Overview of microbial ecology in Peru

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Introduction

With over 29.5 million people, Peru is a tropical country but its climate is not exclusively equatorial since the influence of the Andes and the Humboldt Current cause great climatic diversity within the country. The Andes Mountains run parallel to the Pacific Ocean, dividing the country into three geographic regions. The *costa* (coast), to the west, is a narrow plain, largely arid except for valleys created by seasonal rivers. The *sierra* (highlands) is the region of the Andes; it includes the *Altiplano* plateau as well as the highest peak of the country, the 6,768 m Huascaran. The third region is the *selva* (jungle), a wide expanse of flat terrain covered by the Amazon rainforest that extends east. Almost 60% of the country's area is located within this region. The *costa* has moderate temperatures, low precipitations, and high humidity, except for its warmer, wetter northern reaches. In the *sierra*, rain is frequent during summer, and temperature and humidity diminish with altitude up to the frozen peaks of the Andes. The *selva* is characterized by heavy rainfall and high temperatures, except for its southernmost part, which has cold winters and seasonal rainfall.

Because of its varied geography and climate, Peru has a high biodiversity with 21,462 species of plants and animals reported as of 2003; 5,855 of them endemic. However, microbial diversity is largely unknown and only recently it is being studied by some research groups.

Societies

There are three scientific societies on microbiology: *Peruvian Association of Microbiology*, *Peruvian Society of Infectious and Tropical Diseases* and *Peruvian Scientific Society of Microbiology*, totaling over 700 members. However, none of them has specific divisions on microbial ecology but some members are involved in investigating on diversity, ecology, environmental and industrial uses of microorganisms.

Research activities

Research on microbial ecology began in the last years of the 70's at our laboratory (formerly Laboratorio de Micología) with studies on soil fungal and nitrogen-cycle bacterial population dynamics, including mathematical modeling, and rhizosphere microbial populations in the "Lachay's Lomas" which is a fog-dependent ecosystem found in the northern coast; several papers were published. Nowadays, there are some important research groups working and publishing on various topics related to microbial ecology.

Research on bacterial leaching and basic studies in microbiology, biochemistry and genetics of leaching microorganisms or acid water generators as well as water and soil bioremediation of cyanide, chromium, mercury, selenium, oil and process development of microbial consortia is being carried out at the Laboratory of Environmental Biotechnology (Universidad Peruana Cayetano Heredia, UPCH) led by Dr. Jasmín Hurtado (jasmin.hurtado@upch.pe). Likewise, at the Biomining and Environment Unit led by Dr. José L. Bauer (jose.bauer@upch.pe) of the same university research is being conducted on the physiology of autotrophic microorganisms as well as on bio-oxidation, bioleaching and bioremediation through several approaches.

Marine microorganisms are being studied at the Laboratory of Microbial Ecology (Universidad Nacional Mayor de San Marcos, UNMSM) led by Dr. Jorge León (jleonq@unmsm.edu.pe), particularly actinomycetes with antibacterial activities; some *Streptomyces* strains have been already isolated from marine sediment of the central coast showing high antibacterial activity. Also, at the Unit of Biological Oceonagraphy (Instituto del Mar Peruano, IMARPE) led by Dr. Dimitri Gutiérrez (dgutierrez@imarpe.gob.pe) research is carried out on phytoplankton dynamics and microorganisms of the marine sediments.

Other important research group is at the Laboratory of Microbial Ecology and Biotechnology "Marino Tabuso" (Universidad Nacional Agraria La Molina, UNALM) led by Dr. Doris Zúñiga (dzuniga@lamolina.edu.pe) in which the following studies are being conducted: nitrogen fixation, molecular characterization of symbiotic and free-living diazotrophs, optimization of bio-fertilizers production, beneficial effects of rhizobia and PGPR in important common and native crops such as lima beans, beans, cotton, corn, maca, tare, aguaymanto, and others as well as microbial interactions in the rhizosphere of different crops.

Bioprospecting, both microbial and molecular, is being carried out at the Laboratory of Mycology and Biotechnology (LMB, UNALM) led by the author and Dr. Gretty K. Villena (gkvch@lamolina.edu.pe) from soils of an undisturbed Amazonian Forest and from hot springs. Several bacterial and fungal strains have been isolated and evaluated for alkalophilic and thermophilic lignocellulase production. Lignocellulase encoding genes have been detected and some have been cloned by expression cloning procedures and they are in the process of being sequenced. Also, soil basidiomycete strains haven isolated with textile azo-dye degrading activities. LMB is helping in establishing a research group at the Universidad Nacional Santiago Antúnez de Mayolo (Huaraz) led by Carmen Tamariz (our PhD student) who is studying oil-degrading fungi and endophytic microorganisms in native medicinal plants.

Education

Microbial ecology is part of both undergraduate and postgraduate studies in biology and microbiology majors at the main Peruvian universities. Also, environmental microbiology is given at some environmental engineering and management programs. There are labor opportunities in the mining, textile and agricultural corporations for professionals with a background in microbial ecology.

Practical applications

Peru has a well developed mining industry that is using some developments in bacterial leaching for mineral recovering and for the bioremediation of soils and metal contaminated water released by mines. Bacterial inoculants both for nitrogen fixation and for promoting plant growth are being used in organic agriculture. Also, textile industry is demanding both liquid effluent treating systems due to the high release of azo-dyes and thermo-alkalophilic cellulases for better textile processing; thus, fungal biofilm continues processes are being developed accordingly. Lignocellulase encoding genes will be used in cell factories for biofuel production.

Future prospects

Microbial diversity may hide many microorganisms with unique ecological and physiological features that could be used for the development of agricultural, environmental and industry processes and therefore requires greater research effort on this issue. Peruvian Microbiological societies need to address this field seriously or a new specific society may be organized.