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Perceptions of Latin American scientists about science and post-graduate education: Introduction to the 5th issue of *CBP-Latin America*☆

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ABSTRACT

Although science and engineering (S&E) publications and doctoral degree awards in Latin America had experienced an impressive growth in the past decades, a qualitative evaluation of this increased output must be performed. Previous studies have indicated that growth in visibility of Latin American science – determined by ratio of citations per paper – has not kept pace with the increase in number of publications. In the present editorial, we analyzed – by means of a 12-item questionnaire – the individual perceptions of forty senior researchers involved in *CBP-Latin America* (29 Brazilians and 11 non-Brazilians) plus a special group composed by six extraordinary Latin American scientists (the "masters"). The questionnaire – using 6-point Likert-like scale for quantification of perception – focused on issues surrounding doctoral educational system as well as the governmental educational policies and publication pressure from funding agencies. In general, the most striking result was the perception (by 82% of respondents) of lack of job opportunities for people holding a PhD diploma in the field of comparative biochemistry and physiology. Other major trends include (i) lack of satisfaction with governmental policies for science and post-graduate education due to policies promoting mass production for papers and PhD diplomas (65–77% of respondents felt that way) (ii) that current PhD students are doing an adequate job, but have not improved in quality as compared to those from 10 years ago (the same was observed for PhD thesis in terms of present *versus* past), and (iii) that research infrastructure and the curricula of post-graduate courses do not constitute a problem, but (iv) recent-PhDs are not as fit as they should be in paper-writing skills, especially as perceived by Brazilian respondents. The general perceptions were very similar among Brazilians, non-Brazilians and "masters". The use of a larger study-population, with scientists of more diverse fields is the next logical step to best evaluate the level of satisfaction about science and post-graduate policies in the continent. Finally, this fifth and last special issue of *CBP-Latin America* celebrates the contribution of 20 new manuscripts, which adds up to 118 published studies highlighting the depth, breadth and enthusiasm of Latin American comparative biochemistry and physiology — enjoy.

1. Preface

This is the 5th and last volume of the project *CBP-Latin America*, where 118 original papers and 5 editorial articles (including this) were published by many authors from several countries from Latin America. The original idea behind this ambitious project (which started in mid 2004) was presented in our first editorial article, by Hermes-Lima and Navas (2006). The second to fourth volumes of *CBP-Latin America* were introduced by Zenteno-Savín et al. (2007), Navas and Freire (2007), and Hermes-Lima et al. (2007a), respectively, each focusing on relevant aspects surrounding science, specifically comparative science, while also introducing the topics of the individual studies.

The current issue presents twenty publications in the field of comparative physiology and biochemistry (CPB); see more about *CBP-Latin America* in Section 6. Before presenting the studies themselves, we shall discuss the perceptions of scientists – those involved in this editorial project – about the facts and policies of science and post-graduate education in Latin America.

2. Science and post-graduate education in Latin America

In recent years, the scientific growth experienced by Latin American countries in the last 10–15 years has been broadly discussed, particularly, considering the increased number of publications in science and engineering (S&E) and S&E doctoral degrees awarded in this period

☆ With the special participation of Natacha C. Santos, CNPq, Brasília, Brazil.

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(Glanzel et al., 2006; Hermes-Lima et al., 2007a,b). The number of Latin American publications (in Pascal database) increased from 6994 in 1990 to 17,919 in 2004, reaching a share 3.4% of the world's scientific publications compared to only 1.8% in 1990 (Science Watch, 2001; Hill, 2004; Hermes-Lima and Navas, 2006; Hermes-Lima et al., 2007a,b). In addition, looking at the absolute number of papers in all academic areas, Brazil – the largest nation in Latin America – reached the 17th position in a 10-year coverage (see Table 1).

Moreover, the number of S&E doctoral degrees awarded in Latin America increased from a total of 1695 to 7815 from 1990 to 2004. The expectation of continued increases of these parameters in the coming years remains high (Science Watch, 2001; Hill, 2004; Triunfol, 2007). Between 1976 and 2004, the number of Brazilian post-graduate programs (for MSc and PhD) increased in a vigorous manner, from 673 to 2993 courses in different fields — an increase of 5.5% per year (CAPES, 2004). Moreover, in accordance with the current *Brazilian National Plan to Post-Graduate Studies* (2004–2010), the graduation of 45,000 and 16,000 Masters and PhDs, respectively, is expected in the year 2010 alone (see Table 2 for number of PhD diplomas in several countries). The increased number of doctoral awards and the current accountability expectations might be explained by an attempt to diminish the cumulative deficit of doctoral graduates in Latin American countries in relation to developed ones. In fact, even taken into account these recent efforts and discounting the effect of "Brain-Drain" (emigration of scientists; see Saravia and Miranda, 2004), the quantity of researches in the European Union, Canada and USA (in 2002–2004) was 2439, 3922 and 4605 per million inhabitants, respectively. By comparison, this number is only 261 in Latin America and the Caribbean (in 2002), even after the 4.6-fold increase in Latin American S&E doctoral degrees from 1990 to 2004 mentioned above (UNESCO, 2005; Hermes-Lima et al., 2007a).

When looking at the scenario discussed above, and only evaluating the absolute growth in numbers of S&E publications and PhD diplomas, Latin American science and post-graduate education seems to be moving forward along the right tack. However, looking at the concepts of visibility and recognition of science, as defined by Leta and Chaimovich (2002), for example the ratio of citations per paper (CpP), a bit of disappointment arises. The increased scientific performance (as publication output) of Latin America during the past 10–15 years was not paralleled by an increase in recognition (or visibility), as demonstrated by a small increase in CpP over time (Hermes-Lima et al., 2007b). In fact, the rate of growth of CpP per year was about 3 fold smaller in Brazil and Mexico than that obtained by Spain or Australia. Moreover, developing nations are also lagging behind in absolute values of CpP compared to developed nations (see Table 1). In the case of Brazil, the increase in paper output has not been matched by increased visibility (Glanzel et al., 2006), "making it important to devise policies to increase the quality of Brazilian scientific output" (Loureiro and Augusto, 2008).

Table 1
Publications and citations per paper (CpP) among selected nations in 1997-to-2007

	Papers	CpP
Selected developed nations ranked by CpP		
Switzerland (16)	159,667	14.32
USA (1)	2,864,275	13.63
Denmark	87,496	12.91
Netherlands (12)	220,881	12.85
Iceland	3964	12.52
Sweden (15)	168,574	12.18
England (4)	653,177	12.18
Finland	82,001	11.57
Canada (7)	393,143	11.14
Germany (3)	738,067	10.75
France (5)	529,636	10.22
Australia (11)	249,892	9.77
Italy (8)	371,205	9.68
Japan (2)	777,992	8.50
Spain (10)	270,139	8.32
Selected developing nations ranked by CpP		
Mexico (1996 to 2006)	57,602	5.54
Brazil (17)	137,159	5.25
South Korea (14)	192,361	5.22
Argentina (1994 to 2004)	40,438	5.17
India (13)	215,847	4.15
China (6)	471,890	4.02
Russia (9)	275,945	3.83

Source: In-cites, December 2007 (http://www.in-cites.com/countries/2007allfields.html). Number in parenthesis indicates the world rank – 1st to 17th – in the amount of papers for the period 1997–2007.

Table 2
PhD defenses (in all areas) in selected countries[a]

	1990	2000	2005	Increase 1990/2000	Increase 1990/2005
Brazil	1410	5335	8987	3.8 fold	6.4 fold
Chile	29	83	222	2.9 fold	7.7 fold
Mexico	201	1035	1783	5.1 fold	8.9 fold
Colombia	6[b]	28	60	–	10 fold
Cuba	233	291	440	1.2 fold	1.9 fold
USA	38,277	44,947	52,855	1.2 fold	1.4 fold

[a] Source: http://www.ricyt.edu.ar/indicadores/comparativos/20.xls.
[b] 1998.

A comparison of CpP in specific areas of knowledge also shows frustrating trends: the average CpP values for G7 and three Latin American countries (Brazil, Mexico and Argentina) in the area of biology and biochemistry are 15.2 and 5.1, respectively. In molecular biology and genetics, average CpP values are 24.3 for G7 countries and 7.0 for Brazil, Mexico and Argentina, respectively (Hermes-Lima et al., 2007b).

As in the case of publication output, a comparative evaluation of post-graduate programs in Latin America is an urgent necessity. Governments produce complex peer-based evaluations and some are available on the web (e.g., www.capes.gov.br). In Brazil, post-graduate programs are required to submit biannual reports that are evaluated by a group of experts in each specific area (Spagnolo and Souza, 2004). However, the perception of scientists regarding governmental policies of post-graduate science education, the science educational system and its efficacy, are not evaluated.

In this study, we investigated the perception of senior Latin American researchers in the area of CPB about several issues surrounding the post-graduate educational system (including academic performance of PhD students and quality of PhD theses), as well as the governmental educational policies and publication pressure from funding agencies. This study was based on a questionnaire sent to over 200 senior researchers involved in the *CBP-Latin America* project (40 replies were obtained), plus a special group of six extraordinary senior Latin American scientists. The results were quite surprising.

3. Methodology

This paper is based on a broad survey about the profile, perceptions and backgrounds of senior comparative physiology and biochemistry (CPB) researchers – defined as those coordinating a research group – involved with the project *CBP-Latin America* (2004 to 2007). An interview-questionnaire was developed and e-mailed to 204 researchers from Latin American countries involved in the *CBP-Latin America* project, either as authors and/or referees. 122 Brazilians and 80 non-Brazilians received the questionnaire in Portuguese or Spanish, respectively. We obtained replies from 29 Brazilians and 11 non-Brazilians (24% and 14% of each "population", respectively). The non-Brazilians respondents were from Chile ($n=2$), Mexico ($n=4$) and Argentina ($n=5$). Of the Brazilian respondents ($n=29$), ten were from the State of São Paulo, which is responsible for 1/3 of Brazilian GDP (researchers from São Paulo were major contributors in *CBP-Latin America*; Navas et al., 2007). The other Brazilians were from Distrito

Box 1

What is expected for a good young scientist?

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We queried the participating researchers (in this survey) how they define a successful world-class young scientist in the context of Latin American reality. They were free to write as much as they wanted. About 56% (from 43 that sent written comments) understood that a good young scientist should be able to formulate relevant questions. Moreover, they should be capable to workhard, execute the project properly and understand the results and implications (43% of replies). They should have an excellent knowledge (means = reading!) of their area (35% of replies).

In addition, it is quite understandable that thirteen respondents (30%) answered a scientist should be able to write well. In the 12-item questionnaire, 70% agreed that writing skills are not adequate for recent-PhDs (Q12). Others qualifications were included as creativity (16%), academic independence (21%), ethic (14%), involvement with graduated student supervision (21%) and a critic view of science (19%). Finally, it was interesting that only a few respondents mentioned previous scientific formation during undergraduate/post-graduate years, even though most respondents judged (see Q4) they had a solid science education. Thus, we may conclude that a future great scientist rise with his capacity, creativity, study, dedication and acquisition, that is, on his on. In the words of one respondent: "a young scientist should be critic, devoted, autonomous and innovative" (in the words of another respondent: "a bit of luck should not hurt"). Such scientist-to-be should also be devoted to the new frontiers of knowledge and, so how, contribute with the needs of our communities.

One of the "masters" (geneticist Darcy Fontoura de Almeida) prepared a note from Chargaff (1978) – a famous biochemist – that clearly defines the sensations when working on science. These sensations are the ones that bring out the real scientist:

> "It is the sense of mystery that, in my opinion, drives the true scientist; the same force, blindly seeing, deafly hearing, unconsciously remembering, that drives the larva into the butterfly. If he has not experienced, at least a few times in his life, this cold shudder down his spine, this confrontation with an immense, invisible face whose breath moves him to tears, he is not a scientist. The blacker the night, the brighter the light…".

Federal (n=5), Rio de Janeiro (n=4), Rio Grande do Sul (n=3), Paraná (n=2), Minas Gerais (n=2) and one each from Rondônia, Piauí and Santa Catarina.

The questionnaires were also sent to six Brazilian researchers (from biological/biochemical areas) identified as extraordinary scientists with exceptional knowledge and understanding about the situation of science and/or post-graduate education in the continent. All of them (called "masters") sent in responses.

The questionnaire had 12 affirmatives and the respondents had to mark 1 to 6: 1 if disagree 100% with the affirmative or 6 if agree 100%. Using this 6-point adaptation of the classic 5-point Likert scale (Sé et al., 2008), we can roughly divide two major groups of answers: those who "agree" (scores 4 to 6) and those who "do not agree" (scores 1 to 3). This is a way to avoid "neutral answers", which happens when people score 3 in a 5-point Likert scale.

In addition to the questionnaire, respondents (CPB researchers and "masters") were asked to freely answer the question: "How do you define a successful young scientist?" This is explored in Box 1.

4. Results from the questionnaire

Q1. ***Post-doctoral professional market***

The post-doctoral professional market, in my area of research and in my country, is currently excellent (this excludes governmental fellowships to work in the university or elsewhere). Negative impression (low scores, 1–3), positive (high scores, 4–6).

Scores	**1**	**2**	**3**	**4**	**5**	**6**	N.A.	**1 to 3**	**4 to 6**
n	19	6	8	5	1	1	0	**82.5%**	17.5%

N.A.: No answer (the same for Q2 to Q12). The mode-score was underlined (the same for Q2 to Q12).

Q2. ***Publication pressure***

The biggest pressure for publication (from governmental funding agencies), in my area and in my country, is for quality and not for quantity of papers.

Scores	**1**	**2**	**3**	**4**	**5**	**6**	N.A.	**1 to 3**	**4 to 6**
n	9	9	8	8	4	2	0	**65.0%**	35.0%

Q3. ***Governmental policies for post-graduate programs***

I am fully satisfied with the federal policies for evaluation and regulation of post-graduate programs, in my area and in my country.

Scores	**1**	**2**	**3**	**4**	**5**	**6**	**N.A.**	**1 to 3**	**4 to 6**
n	7	15	9	6	2	1	0	**77.5%**	22.5%

Q4. ***"My formation"***

During my formation as a PhD student (and/or MSc student) I was part of a solid line of investigation in the laboratory I worked for.

Scores	**1**	**2**	**3**	**4**	**5**	**6**	**N.A.**	**1 to 3**	**4 to 6**
n	2	2	1	3	10	20	2	13.2%[a]	**86.8%**[a]

a: Percentages were based in n=38. The 40 researchers finished the PhD thesis 17.0±10.1 (mean±SD) years ago.

Q5. ***PhD students: present-day***

The present-day PhD students in the post-graduate courses I work for (or collaborate with), in my area, have a very good student-profile.

Scores	**1**	**2**	**3**	**4**	**5**	**6**	**N.A.**	**1 to 3**	**4 to 6**
n	0	7	11	11	6	4	1	46.2%[b]	**53.8%**[b]

b: Percentages were based on n=39.

Q6. ***PhD students: present versus past***

Present-day PhD students in the graduate courses I work for (or I collaborate with), in my area, have a student-profile that is notably better than those from 10 years ago.

Scores	**1**	**2**	**3**	**4**	**5**	**6**	**N.A.**	**1 to 3**	**4 to 6**
n	10	8	9	4	5	2	2	**71.1%**[a]	28.9%[a]

a: Percentages were based on n=38.

Q7. ***Infrastructure***
The infrastructure conditions in the graduate program I work for (or collaborate with) are totally satisfactory.

Scores	1	2	3	4	5	6	N.A.	1 to 3	4 to 6
n	4	7	8	11	7	3	0	47.5%	**52.5%**

Q8. ***Graduate course curricula***
The graduate course curricula in my area and my institution are in agreement with the modern contexts of research (in science and technology) and development.

Scores	1	2	3	4	5	6	N.A.	1 to 3	4 to 6
n	2	3	9	8	13	5	0	35.0%	**65.0%**

Q9. ***Supervising PhD theses***
The supervising of PhD theses in the graduate program I work for (or collaborate with) are very well conducted by the majority of our professors.

Scores	1	2	3	4	5	6	N.A.	1 to 3	4 to 6
n	3	4	7	13	7	5	1	35.9%[b]	**64.1%**[b]

b: Percentages were based on $n=39$.

Q10. ***Paper-writing skills***
Those with a recently awarded PhD degree (obtained in the last 3 years), in my area and in my institution, are able to write papers of excellent quality, covering relevant scientific issues.

Scores	1	2	3	4	5	6	N.A.	1 to 3	4 to 6
n	6	11	10	4	7	1	1	**69.2%**[b]	30.8%[b]

b: Percentages were based on $n=39$.

Q11. ***PhD thesis: present-day***
The PhD theses defended in the last 3 years, in my area and in my institution, are of very good quality

Scores	1	2	3	4	5	6	N.A.	1 to 3	4 to 6
n	2	5	7	16	6	3	1	35.9%[b]	**64.1%**[b]

b: Percentages were based on $n=39$.

Q12. ***PhD thesis: present versus past***
The PhD theses defended in the last 3 years, in my area and in my institution, are considerably better than those from 10 years ago?

Scores	1	2	3	4	5	6	N.A.	1 to 3	4 to 6
n	6	9	8	9	5	2	1	**59.0%**[b]	41.0%[b]

b: Percentages were based on $n=39$.

5. Discussion

The results from the questionnaires showed some clear trends among respondents in fields of comparative physiology and biochemistry (CPB). The most striking is the lack of job opportunities for people holding PhD degrees in the areas of CPB, either in the university or private sector (Q1). This observation *may not be* caused by low quality of recently awarded PhD degrees. Although 64% of senior respondents (scores 4 to 6, Q11) believe that current PhD theses are of good quality (mode-score was 4 for Brazilians and non-Brazilians, Table 3), 59% of them (scores 1 to 3, Q12) noted that current PhD theses are not better than those from 10 years ago. About 54% of respondents (scores 4 to 6, Q5) express the opinion that PhD students in the CPB field are doing a good job, but it is important to stress that respondents also strongly believe (71% scored 1 to 3 in Q6) that current PhD students are not best fit for their work/studies than those from 10 years ago. In addition, almost 70% of respondents (scores 1 to 3, Q10) judge that writing skills of the majority of recent-PhDs (post-doctoral fellows with a recent-PhD degree) are inadequate. This result was biased by the lower scores of Brazilians, since they represent about three quarters of respondents. When looking at the mode-scores for Brazilians and non-Brazilians, the higher satisfaction among non-Brazilians becomes clear (see Q10 in Table 3).

Table 3
Average and mode-scores for Brazilians and non-Brazilians in the CPB fields

	All* mean±SD (n=38–40)	All* mode	Brazilians mean±SD (n=27–29)	Brazilians mode	Non-Brazilians mean±SD (n=11)	Non-Brazilians mode
Q1	2.15±1.35[a]	1 (19)**	2.14±1.36[a]	1 (14)	2.18±1.40	1 (5)
Q2	2.88±1.49[a]	1,2 (9,9)	2.72±1.46[a]	2 (8)	3.27±1.56	3,4 (3,3)
Q3	2.60±1.24[a]	2 (15)	2.62±1.32[a]	2 (10)	2.55±1.04	2 (5)
Q4	5.03±1.44[c]	6 (20)	4.96±1.56[c]	6 (15)	5.18±1.17	5,6 (5,5)
Q5	3.72±1.23[b]	3,4 (11,11)	3.50±1.29[b]	3 (9)	4.27±0.91	4 (5)
Q6	2.79±1.54[c]	1 (10)	2.74±1.65[c]	1 (9)	2.91±1.30	2 (4)
Q7	3.48±1.43[a]	4 (11)	3.52±1.48[a]	4 (9)	3.36±1.36	3 (5)
Q8	4.05±1.36[a]	5 (13)	3.90±1.42[a]	5 (9)	4.45±1.13	5 (4)
Q9	3.82±1.41[b]	4 (13)	3.59±1.49[b]	4 (8)	4.10±1.22	4 (5)
Q10	2.95±1.41[b]	2 (11)	2.75±1.35[b]	3 (9)	3.45±1.51	5 (4)
Q11	3.72±1.26[b]	4 (16)	3.50±1.32[b]	4 (11)	4.27±0.91	4 (5)
Q12	3.10±1.45[b]	2,4 (9,9)	3.04±1.55[b]	1,3,4 (6,6,6)	3.27±1.19	2 (4)

*: "All" stands for Brazilians and non-Brazilians in the survey (n=40). **: In parenthesis is the number of respondents giving a specific score — in the case marked above 19 researchers marked 1 (disagree 100%) in Q1. a: n=40 for "All" and n=29 for Brazilians, b: n=39 for "All" and n=28 for Brazilians, c: n=38 for "All" and n=27 for Brazilians.

In contrast, respondents feel that infrastructure for research and post-graduate studies are fair enough for their needs — the majority scored 4 in Q7 (among non-Brazilians the mode-score was 3, suggesting less satisfaction). Differences in research infrastructure need to be taken into account when evaluating academic efficacy among post-graduate programs across regions and/or countries (see correlation studies below). The respondents are also confident that PhD student supervising work is adequate in their institutions (64% scored 4 to 6 in Q9), as well as the graduate program curricula (Q8). The majority of respondents believe that they had a solid science education when they were students — about 3/4 of them marked 5 or 6 in Q4. This suggests that these senior researchers in the CPB fields have a strong standpoint about what is good science and adequate post-graduate education. Nevertheless, a much deeper and less personally biased understanding about this matter is needed. There are several aspects to be considered, including the relationship between scientists and productive forces, and other relevant socio-economic influences, such as the researcher origin (as a person) and the cultural context involved in their formation as PhD students or post-doctoral fellows (Sousa, 1993; Velloso, 2003, 2005; Trigueiro, 2001).

5.1. Perceptions about governmental policies for science — publication pressure

Taking into consideration (i) the immense effort by governmental agencies dedicated to regulate, stimulate and improve post-graduate courses in Latin America (CAPES-Brazil, for example), and (ii) that research conditions (as laboratory infrastructure), disciplines in post-graduate courses and supervisorship are considered (by the respondents) to be in adequate/good conditions, we wonder why present-day recent-PhDs and PhD students in CPB are not best fit for their work/studies as compared from those from the past. Based on the

responses, we cannot conclude that present-day PhD students and recent-PhDs are doing "worse" than those from 10 years ago, but many respondents scoring 1 or 2 in Q6 (18 out of 38) and Q12 (15 out 39) sent a "message" in that direction.

Why are recent-PhDs – as suggested by respondents – handicapped in their paper-writing skills? One of the reasons for this could be the pressure from funding agencies – during evaluation of research projects or fellowship applications – for number of publications instead of quality-evaluation. In agreement, 65% of respondents of CPB (scores 1 to 3 in Q2) feel major pressure for mass-producing science (and papers). The group of non-Brazilian respondents senses considerably less publication pressure (in quantity) than Brazilians: the most frequent scores for Brazilians and non-Brazilians were 1–2 (55% of scores) and 3–4 (54% of scores), respectively (see Table 3). Even the small group of "masters" feels high pressure for mass production of papers (see Q2 in Table 4). This matter is very important if we consider researchers from different academic areas in Latin America, including other biological sciences, physics, chemistry, medicine, engineering and social sciences. One has to wonder whether they share the same perception of high pressure for quantity at the expense of quality?

It would be reasonable that the more PhD students and recent-PhDs practice paper writing, the better they should get. Thus, mass production of papers could be seen as positive on improving writing skills. Surprisingly, quite the opposite is sensed by respondents (Q2). We may speculate that when people have to write so many articles in limited time, there are less creative thoughts, less judgment and, perhaps, little care. Publication of "*fast-food articles*" may also be "helped" by the increasing number of new science journals every year, and publishers and editors eager to get publications for their journals with little care for quality. The result may just create an attracting "magnetic force" that is not good for young scientists and for science in general (this "force" might also be part of the explanation for the gigantic increase in paper output of Latin American countries over the last 10–15 years[1]).

Pressure based on number of publications has been discussed elsewhere and suggested as a major cause of anxiety and stress among scientists, especially young scientists (Aranda et al., 2003; Barcinski, 2003; Louzada and Silva-Filho, 2005; Zenteno-Savín et al., 2007). Thus, as discussed above, pressure for mass-publication appears to have a negative effect, instead of helping students or post-doctoral fellows to master scientific writing. It is quite common in Brazil and Mexico (at least among researchers in CPB and other areas of biology and biomedical sciences) that senior researchers write the manuscripts of their PhD students and post-doctoral fellows (this is based in informal conversations with many researchers in various fields of biochemistry, molecular biology and physiology), since they are all in need for numbers (of papers) in their CVs. We did not include a question in the questionnaire whether or not senior researchers are the ones actually writing the papers of students or recent-PhDs for ethical reasons; it would have been quite uncomfortable for them to admit they are doing so. The art of paper writing has been discussed by many articles and books and there is no agreement of an exact "formula" for that. For example, disagreement among authors regarding interpretation of results and the discussion of the data has been pointed by as a major problem for paper writing (Horton, 2002). Thus, it is critical that PhD students get involved as soon as possible (in their laboratory life time) in this process (for example, see: Howard et al., 2006). If current PhD students and recent-PhDs do not master their skills of critical experimental design and paper writing, when the current generation of senior scientists retires, the next generation might become handicapped in supervising and coaching[2] the following generation of Latin American students. In addition, funding agencies, at least in Brazil, have increasingly restricted financial support for pursuing doctoral studies abroad (in developed countries). How could a Brazilian PhD student master the *lingua franca* of science (which is English; Meneghini and Packer, 2007; Vasconcelos et al., 2008) if he or she cannot spend a few years in an English-speaking country?

Table 4
Individual scores, means and mode-scores for "masters" ($n=6$)

	OO[a]	DD	RR	HH	VV	BB	Mean±SD	Mode
Q1	2	2	2	5	2	1	2.33±1.37	2
Q2	2	4	2	2	4	2	2.67±1.03	2
Q3	3	1	2	5	4	2	2.83±1.47	2
Q4	5	6	5	6	4	3	4.83±1.17	5,6
Q5	2	5	4	4	5	5	4.17±1.17	5
Q6	2	5	Not	2	5	4	3.60±1.52	Not clear
Q7	5	4	5	5	3	6	4.67±1.03	5
Q8	3	6	1	3	6	2	3.50±2.07	Not clear
Q9	4	4	2	4	5	4	3.83±0.98	4
Q10	2	3	2	4	3	2	2.67±0.82	2
Q11	3	4	2	4	4	4	3.50±0.84	4
Q12	3	5	Not	2	5	4	3.80±1.30	5

[a]OO, DD, RR, HH, VV and BB are tags for the "masters". Not: Not answered.

5.2. Perceptions about governmental policies for post-graduate education

Publication pressure by science funding agencies is just part of the problem. Respondents are also quite dissatisfied with the way post-graduate programs are evaluated and regulated by federal agencies — those dedicated to post-graduate education (Q3). This is perceived among non-Brazilians, and more heavily among Brazilians: non-Brazilians scored mostly 2 or 3 in Q3 (9 out of 11), while 55% of Brazilians scored 1 or 2 in Q3 (see Table 3). Low scores for Q3 were also observed in the group of "masters" (Table 4).

Moreover, pressure by educational agencies from federal governments target mostly higher publication output (in Brazil the current pressure is to publish papers in journals with a "minimum cut-off" in terms of impact factors – see footnote[3] – committees in each field decide the cut-off limit), and the reduction in the duration of PhD programs: from 6–7 years to 4 years. In many cases, these education agencies target the end of Masters programs, therefore people could obtain a PhD diploma 8 to 9 years after finishing high-school — Mexico is currently starting this policy (Gutiérrez et al., 2004; Martos, 2005; see also: http://www.posgrado.unam.mx/). In Brazil, the federal government also targets an increase in the number of post-graduate courses across country and high publication output from those involved in these courses (professors and students). In support that this kind of policy is widely taking place is the exponential growth in the number of PhD diplomas awarded in Brazil and Mexico in recent years, especially in the areas of engineering, medicine and natural sciences (Hermes-Lima et al., 2007b; UNESCO, 2005). However, the less time students dedicate to post-graduate scientific education, the scarcer the opportunity for training and mastering the ability of conducting 'science' and writing papers.

In Table 3 the average scores for the 12 items in the questionnaire are essentially the same for Brazilians and non-Brazilians (the correlation analysis of average values resulted in $R^2=0.85$, $n=12$),

[1] Listen to Hermes-Lima's podcast (in Portuguese) on this subject at: http://cienciabrasil.blogspot.com/2008/03/podcast-episdio-03-publicaes-cientficas.html.

[2] The role of the supervisor is reminiscent of that of a football coach. He or she must be a person with experience and know the tricks of the trade, must be strategically (and politically) astute, must be able to see the 'big picture' and have the ability to open the minds of young students and keep the pace (in terms of stimulus), while continuously challenging the senior PhD students and recent-PhDs.

[3] For a discussion of the 'value' of the impact factor to evaluate scientific excellence of an individual scientist, see the Introduction to the 4th volume of *CBP Latin America* (Hermes-Lima et al., 2007a).

even though mode-scores suggest a little less satisfaction among Brazilians — except in the case of research infrastructure. Mode-scores for the group of "masters" (Table 4) were also similar to other respondents (Table 3), except for Q7 ("masters" have better infrastructure than average researchers in the continent), Q6, Q8 (no trend was obtained in these two cases for "masters") and Q12 (even though the mode-score for "masters" was 5, the average score was similar in comparison with other respondents).

Taking into consideration that the *CBP-Latin America* project (see Section 6) involves international cooperation, this issue should be spelled out. Although scientific collaboration between developed and developing nations is highly positive (Wagner et al., 2001) (except for the effect of "brain-drain"), the collaboration among Latin American countries is still in its infancy for CPB (Navas et al., 2007; see Stocks et al. 2008) for the field of tropical biology). Since the integration of regional knowledge is a matchless experience to increase excellence and competitiveness of Latin American science, the educational system, particularly in terms of doctoral programs in S&E should be more attractive, especially to Latin American graduate students in their own countries or in neighboring ones.

5.3. Correlation studies

An interesting finding is that satisfaction with policies from federal post-graduate agencies (Q3) correlate with perception of research infrastructure (Q7) (Fig. 1). This indicates that those with better equipped research facilities are more satisfied with federal post-graduate educational policies. Moreover, satisfaction with federal post-graduate policies (Q3) correlates with the perception of paper-writing skills of recent-PhDs (Q10) (Fig. 2). This could indicate, at first glance, that those following the rules of regulating educational agencies are the ones whose former PhD students have mastered "the language of science" (also becoming good paper writers). However, this could also be viewed the other way around: researchers, whose former students are good writers, believe that the federal educational policies are the ones responsible for their success. In support for this second interpretation is the lack of correlation between satisfaction with post-graduate governmental policies among CPB researchers (Q3) and perception of quality of current PhD students (Q5) (data not shown) or PhD thesis (Q11) (data not shown). Thus, the success of a science post-graduate student (in CPB or other academic fields) may be more determined by personal effort (of the student and/or the supervisor-student as a team) rather than by federal policies of education.

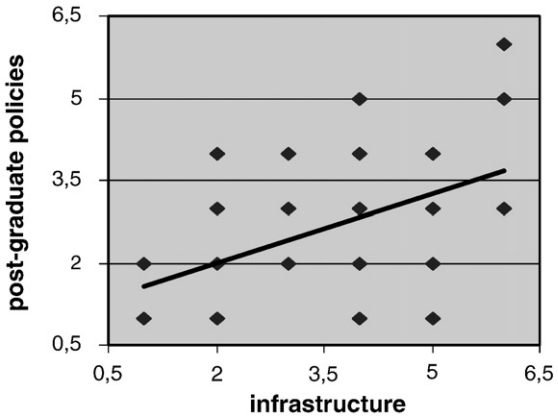

Fig. 1. Correlation between perception of research infrastructure and researcher satisfaction with policies from federal educational agencies. R^2=0.237; P=0.0015 (n=40).

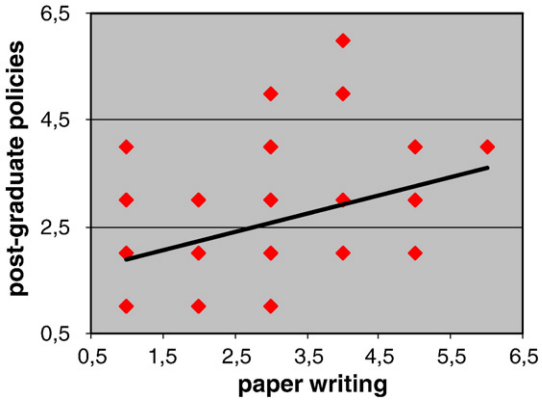

Fig. 2. Correlation between perception of paper-writing skills of recent-PhDs and researcher satisfaction with policies from federal educational agencies. R^2=0.156; P=0.0128 (n=39).

5.4. Perspectives

The great risk in federal policies of mass production of science (i.e., papers) and PhD degrees is a reduction in the quality of both outputs in the future. This could be an announced long term disaster for the national goals – among Latin American nations – of achieving world-class excellence in science (which could be reflected by CpP values in all areas of science; see Table 1). Even though our survey contemplates a very limited amount of researchers (forty CPB Latin American researches, plus 6 "masters") the observed trends cannot be dismissed. A more robust evaluation of perception of satisfaction with science and post-graduate policies must be done – by using scientists of more diverse fields, with a much larger study-population — to support our results. To get started in this direction, we decided to investigate whether researchers from areas other than CPB have similar perceptions about science and post-graduate education as the ones reported in this article. The 12-item questionnaire was sent to a group of 41 senior researchers in other fields of biology (zoology, ecology, botany, genetics, cell biology, molecular immunology, protein biochemistry and free radicals), working in several universities in Brazil — 20 from the University of Brasilia (UnB). We obtained replies from nine researchers (5 from UnB — see[4]). The response of this heterogeneous group was similar that observed for the group of Brazilian respondents in the CPB field. The correlation between average responses of Brazilians (regarding the 12-item quiz) *versus* the heterogeneous group resulted in R^2=0.82 (data not shown).

One possible critique of our work is that our respondents (forty scientists) feel less successful in their research and therefore replied in a biased way. However, this is not the case when the individual CVs of respondents were evaluated (only Brazilians were checked — by using the web-based "Curriculum Lattes", from CNPq, Brazil), showing that the majority have a solid carrier and publication output (24 of 29 CPB "regular" respondents from Brazil; the 6 "masters" have world-class CVs). In addition, the similar response of the small heterogeneous group (n=9, all with solid scientific carriers) compared to Brazilian CPB researchers also suggests that the observed perception about science and post-graduate education in Brazil configures a genuine and relevant trend. Such trend includes: (i) lack of satisfaction with governmental policies for science and post-graduate education due to mass-production policies for papers and PhD degrees, (ii) that current PhD students are doing an adequate job, but have not improved in quality as compared to those from 10 years ago (the same was

[4] This excessive percentage of researchers from UnB made this analysis biased towards the reality of one institution only. However, the nine respondents belong to diverse fields in biology, with a broad vision of science.

observed for PhD thesis in terms of present *versus* past), (iii) that research infrastructure and the curricula of post-graduate courses do not constitute a problem, but (iv) recent-PhDs are not as fit as they should be in paper-writing skills (especially in the eyes of Brazilian respondents), and (v) that "real job" opportunities in the field are scarce.

However, there is good news for those in the CPB fields in Latin America. A recent survey by Hermes-Lima et al. (2007a) indicated that CPB researchers – selected at random – from Latin America have, on average, almost identical bibliometric indicators (e.g., number of papers and citations, citations per paper and index *h*) as CPB researchers (of comparable "scientific age") from developed countries. This indicates that CPB researchers are doing a good job in Latin America despite the well-known difficulties (Zenteno-Savín et al., 2007, this study) and challenges for the future, especially for the formation of the next generations of researchers. A discussion of what Latin American researchers believe to be important for the next generation of young scientists is shown in Box 1.

6. The *CBP-Latin America* project and its final volume

Between August 2004 and March 2008, 118 articles dedicated to the *CBP-Latin America* project were accepted for publication in *Comp. Biochem. Physiol.* after the usual external peer-review process of the journal. The effort represents the extensive involvement of research groups from several countries in Latin America (Table 5). Moreover, more than 70% of our referees were from outside Latin America and about 15% of the articles published in *CBP-Latin America* resulted from collaboration with at least one author from a developed country. This means that our editorial project received a reasonable input of external researchers (as referees or co-authors), particularly from the USA, Canada and Europe. A great variety of research fields on CPB was covered — (i) classical physiology, (ii) oxidative stress, (iii) protein science, (iv) metabolism and endocrinology, (v) ion transport, (vi) reproduction and development, (vii) toxicology, (viii) neurobiology and (ix) lectin biochemistry — confirming its accomplishment (for more details, see Zenteno-Savín et al., 2007).

6.1. The fifth issue of CBP-Latin America

This present issue presents 20 original CPB manuscripts and celebrates the conclusion of this project as a representative attempt to encourage the unification and promotion of comparative animal sciences in Latin America. The following paragraphs briefly introduce these twenty studies.

In the field of protein science, Sant'Ana et al. (2008) described the isolation and biochemical/pharmacological characterization of a new thrombin-like enzyme from *Bothrops jararacussu* snake venom. In the work by Silva et al. (2008), dermaseptins (DS 01, DD K, and DD L) from *Phyllomedusa oreades* and *Phyllomedusa distincta* frogs were compared with respect to their structural characteristics and interactions with liposomes. Fluorescence and atomic force microscopy evaluations showed the strong fusogenic activity of DS 01 whereas DD K and DD L presented a high lytic activity. On a complementary article from the same research group, Leite et al. (2008) reported the structural characteristics, antimicrobial activity and mammalian cell toxicity of these dermaseptins. In addition, Cardoso et al. (2008) showed that glutathione reductase from *Saccharomyces cerevisiae* is partially inactivated by a reductive mechanism mediated by NADPH and ferrous ions, suggesting that the enzyme is diverted from its normal catalytic cycle during inactivation.

In the area of animal comparative metabolism, Carvalho and Fernandes (2008) studied the effects of copper ions on specific hepatic enzymes of anaerobic glucose metabolism from freshwater tropical fish *Prochilodus lineatus*. They observed that enzymatic activities are affected (by copper ions) depending on water conditions (different pHs and temperatures). The work by Dutra et al. (2008) dealt with seasonal variation in several metabolic substrates – as well as lipid peroxidation – in the amphipod *Hyalella curvispina* showing correlations between intrinsic and environmental factors. Finally, Nowicki and Cazzulo (2008) reviewed the aromatic amino acid catabolism in trypanosomatids.

In the physiological arena, Contarteze et al. (2008) compared stress biomarkers during intensity swimming and treadmill running exercises performed by Wistar rats, showing that only in acute swimming they observed expected alterations in endocrine and metabolic stress-responses. Escamilla-Chimal and Fanjul-Moles (2008) investigated the circadian expression of cryptochrome protein during the ontogeny of crayfish (*Procambarus clarkii*), suggesting relevant changes in the functions of the crayfish pacemaker through development. In addition, Heredia et al. (2008) described the autofluorescence in the earthworm *Eisenia foetida* and examined the possible mechanism for mucus secretion in that organism. Sabat and Bozinovic (2008) investigated whether the digestive performance of the herbivorous rodent *Octodon degus* is influenced by the diversity of their diet. The results suggest that dietary treatments do not influence digestive performance, and therefore that this species exhibits reduced physiological flexibility of digestive traits. Navas et al. (2008) reviewed the relationships between temperature and behavioral performance in amphibian anurans at various levels of organization. They illustrate some examples of coadaptation between thermal ecology and thermal physiology, and highlight the remarkable evolutionary flexibility of this taxon regarding the best temperature for locomotor performance. Another interesting review was presented by Castelló et al. (2008), who discuss the role of the fast electrosensory pathway of pulse gymnotids in the streaming of self-generated electrosensory signals, suggesting that the combination of sensory filtering and electromotor control favors the self-generated signals and then the electrolocation stream. Moreover, Ayala-Guerrero and Mexicano (2008b) investigated the physiological parameters of vigilance states in the green iguanid lizard (*Iguana iguana*), suggesting that this species displays two sleep phases that are similar to those observed in birds and mammals.

Covering osmoregulation and ion transport, Ruiz and Souza (2008) describe tissue volume regulatory processes of the freshwater bivalve *Corbicula fluminea* when challenged with anisosmotic media, indicating transport pathways involved, and suggesting their potential use as targets for ecotoxicological studies. Moreover, Freire et al. (2008) present an extensive review about structure and function of crustacean gills and excretory organs, employing a fully comparative and environmentally-related perspective, and Bianchini et al. (2008) focus on the adaptations exhibited by the extremely euryhaline intertidal crab *Neohelice granulata* (*Chasmagnathus granulatus*) with respect to its challenging environment.

Table 5
List of countries participating in *CBP-Latin America*[a]

	Published papers
1. Brazil	62 (52.5%)
São Paulo State	26
All other states	36
2. Mexico	26 (22%)[b]
3. Argentina	14 (12%)
4. Chile	10 (8.5%)
5. Uruguay	3
6. Venezuela	2
7. Cuba	1
Total	118

[a]The list excludes the 5 editorial articles (4 from Brazil and 1 from Mexico), and it is based on the address of the corresponding author and/or the Principal Investigator. Percentages in the list included only the countries with more contributions.
[b]One study from Mexico was published in regular CBP, volume A (Ayala-Guerrero and Mexicano, 2008a).

In the pharmacological field, Takeara et al. (2008) studied the chemical structure of several low-molecular weight constituents isolated from *Didemnum psammatodes* (Tunicata: Ascidiacea). In addition, the authors investigated the antileukemic effects of these compounds suggesting that the active ones act by means of inhibition of DNA synthesis and induction of necrosis and apoptosis. In another work by Ayala-Guerrero et al., (2008), using an animal model that reproduces behavioral and electrographic features of temporal epilepsy, they investigated the effects of oxcarbazepine against epileptic activity and brain damage in rats pre-treated with kainic acid. They observed that the latency time for seizures was significantly increased by this antiepileptic drug. Furthermore, Jimenez et al. (2008) showed the chromatographic fractionation of an extract from *Eudistoma vannamei* (Tunicata: Ascidiacea) and the antileukemic characterization of the active fractions. The observed cytotoxic activities of certain fractions appeared to be related to apoptosis.

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