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INVITED PAPER

MINIREVIEW

Scientific publications about DNA structure-function and PCR technique in Costa Rica: A historic view (1953-2003)

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Abstract: The spreading of knowledge depends on the access to the information and its immediate use. Models are useful to explain specific phenomena. The scientific community accepts some models in Biology after a period of time, once it has evidence to support it. The model of the structure and function of the DNA proposed by Watson & Crick (1953) was not the exception, since a few years later the DNA model was finally accepted. In Costa Rica, DNA function was first mentioned in 1970, in the magazine *Biología Tropical* (Tropical Biology Magazine), more than 15 years after its first publication in a scientific journal. An opposite situation occurs with technical innovations. If the efficiency of a new scientific technique is proved in a compelling way, then the acceptance by the community comes swiftly. This was the case of the polymerase chain reaction, or PCR. The first PCR machine in Costa Rica arrived in 1991, only three years after its publication. Rev. Biol. Trop. 52(3): 417-421. Epub 2004 Dic 15.

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Palabras clave: Publicaciones, genética, ADN, PCR, Costa Rica.

The first issue of Tropical Biology Magazine, in July 1953, was not only a very important date for our scientific community, but a few months earlier that same year was published the model of the structure and function of DNA (Watson and Crick 1953). One reason to publish a journal in Costa Rica was the perception of some researchers to use our tropical regions in order to study Biology and make a contribution to the scientific community. How did these events impact the scientific work in our country? In the first years of *Revista de Biología Tropical*, a clear trend dominated to publish works on the Natural History and Taxonomy fields, because most of the researchers belonged to those areas. In the 35th anniversary of the journal Monge-Nájera and Díaz (1988) detailed the main subjects of the scientific output. The most frequent subjects were animal taxonomy, human biology - including medicine-, ecology and animal behavior (Monge-Nájera and Díaz 1988). Later for its 50th anniversary, a special issue was dedicated to review the contributions in main stream areas like Biomedicine (Gutiérrez 2002), Entomology (Hanson 2002), Marine Biology (Cortés and Nielsen 2002), Paleontology (Aguilar 2002), and Botany (León 2002). However, it was hard to trace a line of scientific publications in those former days related to molecular biology or in general DNA techniques. Another major practical discovery with a broad use in Biology was the developing of the first polymerase chain reaction by K.B. Mullis in 1983, but published until 1985 (Saiki *et al*. 1985), and the use of the *Thermus aquaticus* polymerase (Saiki *et al*. 1988).

In general terms, I searched for most of the publications from national researchers dealing with nucleic acids topics, covered in

national and international journals indexed in public databases. In a review, León (1993) mentioned that recombinant DNA techniques have been introduced to our region for diagnostic and research purposes. Since that time in Costa Rica, those techniques have extended into universities and higher education centers (University of Costa Rica, National University, Technological Institute of Costa Rica, and CATIE), public institutions (Judicial Investigation Organism, San Juan de Dios Hospital, Children's Hospital, INCIENSA) and some private companies. I found two types of publications which mention DNA or genetic material and articles with experimental work on DNA (i.e. chromosomes, expression) or RNA (viruses). A mention about DNA or genetic material does not necessarily imply an experimental approach on DNA or RNA. A similar case could be extrapolated to the proposal of the DNA model elaborated by Watson and Crick in 1953. For example, Francis Crick had never performed an X-ray diffraction experiment (Fresco 1998). In Costa Rica, the first paper which made a DNA citation to explain the genetic of hemoglobinopathies was done in 1965 (Bickers *et al*. 1965). The next paper with a DNA-mention, dealing with clinical epidemiology about hemoflagellates, was published six years later (Zeledón 1971). In conclusion, we can say that it took about 12 years to mention the word DNA and their implications in a scientific journal. And it is no surprise that both quotes were in the biomedical field.

The first publication on experimental DNA work in a scientific journal was submitted by León (1969). The paper was the presentation of karyotypes of 21 species of anurans. I consider this work the start point of the cytogenetics in Costa Rica because it inspired other persons to continue using this technique. The implementation of karyotypes to study snakes in Costa Rica was a fertile field in terms of publications. A detailed protocol was published by Taylor and Bolaños (1975). Karyotypes of coral snakes (Gutiérrez and Bolaños 1979, 1981), vipers (Gutiérrez *et al*. 1979, Solorzano *et al*. 1988) and snakes (Gutiérrez *et al*. 1984) were published mainly by researchers from the Clodomiro Picado Institute. Many years later, karyotype has been used as a tool to study some human diseases (Castro Volio *et al.*1993, Solís *et al*. 2000, Castro Volio 2004a, b). This means scientific knowledge was transmitted.

Important to mention were the publications related to DNA structure-function from national researchers as part of their Ph.D. thesis outside of Costa Rica. The first paper was presented by P.E. León during his visit to the University of Oregon (U.S.A.) dealing with ribosomal genes (Wen *et al.* 1974). Only two years later, G. Macaya working at the University of Paris published papers about eukaryotic genome organization (Thiery *et al.*1976, Macaya *et al* 1976). A few years later, a hypothesis about the meaning of plumbed chromosomes was proposed by Espinoza *et al.* (1980). In the decade of the 1980's at least two M.Sc. students worked on DNA structure in *Leishmania mexicana* (Ryan 1982) and in genome organization of the salamander *Bolitoglossa subpalmata* (Alegría 1988). Lately, Mora *et al*. (1996) published the first description in Costa Rica of the eukaryotic genome organization of a tropical organism.

As mentioned above, the PCR technique opened a new dimension in biological research. Since the PCR publication in 1989, some researchers working in contact with international laboratories were interested to apply that technique. Only one year after the publication of the PCR technique, the first researcher in Costa Rica to use the PCR was E. Moreno, for sequencing the 16S RNA of *Brucella abortus* (Dorsch *et al*. 1989). He and the German collaborative group in Kiel performed a reverse transcription, a PCR and a dideoxy sequence reaction to obtain the sequence of the 16S RNA. Finally, the first PCR experiment in Costa Rica was performed in the virology laboratory of Veterinary School in the Universidad Nacional between 1990 and 1991 (L.L. Rodríguez, personal comm.) and

from that work a manuscript was presented to an international journal (Rodríguez *et al*. 1993). However, the first papers using the PCR technique in Costa Rica were published in the issue of *Revista de Biología Tropical* by C. Sierra (2001) and Morera *et al.* (2001). C. Sierra worked on the genetic relationship among the pigs from Coco's Island, supported by the Wildlife Program of the National University. Morera *et al.* (2001) performed a population genetic analysis with DNA markers, which encouraged the introduction this technology in the Costa Rican Judicial branch.

Since these pioneer publications many other researchers have contributed with their work on DNA and related techniques through the last two decades. Their contributions cover different areas; some examples are in molecular bacteriology (Morera-Brenes *et al.* 1994, Bustamante *et al*. 2003, Arrieta *et al.* 2004, Xet-Mull *et al.* 2004), in human genetics (Lynch *et al*. 1997, Leal *et al*. 2001, Morales-Cordero *et al.* 2001, Morera *et al.* 2001, Venegas *et al*. 2003), in plant genetics (Céspedes *et al*. 2003, Muñoz *et al.* 2004, Valdez *et al.* 2004), and molecular zoology and protozoology (Lizano *et al*. 2000, Lamar and Sasa 2003, Sittenfeld *et al.* 2004).

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RESUMEN

La diseminación del conocimiento depende de la disponibilidad de la información y aplicar dicha información para resolver una problema. Los modelos sirvan para explicar fenómenos determinados. En Biología los modelos son aceptados por la comunidad científica después de cierto tiempo si ha probado su validez y reconocido la evidencia para apoyar dicho modelo. El modelo estructural y función de la molécula de ADN propuesto por Watson y Crick (1953) no fue la excepción pues tardó varios años en ser completamente aceptado por la comunidad científica. En Costa Rica la primera publicación relacionada con la función del ADN fue en la Revista Biología Tropical fue en 1970, más de 15 años después de ser propuesta. La situación contraria se presenta cuando son innovaciones técnicas. Si la eficiencia es demostrada, rápidamente se incorpora dentro de la comunidad. Este fue el caso de la reacción en cadena de la polimerasa, abreviado en inglés como "PCR". La primera máquina de "PCR" llegó a Costa Rica en 1991, tan solo tres años después de la publicación de la técnica.

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