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LIMNOLOGY IN ARGENTINA: AN HISTORICAL ACCOUNT

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Introduction

This short review includes major books, articles and episodes concerned with studies on inland waters that have affected the development of limnology in Argentina. Earlier accounts of the history of limnology, though based on various other criteria, are by Popovici & Righi (1948); Olivier (1961a); Marini et al. (1963); Di Persia & Neiff (1973); Schnack (1984); López (1988); Drago (1990); Gabellone & Casco (1992). In this account we adopt the proposal of Di Persia & Neiff (1973) who divided their historical analysis into three periods: (1) an early period of protolimnologists; (2) a period previous to the present times, subdivided into a first stage from 1900 to 1938 and a second stage from 1938 to 1962; (3) a period of integrated research.

The period of protolimnologists

This extended period of time lasted from the discovery of America up to the early 20th century. A growing interest in the New World was promptly manifest among the 16th century European governments. Natural history was part of that interest. For example, clear instructions for the protection of the regional fauna and flora were stipulated by a royal decree of the Spanish crown. Testimonies of chroniclers, explorers and naturalists who travelled throughout America during those early years are a source of information about this period. We consider that Juan Díaz de Solís was the first protolimnologist to reach America, in 1516. When he arrived in the Río de la Plata he called it "Mar dulce" (sweet sea) because of the great width of the river, despite the evident fluvial nature of the waters. Later, during the 19th century, scientists of other countries and enthusiastic local naturalists travelled throughout Argentina and carried out limnological observations. For example, in 1836 D'Orbigny described the waters of the Parana river, and the French naturalist Bonpland reached Corrientes. Unfortunately, Bonpland was imprisoned and held captive by Mariscal Francia for nine years. Several of the early scientists settled and worked at local universities.

After 1850, several academic and scientific institutions having their own publishing section were established, and numerous expeditions were carried out upstream on several rivers of the Plata Basin and Patagonia. These include, for example, journeys by Lavarello in 1856 and Sáenz in 1885 on the Bermejo; expeditions by Crevaux in 1882 and Lange in 1905 on the Pilcomayo; and expeditions by Albarracín in 1881–1883 on the Limay, Martín in 1889 on the Chubut, and Alférez Iglesias in 1900 on the Santa Cruz (see López Piacentini 1970 and Ygobone 1977).

Among the works relating to regional hydrography published during those years, we can mention Gancedo in 1885, Facio in 1889, Carrasco in 1882 and Doering in 1891 (see Ledesma Medina 1970).

The period from 1900 to 1938

Lahille (1905), de la Rúa (1911) and Wehrli (1919) are usually considered to be among the first to publish articles in Argentina that are concerned with studies on inland waters. However, it was Hans Seckt, biologist at the "Universidad Nacional de Córdoba", who first carried out an actual limnological investigation (Seckt 1918, 1921, 1924a,b). During the first meeting of the "Sociedad Argentina de Ciencias Naturales" held in Tucumán, in 1916, Seckt talked about the need for promoting chemical, bacteriological, botanical and zoological research in rivers, lakes, ponds, streams, creeks, etc., these studies to be conducted to solve problems of the physiology, biology and systematics of aquatic organisms. He pointed out that the ecology of inland waters is part of the biological sciences, and that this kind of study can be interesting and attractive though not easy, as aquatic environments are complex multi-factorial systems. He also noted a lack of information about the relationships between hydrogeology and physics related to plant and animal growth.

Doello-Jurado (1924) analyzed the role of universities within the field of hydrobiological research. Later this author, together with some colleagues, proposed to the "Universidad Nacional de Buenos Aires" the establishment of a hydrobiological station on the estuary of the Río de la Plata, to perform studies on taxonomy, applied biology and physicochemistry. The proposal failed; forty years later a station was set up there by the Fisheries Department but it only lasted for a short time.

Emiliano Mac Donagh, a zoologist and director at the "Museo de Ciencias Naturales de La Plata", published a series of articles on ecology and distribution of freshwater fishes. They included data on general ecology from various environments and were the first ichthyological studies based on an ecological criterion (Mac Donagh 1928, 1931, 1934).

In 1937 the "Instituto Oceanográfico Argentino" proposed a limnological project to the Works Ministry (Obras Sanitarias de la Nación), to study the flora, fauna and hydrogeology of the Río de la Plata, in pursuit of an integrated limnographical approach to this large river.

The period from 1938 to 1962

The following is a list of noteworthy articles published during this period of time.

I. R. Cordini (1938, 1939, 1942) and J. M. Cordini (1950) were the first to publish studies of ponds and lakes that are based on a limnological approach, confirming a prevailing trend in limnology towards an integrated understanding of lacustrine dynamics. They also improved methods used in sampling plankton.

Ringuelet (1942a,b, 1957, 1958) and Ringuelet et al. (1955) published articles relating to a rational use and management of freshwater environments, as well as sampling techniques, general methodology and identification keys to organisms. Guarrera (1948, 1950, 1962) produced a series of articles about the relationship between algae and environmental physicochemical factors.

Popovici & Riggi (1948) give a thorough analysis of hydrobiology in Argentina. Among other issues the authors proposed the following: the establishment of a Section of Limnology at the "Museo Argentino de Ciencias Naturales Bernardino Rivadavia" in Buenos Aires; the foundation of an "Instituto Superior de Hidrobiología de la Nación" to train scientists and technicians on limnology, general hydrobiology, fisheries and aquaculture; the establishment of limnological stations at Bariloche, Chascomús and Río de la Plata, for promoting limnological research in Andean lakes and rivers, and Pampasian ponds and estuaries, respectively; and finally, they suggested the production of a Bibliography of Theoretical and Applied Hydrobiology Literature in Argentina. The last proposal was accomplished in part during the 1980s (Ponte Gómez et al. 1984; López 1988).

Olivier (1949, 1952, 1955a,b, 1961a) produced a series of papers related to Pampasian freshwater environments, particularly focusing on plankton communities and abiotic features. Angelescu & Gneri (1949) and Gneri & Angelescu (1951) are still two important references in studies about detritivorous fishes and the metabolism of their habitats. Rossi (1957) and Boschi et al. (1958) have improved the methods of plankton sampling and physical limnology, respectively. Boschi et al. (1959) studied the biology and fisheries of silversides (pejerrey) in the family Atherinidae. Thomasson (1959) published a study of the lakes of

the Andean region. Other works are those by Bonetto & Ezcurra (1961) concerning freshwater Porifera and Mollusca, and Bonetto et al. (1962) focusing on the ecology of insect larvae (naiads or nayades) in the Paraná River Basin.

During this period the first attempt to form an association of Argentinian hydrobiologists took place in 1954, through the organization of the "Asociación Limnológica y Oceanográfica Argentina" (ALOA). The first bulletin included notes by Armonía Alonso de Arámburu, Sara Yacubson, Sebastián Guarrera, Raúl Ringuélet and Emiliano Mac Donagh. For reasons we do not know, the Association did not last for long.

The period of integrated research

During the last thirty years a series of episodes and the increment of publications have yielded an explosive development of limnology in Argentina. Therefore an exhaustive analysis of this period, similar to that for the previous ones, would exceed any reasonable length for this article. Here we briefly comment on just a few noteworthy episodes that have taken place through these recent years.

In 1962, two significant events gave a definite impulse to local limnology: first, the publication of the book "Ecología Acuática Continental" by Raúl A. Ringuélet; and second, the establishment of the first Institute of Limnology in Argentina (Instituto de Limnología de Argentina - INALI - in Santo Tomé, Santa Fe) by Argentino A. Bonetto. This institute gathers researchers and technicians working on applied and theoretical limnology throughout a vast geographical area of the Plata Basin, at the floodplains of the Paraná in particular. They have published more than five hundred papers, including some studies concerned with the limnology of the Patagonian and Antarctic regions.

In 1965 the Fisheries Department (Dirección de Recursos Pesqueros del Ministerio de Asuntos Agrarios de la Provincia de Buenos Aires) and a Federal Council (Consejo Federal de Inversiones) signed an agreement (Convenio Estudio Riqueza Ictícola - CERI) to study freshwater environments of Buenos Aires Province. This agreement gathered researchers and advanced students of the "Facultad de Ciencias Naturales y Museo" (Universidad Nacional de La Plata) under the guidance of R. A. Ringuélet.

A symposium of Latinoamerican limnologists held in Santa Fe in 1968, and sponsored by the International Biological Programme, congregated scientists from more than thirty countries. There the foundations for a Latinoamerican Center of Limnology were set, though the project has not been accomplished yet.

In 1969 a course in limnology at the "Facultad de Ciencias Naturales y Museo de La Plata" was offered for the first time in Argentina. In later years similar courses were offered at the universities of Buenos Aires, Tucumán and Comahue.

Also in 1969, by the end of the CERI agreement, the "Instituto de Limnología Dr. Raúl A. Ringuelet" (ILPLA) was established, subordinate to both the "Universidad Nacional de La Plata" (UNLP) and the "Consejo Nacional de Investigaciones Científicas y Técnicas" (CONICET). The research activities of this institute have been specially centred on the aquatic environments throughout southeastern Pampasia as well as on reservoirs and rivers of the Plata Basin. More than five hundred papers have been produced. Moreover the journals *Limnobiós* and *Biología Acuática* – edited at the institute since 1975 and 1981, respectively – are the only ones in Argentina that are primarily dedicated to freshwater research.

In 1973 the "Centro de Ecología Aplicada del Litoral" (CECOAL) was created, owing its existence to the efforts of Argentino A. Bonetto once more. There, research activities are particularly accomplished throughout an extended geographic area of northeastern Argentina. One of the central purposes of this research centre has been to study the environmental impacts caused by reservoirs constructed in that region for hydroelectricity production.

The series "Fauna de Agua Dulce de la República Argentina" and "Flora Criptogámica de Tierra del Fuego", both with relevance to freshwater biology, have been published since the end of the 1970s; they are sponsored by the CONICET.

In 1979 the "Departamento de Aguas Continentales of the Instituto Nacional de Desarrollo Pesquero" (INIDEP) was established. Research has been specially orientated to major rivers of the Plata Basin and lakes of Patagonia. As a result of these activities, a dictionary of inland water environments of Argentina has been published (Quirós et al. 1983).

Also during these years, the Section of Limnology at the "Museo Argentino de Ciencias Naturales Bernardino Rivadavia" was organized. In the beginning it was conducted by Aldo Torno, and worked in association with researchers from both the "Museo de Ciencias Naturales de La Plata" and "Instituto de Limnología Dr. Raúl A. Ringuelet". The first areas of study were reservoirs in the Río Negro and Neuquén Provinces. Also a limnological programme (Programa de Estudios Limnológicos Regionales) has been set up by the "Universidad Nacional de Misiones". The main purpose has been the study of those areas affected by the construction of reservoirs. Other working groups concerned with freshwater environments are at the universities of Comahue and San Juan Bosco de la Patagonia.

In the early 1980s a research centre was founded in Tierra del Fuego: the "Centro Austral de Investigaciones Científicas" (CADIC). Here the first study was made on the lakes of the extra-Andean Patagonian region (Mariazzi et al. 1987).

In 1984, as a result of the aforementioned activities related to limnology, the "Asociación Argentina de Limnología" was established. Since then several meetings and workshops have been organized.

Based on hydrological criteria, Drago (1990) subdivided Argentina into six limnological regions: Parana-Plata, lacustrine, extra-Andean, endorrheic, sub-Antarctic and Antarctic.

In 1991 the "Instituto de Limnología del Noroeste" (ILINOA) was established at the "Facultad de Ciencias Naturales e Instituto Miguel Lillo" (Universidad Nacional de Tucumán). This institute, together with a working group at the "Universidad Nacional de Salta", have focused their research activities on the reservoirs and rivers of northwestern Argentina.

Also in 1991, at the 2nd Argentine Meeting of Limnology, the need for a Latinoamerican Federation of Limnology was stated. The papers offered during the meeting have been published recently (Boltovskoy & López 1993).

The current state of limnology in different countries of Iberoamerica was presented during the 1st Iberoamerican Meeting of Limnologists, held in Sevilla, Spain, in 1992.

Also during 1992, a preliminary proposal for a post-graduate school of limnology was presented by the "Instituto de Limnología Dr. Raúl A. Ringuelet", to be considered by the "Facultad de Ciencias Naturales y Museo de La Plata".

Concluding comments

Following Margalef (1983) we should note that names and dates given above are just a framework for an historical account of the development of limnology in Argentina; the actual number of persons who have contributed to its development is much larger. Universities, research institutes, federal and provincial ministries, and international agreements, have also played an important part. The annotated historical episodes were contemporaneous with various circumstances of Argentinian history, most of them being hard and difficult times. Nevertheless, in spite of insecurity, financial problems, inappropriate working places and other obstacles, the "population" of limnologists has been continuously growing. Also during these years the limnological information necessary for planning development to improve people's living standards, has been provided at low costs and high efficiency.

Finally, following the three main periods of limnological development proposed by Di Persia & Neif (1973), reviewed here, we believe that in these early 1990s we are at the beginning of a "Regional period". Although major research programmes have already been based on a regional criterion, the lack of co-ordinate plans have often resulted in a duplication of effort and funds. Therefore, regions as areas of study should correspond to natural hydrographical basins, which are often shared with neighbouring countries. Only this approach will yield actual global solutions to our limnological problems.

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