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Contributions of South American research centers to *Carbohydrate Research*

Carlos A. Stortz *

Departamento de Química Orgánica-CIHIDECAR, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Ciudad Universitaria, Pab. 2, 1428 Buenos Aires, Argentina

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ABSTRACT

The present article shows the objective figures of the contributions of South American research centers to *Carbohydrate Research* during its 50 years of history, measured in terms of members of the Editorial Board, number of articles and citations to them, together with a country-based comparison, and the progression of these contributions with time. In addition, it also shows the subjective feelings of the author toward the same journal.

1. *Carbohydrate Research* and myself

I started to work in the Organic Chemistry Department of the School of Sciences at the University of Buenos Aires as a graduate student in 1980, under the supervision of Prof. Alberto Cerezo, planning to work on seaweed polysaccharides. This Department had (and still has) a strong background in carbohydrates (see below), but my knowledge about carbohydrates was rather weak. At that time, I only recalled experiments on the isolation of lactose from milk in early Organic Chemistry courses, and on the quantitation of reducing sugars and dietary fibers in the late Food Chemistry courses. Thus, I, like probably about a dozen fellows starting our Ph. D. studies in issues related to carbohydrates, had to start training on the subject. Then was the right time for *Carbohydrate Research* to show up. Why was this journal considered before others? Very simple: it was present from the first issue to the last one in our Department Library. Other journals like the *Journal of the Chemical Society*, the *Journal of the American Chemical Society,* or the *Journal of Organic Chemistry* were also available at our Library, a few feet apart from our labs, but with more restricted timeframes. Even more complicated, in order to peruse other Journals you had to go down a couple of floors to the Main Library, where you had the risk of getting lost within the maze of old unseen books and journals carrying a sophisticated numbering system, hard to understand for a plain chemist.

I guess that this Introduction is hard to grasp for a younger reader, used to capture PDF samples of the papers needed by just pushing a button.

Furthermore, *Carbohydrate Research* had a special charm, at least for me. The use of a SMALL CAPS font for the author names at the author list and the reference list gave it a unique touch. At that time, I had to read multiple papers from many journals. But in my free time, I used to browse through the articles of *Carbohydrate Research*, wondering if I would ever be capable of publishing in this Journal. In time and luckily, I was. My first four papers were published in *Carbohydrate Research*, as were nine out of my first twelve articles, including my postdoctoral ones at the Georgia State University. I still publish in *Carbohydrate Research* every time I can, even though the pressure of our grantors and evaluators for publishing in journals with higher impact factors sometimes precludes a larger share of our articles to appear in this journal. Still, most of us know that *Carbohydrate Research* does not have the impact factor it deserves, considering its high quality and standards. Anyway, I guess that our (or at least my) personal bibliometric impact depends more on *Carbohydrate Research* than on any other journal.

For the reasons stated above, I feel more than honored by the invitation made by Prof. Elizabeth Hounsell to contribute to this issue of *Carbohydrate Research* on the occasion of its 50th Anniversary. I have taken this unique opportunity to present to the readers the relationship between *Carbohydrate Research* and South America since its conception, including members of the Editorial Board, published and most-cited articles originating from South American sources.

2. *Carbohydrate Research* and South America

2.1. Early times and formal associations

Since its birth, *Carbohydrate Research* was linked to Argentina. The inarguable leading scientist from the Organic Chemistry

* Tel./fax: +54 11 45763346.
E-mail address: stortz@qo.fcen.uba.ar

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Department, Prof. Venancio Deulofeu, was appointed to the first 38-member Editorial Board. At that time, the Journal also had an eight-member Advisory Board. This journal was really conceived as an international journal, as stated specifically on the front page, below its name, and this was reflected in the choice of the members of both Boards: 24 from European research centers (10 from the United Kingdom, four from Germany, two from France and the Soviet Union, and one each from Norway, Hungary, Spain, Sweden, Switzerland, and Czechoslovakia), 14 from American centers (10 from the US, three from Canada, and one from Argentina), two from Africa (Egypt and South Africa), three from Asia (two from Japan and one from Israel), and three from Australia. Argentina had a continuous presence on the Editorial Board, as shown in Table 1. Only in the period 1985–1995 and in 2004 there was not any South-American representative. The five members (Table 1) came from the same research center, that is the Department of Organic Chemistry of the School of Sciences of the University of Buenos Aires. No other representative from a South American center has been appointed as a member of the Editorial Board.

The first two papers published in *Carbohydrate Research* originating in Argentina were part of the first issue of Volume 2, published in April 1966. The following chart reflects the first five papers published in the Journal, generated in Argentina:[1–5]

Alberto S. Cerezo and Venancio Deulofeu. Reaction of ammonia with some acetylated and benzoylated monosaccharides. Part X. Assignment of the α-D configuration to the *N*-acetyl-D-glycofuranosylamines obtained. *Carbohydr. Res.* **1966**, *2*, 35–41.

Eduardo G. Gros. Synthesis of 6-deoxy-4-*O*-methyl-D-galactose (curacose). *Carbohydr. Res.* **1966**, *2*, 56–62.

Irma O. Mastronardi, Susana M. Flematti, Jorge O. Deferrari, and Eduardo G. Gros. Methylation of carbohydrates bearing base-labile substituents, with diazomethane-boron trifluoride etherate-I. *Carbohydr. Res.* **1966**, *3*, 177–183.

Alberto Lezerovich, Eduardo G. Gros, Jorge F. Sproviero, and Venancio Deulofeu. Reaction of ammonia with some acetylated and benzoylated monosaccharides. Part XI. Intramolecular migration of *O*-benzoyl groups in the partial ammonolysis of penta-*O*-benzoyl D-glucoses. *Carbohydr. Res.* **1967**, *4*, 1–6.

Jorge O. Deferrari and Rosa M. de Lederkremer. Reaction of ammonia and acetylated aldoheptoses. Derivatives of D-*glycero*-D-*gulo*-heptose, and D-*glycero*-D-*galacto*-heptose. *Carbohydr. Res.* **1967**, *4*, 365–370.

Moreover, Prof. Rosa M. de Lederkremer published another paper[6] in volume 2, but with a US address, working with Melville Wolfrom at the Ohio State University.

All five papers originated in the same Department, from the University of Buenos Aires, and carry the names of the two founding pillars of research in carbohydrate chemistry (Venancio Deulofeu and Jorge Deferrari), a third renowned carbohydrate chemist at that time (Eduardo G. Gros) who later switched very successfully to the synthesis of non-carbohydrate organic compounds, and the names of those who would later become the most relevant carbohydrate chemists in the country (Rosa M. de Lederkremer and Alberto S. Cerezo), both fortunately still working among us. Most of the further researchers in carbohydrate chemistry at the Department had their Ph. D. theses supervised by either of them (or by someone supervised by either of them), and received valuable advice from both.

Table 1
Members of *Carbohydrate Research* Editorial Board affiliated with a South American research center

Venancio Deulofeu	1965–1974
Jorge O. Deferrari	1974–1979
Rosa M. de Lederkremer	1980–1984
Oscar Varela	1996–2003
Carlos A. Stortz	2005–2014

The five papers, as it can be seen, dealt with reactions of monosaccharides with ammonia or the synthesis of methylated monosaccharides. When I wondered about the success of carbohydrate chemistry in the 50s and 60s in our Department, the story I was told is that given the large ups and downs of research funding in Argentina, one of the 'downs' lead to the use of cheap and/or stocked reagents as the only possibility of survival: glucose and ammonia were among this list. It is no wonder then that three[1,4,5] of the first five papers dealt with studies of the reaction of ammonia and carbohydrates, and that attempts to look for old literature on glycosylamines usually find some Argentine chemists among the authors list. It is worth noting, however, that in the early 60s work on a completely different subject, such as polysaccharides, started in our Department, although they were published in other journals,[7,8] like the *Journal of Organic Chemistry* or the *Journal of Chemical Society*.

Within the same time frame (the first four volumes of *Carbohydrate Research*), there was another paper from a South American lab:[9]

João-Batista Chaves-Corrêa, Alexander Dmytraczenko, and José Hazenclave Duarte. Structure of a galactan found in the albumen gland of *Biomphalaria glabrata*. *Carbohydr. Res.* **1967**, *3*, 445–452.

This paper came from the research center in the Federal University of Paraná (Curitiba, Brazil) which today is still one of the most important centers dealing with polysaccharide structure and bioactivity in the region, and carries the name of José H. Duarte, the early supporting pillar of that research center.

2.2. Papers published from South American labs 1965–2013

The number of papers published in *Carbohydrate Research* coming from South American labs, divided by country and five-year periods is shown in Table 2.

This Table shows that Argentinian researchers published more or less regularly since the advent of *Carbohydrate Research*, with a notable increase in the current millennium. On the other hand, Brazilian researchers used to publish only rarely in the Journal in the early days, but reached the publication level of Argentina during the current millennium. The remaining countries in South America published only sporadically, Chile being first of those that did publish.

A better picture of the South American share of publications in *Carbohydrate Research* is shown in Table 3, together with a comparison with other competing journals.

Table 3 shows that the actual share of South American research has grown steadily over the last years. However, the rate at which the growth occurred is not even for the different journals and countries. In *Carbohydrate Research*, Argentina has duplicated its production from the original 1% to a current 2%. Brazil reached the same level, but from a lower starting point. The total share of South America is slightly below 5%. *Carbohydrate Polymers* is an alternative journal for those working on polysaccharides: whereas the South American share before the 90s was similar to that of *Carbohydrate Research*, it grew dramatically when Brazilian authors started to make it a considerable choice for publication: Brazilian papers now represent more than 5% of the total world share on that journal. The *Tetrahedron* set of journals, a customary choice for synthetic carbohydrate chemists shows a total share for South

Table 2
Number of papers published in *Carbohydrate Research* from South American labs, divided by country and quinquennial[a]

	Argentina	Brazil	Chile	Venezuela	Uruguay	Colombia	Total[b]
1965–70	19	1					20
1971–75	35	3	1				39
1976–80	13	4	4				21
1981–85	22	13	7		1		43
1986–90	24	12	1				37
1991–95	17	8	3	3	1		32
1996–00	25	11	4	1	1	1	41
2001–05	35	38	6	3	1	1	76
2006–10	38	42	4		2		81
2011–13	23	17	2		1		42
TOTAL	251	149	30	7	7	2	432

[a] *Sources:* Scopus and SciFinder. Both were needed to compute all the older papers.
[b] The total number of papers is sometimes lower than the sum of those of individual countries, due to collaborative work between labs from different countries, which are added up to both in the country column.

Table 3
Share of the South American-originated papers (in% of total papers) in *Carbohydrate Research* and other alternative journals[a]

	=<1990 (%)	1991–2000 (%)	2001–2013 (%)
Carbohydrate Research			
Brazil	0.36%	0.46%	2.12%
Argentina	1.02%	1.08%	2.10%
Total South America	1.53%	1.83%	4.36%
Carbohydrate Polymers			
Brazil	—	2.65%	5.11%
Argentina	1.19%	0.55%	1.03%
Total South America	1.49%	3.76%	6.96%
Tetrahedron + Tetrahedron Letters + Tetrahedron: Asymmetry			
Brazil	0.15%	0.51%	1.47%
Argentina	0.15%	0.22%	0.42%
Total South America	0.39%	0.87%	2.33%
Glycobiology + Glycoconjugate Journal			
Brazil	0.38%	1.21%	2.07%
Argentina	0.38%	0.81%	1.44%
Total South America	0.76%	2.02%	3.70%

[a] *Source:* Scopus.

American authors quite a bit lower than the carbohydrate journals (Table 3), but with a similar trend: a three-fold increase in share for Argentina in this millennium compared to the 90s, but a ten-fold increase for Brazil in the same time frame. The journals directly related to Glycobiology show a similar trend: and increase in share for both Argentina and Brazil, reaching currently a total share similar to that of *Carbohydrate Research* (Table 3).

In any case, these figures show that South American research has made a considerable progress in the last several years, when compared with the entire world. But it also shows that this progress skyrocketed for Brazil and was more moderate for Argentina. This can be related to the efforts made by both countries to increase the science budget: Brazil started this budget increase in 1993, and now it is over 1% of the total budget. Argentina started about ten years later, and science now accounts for about 0.65% of the total budget. In addition, a Ministry for Science was created in Brazil in 1985, whereas Argentina installed this Ministry more recently (in 2007).

The analysis of the authors and research centers giving rise to the 432 South American-generated papers published in *Carbohydrate Research* will be made by country. It should be pointed out that the contribution of South American scientists to the carbohydrate field is greater than that described in this manuscript. Several authors have published their excellent work in other journals. Thus, the lists that follow do not attempt to rank the scientific careers of the authors, but just to recognize their specific contributions to *Carbohydrate Research*.

2.2.1. Argentina

The number of papers published in *Carbohydrate Research* carrying an Argentinian address is 251. Ten of these papers were collaborations with a Brazilian lab, and four with a Chilean address. The authors appearing most often in those papers are shown in Table 4.

The ten authors appearing in Table 4 belonged to the University of Buenos Aires, and started their careers at the same center, the Organic Chemistry Department, now nucleated as the Center for Carbohydrate Research (CIHIDECAR), chaired by Oscar Varela. However, two of them switched to other centers of the same University: Raúl Cadenas to the School of Agronomy and Alicia Fernández Cirelli to the Veterinary School. Anyway, most of the publications in the Journal from Fernández Cirelli come from her original affiliation.

More than 80% of the total Argentine production in the Journal originated in different research centers of the University of Buenos Aires. It is worth mentioning one paper coauthored in 1973 by the Chemistry Nobel Prize winner in 1970, Luis Federico Leloir related to his work on dolichol sugar phosphates.[10]

Investigations from other Universities or research centers had been published only occasionally in the beginning, but have increased steadily in more recent years. Researchers from the University of La Plata generated 13 papers, with Pedro Colinas (four), Juan Grigera (four) and Enrique Baran/Patricia Williams (three) as the lead authors. The University of Rosario has increased its role mainly with synthetic chemists: the 12 papers published in the Journal have Edmundo Rúveda/María Colombo (five), Rolando Spanevello/Alejandra Suárez (four) and the bioinorganic Luis

Table 4
Authors with Argentinian affiliation appearing more often in *Carbohydrate Research* publications[a]

Author	Number of publications[a]
De Lederkremer, Rosa M.	52
Cerezo, Alberto S.	46
Stortz, Carlos A.	32
Varela, Oscar	30
Deferrari, Jorge O.	23
Cadenas, Raúl O.	21
Matulewicz, María C.	21
Fernández Cirelli, Alicia	19
Thiel, Inge M. E.	19
Marino, Carla	18

[a] *Source:* Scopus. Only the publications with Argentinian addresses were considered. Many of these authors have also published in the journal during their postdoctoral activities, with foreign addresses.

Sala/Sandra Signorella (three) as the main authors. The University of Córdoba, very strong in physical and organic chemistry, generated five papers in *Carbohydrate Research*, all of them related to the study of cyclodextrins. Rita H. de Rossi/Elba Buján were the authors of three of those papers, and Marcela Longhi of the remaining two. There were also contributions from the Universities of Tucumán, La Pampa and San Luis, and collaborations including the Universities of Luján, Mar del Plata, Salta, South (Bahía Blanca), Patagonia (C. Rivadavia), and the Technological Institute of Buenos Aires (ITBA).

2.2.2. Brazil

The number of papers published in *Carbohydrate Research* carrying a Brazilian address is 149. Ten of these papers were collaborations with an Argentinian lab, and one with a Chilean lab. The authors appearing most often in those papers are shown in Table 5.

More than one third of the Brazilian publications in the Journal originated at the Federal University of Paraná, more specifically from the Department of Biochemistry and Molecular Biology, at Curitiba. As shown in Table 5, seven out of the nine most prolific authors also came from that research center, with papers dealing mostly with polysaccharide structure. The Federal University of Río de Janeiro generated 20 of the Brazilian papers in the Journal, most of them (13) authored by Paulo A.S. Mourão. The Federal University of São Paulo generated 13 papers from different groups and centers (São Paulo, São Carlos, Ribeirão Preto). Within the same geographic area, UNICAMP produced 11 papers from different groups, the State University of São Paulo (UNESP) another six papers, and four other centers of the region, an additional six papers. The Federal University of Río Grande do Sul (at Porto Alegre) produced seven papers in the journal, all of them signed by Hugo Verli. The Federal Rural University of Río de Janeiro generated five papers, all of them authored by Clarissa O. Da Silva. Going up north, the Federal University of Pernambuco generated six papers, four of them with Rajendra M. Srivastava as author, and the Federal University of Río Grande do Norte (at Natal) a similar share, five of them with M.R. Pereira as coauthor. At least the other 14 research centers scattered all over this enormous country have produced papers for the Journal, and another 10 have collaborated, but carry no corresponding authors. In all, about 40 different centers from Brazil have contributed to the Journal.

2.2.3. Other South American countries

Not considering Argentina and Brazil, Chile was the main contributor to *Carbohydrate Research*, with 32 papers. More than half of these papers (17) originated in the University of Santiago de Chile (formerly Technical State University—UTE), with Betty Matsuhiro (13) and Alberto Zanlungo (10) as authors. It should be mentioned that these two researchers also started their careers at the Organic Chemistry Department of the University of Buenos Aires (the same fact happened with Miguel Noseda, already mentioned as one of the most prolific authors from Brazil). The University of Chile has generated the other 10 papers, with Sergio Bunel as the author of seven of these articles. The remaining papers come from four other centers (Austral University, Antofagasta University, and the Catholic Universities of Santiago and Valparaíso), and collaborations from other three institutions were detected.

Venezuela gave rise to seven papers in *Carbohydrate Research*, all of them between 1991 and 2004. Gladys L. de Pinto, from the Zulia University (Maracaibo) is the author of five of these papers, whereas the other two come from the Los Andes University (at Mérida), and represent collaborations of Alfredo Usubillaga with a French lab.

Uruguay also contributed with seven papers in the Journal. The first three papers reflect collaborations with foreign centers: Patrick Moyna (University of Montevideo) produced one with Guy Dutton, and Fernando Ferreira (UdelaR, University of the Republic) another two with Lennard Kenne. Later, David González (UdelaR) published three new papers (two of them with Carmen Rossini) with autonomic Uruguayan authorship. Recently, a new paper by C. Giacomini, from the same University, has been published.

Colombia has produced two papers in the Journal (from the University Del Valle, and the National University), both with external collaborations. It is clear that this country, which exhibits a larger share of scientific activity in other areas, does not expend large efforts on carbohydrate chemistry studies. Our search did not yield any paper originated in other South American countries, such as Peru, Ecuador, Bolivia, and Paraguay.

The distribution of the carbohydrate research in the larger South American countries (Brazil and Argentina) reflects the geopolitical structure of each country: Brazil has a vast territory, but is multi-centered, producing scientific endeavors from almost every state, north, south, east, and west, whereas Argentina, which also has a large territory, is centered in Buenos Aires, where about 40% of the total country population resides, and some other centers/cities (La Plata, Rosario) not far away from this megalopolis.

2.3. Citations

The number of citations of the papers published in *Carbohydrate Research* reflects the success of the international diffusion of such work. Table 6 shows the citation rates for the papers published in *Carbohydrate Research* by the South American countries with larger production.

The figures indicate that Brazilian papers have a citation rate higher than that of the world average for any period, and that Argentinian papers are below the Brazilian ones, having citation rates close to the world average, depending on the period considered. Chile shows similar results, although the more erratic behavior is justified by the statistically non significant number of papers. As a matter of fact, Chile shows a very large citation rate for the period 2006–2013, which duplicates the world average, but this is based on just six papers, one of which (by Leal et al.[11]) had the

Table 5
Authors with Brazilian affiliation appearing more often in *Carbohydrate Research* publications[a]

Author	Affiliation	# of publications[a]
Gorin, Philip A. J.	Federal Univ. Paraná	23[a]
Iacomini, Marcello	Federal Univ. Paraná	22
Noseda, Miguel D.	Federal Univ. Paraná	19
Duarte, Maria E. R.	Federal Univ. Paraná	17
Mourão, Paulo A. S.	Federal Univ. Rio de Janeiro	13
Duarte, José H.	Federal Univ. Paraná	8
Gonçalves, Alan G.	Federal Univ. Paraná	8
Sassaki, Guilherme L.	Federal Univ. Paraná	8
Verli, Hugo	Federal Univ. Río Grande do Sul	7

[a] *Source:* Scopus. Only the publications with Brazilian addresses were considered. P.A.J. Gorin has published a total of 57 papers in the Journal, most of them with a Canadian address.

Table 6
Average number of citations per paper published in *Carbohydrate Research*, by country and publication period[a]

Period	World	Argentina	Brazil	Chile
1996–2005	19.1	20.3	21.4	15.9
2006–2013	8.0	6.8	10.4	16.8
Total[b]	11.6	10.2	14.6	10.7

[a] *Source:* Scopus.
[b] Includes the data before 1996, which according to Scopus, underestimates the number of citations.

highest citation rate (49 citations) of all the South American papers during this period. The paper, with Betty Matsuhiro as the corresponding author,[11] deals with the applications of IR spectroscopy to alginate structural determination, and reflects a collaboration with scientists from the US and Italy.

The article describing the methylation procedure of Ciucanu and Kerek,[12] which has facilitated the life of polysaccharide chemists not willing to smell the dimsyl anion is the most cited paper of *Carbohydrate Research* (1704 citations at the end of 2013 and growing every day), according to Scopus. The most cited South American paper in the journal for any period is authored by Ponce et al.,[13] with work carried out in Argentina, and showing 139 citations. This paper ranks 87 in the entire *Carbohydrate Research* history, and is the tenth most cited considering the papers published in the current millennium (2001–2013). The most-cited paper of Brazilian origin is that of Duarte et al.,[14] with 97 citations. Both the Argentine and the Brazilian most-cited papers deal with similar issues: structural aspects of fucoidans from South American brown seaweeds. In the Argentine paper, bioactivity is also presented.

By looking at the list of the most-cited papers from each country (as in Scopus), it is evident that polysaccharide structural studies are at the top of the lists. For Brazilian papers, the seven most-cited correspond to studies on the structure of poly- and oligosaccharides from different origins, or to the development of methods for their study. Only after the seventh place, do papers appear dealing with the migration of protecting groups in cyclodextrins,[15] with modifications of cellulose for thermochemical studies,[16] and with molecular dynamics.[17] For Argentine papers, the four most-cited also deal with polysaccharide structure and methods for their study. In the remaining top ten, one paper each on molecular modeling,[18] synthesis,[19] and spectroscopy[20] appear as the exception.

3. Conclusion

The history of *Carbohydrate Research* is quite short in comparison to the history of science, but somehow long considering the usual publication span for any individual scientist. We (included in this plural are all of the 'older' colleagues from the Department and Research Center) are glad to know that *Carbohydrate Research* has reached its 50th birthday being a well-respected, strictly-refereed, high quality journal, in which we are proud to publish. This article endeavors to show that South America has accompanied the history of this Journal since birth and 'childhood', throughout its 'youth' up until the current adult period with an increasing proportion of contributions that were cited in proportions similar to those of the rest of the world. Let us hope that in the next 50 years the journal will, at the very least, uphold its reputation and quality, and that our South American labs will still find a place where our contributions can be shared with the world.

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