

Plant molecular systematics in Latin America: status, realities, and perspectives

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Molecular biology techniques have had a great impact in modern studies of biodiversity across the globe, and they have contributed significantly to our understanding of evolutionary relationships across all kingdoms. Protein and DNA sequence data have provided a seemingly endless amount of characters to be used in phylogenetic studies, and they have allowed comparisons across divergent groups for which it is very difficult to establish morphological homologies. Researchers in Latin America have not escaped this revolution, and in several institutions efforts have been made to begin utilizing them. Economical, social and political factors have both slowed and stimulated the development of molecular systematics and phylogenetics in Latin America. Even though the continent is not homogeneous, and these factors may differ from country to country, some general patterns do exist across the region. In the present document, we will attempt to summarize the status of molecular systematic studies throughout Latin America, analyze which factors have stimulated or slowed down its development, and we will conclude with some suggestions on how to improve the current state of affairs.

KEYWORDS: collaborations, current status, Latin America, molecular systematics, publications.

CURRENT STATUS

Several plant systematists in Latin America have obtained their advanced degrees in the U.S.A. and Europe and have been trained in or exposed to modern techniques. Most of the authors of this document fall within this category. Moreover, Latin American scientists have contributed significantly to the development of modern systematics, including theoretical tools and software, e.g., J. Crisci and J. Morrone's contributions to cladistic biogeography (Crisci, 1982; Morrone & Crisci, 1995; Morrone, 2002), M. De Pinna's contributions in homology assessment and other theoretical issues (De Pinna, 1991, 1994, 1996) and P. Goloboff's development of Nona, Piwe, and TNT, as well as contributions in several theoretical topics (Goloboff, 1991, 1993a, b, c, 1998; Goloboff & al., 2001). In addition, the high levels of biodiversity in Latin America have attracted several researchers in the U.S.A., Europe, and Japan to establish close collaborations with biologists in Latin America to obtain the natural history and morphological expertise as

well as live organisms necessary to carry out phylogenetic studies. All of these features brought the knowledge, and in some cases equipment, to the continent and have started the development of molecular systematics in Latin America.

In spite of all this, however, the number of publications and laboratories carrying out this type of studies is still very limited. A recent bibliographic survey of the Science Citation Index[®], covering the 10 years from 1992 to 2002, showed that only 142 publications in plant molecular systematics included authors whose primary affiliation was with a Latin American university or research institute. The number of publications is not homogeneous across the region. Mexico, Brazil, Colombia, Argentina and Chile accounted for more than 75% of these publications, and the other 10 countries for the remaining 25% (Fig. 1). In addition, this survey did not find any publications in plant molecular systematics with authors affiliated with institutions in Guatemala, Honduras, Nicaragua, Paraguay and the Dominican Republic.

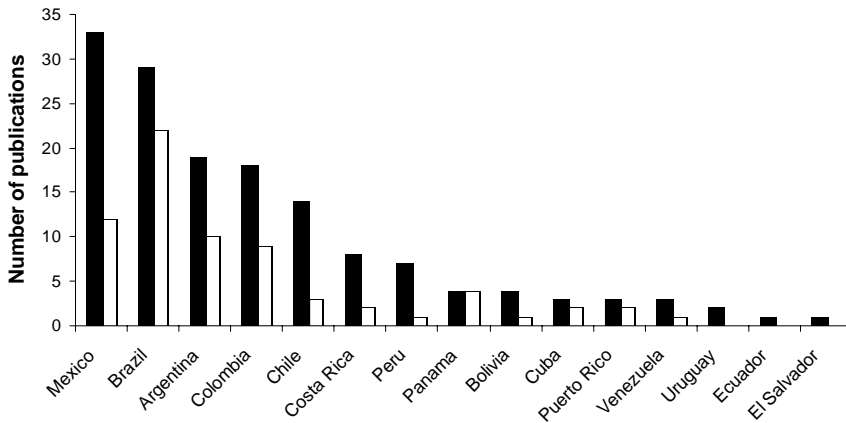


Fig. 1. Publications in plant systematics listed in Biosis for the period 1992–2002 by country in Latin America. Solid bars represent total number of publications involving a country and white bars represent those in which the first author is from that country. Countries not listed had no publications.

This survey also gives us insight on how collaborations have been established in Latin America. Only 69 (49%) of these publications had a first author from Latin America. A closer look at a fraction (30) of these publications revealed that in the majority of the cases the molecular data had been generated in U.S.A. or European institutes either by Latin American researchers during stays in those countries or by their collaborators. Some groups working in Brazil, Mexico, and to a lesser degree Colombia and Panama, are notable exceptions. This is both extremely surprising and disappointing, considering that DNA sequencing facilities have existed in Mexico, Costa Rica, Panama, Colombia, Brazil, Venezuela, Peru, Puerto Rico, Chile, and Argentina for over five years now, and there are even laboratories in Mexico, Brazil and Chile where systematics studies are the main focus of the facility.

Of all the publications found in this survey in plant systematics, only seven had authors from more than one Latin American country, showing the low level of collaborations among scientists within the region. On the other hand, of the 69 publications whose first author came from Latin America, 37 had at least one co-author from Europe, Canada or the U.S.A. This shows that Latin American scientists do establish collaborations with colleagues from other countries, but that these collaborations rarely develop within the region (Fig. 2).

A similar survey, but concentrating on zoological instead of botanical studies, revealed a larger number of publications for the same period. The general conclusions on number of publications, proportion of collaborations, and country of origin were essentially the same.

1. Facilities and logistics. — Several countries in Latin America still lack the laboratory equipment to carry out these types of studies. Others do have sequencing facilities, but they are devoted primarily to genomic and biomedical research programs and access by systematists is limited. Moreover, laboratories that are carrying out phylogenetic studies often have to contend with unreliable electric power, low water quality, and long delays for acquiring necessary repairs and maintenance number. Because the number of automated sequencing machines in Latin America is low, suppliers find it difficult to honor service contracts at a reasonable price and on short notice; even small repairs to equipment can take weeks or months, and they are expensive. Orders for supplies not only take much longer due to shipping and customs, but they also are much more expensive than in the U.S.A. (see also legislation).

2. Human resources. — Even though several researchers from Latin America have studied in the

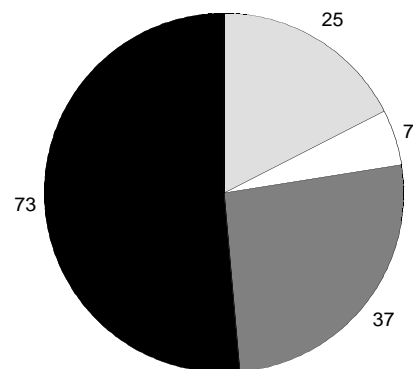


Fig. 2. Collaborations as seen in plant systematic studies in which at least one author is affiliated with an institution in Latin America.

LIMITING FACTORS

Several factors have caused this paucity of molecular studies, even in those countries where laboratories equipped to do molecular biology exist. These factors can be broadly categorized into four groups.

U.S.A. and Europe, current students and technicians in their laboratories (i.e., who will actually be performing the laboratory work) have not obtained the appropriate training in molecular techniques as undergraduates. In addition, a high proportion of Latin American students who obtain their advanced degrees in the U.S.A. and Europe do not return to their home countries due to the lack of professional opportunities. Those who do return may find it difficult to obtain a job in academia much less a job that includes use of their knowledge of modern techniques.

3. Legislation. — Several Latin American countries, especially Brazil and those of the Andean Nations Community (Bolivia, Colombia, Ecuador, Peru and Venezuela), have enacted very strict legislation regulating the collection of living organisms to be used in molecular studies. The spirit of these laws has been to prevent the commercial exploitation of native resources (especially by foreign companies) without a clear profit for the host countries. Even though in some countries local researchers can obtain collection permits without major delays, in the majority of Latin American countries, collection permits have become cumbersome, if not impossible, for both local and foreign researchers, even if no DNA is to be extracted.

Customs and importation laws in Latin America also present a problem. Even though most research institutions are government-funded and administered, they pay high import taxes for both equipment and supplies, which compounded with high shipping charges, result in incredibly high prices. Moreover, in some countries if a local distributor offers a given product at an expensive price, the law does not allow researchers to import directly those supplies more cheaply from abroad.

4. Funding. — It is no secret that most Latin American countries do not have the resources to pay for expensive research. Because phylogenetic systematics is not viewed as a priority by policy-setting officials, the amount of funds devoted to this type of research is only a fraction of that in developed countries. Even in those cases where funding is available, generally less research is produced because of high costs of supplies and equipment (see above).

WHAT ARE THE ADVANTAGES OF DOING MOLECULAR SYSTEMATICS IN LATIN AMERICA?

In spite of logistical, legal and economic hurdles, there are distinct advantages in doing molecular systematics in Latin America. First, Latin America is the repository of a high proportion of the earth's biodiversity. These animals, fungi, bacteria and plants are usually

readily available to researchers residing in these countries with only a short field trip that does not require the logistics involved for traveling to and from Europe or the U.S.A. Botanical gardens exist in almost all large and medium-sized cities, providing easy access to local plant diversity. Collecting costs, therefore, can be minimized.

Second, due to the highly organismic focus of curricula for biology majors across Latin America, potential systematics researchers usually have first-hand knowledge of the anatomy, morphology and natural history of the organisms to be studied. We cannot emphasize this point enough—we believe that research carried out by (or in collaboration with) scientists with this type of training should yield more comprehensive studies involving character evolution and ecology adaptation, speciation, etc.

If the current legal framework persists, the only way in which scientists from the U.S.A. and Europe will have access to DNA from organisms native to Latin America will be through true collaborative efforts with local scientists. Because most countries are attempting to protect germplasm within their borders, those collaborations will have to go beyond the Latin American scientist simply providing the appropriate tissue samples or logistics for collecting trips. In some cases, this may require that part of the laboratory work be carried out in Latin America. This could help direct partial funding from laboratories in the U.S.A. and Europe to those in Latin America. In fact, this has already started to happen, e.g., in Brazil, where foreign scientists are now doing a considerable part of the molecular work before returning to their home institutions to analyze the data. We affirm the principle of scientists of each country studying their own biodiversity using all available techniques.

PROPOSALS

We acknowledge that North-South collaborations have played an important role in training human resources in Latin America, as well as in providing many laboratories with necessary funding. In the long run, however, Latin American scientists could greatly benefit from strengthening collaborations and networks within the region. These collaborations could include training, funding and academic exchanges.

In those countries where several laboratories with molecular facilities already exist, efforts should be made to maintain and improve them, rather than create new ones. Also, those countries that currently do not have molecular facilities, but do have trained scientists, should consider developing collaborations with countries in the region with established laboratories. In the mid 1990s when there were only a few automated sequencing

machines in the U.S.A., it was customary for many laboratories to carry out DNA isolation and amplification locally, and then to submit their reactions to other laboratories for sequencing. Such a model is already employed within some countries in Latin America, but it could be greatly expanded. This would also encourage a higher proportion of the limited funding available to remain in Latin America.

The scientific community should make a strong effort to educate lawmakers and government officials in charge of granting collecting permits on what molecular systematics really entails. In many countries, the collection of organisms for DNA isolation is not permitted, based on the fear that this would allow unlimited access to native germplasm. It is not yet well understood that loci sequenced for phylogenetic studies do not have economic value, and that the small amounts of tissue collected would make it almost impossible for the DNA to be used for other than academic purposes. Mexico has made a clear distinction in this regard in its legislation, and distinguishes between collections intended for taxonomic or systematic use and those for propagating the species or its genes. Such a model should be adopted by other countries to allow collection of tissue for phylogenetic systematics.

FINAL COMMENT

We would like to stress that we are not advocating that all Latin American systematists should be using solely molecular tools. In fact, we believe the knowledge of natural history, anatomy, morphology and development that most Latin American systematists have of their own native species, makes the region ideal for carrying out modern systematics and fostering collaborations with better-equipped laboratories in the U.S.A. and Europe. We must be watchful that this type of knowledge and training is not lost in younger generations of systematists.

This manuscript was derived from a draft written at the symposium on biodiversity and molecules sponsored by the Latin American Botanical Network during the VIII Latin American Botanical Congress held in Cartagena, Colombia, in October of 2002. In writing this document we have drawn on our own experiences in our home countries and in countries where we have established collaborations, on surveys of current literature and bibliographic databases, on conversations with our colleagues, and on data from a survey of Latin American researchers currently employing molecular plant systematics techniques.

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