COMENTARIO

Biodiversity in Action: Advances and Perspectives in Latin America

Cleide Costa
Museu de Zoologia, Universidade de São Paulo, Av. Nazaré, 481, 04263-000 São Paulo, SP, Brazil, cleideco@usp.br

During the «I Congreso Latinoamericano (IV Argentino) de Conservación de la Biodiversidad», in November 2010, in San Miguel de Tucumán, I had the chance to deliver lectures on the future of biodiversity in Latin America, after which I was invited by the editors of the *Acta Zoologica Lilloana* to write an article on this subject. I decided to extend the Tucumán conferences focusing on the taxonomy and biodiversity of insects, which is my study area. However, the questions discussed herein could be pertinent or applied to all living beings.

Biological diversity or biodiversity can be understood as the different living organisms that inhabit the Earth. This «diversity of living creatures», which is completely dynamic and constantly evolving, is threatened with extinction. Little of it is known and it is often unexplored. Its knowledge is essential for scientific and technological advances of society as a whole.

The research on biological diversity includes: a) methods of collecting and sampling, analyses allowing the ecological, genotypic, phenotypic, phylogenetic and biogeographical characterization for which biological collections are of great help, b) complementary methods that enable deeper understanding of biodiversity such as molecular techniques for the production of databases of DNA (genetic libraries), genomic and proteomic sequencing and so on; (c) biogeographical methods to understand the patterns of distribution of organisms and processes which lead them to inhabit the different geographical areas and d) phylogenetic methodologies to provide a conceptual framework and a classification of organisms taking into account the evolutionary relationships of monophyletic groups.

Taxonomy or Systematics, according to some authors, is an independent science whose achievements rank as some of the outstanding successes of modern science. It is not a technical support service for the whole of biology, but a science that advances through testing hypothesis about status and phylogenetic relationships (Godfray & Knapp, 2004a). It is the basic discipline of all the biodiversity sciences responsible for discovering, describing, and classifying biological diversity. It is a reference system for the systematization of the biological collections, real banks of data or repositories of specimens and information on the biota, very important for the management and sustainable use of biodiversity. Biological collections include records of past and recent morphological and genetic variation, geographical distribution, as well as other valuable information such as the register of extant species. They are a requirement for the realization of taxonomic, evolutionary, biogeographic studies and biotechnology.

The knowledge of biodiversity, however, does not depend exclusively on a proper sample, but mainly on the scientific ability and adequate methodologies that can help elicit from them the information which can also serve as management and sustainable strategies. Nevertheless applied efforts in biological collection management and preservation are not sufficient to obtain all the information it contains. Certainly the investment in the taxonomist formation together

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with positions in the institutions that lodge biological collections are fundamental, especially considering the fact that there are a greater number of taxonomic groups with unprepared professionals (Costa, 2005).

No matter the dimension of the diversity which allows some parameters to be known and used in conservation, they are widely insufficient both as a methodological tool and to deepen our understanding of the biodiversity science. Space, time, the evolutionary dynamics and the ethical aspects always require the characters of the biodiversity to be as well known as possible. In this way, the traditional systematics is a starting point to the knowledge, but not a model of systematics to be built in the following years. The refinement of phylogenetic and biogeographic methods provides the systematics and biogeography with predictive scientific power, highly elaborated, nonexistent only a few decades ago, and that should be taken into account (Amorim *et al.*, 2002; Costa, 2005; de Carvalho *et al.*, 2008). It is about a wide variety of correlated activities and actions that have to be planned and enlarged, bearing in mind the rebuilding of the entomological collections because of the «great biodiversity inventory».

The methodologies based on the morphological data, so much used by the traditional taxonomy and cladistic analyses, are still the subject of criticism: they neither produce immediate results, nor meet the demand of current knowledge of the species. Several papers dealing with the role of taxonomy in species conservation and how to solve the 'taxonomic impediment' and other related matters were compiled by Godfray and Knapp (2004b). The incorporation of new technologies into taxonomy should be used to improve taxonomy rather than replace it (Wheeler 2004).

The great concern in the knowledge of global biodiversity, the need of rapid quantification of the number of species, etc., have led taxonomists to use new and complementary tools in the traditional taxonomy: molecular methodologies as DNA or proteins sequencing (genomics and proteomics) and the consequent production of phylogenies and dendrograms. Many people believe that the sequencing of an increasing number of genes and genomes could provide a phylogeny of most living species on Earth, supported only on molecular data. Therefore there would be no need for new studies of comparative morphology. There is resistance not only in the use of morphological data as a source of information in the elaboration of phylogenies but also in the use of morphological data of juveniles, or biological cycles and natural histories of the species.

The knowledge of the whole life cycle of insects is very important to ensure the use of immature of the same instar or stases to propose more consistent phylogenetic hypothesis. The characters of insects immature should be used in classifications and in the establishment of phylogenetic relationships, because there are no characters, either immature or adult, that can previously be considered more relevant in the classification and phylogeny. The entomological fauna diversity is best understood when it includes data involving the immature that provide more accurate knowledge of morphological and ecological adaptations, and interspecific associations among species. The use of larval characters together with adults, in cladistic analyses, can provide a broader view of the evolutionary process (Costa & Ide, 2008). The study of phylogenetic systematics must include a large number of characters to obtain robust phylogenetic hypotheses and predictions.

In many cases, however, it seems that the old confrontation, pointed out by Crowson in 1981, between applied research and basic research is still alive. For instance, Crowson complained that in many cases it was necessary to justify the financing of the execution of the pure research with basis on its indirect applicability. Apart from that, the taxonomists many times have to face, on the one hand, the criticism of those who accuse them of being environmental technician destroyers and, on the other hand, of those who think inadmissible to apply financial resources in scientific researches without any useful objective.

A LITTLE BIT OF HISTORY

In 1986, the «Society for Conservation Biology» was founded in the United States and, in that same year, the «National Forum on Biodiversity» was held in Washington D.C., organized mainly by Walter G. Rosen, who introduced the term *biodiversity*. In June 1992, the Convention on Biological Diversity (CBD) was held in Rio de Janeiro during the Conference of the United Nations on Environment and Development (CNUMAD or ECO-92). During the Conference of the Parties (COP3) in 1996, the participating countries recognized the importance of the biological collections and the need to invest resources for the improvement of infrastructures for storage of specimens, specimen's recovery and expansion of the collections. There was a recognition of the so-called «taxonomic impediment», that is the lack of taxonomists to identify all the species on Earth.

In 2002, world leaders reaffirmed the existence of a «taxonomic impediment» for the implementation of the United Nations Convention on Biological Diversity (CBD). Signatories to the Convention agreed to a significant reduction in the rate of biodiversity loss by 2010. The Global Taxonomic Initiative (GTI) then established several operational objectives including the assessment of needs and capabilities in taxonomy at national, regional and global levels. As a result, they would support the training of human resources and infrastructure needed to sort and cure biological specimens which are the basis of taxonomic knowledge.

The description and analysis of biodiversity require an international approach involving collaboration at all levels, and wide communication among stakeholders, including Government, Institutions, researchers and local communities. In the last ten years, some examples of this type of interaction happened in Latin America in biodiversity studies supported by regional institutions and CYTED (Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo, España).

I had the opportunity to actively participate from 1999 to 2008 in the following initiatives related to biodiversity in Latin America: from 1999 to 2002, in the network «Proyecto Ibero-americano de Biogeografía y Entomología Sistemática» (CYTED PrIBES); from 2003 to 2006, as assistant coordinator of J. H. Llorente (UNAM-Mexico) and a founding member of the XII CYTED network «Red Iberoamericana de Entomología Sistemática» (RIBES); from 2004 to 2008, as founding member of the network XII: L «Red Iberoamericana para la Conservación e Informatización de Colecciones Biológicas - Sistemas de Información», coordinated by E. Romero «Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires» (MACN); from 2002 to 2008, as founding member of «Associação Memória Naturalis: Cidadania, Ciência & Cultura» (AMNAT), also acting in the articulation of AMNAT with the networks CYTED on biodiversity and biological collections in Latin America.

The main idea of all these networks was to put the information and the methodological tools needed at the disposal of the Latin-American scientific community and of those who are responsible in society for decisions on the conservation and preservation of the territory, allowing their decisions to be supported by rigorous scientific data. At the same time, we realized that the human and material resources were not enough in order to put an end to what we now call «taxonomic impediment», because it would be a long delayed process.

The Red Iberoamericana de Entomología Sistemática – PrIBES/RIBES (1999-2006) intended to consolidate an Ibero-American network of Systematics of Entomology. The network would allow, in the medium term, to launch a major multinational project for the study of biodiversity in groups of hiperdiverse insects (Coleoptera, Hymenoptera, Diptera and Lepidoptera). The scientist working group was made up of twenty-three teams from twelve countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Spain, Mexico, Nicaragua, Peru, Portugal and Venezuela. They aimed to promote com-

parable information through taxonomy, phylogenetic and biogeographical analysis; to detect the critical «Hot Spots» areas of insects; and to mobilize Latin American scientific potential in the field of exploration, description, interpretation and analysis of entomological biodiversity from a multidisciplinary perspective. Several multidisciplinary courses at different levels were given and expressive publications about the state of the art of the megadiverse orders of insects were published (e. g. Martin-Piera *et al.*, 2000; Costa *et al.*, 2002, 2006; Llorente & Morrone, 2005; Morrone & Llorente, 2006; and Llorente & Lanteri, 2008). RIBES started a discussion forum on knowledge, estimate and preservation of insects, to stimulate actions and joint projects in systematics and biogeography. This network launched a multinational and multi-institutional cooperation mechanism to foster joint efforts in biodiversity and bioconservation of megadiverse insects.

The network on «Conservation and Computerization of Biological Collections» organized by CYTED «Red Iberoamericana para la Conservación e Informatización de Colecciones Biológicas - Sistemas de Información» from 2005 to 2008 intended to facilitate the development of taxonomic competence in handling data, and conservation and management of Biological Collections. Among other objectives, it proposed: to compile a Catalogue of the Latin-American biological collections; to transfer specific expertise in management of metadata and management of collections; to ease access to data and specimens; to facilitate consultation with experts on specific taxonomic groups. Four scientific meetings were carried out: in Buenos Aires, Argentina; Bogotá, Colombia; Santo Domingo de Heredia, Costa Rica and Lima/Tarapoto, Peru. The results of the Tarapoto meeting were a recommendation document and the acquisition of an internet domain for an active continuous discussion forum called «RECIBIO» (www.recibio.net). For taxonomic competence development, this forum established linkage and cooperation with the Global Biodiversity Information Facility (GBIF) and «Red Temática de Especies y Especimenes», Inter-American Biodiversity Information Network (IABIN), which was essential to ensure the greater and broader access to information on museums, herbaria, zoos, botanical gardens and other institutions in the region. It has also created opportunities for training and exchange of experiences regarding the use of standards, collection conservation and geo-referencing data locations. In 2009, as a result of this network, the Plataforma Iberoamericana para la Información sobre Biodiversidad (PIIB) was created, coordinated by Francisco Pando (GBIF-ES). The institution is still active, contributing to advances in computerization and accessibility of biological collections and training actions to generate and use technological resources to make the biodiversity information accessible.

The Brazilian Association «Memoria Naturalis» (AMNAT, 2002–2008) proposed strategies to maximize the relations between the academy and the responsible persons for decisions of the State. In this regard, AMNAT platform intended to enable the integration of the Brazilian scientific collections, enhancing access to information by the institutions. In this way, it organized many meetings and actions, but one of the most important contributions was the organization of a meeting associated with the Conference of the Parties (COP8) in Curitiba: «Biodiversity - The Megascience in focus» (AMNAT, 2006).

In Brazil, the Government instituted at the beginning of the 21st century the «Comissão Nacional de Biodiversidade» (CONABIO), sponsored by the «Ministerio do Meio Ambiente» (MMA). In 2002, the «Guidelines for the national policy on biodiversity» were promulgated. Since then, there has been a significant growth of Federal and State Government actions related to the Brazilian biological collections. In 2005, the «Programa de Capacitação em Taxonomia» (Protax) was created by the «Conselho Nacional de Desenvolvimento Científico e Tecnológico» (CNPq). It is a training program in taxonomy aiming to stimulate the formation of human resources in taxonomy and curatorship

anchored in the Brazilian postgraduate system. In 2010, a new taxonomy training program (PROTAX) was launched by MCT/CNPq/MEC and «Coordenação de Aperfeiçoamento do pessoal de Nível Superor» (CAPES), in order to give continuity to the program launched in 2005 and to promote the training of human resources to encourage and to develop the country's present taxonomic capacity. Both programs have been greatly attended and a lot of their projects recommended.

In 2006, the CNPq implemented the «Taxonline» project for the consolidation of a network of biological collections in the State of Paraná. It was mainly designed to modernize and adapt the infrastructure of the collections and promote the computerization of their data; 32 collections from the Brazilian Southeast region were integrated (Marinoni & Peixoto, 2010).

In 2005-2006, the MCT coordinated by the «Centro de Gestão e Estudos Estratégicos» with the partnership of the «Sociedade Botânica do Brasil», «Sociedade Brasileira de Zoologia», «Sociedade Brasileira de Microbiologia» and «Centro de Referência em Informação Ambiental» (CRIA) drew up the document «Diretrizes e estratégias para a modernização de coleções biológicas brasileiras e a consolidação de sistemas integrados de informação sobre biodiversidade», guiding principles for the drafting of a policy on collections management, research, and dissemination of the Brazilian biodiversity information (Egler & Santos, 2006). This document was ratified during the COP8 in Curitiba.

In 2009, the «Fundação de Amparo à Pesquisa do Estado de São Paulo» (FAPESP) celebrated the tenth anniversary of the program «Virtual Biodiversity Institute» or «Biota FAPESP» as it is also known. This is one of the most successful programs of FAPESP and it has had a huge impact on the training of human resources in taxonomy.

In 2010, «Sistema Nacional de Pesquisa em Biodiversidade (Sisbiota-Brasil)», a joint initiative of CNPq, FAPESP and 18 more foment foundations proposed to have a national system to gather all the Brazilian biodiversity information involving taxonomy, specific studies on the biota (long term research), climate change and general information.

Ban Ki-Moon, Secretary-General of the United Nations, in the Foreword to the Global Biodiversity Outlook 3 (2010), analyzed the biodiversity knowledge progress since 2002 and realized that an increase in the protection of terrestrial and marine areas caused a greater number of countries to seek protection against invasive species. He also recognized that there was an increase in funding for the implementation of the CBD. However, he pointed out that these efforts were still not enough to achieve a new vision of the biological diversity for the health of the planet and its sustainable future. For this reason, he considered that the objectives agreed upon by the leaders of the world in 2002 were globally unfulfilled despite some regional positive results.

Some of the decisions of the COP10 in Nagoya, Japan, (http://www.cbd.int/decision/cop/?id=12305), include: priority in the taxonomic needs as the «taxonomic impediment» is being reduced, make taxonomic research urgent in all biogeographic regions so as to hold capacity training workshops, training courses both for the users of taxonomic information and for the young professional taxonomists; to enhance the activities of institutions related to taxonomy in order to provide job opportunities and incentives for young taxonomists and to intensify the taxonomic capacity to conduct appropriate training for parataxonomists and relevant end-users of taxonomy at national, regional and global levels.

During the Symposium on «Taxonomía: continuidad y cambio « in November 2010 (San Miguel de Tucumán, Argentina), the newly created «Sociedad Argentina de Taxónomos y Sistemáticos – SATs» was announced. This society intends to promote a discussion forum of current issues related to taxonomy and biodiversity.

Recently two bibliometric studies have been published with the purpose of having a

regional vision of the development degree of Systematics in Latin America (Michián *et al.*, 2008; Michián & Llorente, 2010). The first refers to articles published between 1976 and 2006; the second spans the 20th century. These authors, among other conclusions, determined that the animals were the most studied taxa (65,6 %), followed by the plants (37 %), the fungi (6 %) and the micro-organisms (2,3 %). The countries that were the focus of greatest interest in studying the Latin America biota from a taxonomic point of view were: Brazil, the United States, Argentina and Mexico. They also noted that the articles especially concentrated on descriptive taxonomy related to ecology, anatomy, histology and aquatic biology. The most represented groups were the insects and flowering plants.

CONCLUSIONS

Latin America is a megadiverse region with biota, ecosystems, species, geographical races and a large proportion of endemic species which are priorities for the conservation of threatened hotspots of extinction. It contains nine of the eco regions richest in species of plants in the world. With the current biodiversity crisis, there is a risk that many species will not be described or known, so it is quite possible there will be no record of them. We are on the threshold of a huge biotic impoverishment (Michián & Llorente, 2010).

The last ten years have been prodigal in initiatives to improve the knowledge of the biodiversity of Latin America, but there is still much to be done. The above cited bibliometric studies show that the production published on systematics in the Latin American journals is extraordinary and it is a reflection of the work of many taxonomists.

The challenge before us is thus not only to computerize museum data but also to have an efficient system and a sufficient number of taxonomists to support ongoing improvement and data checking and then make those data rapidly available (Wheeler, 2004). The recognition of a «taxonomic impediment» by the leaders of the world in 2002 was decisive to promote the start of the management and conservation of biodiversity; yet its removal remains a challenge and one of the objectives of the CBD.

One of the most important issues related to the biological collections is still the lack of adequate resources for the safe storage or for the necessary infrastructure to research and retrieve information from the specimen, and also for the expansion of the collections in order to develop their potential contribution to the knowledge of the biodiversity (Marinoni & Peixoto, 2010). On the other hand, we note that the efforts applied in the management and conservation of the biological collections were not even close enough to revealing all the information they contained.

As for the achievement of the proposed goals of CBD in 2002, a lot of work will be necessary, such as expanding the effort of collection of samples in the field; the training and the incorporation of existing new resources; the significant improvement of the physical conditions of preparation of the collections and institutional strengthening, in the sense of refining capacity for data and collections, from independent and consolidated policies. Therefore, considering the study of biodiversity in the near future, the following guidelines or steps for actions, should be taken into account (Godfray and Knapp, 2004a, 2004b; AMNAT, 2006; Aguiar *et al.*, 2008):

1. Continuity in the development of human resources at all levels to have enough elements to meet the challenge and guarantee the resources on a permanent basis for qualified professionals in an institutional framework [e.g., Aguiar *et al*, (2008) pointed out that about 110 000 insects are found in Brazil and for this amount of insects, we have only 127 active entomologists. An analysis of the scientific production of Brazilian entomologists between 1998 and 2008 shows that 68.8 % to 90 % are resident researchers from the South or Southwest regions, being the Northeast and Midwest the critical areas].

2. Increase, in the short term, the spectrum of specialists in taxonomy, enhancing the preparation of «no clones» taxonomists, that is, taxonomists with different taxonomic expertise from their tutors and with an extensive scientific and technical practice (Costa, 2005). The complexity of the analysis of biodiversity, patterns, causes and strategies of conservation, leads us to accept that this new generation of experts in biodiversity must be more than just a new generation of specialists. Taxonomists in the near future, must not only be able to identify and describe species, suggest classifications and biogeographic hypotheses based on phylogenetic inferences, but also meet standards for the management of the taxonomic information and biodiversity georeferable information systems. They will acquire, in short, a solid background which will enable them to cope with the impending problems that make up what has been called: «global change and biodiversity crisis».

3. Provide the new generation of taxonomists with greater expectations and opportunities in their career, more than what is expected in their incorporation to classics taxonomic departments of Museums of Natural History or Universities, because taxonomy will be an absolutely indispensable science in the near future. One might also suggest the creation of new institutions or identification centers in emerging areas to enlarge their employment possibilities.

4. Develop sufficient resources for the implementation of inventories according to previous identification of areas and regions lacking information on various taxonomic groups, in response to scientific issues identified by the research groups and following methodological protocols appropriate to each situation.

5. Make arrangements with national policy-makers in each country, showing the opportunity, need, urgency and importance of evaluation and systematization of the Biological Collections, in the scientific, political and socio-cultural fields of the Latin-American community.

6. Provision of adequate and permanent conditions of physical structures and necessary equipment to guarantee the conditioning and the permanent preservation of the existing samples, with the emergent new field work.

7. Stimulate the writing of monographs and reviews synthesizing knowledge of different taxonomic groups on electronic media, describing and identifying new species; publishing catalogs, checklists, educational books, synopses to be a part of the direct benefits of the curatorship of the Collections.

8. Establishment of intellectual property in clear and permanent legal frameworks.

9. Solution of the Impact Factor (IF) problem. Taxonomic papers are long, require many illustrations, and typically have a very specialized audience that lasts many years; the half-life of a monograph can be estimated in decades or even centuries rather than years or months. We obviously need an impact factor change in scientific publications to value taxonomic papers.

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LITERATURE CITED

Aguiar, A. P., Santos, B. F., Couri, M. S., Rafael, J. A., Costa, C., Ide, S., Duarte, M., Grazia, J., Schwertner, C. F., Freitas, A. V. L. y Azevedo, C. O. 2008. Insecta. En: R. M. Rocha y W. A. P. Boeger (eds.), Estado da arte e perspectivas para a Zoologia no Brasil, Sociedade Brasileira de Zoologia, Cap. 8, 296 pp.

AMNAT (Org.). 2006. Biodiversity, the Megascience in focus: outcomes and recommendations of the COP8 Associated Meeting, and a statement of principles by Brazilian biodiversity scientists/ organized by Associação Memória Naturalis, Rio de Janeiro: Museu Nacional, 2006. Série Livros 20, 44 pp.

Amorim, D. de S., Silva, V. C. y Balbi, M. I. P. A.. 2002. Estado de conhecimento dos Diptera Neotropicais. En: C. Costa, S. A. Vanin, J. M.

Lobo y A. Melic (eds.), Projecto de Red Iberoamericana de Biogeografía y Entomología Sistemática PrIBES 2002. Sociedad Entomológica Aragonesa (SEA) y CYTED, Zaragoza, pp. 29-36.

Costa, C. 2005. O papel de cientistas na geração e gestão da informação para a conservação e utilização da diversidade biológica em países megadiversos. Boletim Informativo, Sociedade Brasileira de Zoologia, Ano XXVII – No 82: 8-9, Curitiba.

Costa, C. e Ide, S. 2008. Importância e significado taxonômico e filogenético dos caracteres dos imaturos de Insecta em especial dos Coleoptera. En: J. Llorente y A. A. Lanteri (eds.), Contribuciones taxonómicas en órdenes de insectos hiperdiversos. UNAM, RIBES-CYTED, México, D.F. 221 pp.

Costa, C., Ide, S. y Simonka, C. E. 2006 Insectos inmaduros, metamorfosis e identificación. Zaragoza: Sociedad Entomológica Aragonesa (SEA), Cyted, Ribes, CNPq, m3m, Monografías Tercer Milenio, 233 pp.

Costa, C., Vanin, S. A., Lobo, J. M. y Melic, A. (eds.). 2002. Proyecto de Red Iberoamericana de Biogeografía y Entomología Sistemática PrIBES 2002. Sociedad Entomologica Aragonesa (SEA), Zaragoza, 329 pp.

Crowson, R. 1981. The Biology of Coleoptera. Academic Press, London, 802 pp.

De Carvalho, M. R., Bockmann, F.A., Amorim, D. S. y Brandão, R. F. B. 2008. Systematics must embrace Comparative Biology and Evolution, not Speed and Automation. Evolutionary Biology, 35: 150-157.

Egler, I. y Santos, M. M. (Coord.). 2006. Diretrizes e estratégias para a modernização de coleções biológicas brasileiras e a consolidação de sistemas integrados de informação sobre biodiversidade. MCT/CGEE, Brasília.

Global Biodiversity Outlook 3. 2010. Secretariat of the Convention on Biological Diversity. Global Outlook 3, Montreal, 94 pp.

Godfray, H. C. J. y Knapp, S. 2004a. Introduction to Theme Issue, «Taxonomy for the 21st Century». Philosophical Transactions of the Royal Society of London B, 359: 559-569.

Godfray, H. C. J. y Knapp, S. (Org.). 2004b. Taxonomy for the twenty-first century compiled by H. C. Godfray y S. Knapp. Philosophical Transactions of the Royal Society of London B, 359: 559-739.

Llorente-Bousquets, J. y Lanteri, A. A. (eds.). 2008. Contribuciones taxonómicas en órdenes de insectos hiperdiversos. UNAM, RIBES-CYTED, México, D. F., 221 pp.

Llorente-Bousquets, J. y Morrone, J. J. 2005 (eds.). Regionalización biogeográfica en Iberoamérica y tópicos afines: Primeras Jornadas Biogeográficas RIBES. Las Prensas Ciencias, Fac. Ciencias, UNAM, México, D. F., 577 pp.

Marinoni, L. y Peixoto, A. L. 2010. As coleções biológicas como fonte dinâmica e permanente de conhecimento sobre a biodiversidade. Ciência e Cultura (São Paulo), 62 (3): 54-57.

Martín-Piera, F., Morrone, J. J. y Melic, A. 2000. Hacia un Proyecto CYTED para el Inventario y Estimación de la Diversidad Entomológica en Iberoamérica: PrIBES 2000. Sociedad Entomológica Aragonesa y CYTED, Zaragoza, 1: 1-326.

Michián, L. y Llorente-Bousquet, J. 2010. Bibliometría de la sistemática biológica sobre América Latina durante el siglo XX en tres bases de datos mundiales. Revista de Biología Tropical (Int. J. Trop. Biol. ISSN-0034-7744), 58 (2): 531-545.

Michián, L., Russell, M. J., Sanchez, P. A., Llorens, C. A. y Lopez, B. C. 2008. Análisis de la sistemática actual en Latinoamérica. Interciencia, 33 (10): 755-761.

Morrone, J. J. y Llorente-Bousquets, J. (eds.). 2006. Componentes bióticos principales de la entomofauna mexicana. Las Prensas de Ciencias, UNAM, I: 562 pp., II: 464 pp.

Wheeler, Q. D. 2004. Taxonomic triage and the poverty of phylogeny. Philosophical Transactions of the Royal Society of London B, 359: 571-583.