THE STREAMS OF GORGONA NATURAL NATIONAL PARK WITHIN THE GLOBAL CONTEXT: AN INTRODUCTION TO THE SPECIAL ISSUE

LAS QUEBRADAS DEL PARQUE NACIONAL NATURAL GORGONA DENTRO DEL CONTEXTO GLOBAL: INTRODUCCIÓN AL NÚMERO ESPECIAL

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Abstract

This paper highlights the importance of islands for proposing and testing hypotheses in stream ecology, and therefore, advocates for implementing reference studies in Gorgona Island (Colombian Pacific). It firstly summarizes past ecological studies in streams in Gorgona Island and outlines a series of papers resulting from a recent survey. These papers report that Gorgona Island exhibits a maritime climate, a tropical rainforest cover, and a basaltic and intrusive lithology, all typical features of islands elsewhere. They also describe that despite of the insular effect on stream biota, the proximity (< 50 km) of the island to the Pacific coast of Colombia facilitated dispersal of many faunal and floristic components from the continent, thus providing a unique opportunity for studying coastal streams in the Biogeographic Chocó. Finally, the status of Gorgona Island as a natural park established in 1984, and a relatively well known history of land uses, may further contribute to support search programs with long-term and large-scale goals.

Key words: Gorgona Island, history, reference sites, stream ecology

Resumen

Este artículo resalta la importancia de las islas para proponer y someter a prueba hipótesis en ecología lótica y, por lo tanto, aboga por la implementación de estudios de referencia en la Isla Gorgona (Pacífico colombiano). Primero se resumen los estudios pasados realizados en las quebradas de la isla y se bosquejan los artículos que hacen parte de éste número especial, que son el resultado de una expedición reciente. Estos artículos informan que la Isla Gorgona posee un clima marítimo, una cobertura de bosque lluvioso tropical y una litología basáltica e intrusiva, características que también son típicas de otras islas. Ellos también describen que a pesar del "efecto isla" en la biota lótica, la proximidad (< 50 km) de la Isla a la costa Pacífica colombiana ha facilitado la dispersión de muchos componentes faunísticos y florísticos desde el continente, y por lo tanto provee una oportunidad única para estudiar las quebradas costeras en el Chocó Biogeográfico. Finalmente, la condición de parque natural establecido en 1984 y la relativamente bien conocida historia de usos pueden ayudar a apoyar programas de investigación con objetivos a largo plazo y gran escala.

Palabras clave: Isla Gorgona, historia, sitios de referencia, ecología lótica

Islands have been instrumental for developing and testing theories in stream (lotic) ecology. Research in insular streams have revealed: **a**) the importance of downstream-upstream connectivity for maintaining population dynamics of migratory fauna (McDowall 1998) and ecosystem processes (Pringle 1997) in headwater reaches, and **b**) the ecosystem-wide influences of predators and macroconsumers (e.g., exotic trout in New Zealand: Townsend

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2003; shrimps in Puerto Rico: Pringle et al. 1999); and **c)** the dynamics of stream biota relative to stormflows and droughts (Covich et al. 2006) and even urbanization (Ramírez et al. 2009). The generality of paradigms developed in continental basins, such as the River Continuum Concept (Vannotte et al. 1980), the Intermediate Disturbance (Connell 1978), and the Landscape Filters (Poff 1997) has also been tested in insular streams (e.g., New Zealand: Winterbourn et al. 1981, Townsend et al. 1997; Puerto Rico: Blanco and Scatena 2006, Greathouse and Pringle 2006). Despite of the importance of islands as model systems in temperate zones (e.g., England, New Zealand, Australia, Japan, and boreal islands), research in the insular tropics has been traditionally concentrated in a few areas (Puerto Rico, Hong Kong, and Hawaii), exceeding the number of studies in continental settings (Jacobsen et al. 2008, Wantzen et al. 2008). However, an increasing number of edited volumes on tropical streams have been published in mainstream journals and demonstrate the growing number of studies and scientists involved with tropical lotic ecology (Boyero et al. 2009, Dudgeon 2008, Jackson and Sweeny 1995a, b, Stanford and Covich 1988, Wantzen et al. 2006). A recently edited book on tropical streams is the first major attempt to collate both local and international publications and discusses the distinctiveness of the tropical environment, setting a bench mark for future research priorities (Dudgeon 2008).

This issue pays homage to Gorgona Island, a 1.333 ha volcanic massif located on the continental shelf 35 km off the Pacific coast of Colombia (figure 1). This island hosts dense tropical rain and cloud forests that are typical of the Biogeographic Chocó biodiversity hotspot. Due to a significant number of studies conducted on the island's diverse ecosystems, it is commonly known as the "Science Island". For this reason we wanted to celebrate the 25th anniversary of its designation as National Natural Park by publishing this special issue on the island's streams. Despite the large number of permanent and ephemeral systems that drain the island, which are fed by one of the highest annual rainfalls of the neotropics (Blanco 2009a), the Island's streams are historically-overlooked ecosystems. Only a handful of papers and one book chapter (Calá 1990) have been published about Gorgona's streams, while several books and chapters, and many journal papers have been written about terrestrial and marine ecosystems and biota (Aguirre and Rangel 1990, Barrios and López-Victoria 2001, Borrero 1987, Prahl et al. 1979, Prahl and Alberico 1986). In the 1970's and 1980's, H. von Prahl (Prahl et al. 1979, Prahl and Alberico 1986) pioneered the exploration of streams in the island and contributed with his work to the declaration of Gorgona as a protected area. Although he focused on decapod taxonomy (e.g., Prahl 1983, Prahl et al. 1984), his legacy includes compiled species lists and descriptions of new species for many localities in the Chocó region, including Gorgona Island. Other taxonomic works reported on heteropods (Hemiptera, Manzano et al. 1995), and a primary freshwater fish (Trichomycteridae, Fernández and Schaeffer 2005). However, prior to this current issue, there were a few written accounts on stream fish and invertebrate assemblages (Calá 1990, Zamora et al. 1996, Zapata et al. 1991) and water physico-chemistry (Vásquez et al. 1996) and none of these early works used a spatially-explicit sampling design. For instance, Calá (1990) identified insects to the family level, and compared taxa composition among substrate types in several streams island-wide. Zapata et al. (1991) only sampled a short segment (240 m) at a single stream (La Camaronera) and found a longitudinal variation in insect assemblage composition. Zamora et al. (1996) sampled 2 m^2 areas within a single reach at ten streams, but all reaches were not located at the same elevation, and the habitat type sampled was not reported.

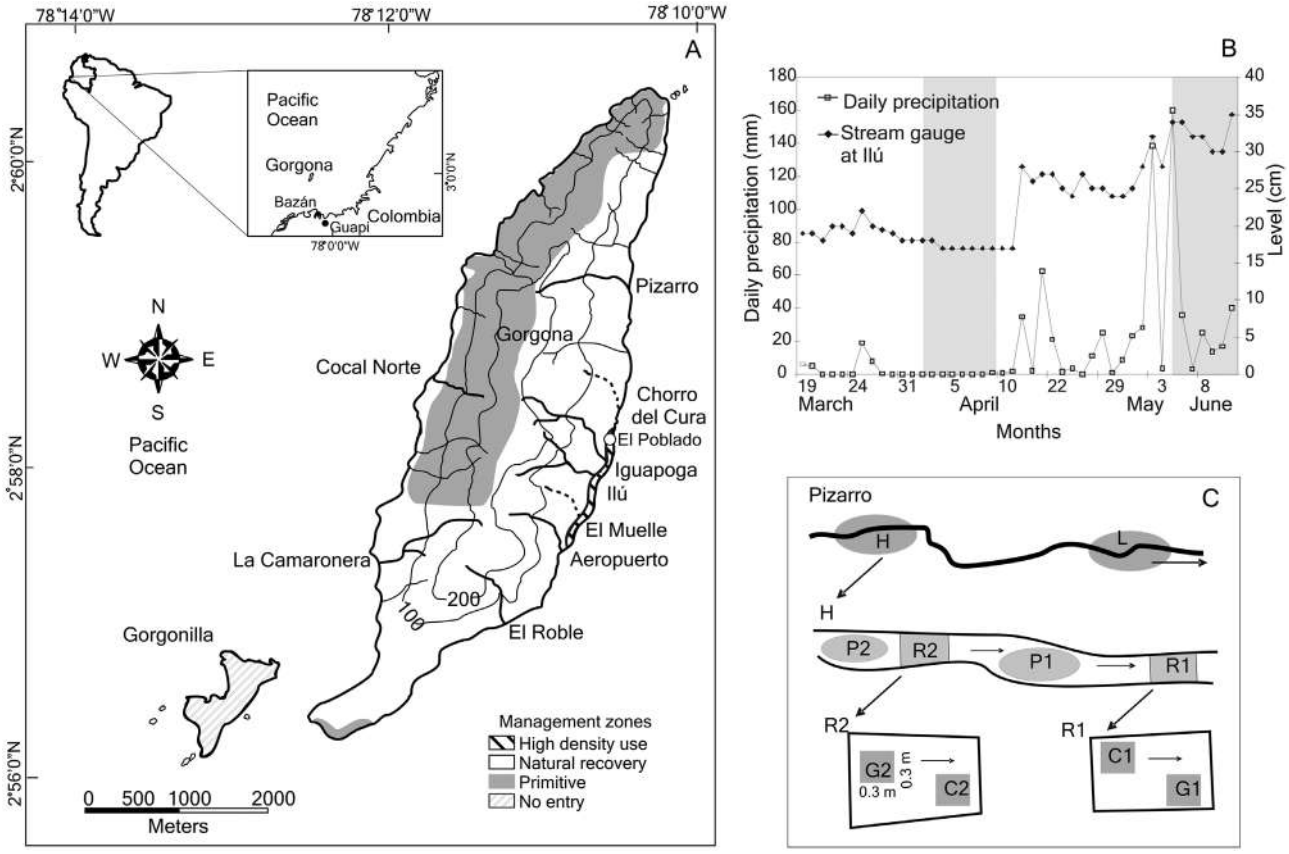

Figure 1. A. Location of streams studied by the Gorgona Island Stream Bioassessment Project (Colombian Pacific coast). **B**. Sampling periods and hydrologic conditions are indicated with shadowed areas. **C**. Hierarchical sampling design with each stream network: *H* = high elevation reach, *L* = low elevation reach, *P* = pool, *R* = riffle, *G* = gravel patch, *C* = cobble patch

This issue summarizes the results of a recent spatially-explicit survey of its streams (figure 1; GIS-Bio: Gorgona Island Stream Bioassessment project) conducted by the Universidad de Antioquia's Limnology Group. The series of papers covered a wide range of topics such as climatology, water physico-chemistry, macroinvertebrates, leaflitter, and microbiology. Blanco (2009a) reported on the intra- and inter-annual variability in precipitation and stream flow using a 20-yr record. The linkages among water physico-chemical properties and climatology, geology and forest cover are discussed by Blanco (2009b). Longo-Sánchez et al. (2009) compared the results of three aquatic insect surveys conducted over the last twenty years in an attempt to test for changes related to forest succession as a consequence of recovery from human influence prior to the designation of the natural protected area. Gómez-Aguirre et al. (2009) reported on differences of macroinvertebrate assemblages and of biotic and abiotic descriptors among nine streams around the island during two sampling periods (dry and rainy). Longo-Sánchez y Blanco (2009) used the Landscape Filter Concept (Poff 1997) as a guiding framework for comparing how biotic and abiotic variables operating at different levels of the spatial hierarchy may distinctively control the distribution of non-diadromous insects and diadromous fauna (gastropods, shrimp, and fish). Valencia-G. et al. (2009) studied leaflitter composition in lower reaches at nine

streams during sampling periods and observed that although there was a great richness of morphospecies (> 100), the pioneer *Cespedesia macrophylla* ("pácora") was the most important species. Finally, Valencia-G. y Lizarazo-M. (2009) studied coliforms, heterotrophic bacteria and aquatic fungi in epilithon, leaflitter and water samples, and found differences between the two island's slopes.

An additional objective of this series of papers was to demonstrate that Gorgona Island is a useful model site for insular stream ecology. The great variability of climates, lithology, and biomes observed in tropical streams is probably similar to that observed in temperate zones, and there is not probably a distinctive characteristic associated with the "tropical" nature (Boyero et al. 2009, Boulton et al. 2008, Wantzen et al. 2006). Therefore, finding reference sites is necessary for advancing in cross-site comparisons not only among tropical sites, but among tropical and temperate sites. We, here, propose that Gorgona Island exhibits a maritime climate and a basaltic and ultramafic geology typical of many tropical and temperate islands. In addition, the presence of tropical rainforests with floristic affinities with the continental areas of the Chocó region suggest that the Island's streams may also serve as reference sites for coastal streams in the Pacific drainage of northern South America. However, the influence of insularity on stream biota remains to be tested. In addition, the small size of the island eases simultaneous sampling at several basins at the island scale (region), a very difficult task in the continental area of the northern Andes due to prohibitive costs, logistics, and public order issues.

The island is also unique because human activities on the streams have been minimal since the designation as natural reserve, and many areas were probably untouched by humans before that (Torres 1986; UAESPNN-DTO 2005). The few remains (engraved stones, pottery, and arrow points) of pre-Columbian indigenous cultures found in the island suggest that it was a ceremonial place rather than a permanent settlement. During the Spanish conquest period the explorers of the Pacific, Francisco Pizarro and Diego de Almagro, were deterred by the abundant venomous snakes (they actually named the island after the Greek goddess). According to their chronicles "the island's abundant springs and streams sustained us", and similar accounts were later made by British pirates. By the end of the 19th century, General Simón Bolívar offered this inhabited island to Sergeant Federico D'Croz in gratitude for his services rendered during the independence war against the Spanish domination. During the early years of the 20th century, the eastern part of the island was used by D'Croz and the Payán family as a farm land, however, the national government reclaimed the island in the late 1950's for installing a high security prison. This prison was officially closed in 1983, and the national natural park was approved in 1984 by the former Institute for Natural Resources (INDERENA, Ministry of Agriculture). It is currently considered a key area within the Eastern Pacific Marine Conservation Corridor, also including the Galapagos, Coiba, and Cocos. Currently, human population oscillates around 100 persons including park personnel and visitors, but their activities are restricted to "El Poblado" (3 ha) and interpretive trails. Most of the prison facilities and cleared areas have been completely covered by secondary forest.

Gorgona Island provides a unique opportunity for advancing our understanding about tropical streams under nearly "natural" conditions as opposed to other islands (e.g., Hawaii, Puerto Rico, Hong Kong, and New Zealand) where many studies have been conducted but there has been a long human domination, even around natural reserves. With this series of papers, we expect to stimulate research by both national and international teams.

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