



Anais da Academia Brasileira de Ciências

ISSN: 0001-3765

aabc@abc.org.br

Academia Brasileira de Ciências

Brasil

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Anais da Academia Brasileira de Ciências, vol. 80, núm. 4, diciembre, 2008, pp. 771-781

Academia Brasileira de Ciências

Rio de Janeiro, Brasil

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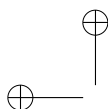
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Anais da Academia Brasileira de Ciências (2008) 80(4): 771-781
(Annals of the Brazilian Academy of Sciences)
ISSN 0001-3765
www.scielo.br/aabc

***H*-index in the Brazilian Academy of Sciences – comments and concerns**

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*Manuscript received on August 26, 2008; accepted for publication on September 9, 2008;
contributed by ALEXANDER W.A. KELLNER**

ABSTRACT

Bibliometric parameters have been used in order to evaluate a scientist's performance. The *h*-index has been gradually accepted as the most adequate parameter for this purpose. To have an idea of this index among Brazilian scientists, we performed an analysis of this parameter for the full members of the Brazilian Academy of Sciences (BAS). The *h*-index of 402 members listed in 10 distinct categories by the BAS was determined, cross-checked with the curriculum vitae of each of them listed at the Plataforma Lattes database (CVL) and compared with each other. Despite the large production, mostly in journals without impact factor, the *h*-indexes among the BAS members are comparatively low and show a large variation in all of the 10 categories, particularly in Biomedical and Physical sciences. The highest average of *h*-index values was found in Biomedical, Health and Chemical sciences; the lowest values were found in Human sciences where this index is meaningless. Several problems due to the trend that new authors "fresh" publications need be constantly produced (the "bakery-effect") are discussed. This study points to the need of developing countries such as Brazil to invest in national scientific journals in order to make them gradually part of the mainstream journals. This would have a positive effect on bibliometric parameters of Brazilian researchers, including the *h*-index.

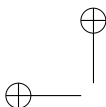
Key words: scientometrics, bibliometric indexes, *h*-index, Brazilian Academy of Sciences.

INTRODUCTION

There is a fundamental question that gradually gains more importance in the Academia: how can we evaluate a scientist's performance and his contribution to the field? As well known, there is a steady increase in the number of active scientists worldwide resulting in a large output in terms of publications. On the other hand, there are limitations of funding and permanent jobs. Therefore, evaluation procedures that lead to comparisons are inevitable, which have a direct effect on a researcher's career.

In order to make decisions more empirically, less subjective, bibliometric parameters were introduced, ranging from number of publications (e.g., productivity) to total citations (e.g., total impact). One can even use the amount of papers published in high-profile publications such as *Nature* and *Science* to evaluate scientific performance (Ball 2007).

One of the indexes that receive most attention is the *h*-index, which is allegedly considered to have several advantages over previous indicators (see Hirsch 2005). Essentially, this index is based on the citations of a researcher's publications received in periodicals at the Thomson



at least 10 times in periodicals of ISI. If one or more of his/her papers are cited over 100 times, his/her *h*-index will still remain the same; if he/she has 20 other papers cited only 10 times or less, the *h*-index will not change either. No other kind of production such as books, chapter in books or proceedings is being considered for this index, neither publications in journals that are not part of ISI, no matter how many times they are cited.

The *h*-index has gained wide acceptance and is being progressively more influential in scientific rulings such as grant proposals, promotions, general advances in careers, fellowships and post-doctorate decisions. When introduced, there was a suggestion to rank whole departments or institutions based on this index (Hirsch 2005) and it is apparently being applied by some committees, even in an unofficial and non-systematic way. Bornmann and Daniel (2005), for example, have shown that successful post-doctoral research fellowships had consistently higher *h*-indexes than the non-successful applicants.

In Brazil, the use of bibliometric measurement is also being gradually more considered although apparently it is not yet determinant in most areas. Publications with impact factor, which are restricted to those included in ISI, are presently the main parameter applied by CAPES to evaluate Brazilian graduate programs, and it probably will not take very long until the *h*-index becomes paramount in such evaluations.

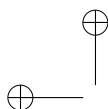
To realize the range of *h*-index among Brazilian scientists, we determined the index values for all full members of the Brazilian Academy of Sciences (BAS). Although certainly not having every prominent scientist of the country as a member of the BAS, we believe that this analysis serves as a proxy for the scientific production in the country. Our aim is not to provide a definitive work on this subject, but to achieve some information and make comments that might help in discussions of the problems involved when applying bibliometric indexes used in scientific developed countries (e.g., USA, Germany, and England) to researchers active in developing countries.

tal of 405 researchers divided into 10 distinct categories as shown by the BAS (see results) were found. During the development of this study, three members passed away and were not considered due to difficulties in retrieving the necessary information, reducing the number to 402 BAS members. In order to minimize problems of homonymous authors, all publications listed in ISI were checked with the *curriculum vitae* of the Plataforma Lattes database (CVL). A total of 45 BAS members lacked a CVL (11,19%) and therefore their publication list could not be confirmed. The *h*-index for 357 BAS members was obtained from ISI through the site Periódicos Capes (<http://www.periodicos.capes.gov.br>).

We observed how the author has signed his scientific paper both at the BAS and in CVL database for the ISI search. In several cases, the author was listed in ISI with a distinct combination of names (e.g., Diogenes de Almeida Campos could be found as Campos, D; Campos, DA or Campos, DD; Sylvio Ferraz-Mello as Ferraz-Mello, S; FerrazMello, S or Mello, SF; Celso Pinto de Melo as de Melo, CP; deMelo, CP and Melo, CP). We tried every combination and calculated the *h*-index for each of them, combining the results. We did not come across a situation where the same paper was listed twice with a different combination of the author's name.

Once the *h*-index was established, the papers listed by ISI were checked at the site of the Plataforma Lattes in order to ensure authorship and avoid problems of homonymy. When the paper was not listed there, it was also checked at the BAS site. If not found, the paper was excluded and a new *h*-index obtained. This procedure may have produced results lower than the real values of the *h*-index, but it did not influence the general results of the present study.

The average *h*-index of all members in each category was obtained by adding the total of the *h*-indexes and dividing the sum by the total number of the members of a category. All searches were done in alphabetical order of the first name, as listed in the BAS site. All data were stored either electronically or in printed version.



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TABLE I
H-indexes of the members of the 10 categories of the Brazilian Academy of Sciences.

	Math.	Phys.	Chem.	Earth	Biolog.	Biomed.	Health	Agrar.	Engin.	Huma
Total members	47	67	46	43	26	96	19	18	23	17
BAS per area										
Members BAS without CVL	4	10	6	7	5	8	0	3	1	1
Members BAS used	43	57	40	36	21	88	19	15	22	16
no. <i>h</i> -index	0	0	0	0	0	0	0	0	0	7
<i>h</i> -index 1–5	11	4	2	9	6	2	1	3	10	9
<i>h</i> -index 6–10	21	8	5	9	5	4	0	3	6	0
<i>h</i> -index 11–15	11	18	11	16	3	11	4	5	1	0
<i>h</i> -index 16–20	0	15	6	1	4	21	6	1	4	0
<i>h</i> -index 21–25	0	9	6	0	0	21	2	2	1	0
<i>h</i> -index 26–30	0	0	4	0	1	17	3	1	0	0
<i>h</i> -index 31–35	0	1	4	1	0	4	2	0	0	0
<i>h</i> -index 36–0	0	1	3	0	2	3	1	0	0	0
<i>h</i> -index > 40	0	1	0	0	0	5	0	0	0	0
average <i>h</i> -index	7	16	19	9	13	23	20	12	8	1

h-index average (7), ranging from one (one member) to 15 (three members). Four members (8.5%) lack a CVL, two have disclosed their *h*-index and another two provided the total citation number.

In Physical sciences (data collected between 09-15/January) there was a surprisingly high number of BAS members without CVL (14,92%). The lowest *h*-index obtained was one (two members) and the maximum 55 (one member), with an average of 16. Four members have presented their *h*-index in the CVL and another one provided the total citation number.

In Chemical sciences (data collected between 16-28/January) the average *h*-index was 19. However, no member in this category shows values above 40, with the lowest and highest values of one (one member) and 38 (two members), respectively. A great number of members (16) in this category provided the *h*-index in the CVL and another presented the number of citations. Six members (13.04%) lack a CVL.

The Earth sciences category (data collected between 08-11/March) is the second area where the minimum *h*-index number is higher than 1; three members

actively low (9). Seven members (16.28%) lack a CVL, four have disclosed their *h*-index in the CVL and another provided the total citation number.

In Biological sciences (data collected between 16-16/March) four members lack a CVL and one member list any publication on this database, being considered as lacking a CVL for the purpose of this study (five, 19,23%). The lowest and highest *h*-index are one (one member) and 40 (one member), respectively. The average *h*-index value is 13. Two have shown their *h*-index in the CVL and another provided the total citation number.

Biomedical sciences (data collected between 16-16/January-14/March) form the largest BAS category with 96 members, eight (8.33%) of which lack a CVL. This category also displays the overall highest *h*-index, ranging from four (one member) to 67 (one member) and an average of 23. This category also had the highest number (26) of scientists that presented their *h*-index in the CVL and another presented the total citation number. It should be noted that there is a comparatively higher number of Brazilian journals in ISI from the Biomedical

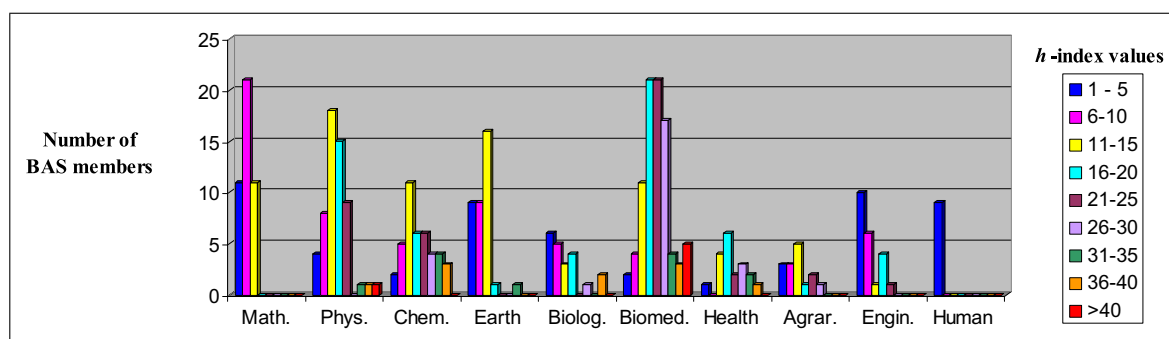
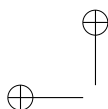


Fig. 1 – The h -index distribution in Brazilian Academy of Sciences (BAS).

ships in the BAS (data collected between 16 and 30/March). All presented a CVL, with the lowest h -index of one (one member) and the highest of 36 (one member). The average h -index is surprisingly high (20). Curiously, except for one, all have an h -index above 10 (the second lowest h -index = 13). Some BAS members in this category did not list all their publication in the CVL, some of which could be retrieved from the BAS files. Six have disclosed their h -index in the CVL, none presented the total citation number.

The Agrarian sciences have the second smallest member number in the BAS (data collected on 31/March). Three had no CVL (16,66%). The lowest and highest h -index are one (one member) and 26 (one member), respectively, and the average is 12. Two have presented their h -index, none the total citation number.

The Engineering sciences (data collected on 8/April) show the third lowest average values of h -indexes (8), with the lowest value of one (three members) and highest of 23 (one member). Four have shown their h -index, none the total citation number and only one member (4.45%) lacks a CVL.

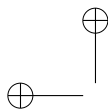
The last category, Human sciences (data collected on 8/April), is also the newest at the BAS. The h -indexes are surprisingly low, with seven members lacking any. One member shows an h -index of four, which is the highest value in this category. The average of this index considering all members is one. Only one member has presented the total citation number. another one (5.88%)

are some cases in which the author presented all combinations of how he could be cited in each listed publication, what does not reflect how he was actually cited. Cases of discrepancies regarding titles and publication dates were also found. Some changed the order of their real names or omitted middle names and there have been instances of differences between the combination of the names at the BAS and CVL databases. In one occasion the author's name was misspelled in the ISI and his paper was only found due to cross-checking between the BAS and CVL data bases. It was also noted that some authors have not provided the full list of their publication in the CVL.

Based on the publications listed at the CVL, the BAS members have a very large production but comparatively low h -indexes. A general search indicates that a significant part of the scientific output of Brazilian researchers is in periodicals that are not surveyed by ISI, which was particularly observed in Physical and Earth sciences and at a lesser extent in Biomedical sciences. The extreme situation was found in Human sciences, in which several researchers listed a numerous quantity of publications, most in books and proceedings of meetings that are not covered by ISI. The average h -index of all the categories of the BAS is 15.

DISCUSSION

The comparatively high number (45 out of 402; 11,19%) of the BAS members that do not provide their informa-



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having a CVL is mandatory in order to compete for grants at the Brazilian Scientific Council (CNPq). An age survey indicates that all scientists without a CVL are older than 57 years, but this does not necessarily confirm our previous explanation.

One striking result from our study is the remarkable variation of the h -index in all areas, which is highest in the Biomedical and Physical sciences. Except for Biomedical and Earth sciences, all other categories have at least one member with an h -index value of one. The case of Human sciences is dramatic, since seven members have no h -index at all despite their high productivity according to their CVL. The percentage of scientists with no or an h -index of one in all areas of the BAS is 2,8% and in Human sciences is 75%.

In an earlier study and using a different methodology Mugnaini et al. (2008) also observed this h -index variation in the BAS, which according to them is higher than in the members of the National Academy of Sciences of the USA (NAS). The authors pointed out that there might be other criteria for membership selection at the BAS and the possible existence of sub-areas in the same category with distinct trends of citation. Based on the present study, the authors appear to be correct in both assumptions. Regarding the first point, the final step to become a member of the BAS is to be voted by all other full members that receive a two-page information about the candidate, including honors, the five more important publications, participation in committees and a brief summary of the candidate's achievement. No information about the h -index is presented (unless specifically mentioned in the brief summary which is rarely the case), suggesting that this index is not the main criteria in the BAS selection process.

Regarding the existence of sub-areas, a brief survey among the Earth Sciences members of the BAS readily identifies two (and there are more), one related to isotope studies and other to Paleontology; the h -index of scientists active in those areas is quite distinct, favoring the former.

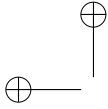
There is at least another possible explanation that can account for the large h -index variation within the

jobs, promotions) of new publications at all times. The “bakery-effect” – see comments below) in journals. The impact factor was not stressed in the same fashion nowadays. Furthermore, bibliometric indexes were not applied to evaluate a scientist's performance in these days.

The striking low h -indexes within the category of Human sciences have traditionally been explained by the predisposition of researchers in this field to the publication of their results in books, chapters, books and proceedings of meetings that do not make it into ISI. This is apparently a general characteristic of this area and not restricted to the BAS. However, in the NAS there is now a tendency to present more quantitative studies that are being published in significant journals (Mugnaini et al. 2008). The indexes are calculated within the BAS members of this area that any evaluation based on the h -index cannot even say to produce a distorted view of the field; it just does not reflect scientific performance at all.

Despite the general notion that the h -index is “here to stay” (see Ball 2007), there have been many critics of this and other bibliometric measures. There are of various nature, starting with the problem that not all relevant journals make it into ISI (Porta et al. 2007). Periodicals with high impact factors due to an editorial line more concerned with reviews than original research (e.g., Pinto and Andrade 1999). Even the initials of an author's last name has been regarded as influencing citation potential (Tregenza 1997) and double-blind review names could end up being incorrectly listed in citation databases (Lorenzini 1996), including ISI. Other indexes that could complement the h -index have been suggested (Jin et al. 2007) but are not yet applied on a larger scale.

Other problems are more concerning. According to Glänzel and Schubert (2005), researchers in countries such as the USA (who produces by far the largest amount of published papers in periodicals represented in ISI) and Germany tend to be more “nationalistic” when it comes to citation, what potentially has a negative effect on the h -index of scientists working



tionally well funded institutions provide more research facilities than new and smaller ones. This is an international problem since there are tremendous differences in resources that countries do provide for science, but also a domestic one for the same reason (i.e., different regions, different research facilities). Large labs with lots of resources have more students, more possibilities to produce science and therefore more opportunities to generate papers in the mainstream journals. Therefore, comparing scientists working in those quite distinct realities can be regarded as comparing the time achieved by swimming athletes in a 100 meter free-style competition, one in the open sea and the second in a swimming pool situated in a covered gym and having in hand a trainer and the latest “fast swimming” suit. However it must be pointed out that one should not punish researchers of high-profile scientific institutions just because they have better working conditions. Merit and achievement should always guide scientific decisions. One of the measures that could ease this situation is to provide special funds for young scientists and for those working in new and developing research institutions.

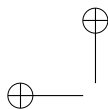
Regarding the h -index, there is not only the question of comparing scientific achievement of individuals working in countries with distinct scientific realities, but also the problematic of using ISI only. Granted, this particular database is easy to use and widely accessible. However it does not take into account that most researchers in developing countries publish in so-called local journals that, despite their good quality and strong editorial policies regarding evaluation of papers, are not considered by ISI. Keeping in mind that scientific periodicals of the USA and several countries in Europe (e.g., England, Germany) traditionally have more possibilities to join ISI, the h -index can potentially introduce large distortions when scientists of those different countries are compared, particularly if the “nationalistic effect” observed by Glänzel and Schubert (2005) is taken into account.

There is a general notion that the h -index of researchers working in distinct scientific fields is not comparable (Hirsch 2005). This was demonstrated for the

dependent of scientific performance but rather a peculiarity of one particular field. As a general example, in some (but not all) cases isotope analyses can be done in months and be significant for publication, while to excavate and prepare a dinosaur can take several years before any meaningful result can be achieved (Calvo et al. 2007). More important in our view is the amount of scientific activity in a certain field: the greater the number of scientists, the higher the chances (and the times) that a paper gets to be cited, which has a direct effect on the h -index value.

As pointed out before, one (and perhaps the main) reason of the large variation regarding the h -index among the BAS members may be a result of sub-areas within the same category that have a different publication turnover. This is quite concerning since one of the advocated advantage of the h -index is to compare scientists classified in the same scientific category. Therefore all arguments used to point out the difficulties and ineffectiveness of comparing such index from scientists of different fields does also apply in this case. We think that a profound study of each scientific field should be done in order to identify main sub-areas that should be separated at least for comparative purposes. In Earth sciences category of the BAS, Atmospheric sciences, Geochemistry and Paleontology are some of such sub-areas.

Another issue of great concern is the change in behavior that bibliometric indexes can introduce as they are applied more regularly, causing authors to adjust their publication and citation strategies, some of which being questionable. One problem is self-citation. Fowler and Aksnes (2007) have pointed out that more than 50% of the citation received by a researcher is linked directly or indirectly to self-citation. Regarding the h -index, authors can burst it up by selectively citing their own papers, giving preference to those that have not been cited very much. This practice can have an effect on researches with low h -indexes, but is more complicated to achieve as the index goes higher. A rather simplistic approach would be to eliminate self-citations from the indexes calculations (Schreiber 2007). Concerning this measure, it has been pointed out that the removal of



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in his studies? A normal consequence of scientific activities, particularly for young researchers, is to find his own scientific niche to produce original work (and avoid “stepping on others toes”). If a research group finds such a scientific slot and is making important progress that leads to several publications, is it not expected that they will use their own work in their future studies?

With the increasing competition and the inevitable obligation of a gradual higher productivity, there has been a general trend to publish smaller papers with one aspect of the research rather than longer monographs. The space reduction of high-profile journals (normally with the highest impact factors) also stimulates this behavior, even if unintentionally. This “salami-slices-science” (e.g., Ball 2007, Castiel and Sanz-Valero 2007) as a result of the need imposed by the Academia (through funding agencies, career advancement and hiring committees) to have regularly new and “fresh” publications at “all times” (what we here call the “bakery-effect”) is another problematic issue that potentially affects the *h*-index as well as other bibliometric parameters. One potential negative side effect of this situation is that researchers might not be willing to take many risks to end up without results and therefore direct his or her studies to areas where results are more guaranteed, and to focus on scientific topics that are in vogue rather than to explore new areas.

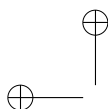
Perhaps the most effective solution that can at least minimize the unwanted “bakery-effect” might be the peer-review system of grants that could in some cases favor the originality of the problem to be investigated. In terms of publications, editors and reviewers can get more severe in pointing out if the results presented are enough to provide a significant advancement or observation to a certain scientific problem.

Still regarding the “bakery-effect”, it has been noted that plagiarism is becoming quite common, particularly self-plagiarism. This damaging behavior affects the credibility of science (as well as potentially the bibliometric parameters) and appears to be much larger than one would expect, being a rather global phenomenon (see Errami and Garner 2008 for a detailed analysis). It

that a more complete study is published subsequently which inevitable will in part repeat the main results already published. The same applies to review articles that, by definition, must represent the advancement in certain fields showing already published results. To directly address this issue, it has also to be considered significant divergences of scientific ethical concepts in different cultures. Notwithstanding those observations, we are convinced that the majority of scientists are aware of what might constitute plagiarism, including self-plagiarism. Therefore, if tools might be given to editors (which in several cases are already available) to detect duplication of papers and this becomes a standard submission procedure, most scientists that work in such a way might fear being exposed and therefore refrain from such a malpractice (Errami and Garner 2008).

Another major issue regarding publication is multi-authored papers. A random examination of the papers presented by the BAS members shows that the number of publications (particularly in certain areas) is high under this condition. This is a global phenomenon and in extreme cases, publications show dozens of authors (e.g., The International HapMap Consortium).

These multi-authored papers constitute a complex and difficult subject to deal with. On one hand, several countries have developed scientific policies to encourage international collaborations. This is also the case of the Brazilian funding agencies that also encourage domestic cooperation between developed research centers (generally placed in Rio de Janeiro and São Paulo) and smaller or new ones, particularly those located in the northern and northeastern parts of the country. This is a quite beneficial step forward for the development of science (e.g., changing know-how and experiences), being the generation of multi-authored papers an expected consequence. On the other hand, it has also been noted that, perhaps driven by the “bakery-effect”, there seems to be a more “easy-going” attitude in including a co-author in a paper that might not have provided a substantial contribution (e.g., Ball 2007), even bordering the line of standard scientific



significant advancements with interdisciplinary research that will obligatorily include researchers of different fields of expertise.

How shall one proceed regarding this issue? There are no doubts about the great number of easily recognized benefits of collaboration among scientists (particularly of different disciplines) by far outweighing the unwanted side effects. Apparently this question seems to already concern several periodicals that are now asking authors to provide information regarding their role in the published study (e.g., *Nature*, *PNAS*, *Science*, *Plos One*). This procedure is expected to be followed sooner or later by all mainstream publications. How this information might end up being evaluated is still an unanswered question. In any case, the basic notion of authorship is that the contribution to a particular research project was substantial (see Syrett and Rudner 1996) and that the results could not have been achieved in that form (or speed) without it. Therefore, one might be tempted to somehow divide the indexes attached to such a publication (e.g., the number of citations, directly affecting the *h*-index) between all authors. It would have the advantage of discouraging the inclusion of names that have actually contributed little (if anything) to the publication. If such measures are introduced, one has to avoid the damaging effect to restrain legitimate collaborations.

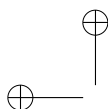
A more pressing issue that surely can burst up bibliometric indexes (including the *h*-index) is linked with scientific journals, particularly those in developing countries. As common knowledge, there are few Brazilian periodicals that take part in the ISI database (not always related to problems regarding quality). Consequently, the remarkable difference between the *h*-index of the BAS and the NAS members is not surprising (Mugnaini et al. 2008). Although differences are expected due to distinct working conditions (such as funding and infrastructure) that also includes the general importance of science within the respective societies, one might wonder how those numbers would look-like if the Brazilian periodicals not in ISI would be taken into consideration.

It has been pointed out during the review process

Although we will not address the discussion if this database (supposedly much larger than ISI) is more appropriate, we have made an exercise searching the papers of the first author (AWAK) in GS. Searching for the exact phrase “AWA KELLNER”, 238 entries were found (as opposed to 31 in ISI). As expected, the publication list includes chapters in books and articles of journals not covered by ISI. In order to calculate the *h*-index, the program “Publish or Perish” (<http://www.harzing.com/pop.htm>) was used, despite the fact that it may give only an approximate value, as it lists some references more than once whenever it finds typos in the citation (therefore potentially lowering the *h*-index). This analysis resulted in an *h*-index of 15, almost twice the one obtained by ISI (eight). Most papers listed by GS present a higher number of citations than in the ISI database such as Kellner et al. (1994). Surprisingly, in at least one instance, the listed paper shows a lower number of citations: Fara et al. (2005) was cited five times according to ISI against three times in GS. This result indicates that a more detailed analysis has to be made in order to evaluate the consequences of using GS instead of ISI for the *h*-index or any other bibliometric parameter calculation.

A survey reveals that only 27 periodicals published in Brazil are considered by ISI (JCR Science Edition 2007). The highest impact factor belongs to the Journal of Brazil Chemical Society (1.539). The periodical *Anais da Academia Brasileira de Ciências* (AABC) has an IF of 0.895 and publishes four volumes (776 pages in 2007) a year. The correspondent journal in the USA is the *PNAS* (Proceedings of the National Academy of Sciences) that has an IF of 9.64 and publishes 52 volumes a year (21.021 pages in 2007). It is easy to realize the brutal differences between those journals.

If bibliometric indexes (including the *h*-index) are the way to go, what can be done to make the scientific output of developing countries such as Brazil more accessible worldwide? Having in mind that it is natural for scientists to publish a significant part of the research outcome in the country where they live, and considering that it might not be of best interest for a country to



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nals), the solution is to make national periodicals more competitive and to be considered by ISI. Despite the fact that Brazilian funding agencies have a program for national periodicals, presently it seems that the “cake” is being split evenly, without much consideration of the journal’s importance or efforts to meet higher international standards. This would not be a problem, if the “cake” would be large enough, what is not the case. Since there is an increasing tendency to apply bibliometric factors to evaluate scientific performance, why not consider them when decisions are made for funding periodicals? Just as an example, the resources recently approved by the CNPq to support the AABC (of free access at www.scielo.br/aabc) provide less than 40% of the total costs. Periodicals that cannot find additional support (luckily not the case of the AABC, at least for the next years) have to adapt, reducing the number of issues or finding other publication alternatives (e.g., changing from printed to fully on-line versions, reducing staff).

At the same time, there must be a change in attitude of some journals regarding their editorial policies. There is no doubt that English is the current *lingua franca* of science and even countries where the language barrier is large (e.g., China) are working to adjust their main scientific periodicals to this reality. Therefore periodicals should provide editorial help by a professional fluent in English to assist editors and authors in improving the language of the manuscript after its acceptance. Furthermore, periodicals should make an effort to attract important papers, always keeping rigorous editorial standards for quality control. One of such attempts has recently been made by the AABC, whose outcome remains to be evaluated (Kellner and Meneghini 2008).

CONCLUDING REMARKS

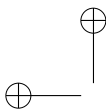
Evaluation of a scientist’s performance has been done in the past and will continue to be done in the future. In a world with limited resources competition is inevitable and scientists hope that comparisons are fair and less subjective as possible. In order to assist those responsible for such evaluations, bibliometric indexes have been introduced based on the notion that the pub-

lures are becoming imperative, the British government has announced that all funding assessments for universities will be based solely on such measures after 2007 (Ball 2007). An example from Brazil is the study by Packer and Meneghini (2006), who analyzed the most cited papers with at least one author affiliated to a Brazilian institution and used this information to subsequently identify nuclei of excellence in the country (Meneghini and Packer 2006). From all indexes, the *h*-index is regarded as the most interesting one, and is very used in Brazil.

Notwithstanding, there are limitations in the use of the *h*-index. The *h*-index is currently obtained that must be taken into account, and it seems problematic to evaluate a scientist’s performance solely on this index. According to Kellner (2005), a membership of the National Academy of Sciences of the USA may be associated with an *h*-index of 45. If such a value would be applied for the Brazilian Academy of Sciences, the total membership would resume to five members. Just as an exercise, even if this number would be reduced down to an *h*-index of 10, 35% of all present members would not have been elected, including the mathematicians, engineers and researchers of the physical sciences. The situation of Human sciences is even worse and no current BAS member of that field would have been admitted.

Interestingly an *h*-index of 10 would have no effect in the membership of Health sciences (see Table I). The reason for that is unknown, but it is possible that Brazilian scientists of that field are more “adapted” to this index, concentrating their publication in periodicals present in the ISI database.

As pointed out before, the base of the *h*-index and other bibliometric parameters is ISI. This poses a problem for the Brazilian scientific community since there are only a few journals printed in the country indexed by this database and perhaps one explanation is the comparatively low *h*-indexes of scientists of the BAS despite their high productivity. An interesting exercise might be to examine the total publications of prominent Brazilian scientists and compare them with the leagues of the USA (and perhaps also from other



(including Brazil) want to compete regarding bibliometric indexes, their government must find a way to provide not only more funding for science in general, but also to invest in scientific periodicals published in the country, aiming to be included in ISI. In the case of Brazil, although it is important to encourage researchers to publish in mainstream journals abroad, it is paramount to make national periodicals part of those mainstream journals. Hiring professional editors that are perhaps less passionate and might be in some cases more objective in accepting or refusing contributions is one way to go. At the same time there is a need of a competent staff which must include professionals fluent in English to assist editors and authors in improving the language of the manuscript after its acceptance.

Another important measure which does not only concern Brazilian researchers is to provide ways to include books and chapters in ISI (as long as this database will continue to be used to calculate bibliometric indexes). This would be a step forward not only for Human sciences, where the *h*-index is useless (at least for the BAS), but for several other areas as well since many relevant and original work is published (and cited!) in such publications.

The necessity to join the ISI for what one can say “survival” has moved journals to organize and attract important papers. Some initiative, such as asking authors that publish in the periodical to cite other articles of that periodical (e.g., Plasência 2002), should be avoided, coming quite close to the line of scientific ethics.

Another problem regarding citations that has bearing on the *h*-index is the apparent “bad habit” of several Brazilian researchers active in the field of Chemical sciences not to cite their own Brazilian colleagues (Pinto and Andrade 1999). If this malpractice and unwise attitude (to say the least) is a general trend in the country, we would have the worst of the worlds regarding any bibliometric measurement. The firm action of the editor and the peer-review system might avoid such “habits” to prosper.

A last topic that we would like to address: how shall a scientist in modern times advise his students?

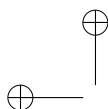
ralist would be active today, he might have published his most famous work about the origin of species quite faster and due to the “bakery-effect” perhaps in dozens of papers and not in a book. That if, of course, he would have gotten a five-year grant to travel around the world to make his studies being a young and unknown scientist at that time.

ACKNOWLEDGMENTS

Rogério Meneghini (BIREME, OPAS-OMS and USP, São Paulo), Ronaldo Fernandes (Museu Nacional/UFRJ), Alcides Sial (UFPE), Douglas Riff Gonçalves (Universidade Estadual do Sudoeste da Bahia), Diogenes de Almeida Campos (Museu de Ciências da Terra/DNPM), and Waltécio de Oliveira Almeida (Universidade Regional do Cariri – URCA, Ceará) are thanked for incentive and criticisms regarding this paper. Fabiana Rodrigues Costa (Museu Nacional/UFRJ) is thanked for the revision of the language. Funding was provided by the Fundação Carlos Chagas Filho de Amparo à Pesquisa do Rio de Janeiro (FAPERJ, #E-26/152.885/2006) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, #304965/2006-5). Luiza Ponciano also acknowledges the Master fellowship of the CNPq.

RESUMO

Índices bibliométricos estão sendo utilizados como ferramentas na avaliação do desempenho de cientistas, sendo o índice *h* o mais empregado atualmente. Com o propósito de tecer considerações sobre o índice *h* de cientistas brasileiros, foi realizada uma análise do mesmo entre os membros titulares da Academia Brasileira de Ciências (ABC). Foram calculados os valores do índice *h* para os 402 membros titulares separados nas 10 áreas do conhecimento distintas listadas pela ABC. Concomitantemente os trabalhos de cada pesquisador foram conferidos através da comparação com os currículos apresentados na Plataforma Lattes. Apesar da grande produção científica, a maioria em jornais sem fator de impacto, os índices *h* dos membros da ABC demonstram uma grande variação em todas as 10 áreas, particularmente nas Ciências Biomédicas e Físicas. As maiores médias do índice *h* foram encontradas nas Ciências Biomédicas, da Saúde e Químicas; os menores



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blicação (*the bakery-effect*), diversos problemas relacionados são discutidos. A conclusão principal deste estudo corrobora a necessidade de países em desenvolvimento, como o Brasil, investirem em periódicos científicos nacionais, possibilitando a incorporação gradual dos mesmos nas principais listagens dos periódicos com fator de impacto, causando um efeito positivo sobre os índices dos pesquisadores atuantes no país.

Palavras-chave: cienciometria, índices bibliométricos, índice *h*, Academia Brasileira de Ciências.

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