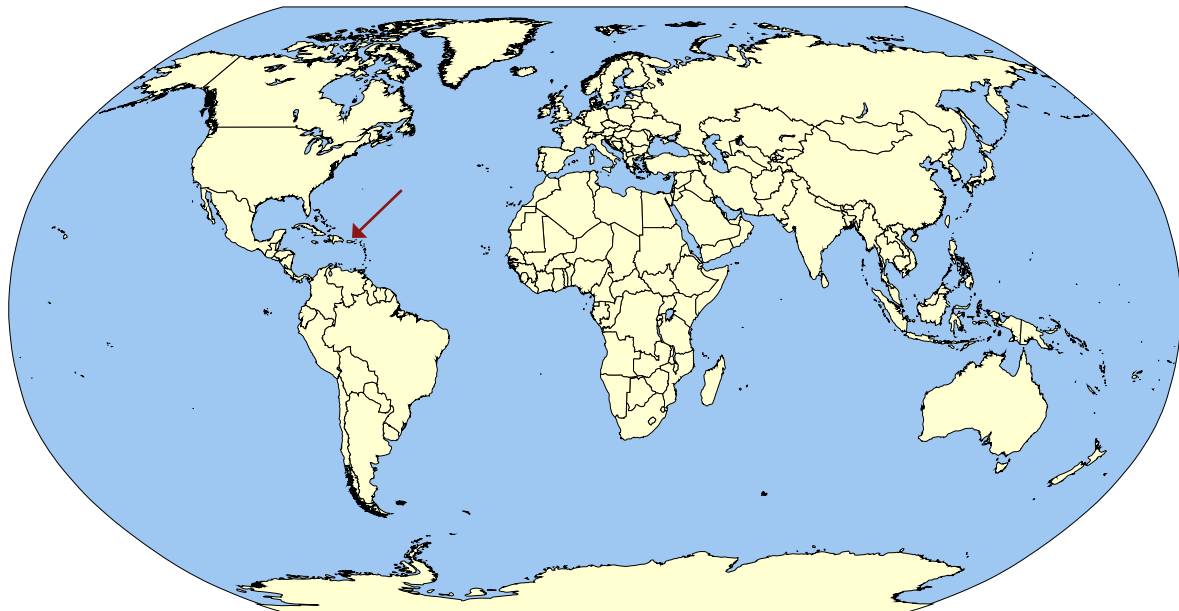


Puerto Rico

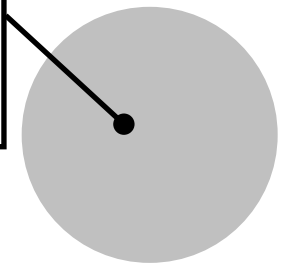


A History of Schistosomiasis in Puerto Rico

In Puerto Rico, cases of *S. mansoni* and its host snail *Biomphalaria glabrata* have been found throughout the island since 1904 [1]. Because *B. glabrata* prefers the alluvial waters of the southeast, eastern Puerto Rico has traditionally had the highest disease prevalence [2]. After the first description of *S. mansoni* on the island in 1904, the large scale survey of the disease in people was performed in the 1930s and found high infection rates in the sugarcane-producing, heavily-irrigated region of Guayama-Arroyo-Patillas [1]. The island-wide prevalence was estimated at 13.5% in 1943, the same year that the Aqueduct and Sewer Authority began a program to provide safe water and improve sewage systems throughout the island [1]. In 1952, reports emerged about the ability of a competitor snail to eliminate *B. glabrata* from natural water bodies in focal sites in Puerto Rico. The competitor snail was *Marisa cornuarietis*, a large, operculated freshwater snail in the apple snail family, native to Venezuela and introduced to Puerto Rico between 1954 and 1958 [4].

Schistosomiasis in Puerto Rico

Schistosomiasis
eliminated
due to transmission interruptions and successful control



Overview of Puerto Rico [14]

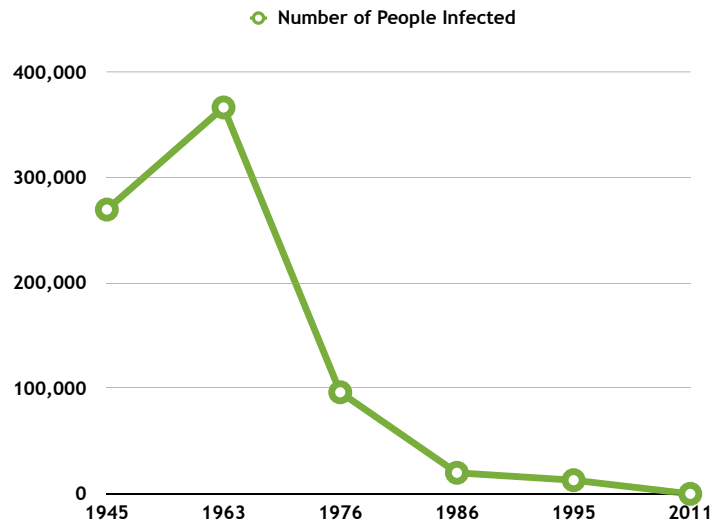
- » Population in 2015: 3,598,357
- » Official Languages: Spanish and English
- » Capital: San Juan
- » Commonwealth of the United States
- » Percentage of Population with Access to Improved Drinking Water in 2015: 93.6%
- » Percentage of Population with Access to Improved Sanitation in 2015: 99.3%

Early Control Efforts

Between 1953 and 1955, small-scale surveys suggested that schistosomiasis prevalence on the island peaked [3]. In response, a national schistosomiasis control program began in 1953 and emphasized the biological and chemical control of snails [1]. It also included “improvement of public water supplies, health education, a free latrine distribution program, and limited chemotherapy with niridazole” [6]. However, chemotherapy was not widely used during this time due to dangerous side effects of available drugs during the 1950s like Fuadin, which caused drug-related deaths when implemented as a part of the Puerto Rican control [1]. Mollusciciding began with copper sulfate in 1953 at the program’s start, but was soon switched for sodium pentachlorophenate. Niclosamide was first used in Puerto Rico in 1963 [7], and became the preferred chemical by the late 1970s [1].

Snail Control in Puerto Rico

Biological control of *B. glabrata* was extensively used in the early Puerto Rican control programs, mostly by the intentional introduction of exotic competitor snails to irrigation ponds, the primary transmission sites. In 1956, *Marisa cornuarietis* was transferred to 111 irrigation ponds southern Puerto Rico. By 1965, *B. glabrata* was displaced from 89 out of a total of 97 ponds still in operation [5]. Because of the success of competitor snail introductions, biological control was found to be far more cost-effective than chemical control in Puerto Rico [8]. In 1954, the snail *Tarebia granifera* was found in a single stream on the island, and remained there for two years before spreading rapidly to other parts of the island [4]. It was likely introduced from Texas or Florida, where the exotic snail was found in 1935 and between 1940-1947, respectively [9]. *T. granifera* was reported in a study from 1964-1969 to displace *B. glabrata* [3], so it likely helped decrease schistosomiasis prevalence on Puerto Rico as well. It is possible that this snail was actually *Melanooides tuberculata* and was misidentified as *T. granifera*, as has occurred in the past [5]. In 1997, a survey of 4 streams, 10 rivers and 8 lakes on Puerto Rico all revealed an absence of *B. glabrata*, plus the presence of *T. granifera* and *M. cornuarietis*, suggesting that the schistosome-hosting snail species had been displaced over the long-term by these other two species [3].



The Decline of Schistosomiasis Cases in Puerto Rico

Schistosomiasis has declined over the years in Puerto Rico due to successful snail control and invasive snail species. The intermediate host of *Schistosoma mansoni*, or *Biomphalaria glabrata*, became gradually pushed out from the island -- to the point where no schistosomiasis case were reported from 1998 to 2007.

Two different invasive snail species helped push out the schistosome-hosting *B. glabrata* off the island of Puerto Rico

Snail Control in Puerto Rico

As expected for a program primarily emphasizing snail control without widespread human treatment, Puerto Rico's national control program showed a slow reduction in human prevalence during the first few years, but had very positive results in the long term. In 1963, nationwide prevalence was estimated at 15.6% and 9% in 1968 [10]. By 1975, prevalence had fallen to 3.4%, and only 20 people out of the island's 2,908,000 were hospitalized for schistosomiasis that year [6]. As a testament to the success of early snail control operations (and possibly to the serendipitous displacement of *B. glabrata* by naturally spreading exotic competitor snails), by 1976, only 5 of the island's 30 main freshwater reservoirs still harbored *B. glabrata* [2]. A further reduction in the nationwide disease prevalence to 2% was reported in 1989 [11]. It is unclear if Puerto Rico's continued success in reducing schistosomiasis prevalence in the 1990's was due to ongoing integrated control efforts, or due to other more cryptic factors such as the further inadvertent spread of competitor snails, or strengthening of the country's sanitation and health systems via development, or an increasing population shift from rural to metropolitan areas. There is little record of control efforts in the 1990s. In 1997, researchers found 0.3% prevalence in areas with previously high transmission, and the few cases found (3 of 495) were in patients 36+ years old, despite 57.8% of those studied being under 16 years old. Those cases were understood as 'residual cases', and transmission was considered 'interrupted' by 1997 [2]. No evidence of schistosomiasis was found in Puerto Rico between 1998 and 2007 [12]. According to the World Health Organization, the disease was 'formerly present in Puerto Rico' but its absence should continue to be confirmed through ongoing surveillance [13].

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