Institutional genetic stamp and development of international identity: bibliometric study of spinal cord research and protocols using cats en Cinvestav

Francisco Collazo-Reyes
María Elena Luna-Morales
Evelia Luna-Morales*

Received:
Jane 13, 2014.
Accepted:
December 2 , 2015.

Abstract

A corpus of literature addressing the neurophysiology of the spinal cord and the cat as an experimental model are examined. An early research practice as product of genetic institutional imprinting. The objective is to analyze the body of literature as a scientific communication event, showing how each peer reviewed paper contributes to developing a sense of international identity in the Department of Physiology and Cinvestav. The formation of relationships and structures of scientific communication through quinquennial socio-technical networks and the weight of institutional contribution to the global literature on the subject are analyzed. The thematic association of the spinal

* Los tres autores pertenecen al Cinvestav, México. (fcollazo@fls.cinvestav.mx); (meluna@cinvestav.mx); (eluna@cinvestav.mx)

cord, the cat as experimental model and P. Rudomín, as the most productive author, have remained stable in indexes for over 50 years. During this period, the association has developed patterns of institutional affiliation with regard to international systems of scientific communication, giving rise to the development of one of the most symbolic lines of research in genetic imprinting in the Cinvestav.

Keywords: Bibliometric study; Bibliometric indicators; Spinal-Cord; Experimental models; Cat; Cinvestav-Department of Physiology; Pablo Rudomín; Sociotechnical-Networks.

Resumen

Se estudió la literatura generada en aspectos neurofisiológicos de la médula espinal y el gato como modelo experimental. Una práctica de investigación temprana como producto de la impronta genética institucional. El objetivo es analizar el cuerpo de literatura como un evento de comunicación científica, para mostrar cómo cada publicación arbitrada aporta al desarrollo de un sentido de identidad internacional del trabajo del Departamento de Fisiología y del Cinvestav. Se analizó la conformación de relaciones y estructuras de comunicación científica a través de redes sociotécnicas quinquenales así como el peso de la aportación institucional a la literatura global en el tema. La asociación del tema de la médula espinal, el gato como modelo experimental y P. Rudomín como autor más productivo se han mantenido vigentes en la literatura científica del tema por más de 50 años. Durante este periodo, esta asociación ha desarrollado patrones de afiliación institucional al sistema de comunicación científica internacional, dando lugar al desarrollo de una de las líneas de investigación más simbólicas de la impronta genética en el Cinvestav.

Palabras clave: Estudio bibliométrico; Indicadores bibliométricos; Médula espinal; Modelos experimentales; Gato; Cinvestav-Departamento de Fisiología; Pablo Rudomín; Redes-Sociotécnicas.

DOI: http://dx.doi.org/10.1016/j.jbbai.2016.10.003

Introduction

The founding of the Advanced Studies Center of IPM (Cinvestav, by its Spanish-language acronym) carries the early spirit of the genetic stamp of post-war science.[1] An institutional model conceived to act in a given period as a transition from small to big science[2] which arose to face a twin challenge entailing the construction of modern scientific practices that involve, on one hand, finding solutions to local problems and, on the other, generating results that contribute to the body of universal knowledge.[3] The principles and values needed to face these challenges reside in the institutional genetic stamp,[4] expressed in the official decree of founding in 1961[5], and in the patterns of scientific communication contained in an early journal article by A. Rosenblueth, J. Alanis and G. Pilar that marks the date Cinvestav first entered in international bibliographic indexes, in fact, in the same year of its founding.

On one hand, the explicit values expressed in the founding decree include rigorous criteria for hiring researchers, requiring candidates to hold a PhD, work full-time and undergo ongoing evaluation. Cinvestav researchers were not offered tenure, though academic and research freedom were guaranteed. Candidates, moreover, were expected to participate in scientific collaboration project and the training of new researchers. This foundational document also provided for an institutional administration based on very simple standards.[6] On the other hand, the first journal publication[7] establishes six international publication standards: 1) dissemination in international peer-reviewed journals; 2) international collaboration; 3) contents presented in compliance with IMRD scientific format (introduction, materials, results and discussion);[8] 4) use of citations from accredited sources; 5) international visibility through use of citation, and 6) papers written in English. These criteria correspond to the emergence of the international modes

1 M. Albornoz, "La política científica y tecnológica en América Latina frente al desafío del pensamiento únic
2 D. J. de Solla Price, Little Science, big Science, y Little Science, big Science…and Beyond.
3 Manual de Santiago, Manual de Santiago de internacionalización de la ciencia y la tecnología
4 M. Ibarrola, "La impronta genética del Cinvestav. Una mirada a la excelencia de la institución entonces y ahora"; B. R. Clark, The Higher Education System: Academic Organization in Cross- National Perspective.
5 Diario Oficial de la Federación, Decreto de la creación del CIEA, 5 noviembre de 1960.
6 M. Ibarrola, "La impronta genética…".
7 A. Rosenblueth, J. Alanis y G. Pilar, "The Accessory Motor Innervation of the Diaphragm".
8 L. B. Sollaci y M. G. Pereira, "The introduction, methods, results, and discussion (IMRAD) structure: a fifty-year survey".

of production and certification of knowledge in the post-war period.[9] The totality social and scientific relations are oriented toward providing the institutional context for scientific development, the formation of resources and the continuity of results. These features have provided Cinvestav a differentiated identity for practicing science in Latin America and the Caribbean.[10] The details of its development lie in diverse efforts aimed at constituting research teams and lines of research with the international scientific community. These lines of research stand out for having maintained stability in the generation of scientific products. These lines of research are like spinal medulla, which have been strengthened by affiliation to international scientific practices and standards. Generally, these processes are still in the stage of development of local capacities for accrediting results in the international system of knowledge by way submitting their results to a peer review system. The conception and materialization of Cinvestav coincided with other key events: a) the creation of citation indexes by the Institute for Scientific Information (ISI), which set the stage for the emergence of highly influential mainline journals supporting the mechanisms for certifying science; b) increased use of large vertebrate animals as research models, which exerted an influence in the exponential growth of literature in diverse fields, including spinal cord research.[11] The use cats in neurophysiological spinal cord research researched its zenith in indexed scientific output in the first decades of the second half of the twentieth century. Diverse experimental techniques were developed in cats before being used in smaller animals.[12] A search of Scopus of the terms afferent, muscle, depolarization in conjunction with spinal-cord and cat reveals an annual output that is clearly exponential in form over the period 1960 to 1980. This period is followed by a long period of decline until 2013, in which the interest in using cats in experimental model waned in view of rising social resistance to using large animals, the associated costs of their maintenance and the imposition of more stringent bio-ethical standards.

The study of these topics has been approached by and large through historiographical methods, including those that employ scientific literature as a unit of analysis. The most frequently used is developed on the basis of genealogical

9 R. Florida y M. Kenney, "Institutions and Economic Transformation. The Case of Postwar Japanese Capitalism".

10 H. Vessuri, "El Centro de Investigación y de Estudios Avanzados del IPN (Cinvestav)".

11 B. Rexed, "The Cytoarchitectonic Organization of the Spinal Cord in the Cat"; P. A. Guertin, "The Spinal Cord: Functional Organization, Diseases, and Dysfunctions".

12 A. Frigon, A. "The Cat Model of Spinal Cord Injury"; D. P. Cardinali, Neurociencia aplicada: Sus fundamentos.

DOI: http://dx.doi.org/10.1016/j.jbbai.2016.10.003

algorithms and profiles of the development of a fields.[13] Other approaches examine diverse indicators in order to analyze the development of fields through the identification of changes in the modes of knowledge and scientific practices in each field.[14] In accord with another methods, such as the "network actor",[15] the developmental dynamics of scientific fields is the product of many interactions and elements explained only by social and technical factors.[16]

This work uses scientific papers as a unit of analysis, based on the concept of referential intertextuality as a naturally occurring feature of scientific literature,[17] which helps us weigh the operational influence of the texts.[18] Pursuant to this idea, each new publication contributes elements to the construction of relational networks activated through references, citation and co-authorship. The continuity of the publication of results creates the web of relations and communication flows tat orient sense of institutional scientific affiliation. In accord with the type of journal, these flows be involved with scientific discourses contained in local, regional or international sources (or any combination of these). In this way, scientific communities build their lines of research, objects of study and discourses insofar as they achieve stable conditions for maintaining the continuity of publication.[19] Seen in this way, texts are understood as knowledge that is socially constructed.

It is assumed that a line of research on spinal cord using cats for experimentation is signified by marks contained in the texts (lead a uthors, most frequently used terms, preferred journals and the model) as a symbolic topic in Cinvestav's Department of Physiology. The developmental scenario of this symbolic sense is the formation of international scientific communication developed in the institution for over fifty years.

13 E. Garfield, A. I. Pudovkin y V. S. Istomin, "Why Do We Algorithmic Historiography"; L. Leydesdorff, "Eugene Garfield and Algorithms Historiography: Co-Words, Co-Authors and Journals".

14 J. V. Pickstone, "Working knowledge before and after circa 1800: Practices and disciplines in the history of science, technology and medicine"; J. V. Pickstone, "A Brief Introduction to Ways of Knowing and Ways of Working. History of Science".

15 M. Callon y B. Latour, "Unscrewing the big leviathan: How actors macrostructure reality and how sociologists help them to do so"; B. Latour, "On actor-network theory - A few clarifications".

16 J. Law, "Notes on the theory of the actor network-ordering, strategy, and heterogeneity".

17 A. J. Devitt, "Intertextuality in Tax Accounting; Generic, Referential and Functional".

18 S. Doheny-Farina, "Creating a text / Creating a Company. The role of a text in the Rise and Decline of a New Organization".

19 Ch. Bazerman, Shaping Writing Knowledge; Ch. Bazerman y J. Paradis, Textual Dynamics of the Professions. Historical and Contemporary Studies of Writing in Professional Communities; C. Berkenkotter, T. N. Huckin y J. Ackerman, "Social Context and Social Constructed Text".

In this paper, we use a methodology based on three complementary features: 1) an analytical matrix that combines diverse bibliographical elements (authors, references, citations, co-authorship, frequently used terms and experimental models); 2) analysis of these elements organized in eleven quinquennial socio-technical networks; 3) the study of international scientific output in order to determine the positions held by authors, Cinvestav and Mexico in the spinal cord and cat topic area in Scopus. This indicator of the contribution of Cinvestav and the Department of Physiology to the body of knowledge in this field is, according to Manual de Santiago,[20] and indicator of the degree of internationalization of the institution.

We find that the study of neurophysiological features of the spinal cord, the use of cats in the experimental model, Cinvestav, the Department of Physiology and P. Rudomín emerged in the scientific literature at the same time and they have continued to be visible for period of more than fifty years (1961-2013). Over this period, the association of the topic area, the experimental model, the authors and the institution have continued to appear in bibliographical indexes and international indicators of scientific output. This association has built a line of research on the international stage and, at the local level, a symbolic libe of research that has built the international identity of the Department of Physiology of the Cinvestav.

Methodology

On the basis of a previous paper on the output of the Department of Physiology, [21] we identified the first group of researchers consisting of A. Rosenblueth, J. García Ramos and P. Rudomín that was able to maintain continuity of output and who established a line of research that has remained active over the entire life of the Cinvestav. The Atlas de la Ciencia Mexicana, 1961-2013 (The Mexican Science Atlas, 1961-2013) was used as the basis of information (http://atlasdelacienciamexicana.org/).[22] We have included papers lf the aforementioned authors who used cats in the experimental design to study the neurophysiological aspects of the spinal cord.

20 Manual de Santiago, Manual de Santiago…, 111.
21 F. Collazo-Reyes, M. E. Luna-Morales y E. Luna-Morales, "Aproximación a las formas de organización de la producción científica a través de redes de coautoría".
22 Atlas de la Ciencia Mexicana 2012: Bilingual edition.

DOI: http://dx.doi.org/10.1016/j.jbbai.2016.10.003

We identified 132 papers. From this body of work we generated two files: the first includes references made by them and the second references received. Upon this basis, a local data base was developed with three relational tables: 1) published papers, 2) references included, and 3) references received.

Development of socio-technical networks by five-year intervals

On the basis of the organization of information resources, a historical analysis of the literature was performed. In this case, scientific output was divided into five-year blocks and the methodology employed was the analysis of socio-technical networks. Consequently, eleven networks were developed that include the following components: 1) co-authorship relationships of the paper published in the topic area; 2) journals; 3) the number of references included in the papers; 4) the number of citations received; 5) most frequently used terms in titles of papers; and 6) experimental models. The networks are depicted using the following symbols: the author nodes are represented by a square; the journals by a diamond; the number of references by a triangle; the number of citations by a red circle; the key words by a pink circle and the experimental model by a hexagon. All of the components of a single paper are connected by lines, as are all of the authors or words that concur in the papers published in each five-year interval. In each period, we analyzed the structure of the co-authorship relationships; the preferred journals for publications for citing and being cited; the average number of references and citations per work; the frequency of the use of terms, and the experimental models used. We also analyzed the co-occurrence of words in two or more papers. This approach allowed us to describe the patterns of communication associated with the continuity of output in the spinal cord-cat line of research in Cinvestav. Pajek software (http://vlado.fmf.uni-lj.si/pub/networks/pajek/doc/pajekman.pdf)[23] was used to develop the matrices and the networks. This program is useful for analyzing large networks.

2.2 Contribution of the institution to international science.

The internationalization of the work of a research institute is expressed

23 V. Batagel y A. Mrvar, Pajek. Program for Analysis and Visualization of Large Networks: Reference Manual. List of commands with short explanation version 2.05.

in multiple ways, one of which is the output of scientific papers published in peer reviewed journals.[24] In this case, the weight of the position of the author or institution was used, assigned as a function of scientific output in the international classification obtained through the Scopus information system. In this way, we determined the position of P. Rudomín and Cinvestav within the international scientific literature. In this case, we used information searches in the Scopus system of the most meaningful words in titles as topics of information, combined with the topic spinal cord and cat in the experimental under four distinct search strategies: 1) Afferent + spinal-cord and cat; 2) Muscle + spinal cord and cat; 3) Presynaptic and cat, y 4) Depolarization + spinal-cord and cat, all within the period of 1960-2013. For these three searches, the global data were refined by country, institution and author. The Scopus system organizes information in accord with the output of the forty most productive authors o institutions. The information on the names of institutions where authors work was normalized, and on the basis of output the position of Cinvestav and the authors was determined.

Results

General findings

A set of 132 papers were found that address the line of spinal cord-cat research in Cinvestav, consisting of the establishment of multiple relationships of collaboration, referential intertextuality and citation involving authors, journals and keywords in the dominant discourse in the scientific literature of the main current associated with the topic at hand. This web involves thousands of influence and acknowledgement relationships established in 4,298 references made and 3,458 citations received. It includes forty-four preferred journals for publication, 444 cited in references and 360 that contain cited works. Hundreds of authors are involved in the references and citations. These relationships of scientific communication have maintained the visibility of Cinvestav in bibliographic indexes of mainline scientific literature over the last fifty years.

24 Manual de Santiago, *Manual de Santiago…*

DOI: http://dx.doi.org/10.1016/j.jbbai.2016.10.003

Five-year networks

The spinal cord-cat line of research has its background in the practical research performed by the National Cardiology Institute. It began with the research group put together by the internationally renowned researcher A. Rosenblueth. The main networks show the formation of scientific communication structures that characterize international accreditation practices that came after the first research done in Cinvestav. The five-year period of 1961-1965 (*Figure 1*) shows the pioneer research team in the topic area. It includes the first institutional international bibliometric indicators: 11 papers, written by nine authors, principally: P. Rudomín, A. Rosenblueth and J. García Ramos; in four journals (one regional journal and three international journals); with 179 references that correspond to papers published mainl,y in the following journals: Journal of Neurophysiology, Brain Research, Brain Research Bulletin, Archives Italiennes de Biologie, and Journal of Physiology; 117 citations received to date, appearing largely in Archives Italiennes de Biologie, Brain Research, Electro Encephalography and Clinical Neurophysiology, Acta Physiologica Latinoamericana, and Experimental Brain Research; using a discourse featuring six terms: afferent, arterial, blood, control, motor and pressure; with the cat as the experimental model.

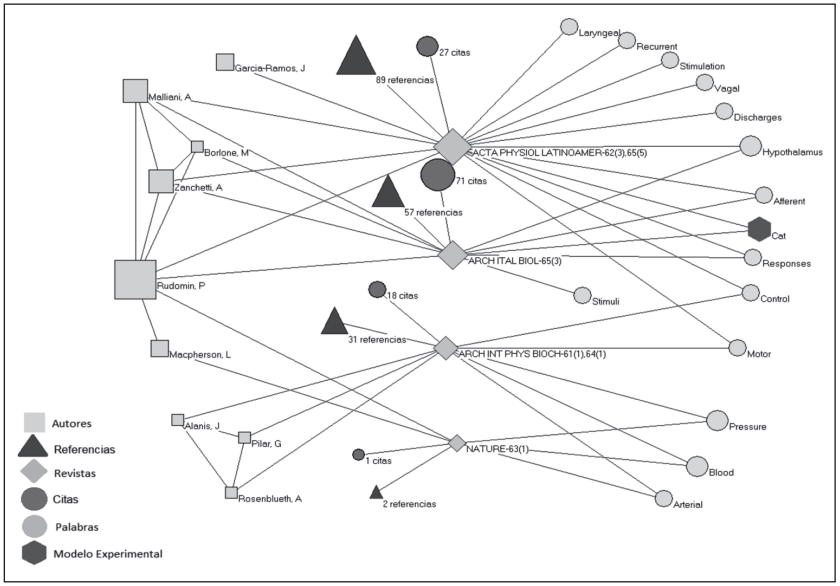

Figura 1. Five-year socio-technical network: 1961-1965

The five-year periods of 1966-1970, 1971-1975 and 1976-1980 reveal patterns of scientific communications that have the features of the first five-year period. The number of papers grew to 69 and citations moved to over 1,000; a co-authorship of 55 researchers, 15 journals and more than 1,000 references. The scientific discourse is centered on the terms afferent, depolarization, spinal, cord and cat.

The first four networks (1961-1980) share several features. They publish mainly in the regional journal Acta Physiologica Latinoamericana; the most productive and consistent authors are P. Rudomín and J. García Ramos; the most cited papers cited are published in Brain Research and the most important citing journals are Physiological Reviews, Journal of Neurophysiology and Brain Research. The continuity of publication in the line of research maintained the visibility of Cinvestav's Department of Physiology in the Science Citation Index during the decades of the 60s and 70s.

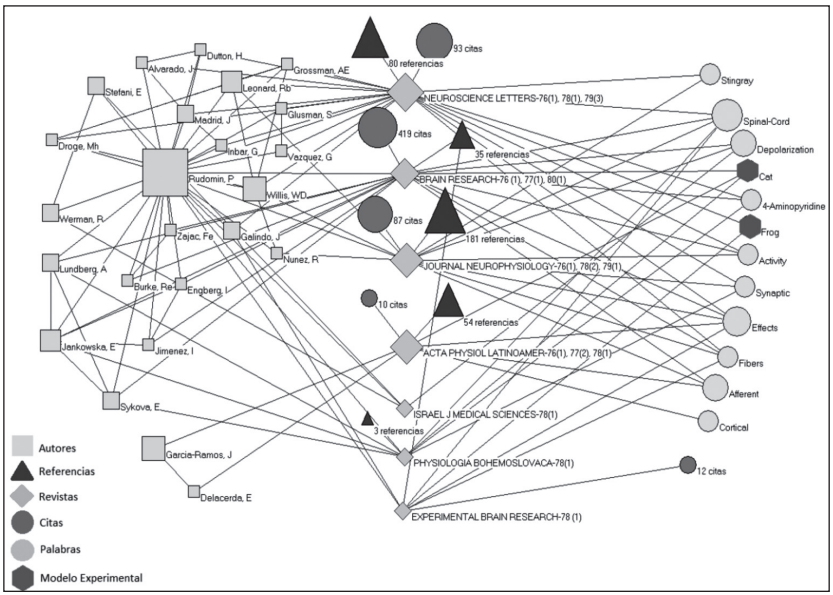

Figura 2. Five-year socio/technical network: 1976-1980

In the period after the third network (1971-1975) the co-authors S. Glusmann, R. Nuñez and J. Madrid emerge as leading researchers of the generation of students formed in Cinvestav by P. Rudomín. The network of

DOI: http://dx.doi.org/10.1016/j.jbbai.2016.10.003

1976-1980 (*Figure 2*) exhibits the most productive period associated with greater diversification of the nationality of the authors. More traditional local authors coincide: P. Rudomín y J. García-Ramos, as do young researchers trained in Cinvestav (R. Nuñez, J. Madrid, S. Glusman, I. Jiménez, J. Galindo); moreover, authors assigned in other departments (H. Dutton) and authors from recognized foreign institutions (F.E. Zajac) and mainly new coauthors (R. Leonard, R. Werman, W.D. Willis, A. Lundberg, T. Jankowska, among others). Fully 79 % of the output is attributable to P. Rudomín, who consolidated as the main builder of the line of research. In this period, the frog as experimental model appears for the first time.

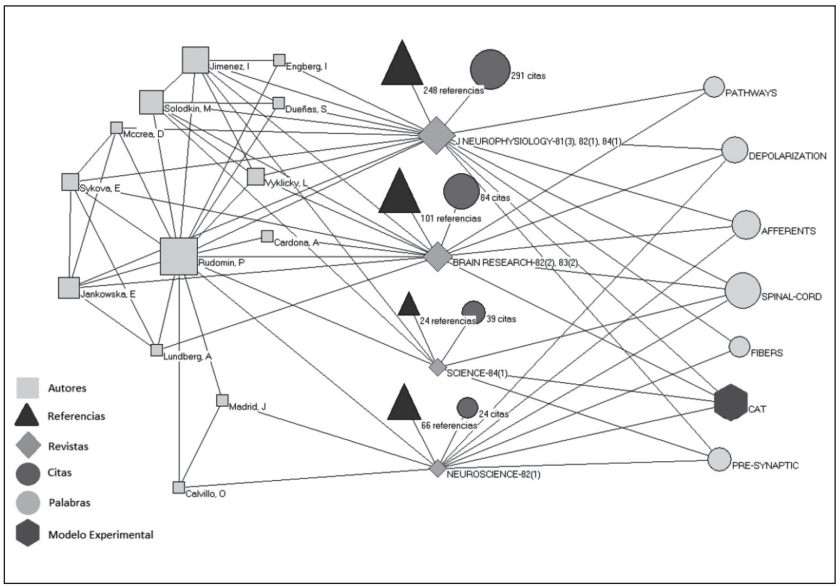

Figura 3. Five-year socio/technical network: 1981-1985

The patterns of communication of the networks in the decade of the 80s exhibit changes in communications patterns (*Figure 3*). The journal Acta Physiologica Latinoamericana, one of the more productive journals of the first two decades, no longer appears, nor does its most productive author J. García Ramos. The output is based largely on researchers working in Cinvestav. The terms spinal, cord, afferent, cat, depolarization, fibers, among other, comprise the matrix of most frequently used words identifying the literature of this group of researchers in these topics at the international level. The authors P. Rudomín, I. Jiménez and M. Solodkin stand out as the most productive collaborative relationship. It includes the most frequently cited

papers which reached average citation and references per paper twice as high as those reached by authors in previous five-year intervals.

According to *Figure 4*, in the first half of the 90s, with the same base of authors formed in Cinvestav, production and journals grew, but one of the lowest citation averages was obtained. Some of the words in the traditional matrix changes to include such words ad stimulation, muscle, synaptic y presynaptic; while others such as afferent, inhibition depolarization remained unchanged.

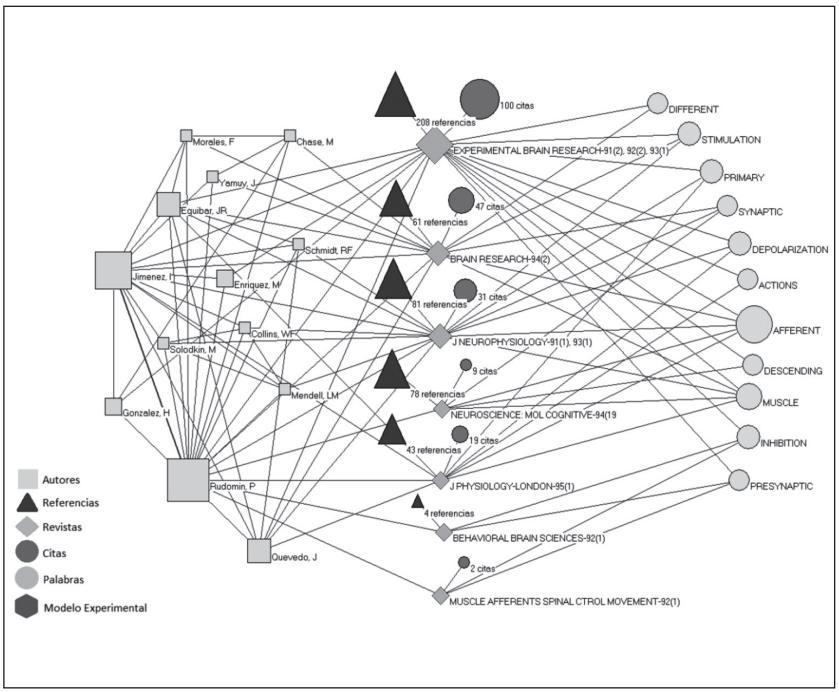

Figura 4. Five-year socio/technical network: 1991-1995

As can be observed in *Figures 5 and 6*, with the production periods of 1996-2000 and 2001-2005, the traditional term matrix that includes the words afferent, spinal, cord and cat are taken up again, including the same patterns of communications of previous five-year intervals. The most frequently cited papers are published in Experimental Brain Research and are authored by researchers trained in Cinvestav. These networks have the same nuclei of lead authors, journals and average number of references. In the period 2001-2005 the historical average of citations per work declined with respect to the previous five-year period.

DOI: http://dx.doi.org/10.1016/j.jbbai.2016.10.003

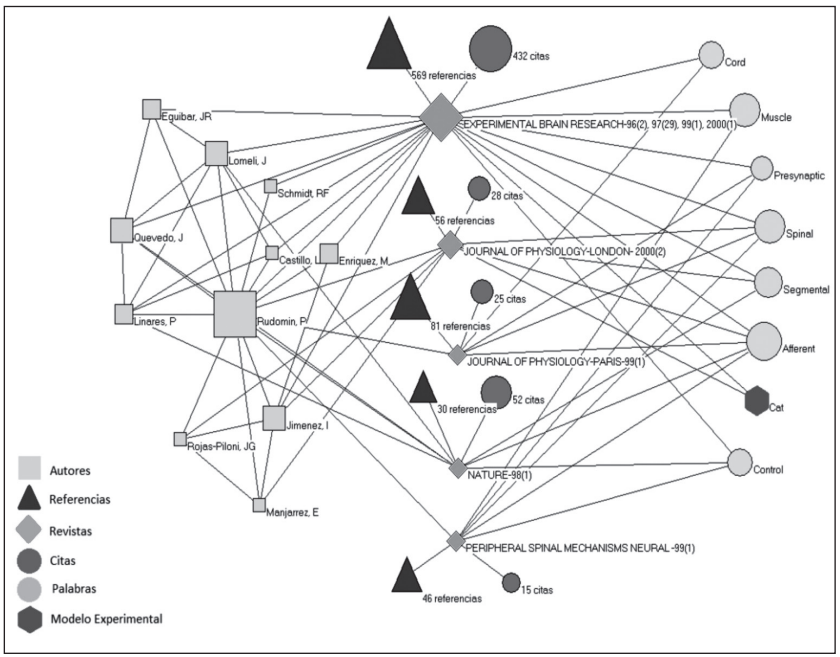

Figura 5. Five-year socio/technical network: 1996-2000

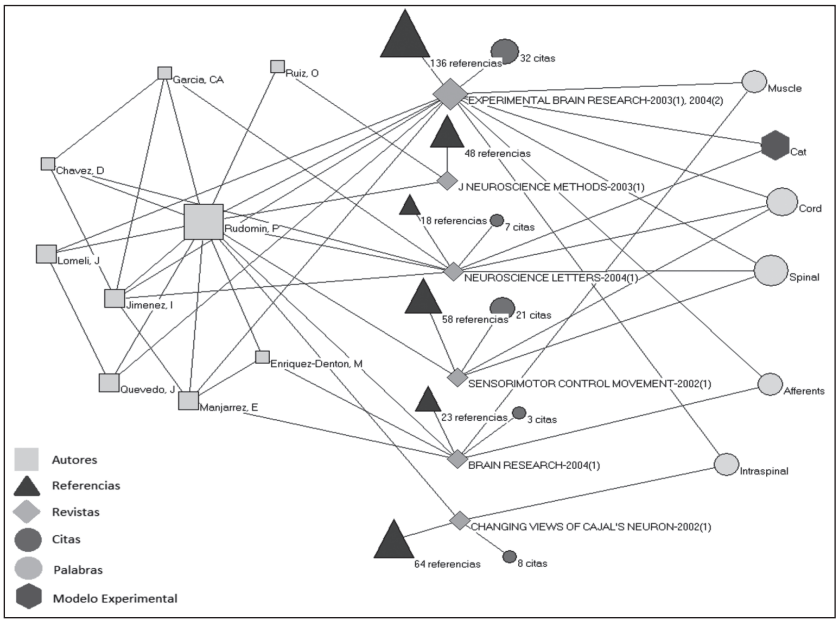

Figura 6. Five-year socio/technical network: 2001-2005

The five-year period 2006-2010 exhibits distinct communication patterns in terms of production (*Figure 7*). Four papers, three co-authors, one journal (Experimental Brain Research) and three main words: afferent, joint and cat.

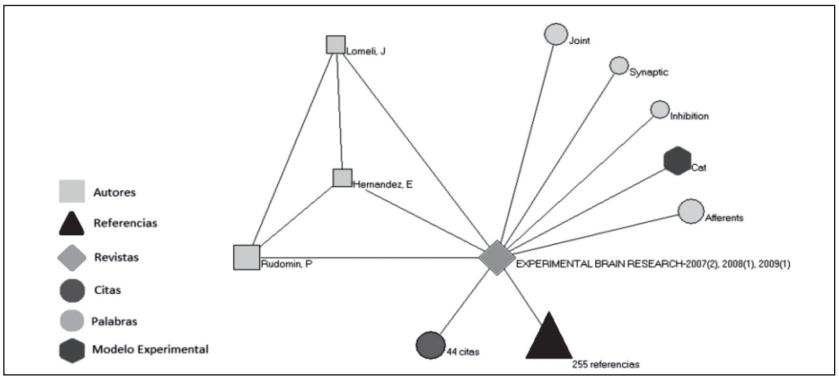

Figura 7. Five-year socio/technical network: 2006-2010

Figure 8 shows the last network (2011-2013) with the lead authors (P. Rudomín and I. Jiménez), the traditional words of the research group and one of the preferred journals, Journal Physiology. New names of authors and journals also appear with aspects of engineering and computers, among these an open access journal. The features of *Figures 7 and 8* are interpreted as signs of a change in the traditional patterns of communication.

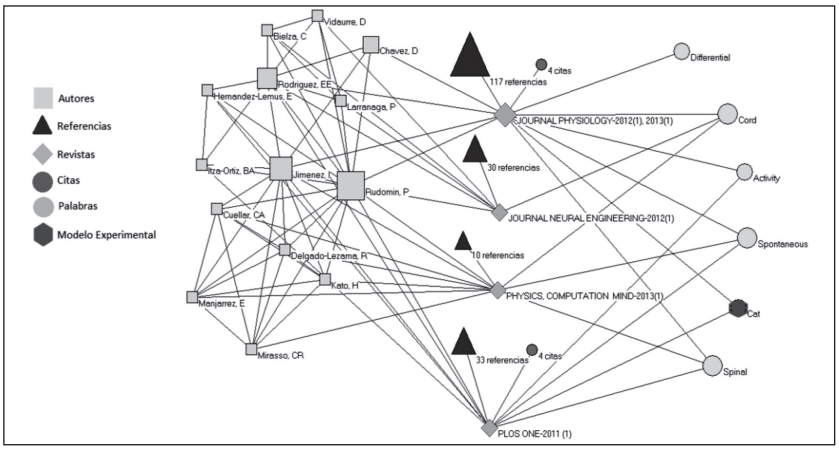

Figura 78 Five-year socio/technical network: 2011-2013

DOI: http://dx.doi.org/10.1016/j.jbbai.2016.10.003

The socio-technical of authors, journals, citation, references and words show step by step the production events building the sense of an international identity of Cinvestav. The networks offer information on the aspects that have to do with diverse dimensions of the internationalization of the institutional work. In the first place, is the fact that using the most prestigious journals in the field (Journal of Neurophysiology, Experimental Brain Research, Journal of Physiology-London and Brain Research). These four titles are among the five first places of journals in accord with the three functions they carry out in the communication system: 1) as sources of publication; 2) as sources cited; and 3) and as citing sources. >In the second place, in the publication of co-authored works, 37 researchers from foreign institutions participated. In the third place, a high average of 26 citations per work was identified. In the fourth place, the journals used for publication are included in the international bibliographical indexes as mainline journals.

Institutional contribution to international scientific production

The scientific production, as an expression of institutional internationalization, is measured by looking at the positions of authors and institutions in a classification of the international production in the field obtained from Scopus. In accord with Table 1, the institutional scientific production generated in the time has positioned the authors internationally, represented by P. Rudomín, and Cinvestav among the 10 first places of 40 in the three topic areas analyzed. In the most representative topic area, Afferent + Spinal Cord + Cat, theyu occupied second and fourth place, respectively. These positions in the international level have a specific weight: they are indicative of an important degree of contribution to the international body of knowledge in the three topic areas.

Tabla 1. Indicadores de internacionalización de la producción científica sobre médula-espinal-gato, 1960-2013

Number	Search strategy		Production	Positions in international scientific literature (Scopus) [1]		
	Words	Model	Words	Author		Cinvestav[2]
1	Afferent + spinal cord	Cat	2,867	P. Rudomín	2	4
2	Muscle + spinal cord	Cat	2,864	P. Rudomín	6	10
3	Depolarization + spinal cord	Cat	488	P. Rudomín	1	1

Source: Scopus, 1960-2013.

1 Scopus, includes the top 40 most productive places in terms of scientific output.

2 Scientific production registered in Scopus.

Discussion

The creation of the Cinvestav, the beginning of the citation indexes, the increase of scientific output in the area of spinal cord and the use of the cat as an experiemental model, as well as the adscription of a group of neurophysiology researchers to Cinvestav (A. Rosenblueth, J. García-Ramos and P. Rudomín)[25] are events that coincided in the early 1969s in science in Mexico. This relationship has remained unchanged in the international bibliographic indexes up until 2013, a period of over fifty years. During this period, the matrix of terms of afferent, cord and spinal; the cat as experimental model and the author P. Rudomín have signified in the indicators of the scientific output in the field. Cinvestav and the Department of Physiology-Mexico have attained a position on the map of international scientific geography as an important node of flow, attraction and production of knowledge in the area.

The five-year socio-technical networks reveal the process of institutional rooting in this research practice. It is characterized by creation of stable institutional conditions to support the production of knowledge in neurophysiological topics on spinal cord over the history of the institution. In the scenario of scientific communication, this body of literature is comprised of diverse elements: authors, journals, citations, references, experimental models and words. What can be seen in the five-year networks is that every time a new communication unit published this influences in the structures of the conformation of the networks: nodes and relationships appear and disappear in the networks. The components that repeat increase the value of the nodes and create a distinction. New relationships are established, while other that already exist consolidate and structures that are differentiated by the density of the relationships between the components of the network are developed. In this way, each five-year network, in its context, represents a production event in the sense of the international identity of the line of research.

Each new peer-reviewed journal, as an expression of the institutional genetic imprint, contributes elements to the construction of the sense of institutional affiliation to the dominant international discourse. According to Bourdieu,[26] the construction of this sense constitutes a symbolic institutional capital in the scientific-academic landscape. This capital, insofar that it is accredited in journals included in bibliographic indexes, can be interpreted

25 F. Collazo-Reyes, M. E. Luna-Morales y E. Luna-Morales, "Aproximación a las formas…", 1-9.
26 P. Bourdieu, *The scientific calling: science of science and reflexivity*.

DOI: http://dx.doi.org/10.1016/j.jbbai.2016.10.003

as an indicator of the scientific visibility in the international scientific communication system. Likewise, the components of the publications (authors, journals, words and model), insofar as they repeat, establish relationships and distinguish and accumulate certified symbolic capital in international bibliographic indexes. According to the results, in the topic area of spinal cord the most frequently repeated components that distinguish and accumulate capital are P. Rudomín, as author; afferent, spinal, cord, cat, depolarization, and muscle, as words; and cat, as experimental model; Journal of Neurophysiology, Experimental Brain Research, Journal of Physiology-London and Brain Research, as the preferred sources for publication, and as the most citing and citing.

Conclusions

Every time a the international scientific communication system certifies an article with the marks P. Rudomín, spinal-cord-cat and Cinvestav-Department of Physiology, there is an expression of the genetic imprint of Cinvestav in the context of mainline scientific discourse in the topic area of spinal cord.

The structures of the communication relationships resulting from authors, words, journals, references and citations allowed for the showing of the scientific-academic capital of Cinvestav as an indicator of the scientific visibility constructed in the international bibliographic indexes.

The terms Rudomín, spinal-cord-cat and Cinvestav have signified, in terms of key word of access to sceintific literature, as elements of a single information search matrix or equation. They constitute the most symbolic code of Cinvestav that has maintained the visibility of this institution during its whole history in international indexes.

Acknowledgements:

to Dr. Ricardo Félix Grijalva for his valuable comments on the contents of this paper.

To CONACYT-Red **Complexity**, Sciences and **Society**.

REFERENCES

Albornoz, M. "La política científica y tecnológica en América Latina frente al desafío del pensamiento único". *Redes* 4 (10) (1997): 95-115.

Atlas de la Ciencia Mexicana 2012: Bilingual edition. México: AMC, 2 vols., 2012. Fecha de consulta: 26 de noviembre de 2014, http://atlasdelacienciamexicana.org/

Batagel, V. y A. Mrvar. *Pajek. Program for Analysis and Visualization of Large Networks: Reference Manual. List of commandswith short explanation version 2.05*, 2011. Fecha de consulta: 26 de noviembre de 2014, http://vlado.fmf.uni-lj.si/pub/networks/pajek/doc/pajekman.pdf

Bazerman, C. y J. Paradis. *Textual Dynamics of the Professions. Historical and Contemporary Studies of Writing in Professional Communities.* Wisconsin; University of Wisconsin Press, 1991.

Bazerman, C. *Shaping Writing Knowledge.* Wisconsin: University of Wisconsin Press, 1988.

Berkenkotter, C., T. N. Huckin y J. Ackerman, "Social Context and Social Constructed Text", en *Textual Dynamics of the Professions,* Charles Bazerman y James Paradis (eds.), 191-233. Wisconsin: University of Wisconsin Press, 1991.

Bourdieu, P. *El oficio del científico: ciencia de la ciencia y reflexividad.* Barcelona: Anagrama, 2003.

Callon, M. y B. Latour. "Unscrewing the big leviathan: How actors macrostructure reality and how sociologists help them to do so", en *Advances in Social Theory and Methodology*, K. D. Knorr-Cetina y A. V. Cicourel (eds.), 277-303. 1981. Boston, MA: Routledge & Kegan Paul, 1981.

Cardinali, D. P. *Neurociencia aplicada: sus fundamentos.* Buenos Aires: Editorial Médica Panamericana, 2007.

Clark, B. R. *The Higher Education System: Academic Organization in Cross-National Perspective.* Berkeley: University of California Press, 1983.

Collazo-Reyes, F., M. E. Luna-Morales y E. Luna-Morales. "Aproximación a las formas de organización de la producción científica a través de redes de coautoría". *Avance y Perspectiva* 4 (3) (2012): 1-9. Fecha de consulta: 26 de noviembre de 2014, http://avanceypers
pectiva.cinvestav.mx/1866/aproximacion-a-las-formas-de-organiza
cion-de-la-produccion-cientifica-a-traves-de-redes-de-coautoria

De Solla Price, D. J. *Little Science, Big Science… and Beyond.* Columbia: Columbia University Press, 1986.

Little Science, Big Science. Columbia: Columbia University Press, 1963.

Devitt, A. J. "Intertextuality in Tax Accounting; Generic, Referential and Functional", en *Textual Dynamics of the Professions,* Charles Bazerman y James Paradis (eds.), 336-355. Wisconsin: University of Wisconsin Press, 1991.

Diario Oficial de la Federación. *Decreto de la creación del CIEA*, 5 noviembre de 1960.

Doheny-Farina, S. "Creating a text / creating a Company. The role of a text in the Rise and Decline of a New Organization", en *Textual Dynamics of the Professions,* Charles Bazerman y James Paradis (eds.), 306-335. Wisconsin: University of Wisconsin Press, 1991.

Florida, R. y M. Kenney. "Institutions and Economic Transformation. The Case of Postwar Japanese Capitalism". *Growth and Change* 25 (2) (1994): 247-262.

Frigon, A. "The Cat Model of Spinal Cord Injury", en *Animals Models of Spinal Cord Repair,* Hakan Aldskogius (ed.), 159-186. Uppsala, Sweden: Uppsala University, Department of Neuroscience, Biomedical Center, 2013.

Garfield, E., A. I. Pudovkin y V. S. Istomin. "Why Do We Algorithmic Historiography". *Journal of the American Society Information Science and Technology* 54 (5) (2003): 400-412.

Guertin, P. A. "The Spinal Cord: Functional Organization, Diseases, and Dysfunctions", en *Animals Models of Spinal Cord Repair,* Hakan Aldskogius (ed.), 1-24. Uppsala, Sweden: Uppsala University, Department of Neuroscience, Biomedical Center, 2013.

Ibarrola, M. "La impronta genética del Cinvestav. Una mirada a la excelencia de la institución entonces y ahora", en *Trayectoria de sus departamentos, secciones y unidades: 1961-2001,* Cinvestav, 11-51. México: Cinvestav, 2002.

Latour, B. "On actor-network theory - A few clarifications". *Soziale Welt-Zeitschrift fur Sozialwissenschaftliche Forschung und Praxis* 47 (4) (1996): 369-381.

Law, J. "Notes on the theory of the actor network-ordering, strategy, and heterogeneity". *Systems Practice* 5 (4) (1992): 379-393.

Leydesdorff, L. "Eugene Garfield and Algorithms Historiography: Co-Words, Co-Authors and Journals". *Annals of Library and Information Studies* 57 (3) (2010):248-260.

DOI: http://dx.doi.org/10.1016/j.jbbai.2016.10.003

Manual de Santiago. *Manual de Santiago de internacionalización de la ciencia y la tecnología.* Buenos Aires: *REDES*, 2007.

Pickstone, J. V. "A Brief Introduction to Ways of Knowing and Ways of Working". *History of Science* XLIX (2011): 235-245.

"Working knowledge before and after circa 1800: Practices and disciplines in the history of science, technology and medicine". *Isis* 98 (3) (2007): 489-516.

Rexed, B. "A Cytoarchitectonic Atlas of the Spinal Cord in the Cat". *Journal of Comparative Neurology* 100 (2) (1954): 297-379.

"The Cytoarchitectonic Organization of the Spinal Cord in the Cat". *Journal of Comparative Neurology* 96 (3) (1952): 415-495.

Rosenblueth, A., J. Alanis y G. Pilar. "The Accessory Motor Innervation of the Diaphragm". *Archives Internationales de Physiologie et de Biochimie* 69 (1) (1961): 19-25.

Sollaci, L. B. y M. G. Pereira. "The introduction, methods, results, and discussion (IMRAD) structure: a fifty-year survey". *Journal of Medical Library Association* 92 (3) (2004): 364-371.

Vessuri, H. "El Centro de Investigación y de Estudios Avanzados del IPN (Cinvestav)", en *37 Modos de hacer ciencia en América Latina,* B. Hernando Gómez y S. Hernán Jaramillo (comps.), 25-47. Colombia: Tercer Mundo Editores, 1997.

Para citar este artículo:

Collazo-Reyes, Francisco, María Elena Luna-Morales y Evelia Luna-Morales. 2016. "Impronta genética institucional y desarrollo de identidad internacional: estudio bibliométrico sobre médula-espinal-gato en Cinvestav." *Investigación Bibliotecológica: Archivonomía, Bibliotecología e Información 70*: 39-58 . http://dx.doi.org/10.1016/j.ibbai.2016.10.003