to describe the growth and concentration of researches in the area of fishfarm and reproduction.

Key words: fish, breeding, research, bibliometrics.

1 – Introduction

The farming of aquatic organisms has been increasing significantly at the last decades and, among the cultivated organisms, fish are the most highlighted in this area. With the increase of fish farming, were also increased the number of researches performed in this area, in aim to solve problems to the better of activity development. Consequently, the number of publication regarding fish farming has been gradate increasing, being fish reproduction a much exploited knowledge area (FAO, 2010).

The growth of fish farming, by its way, is directly linked to the fisheries consumption that has significantly increasing at the last years, mainly stimulated by the population growth and by the worldwide tendency of adopting a more healthful diet (Andrade and Yasui, 2003).

So, to supply this need is fundamental to dominate the management and production techniques of these cultivated organisms. The breeding constitutes a fundamental part of the biological cycle of life being, thus, reproduction studies are important to understand the life cycle of the species, mainly to establish management politics of the fisheries resources and its preservation.

The knowledge about the reproductive processes in aquaculture is imperative to the success of this activity. The obtaining of cultivated fish fry that could be used in growth was one of the first steps to the change of aquaculture from extrativism to the actual models of farming. The handling process of fish reproduction in captivity is quite ancient, since at 1795 were already known the artificial reproduction technique of trout (Andrade and Yasui, 2003).

The understanding about reproductive cycle of a specific species of fish, as well as the endogenous and exogenous factors that controls this activity are very important to the reproduction success (Barbieri et al., 2000).

Fishes are known by its elevated fecundity, with individual of most species releasing hundreds to thousands of oocytes, annually. The population stability, when are initially consider annual spawning, is rarely reached, and the numbers increase or decrease according to the pressure of the abiotic factors (Nakatani et al., 2001).

Despite the reproduction process be one of the most studied aspects of fishes' life cycle, the amount of available information became quite reduced when are compared the number of existing species and the number of those about what are known the reproductive tactics (Araújo, 2009).

The understanding about the biology of reproduction of fishes provides subsidies to the development of reproducing techniques, however, more researches in management of breeding fish, spawning induction and preservation of natural stock are required, thus providing a better efficiency in fry production (Crepaldi et al., 2006).

Despite the information specifically about fish reproduction not be so abundant, is a fact that the development of scientific methods and the increasingly interest on research have been generated a wide gamma of publications, that are not always easily accessed (Jacso, 2005).

The great amount of annually produced information has demanded informatics systems that store, manage and provide to the user the required information, in an adequate and satisfactory manner. For this, there are many data storage basis that allows the user to access more easily the publications in several areas (Mesquita et al., 2006).

Among these is highlight the Scopus, which is a multidisciplinary database, produced by Elsevier since 2004 and that covers publication since 1960, presents 27 million of articles, abstracts, references about scientific, technician and medical literature (Elsevier, 2004). Besides, with Google, Scholar and Web of Science, represents one of the largest multidisciplinary databases. Because of the high level of requirements for the periodic indexing on Scopus database and the high visibility/accessibility, it is considering that publications in this database are of high qualification (Jacso, 2005).

For a more efficient utilization of this database, the bibliometrics or scientometrics is a methodology of analysis that can provide reliability and detailing on the researches. Bibliometrics can be defined as the counting and statistical analysis of publications or citations found on the scientific and academic databases (Coates et al., 2001).

A bibliometric analysis tracks publications, words, citations, cited references, co-citations, phrases and authorship. Beyond the counting itself, the connection between tracked themes, or between authors, or between institutions can indicate the trends on the publication (Porter, 2007).

Although not widely used, the accessibility of scientific databases on the internet, and the fact of many of them offers search tools that allows to obtain quantitative results sufficient to perform an bibliometric track, the usage of bibliometrics tents to grow (Coates et al., 2001).

This research aims to realize a bibliometric study, using the Scopus database, concerning the theme “Fish reproduction”, as in Brazil as worldwide, being the results presented stratified, pointing the publication trends by scientific knowledge area.

2 - Material and Methods

The data were obtained by the search in the scientific articles database Scopus, available on Periodic CAPES portal.

The search was performed at June, 19th, 2012, using the expression “fish reproduction”, included on title, abstract or keywords. Initially were verified the information concerning to worldwide publication and, following, the articles published in Brazil.

The data extracted of this research were the number of publications per year, number of publication by country, by author, by periodic, by institution, and the most used keywords.

The concentration analysis was performed by comparison of the number of publications of the 10 major contributors (countries, authors, institutions, and periodic) in relation to the total of publications.

For the calculation of the concentration, were always used the top 10 of each search mode in the statistical analysis. For a temporal analysis, were used exponential regression equations (log - log) of the number of publications in relation to the year, according the statistic model: $\log Y = a + b \cdot \log X$, where the angular coefficient "b" represents the growth rate (Gujarati, 2011). For the obtaining of the growth rate were related all the publications until 2011, since the data about the year of 2012 were not totally indexed on Scopus database. The statistical analyses were performed using the Minitab application, version 15.

3 – Results

Until June, 16th, 2012, the realized research showed 7,374 articles registered at Scopus database related to “fish reproduction”.

In Table 1, are verified the countries that have a greater number of publications referring the theme, with the respective number of publications.

Table 1 – Main countries, in number of publications using the term “Fish reproduction” for research.

Country	n°
USA	2117
Canada	696
UK	523
Japan	434
France	426
Germany	330
Spain	328
Brazil	292
Australia	257
China	229
SUM	5632
TOTAL	7374
%	76.38

In Table 2 there is the ranking of the top 10 major authors that most published, worldwide and in Brazil, when using the methodology of search and refine.

Table 2 – Authors that most published worldwide and in Brazil in the area “Fish reproduction”.

Worldwide		Brazil	
Author	n°	Author	n°
Zanuy, S.	39	Bazzoli, N.	17
Tyler, C.R.	38	Rizzo, E.	13
Ankley, G.T.	37	Gomiero, L.M.	11
Zohar, Y.	35	Sato, Y.	10
Pankhurst, N.W.	34	Agostinho, A.A.	9
Carrillo, M.	33	Araujo, F.G.	8
Fernald, R.D.	31	Bombardelli, R.A.	8
Jensen, K.M.	27	Braga, F.M.S.	7
Denslow, N.D.	27	Gomes, L.C.	7
Trudeau, V.L.	25	Sanches, E.A.	7
SUM	326	SUM	97
TOTAL	7374	TOTAL	296
%	4.42	%	32.77

Using the same methodology, it was performed a research of the total number of publications, by institution, worldwide and in Brazil, being the top 10 ranked in Table 3.

Table 3 – Number of publications by institution, worldwide and in Brazil.

Worldwide		Brazil	
Institution	n°	Institution	n°
EPA (EUA)	89	UNESP	61
USGS (EUA)	83	UEM	31
University of Florida (EUA)	74	USP	22
UC Davis (EUA)	69	UFRGS	21
Hokkaido University (Japan)	67	UFMG	20
University of Guelph (Canada)	67	Unioeste – PR	17
UNESP (Brazil)	66	PUC – MG	13
Havforskningsinstituttet (Norway)	56	UFRJ	12
CEFAS (UK)	52	UFSCAR	11
University of Tokyo (Japan)	52	UNICAMP	10
SUM	675	SUM	218
TOTAL	7374	TOTAL	296
%	9.15	%	73.65

Table 4 demonstrates the top 10 main journals in which are published articles with the theme “Fish reproduction”. This is an especially important information when is considering for what journal the article will be submitted, once a journal that traditionally publishes on the related area will gives more visibility and impact.

A research about the most used keyword was also performed, and is represented in Table 5. From these data can be performed more specific researches about the term “Fish reproduction”, and also using them in articles about this theme, turning easy the track.

Table 4 – Main journals, worldwide and in Brazil, using the search theme “Fish reproduction”.

Worldwide		Brazil	
Journal	n°	Journal	n°
J. fish biol.	286	Neotrop. ichthyol.	34
General Compar. Endocr.	276	Braz. j. biol.	27
Aquaculture	245	Acta sci., Biol. sci.	20
Environ. biol. Fishes	217	Environ. biol. Fishes	9
Environ. toxicol. chem.	193	J. fish biol.	8
Aquatic Toxicology	182	Rev. bras. zootec.	8
Biol. reprod.	121	Biota neotrop.	7
Fish physiol. biochem.	102	Aquaculture	7
Ecotoxicol. environ. saf.	91	Rev. Bras. Zool.	6
Arch. environ. contam. toxicol.	90	Iheringia, Zool.	6
SUM	1803	SUM	132
TOTAL	7374	TOTAL	296
%	24.45	%	44.59

Table 5 – Most used keywords in articles, with the searching theme “Fish reproduction”.

Worldwide		Brazil	
Key words	n°	Key words	n°
Reproduction	4152	Reproduction	174
Fish	2791	Fish	118
Female	2362	Female	68
Male	2162	Male	67
Animal tissue	942	Fish	64
Physiology	879	Physiology	46
Spawning	807	Spawning	28
Fish	681	Season	27
Water pollutants	547	River	24
Development	516	Term	24
SUM	15839	SUM	640
TOTAL	7374	TOTAL	296
%	214.80	%	216.22

The Figures 1 and 2 represents the exponential growth of the number of publications in the area, since 1975, when was published the first article, until 2011, in Brazil and worldwide. When are compared the linearized angular coefficients, it was observed that the growth in Brazil (linearized angular coefficient = 267.4; Figure 2) was smaller than the world media (linearized angular coefficient = 215.2; Figure 1).

At the Figures 3 and 4 can be verified the number of publications restricted at the last 10 years. At both it is possible to notice the growth, however, in Brazil, in a much more expressive manner.

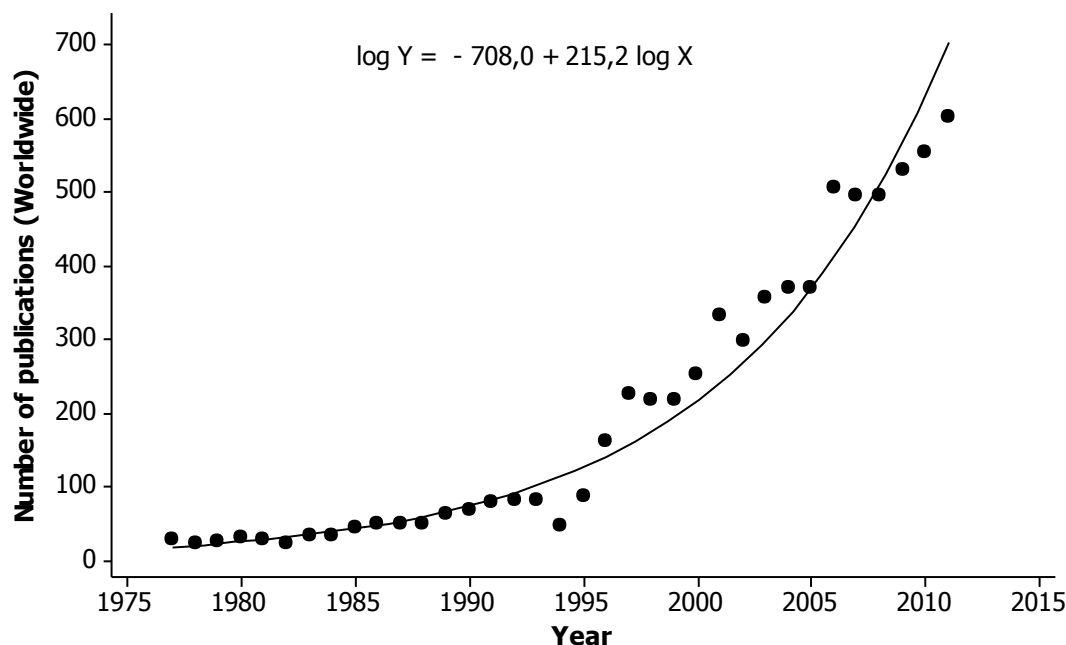


Figure 1 – Growth of worldwide publications referring to the term “Fish reproduction”, since 1975 until 2011.

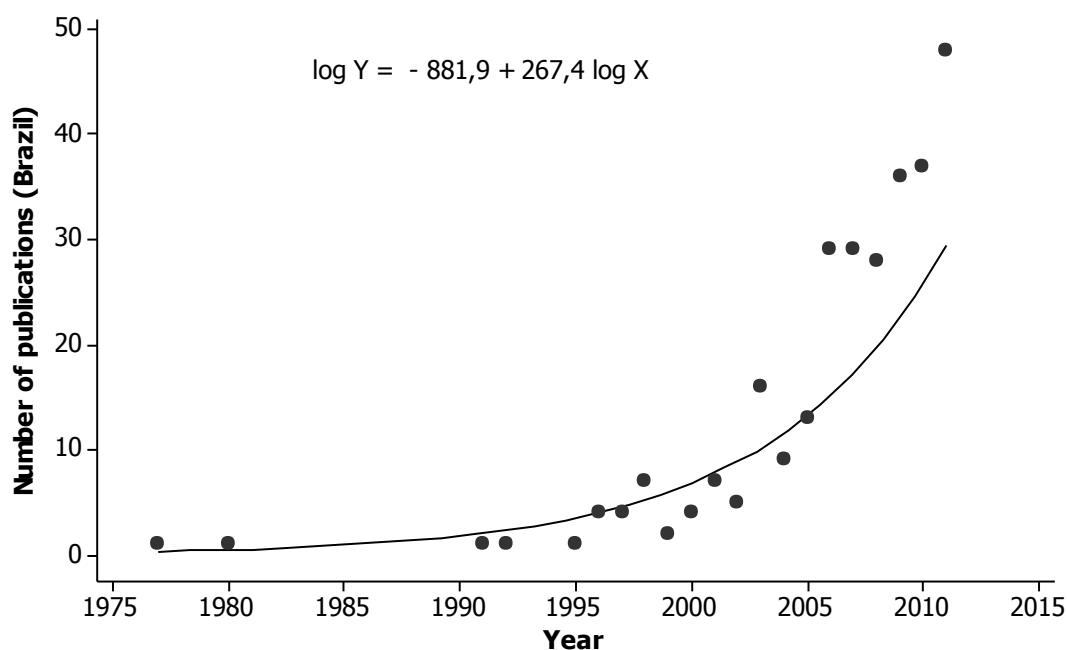


Figure 2 – Growth of publications in Brazil referring to the term “fish reproduction”, since 1975 until 2011.

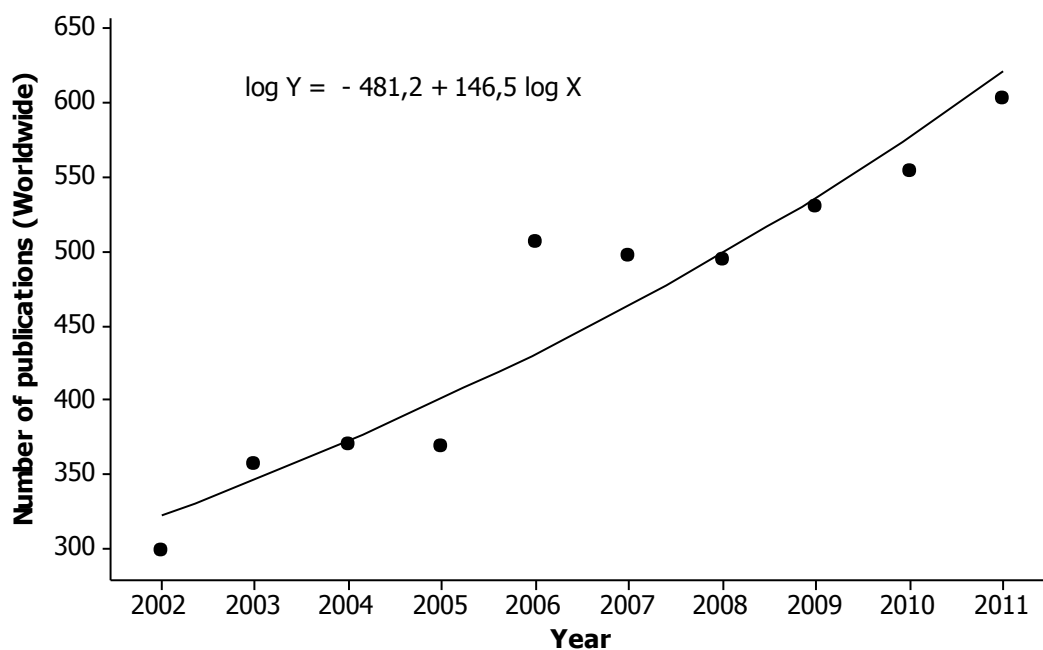


Figure 3 – Growth of worldwide publications referring to the term “fish reproduction”, since 2002 until 2011.

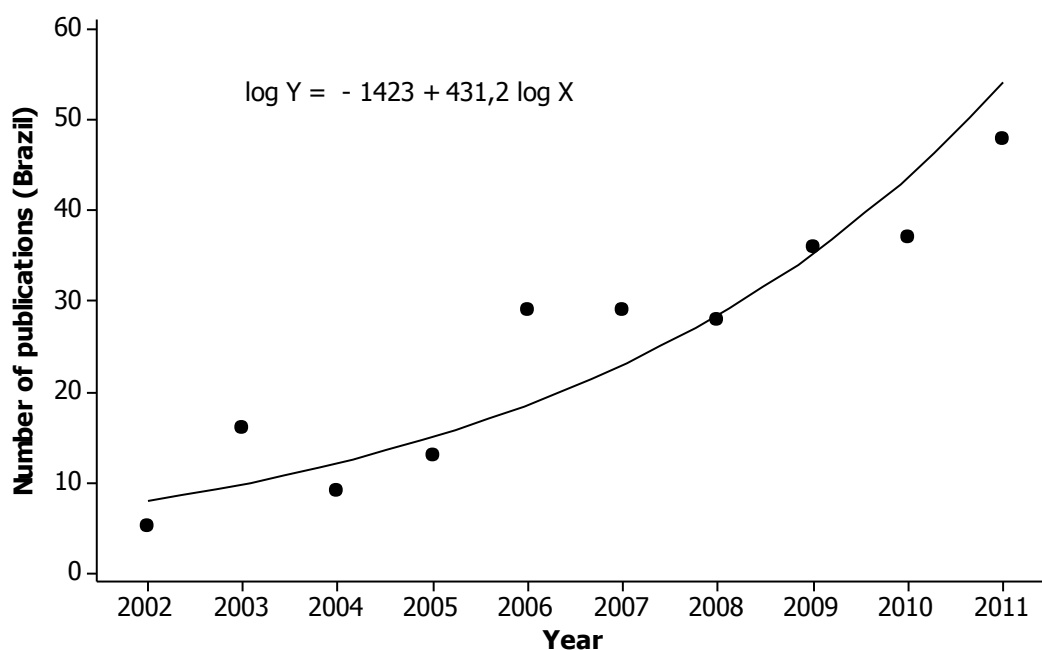


Figure 4 - Growth of publications in Brazil referring to the term “fish reproduction”, since 2002 until 2011.

Figure 5 demonstrates the proportion of Brazilian published articles. It is observed that the percent participation of Brazil was less than 2% of the total of publications at 2002, and at 2011 it increases to almost 8%. This increase of near 6 percent points at the last 10 years indicates a significantly increase of Brazilian participation, being Brazil one of the principal contributors to the scientific production in this area.

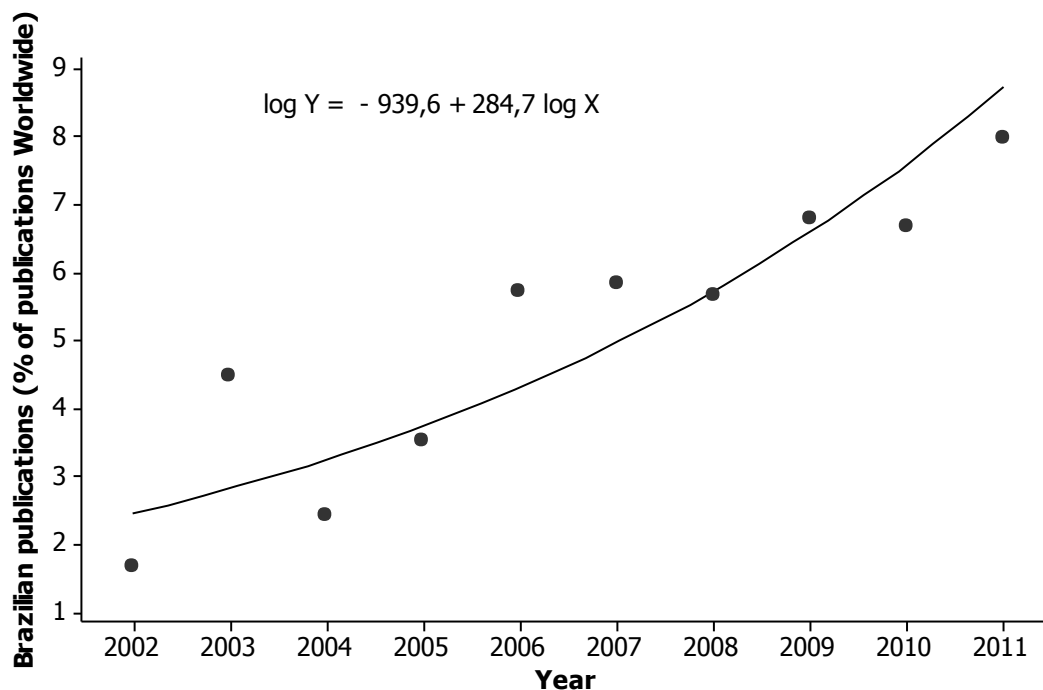


Figure 5 – Brazilian participation referring to the publications related to the term “fish reproduction”, since 2002 until 2011.

4 – Discussion

Referring to the expression “fish reproduction” it is observed that Brazil is among the top 10 countries in number of publication (Table 1), showing significance in Brazilian publication in relation to the total of worldwide publication. Besides, in a global manner, the number of publication in this area is gradually increasing since 1975, year in which was verified at the Scopus database the first publication referring to the theme.

In Brazil, the 10 principal authors of the area possesses 32.77% of the publication (Table 2) and the ten first institutions in number of publication (Table 3) represents 73.65% of all publication, demonstrating that the research in this area is probably concentrated in institutions and research groups previously established and organized. Among these institutions four are from São Paulo State, which is related to the fact of this state be the major responsible for post-graduation training in the Country, representing at the year of 2000 more than 60% of active PhD researchers in the Country, at the most diverse areas of knowledge (Guimarães et al., 2001).

The top 10 journals with the highest rate of articles referring to the expression “fish reproduction” represent 24.45% of worldwide publication (Table 4), being that when the search is restricted to Brazil, this index rises to 44.59%, indicating the major concentration of Brazilian publication in few journals. A fact that must be highlighted is that the top 10 journals in which the Brazilian researchers published, 7 of them are Brazilian journals.

The fishery sector in general has been presented a substantial development at the few years and it has influence the publication in the area, which has been highlighted in national scene mainly after the creation of Fishery and Aquaculture Ministry. So, investments

incoming from both sectors, public and private, have made possible the increase of the number of researches.

It is possible to infer that the theme has been studied in a more expressive manner and that Brazil arises as a great contributor in this area, especially considering the percent of participation at the last ten years that in comparison with the worldwide scene grew up much more representatively (Figures 3 and 4). However, there is not either a national institution or researcher that figures amongst the top 10 of the worldwide ranking, so much more is about to be done for Brazil receives notoriety in research to be up to the aquaculture potential in Country. It is realizable that the incentives received at the last years were efficiently availed by the scientific community, generating more acknowledgements that resulted in more qualified publication in the area. This way, new investments must be encouraged, since there is a high demand for researches linked to the theme (FAO, 2010).

The number of edicts on research projects with possible financing for fish farming also increased and so was possible to extend the studies on several modalities in area. The rise of number of universities and post-graduating courses also influence the researches directly, once most of the experiments and publications incomes from this sector, since at least one article is published from each defended thesis or dissertation (Marchelli, 2005; FAO, 2010).

As the last few decades the number of PhD titles obtained in Brazil has significantly increasing. Until the year of 1985 more than 40% of Brazilian Doctors had obtained their titles in foreign institutions, but in the decade of 1990's only one of five titles was obtained in other countries. So, the concentration of national publications in all areas increases, as the visibility of Brazil among the worldwide research, as previously discussed by Marchelli, 2005.

Another fact that contributes to the increase of Brazilian scientific production is the indexing of new journals to the Scopus database. Because it is a worldwide accessed database, it is expected that more researchers are stimulated to publish in these journals, increasing the probability of their articles be accessed and cited.

5 – Conclusion

Referring to the publication at Scopus database related to the theme “fish reproduction”, the results obtained in this work shows that: (i) Brazil is the 8th country that possesses more publications; (ii) there is a high concentration of Brazilian publication with few researchers, research centers and journals; (iii) Brazil has been presenting higher publication growth rates than the worldwide media. It is suggested that the investments at this area must be maintained or even increased, considering the high demand and response, in terms of qualified researches and publications.

6 - References

ANDRADE, D. R.; YASUI, G. S. O manejo da reprodução natural e artificial e sua importância na produção de peixes no Brasil. *Revista Brasileira de Reprodução Animal*, v.27, p.166-172. 2003.

ARAÚJO, R. B. Desova e fecundidade em peixes de água doce e marinhos. *Revista de biologia e ciências da terra*, v.9, p.24-31. 2009.

BARBIERI, G.; SALLES, F. A.; CESTAROLLI, M. A. Influência de fatores abióticos na reprodução do dourado, *Salminus maxillosus* e do curimatá, *Prochilodus Uneatus* do Rio

Mogi Guaçu (Cachoeira de Emas, Pirassununga/SP). *Acta Limnologica Brasileira*, v.12, p.85-91. 2000.

COATES, V.; FAROOQUE, M.; KLAVANS, R.; LAPID, K.; LINSTONE, H. A.; PISTORIUS, C.; PORTER, A. L. *On the Future of Technological Forecasting*. North-Holland: Elsevier Science. 2001.

CREPALDI, D. V.; FARIA, P. M. C.; TEIXEIRA, E. A.; RIBEIRO, L.P.; COSTA, A. A. P.; MELO, D. C.; CINTRA, A. P. R. Utilização de hormônios da reprodução induzida do surubim (*Pseudoplatistoma* spp). *Revista Brasileira de Reprodução Animal*, v.30, p.168-173. 2006.

ELSEVIER. *Scopus*. Amsterdam: Elsevier. 2004.

FAO. 2010. *The State of world fisheries and aquaculture*. Food and agriculture organization of the united nations, Rome, 218p. 2010.

GUIMARÃES, R.; LOURENÇO, R.; COSAC, S. O perfil dos doutores ativos em pesquisa no Brasil. *Parcerias estratégicas*, Brasília, v.13, p.122-150. 2001.

GUJARATI, D. N. *Econometria Básica*. 5. ed. Porto Alegre: Bookman, 920p. 2011.

JACSO, P. As We May Search--Comparison of Major Features of the Web of Science, Scopus, and Google Scholar Citation-Based and Citation-Enhanced Databases. *Current Science*, v.89, p.1537-1547. 2005.

MARCHELLI, P. S. Formação de doutores no Brasil e no mundo: algumas comparações. *Revista Brasileira de Pós Graduação*, v.2, p.7-29. 2005.

MESQUITA, R.; BRAMBILLA, S.; LAIPELT, R. C.; MAIA, M. F.; VANZ, S.; CAREGNATO, S. Elaboração e aplicação de instrumentos para avaliação da base de dados Scopus. *Perspect. ciênc. inf.*, v.11, p.187-205. 2006.

NAKATANI, K.; AGOSTINHO, A. A.; BAUMGARTNER, G.; BIALETZKI, A.; SANCHES, P. V.; MAKRAKIS M. C.; PAVANELLI, C. S. *Ovos e larvas de peixes de água doce: Desenvolvimento e manual de identificação*. Maringá, EDUEM, 378p. 2001.

PORTER, A. L. How tech mining can enhance R&D management. *Research Technology Management*, v.50, p.15-20. 2007.