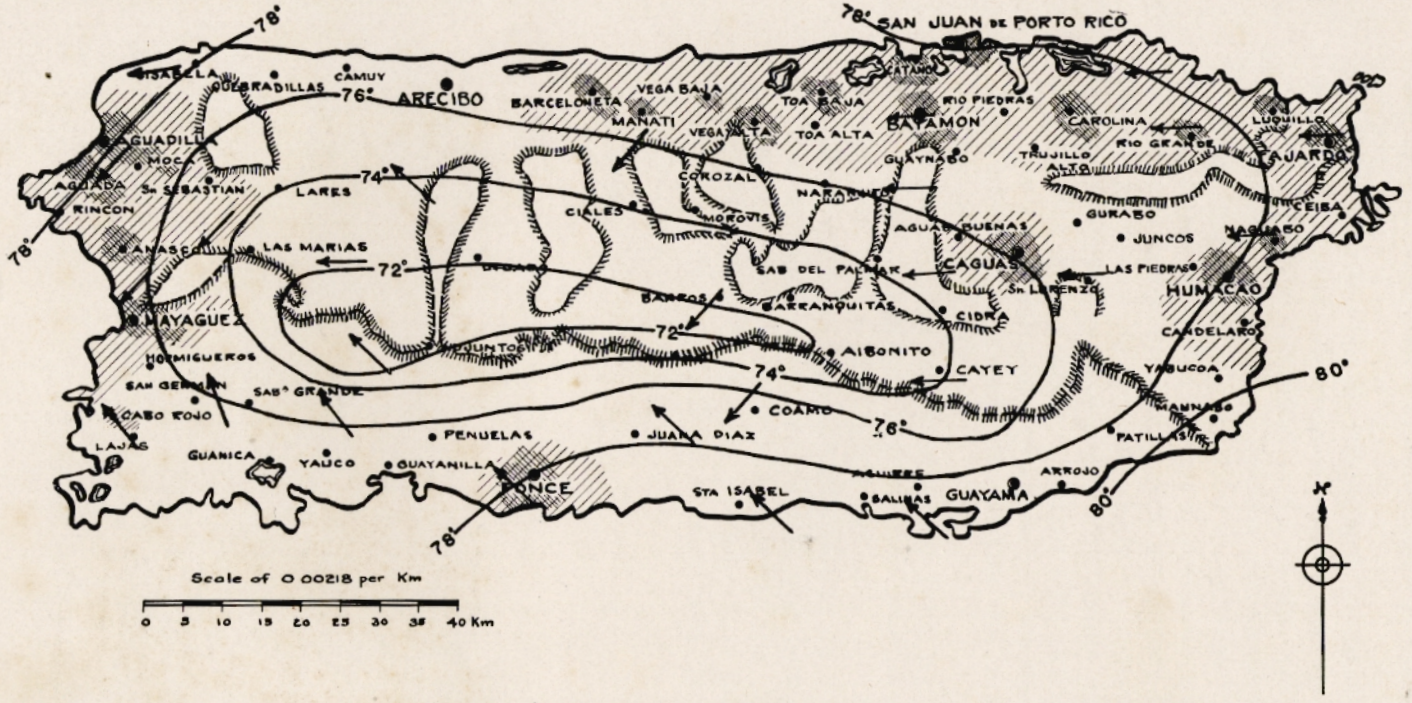


Fig. I. Puerto Rico.

THE PUERTO RICO JOURNAL OF PUBLIC HEALTH AND TROPICAL MEDICINE

VOL. 11 DECEMBER, 1935 NO. 2

STUDIES IN FILARIASIS

I. In Puerto Rico.**

By F. W. O'CONNOR and CONSTANCE R. HULSE

From the Department of Medicine, Presbyterian Hospital, Columbia University, New York, and the School of Tropical Medicine of the University of Puerto Rico, under the Auspices of Columbia University.

TABLE OF CONTENTS

Introduction.

Factors Bearing on the Filariasis Problem of Puerto Rico.
- Historical and Ethnological Data.
- Geography and Topography.
- Climate.
- Winds.
- Water Supply.
- Population.
- Town Distribution and Planning.
- Occupational Liability to Infection with Filariasis.
- Family Incidence of Filariasis.

The Insect Host of Filariasis.
- *Culex Fatigans (C. quinquefasciatus).*
- Efficacy of Other Insects as Hosts of *W. bancrofti.*

Studies of Filarial Incidence in Puerto Rico.
- Periodicity of Microfilariae.
- Infection Survey of the Sardinera Estate.

** Many persons have coöperated in this work. Dr. W. W. Palmer, Medical Director of the Presbyterian Hospital in New York, made possible the expedition to Puerto Rico and arranged all the facilities for the work. The officers of the Departments of Pathology and Surgery were generous with assistance and advice. In Puerto Rico the Staff of the School of Tropical Medicine and University Hospital, directed by Dr. E. B. McKinley and his successor, Dr. George Bachman; the Department of Health, and the Presbyterian Hospital in Santurce under the direction of Dr. W. H. Galbreath, all coöperated to the fullest extent with the writers. Many physicians in private practice gave valuable assistance; amongst these were Drs. Díaz García, García Cabrera, Walter Glines and Carlos González. Dr. Golden, Director of the Department of Roentgenology of the Presbyterian Hospital in New York City, gave unstinted aid in the present studies, and accompanied one of the expeditions to Puerto Rico in connection with the roentgen diagnosis of filariasis. We have been in constant communication with Colonel Clayton Lane of London, and have benefited greatly by his advice, suggestions and encouragement. The pathological studies have occupied much time. To the untiring energy, enthusiasm and loyalty of our technicians, Messrs. Desiderio Canales and Robert Buzen, we owe the abundance and excellence of our sections.

To these persons and the many more who have assisted us we are most profoundly grateful.

Received for publication February 15, 1935.

Symptomatology.
Acute Lymphangitis.
Elephantoid Fever.
Funiculitis and Epididymitis.
Adenitis.
Filarial Fever.
Abscess.

Elephantiasis.
Hydrocele.
Chyluria.
Fistula.
Varicose Lymphatic Vessels.
Adenovarix.
Comment.

Results of Filariasis.
Mental Sequelae.
Fatalities.
Economic Loss.

Pathology.
Discussion of Pathological Findings.

Hematology.
Differential Leucocyte Counts.
Clinical Cases with Elephantiasis, Lymphangitis and Adenitis observed during Course of Disease.
Relationship of the Blood Picture to Microfilarial Periodicity.

Treatment and Prevention of Filariasis.
Bacteria in Association with Filarial Infection.
Association of Filariasis with Other Diseases.

Summary.

INTRODUCTION

The studies of filariasis and elephantiasis in Puerto Rico which are the subject of this monograph were made between January and May, 1929; between August and November, 1929, and between September, 1930, and January, 1931.

While the majority of the cases and nearly all the material discussed have come from Puerto Rico, in a few instances cases and material from other countries have been utilized to emphasize certain points.

With the exception of one case of infection with *Filaria ozzardi* discovered by Dr. W. A. Hoffman in Puerto Rico[1], the only filaria known to infect human beings is *Wuchereria*

bancrofti. All reference to filariasis in this work refers to infection with this parasite, unless otherwise indicated.

FACTORS BEARING ON THE FILARIASIS PROBLEM OF PUERTO RICO

Filariasis is transmitted by the mosquito *Culex fatigans* (*C. quinquefasciatus*). The most favorable circumstances for the development, multiplication and survival of this mosquito in Puerto Rico, and consequently for the transmission of filariasis, are: High temperature and humidity; sufficient stagnant water on the ground or in containers to afford breeding places, and adequate protection of adult mosquitoes from wind.

It is necessary to an understanding of the filariasis problem of Puerto Rico, therefore, to consider the geography, topography and climate of the Island, as well as such factors as town distribution and planning and water supply. The racial elements, the habits and customs of the people, and certain historical data have a bearing on the problem and will be discussed briefly.

Historical and Ethnological Data.—Puerto Rico, discovered by Columbus during his second voyage in 1493, was settled in 1505 by the *conquistadores,* who soon enslaved the seven or eight thousand Indian inhabitants (*Boricuas*). By 1582 the pure native stock had been so decimated as a result of slavery and the ravages of epidemic disease, that in 1508 Father Las Casas conceived the plan of importing large numbers of negro slaves from Africa to take the place of the rapidly disappearing Indians. This importation was authorized officially by Spain in 1513 and abolished in 1820.

There is little information to guide us in determining the origin of filariasis in Puerto Rico. Fray Iñigo Abbad y Lasierra [2] (1788) in his description of the Island and the condition of the people makes no mention of diseases resembling filariasis, and in the 1866 edition of the friar's work, prepared by José Julián Acosta y Calbo, the omission is commented upon by the editor. This edition includes a contribution by Dr. Calixto Romero y Togores, which seems to be the first comprehensive account of clinical filariasis in Puerto Rico. Referring to the frequency of elephantiasis in the arms and legs, he says:

> It has an essentially chronic development. It disappears to reappear in the same place or in other parts. In most of the cases there is true hypertrophy

of the parts affected complicated with inflammation of the lymphatic vessels. Commonly it is never preceded by any precursory symptoms: the patient feels a sharp pain of specific or known direction of the lymphatic vessels which become hard, cordlike and which extends to enlarged glands in the groin or axilla. The part affected is usually marked by an erysipelatous swelling. The cellular tissue is enlarged and gives rise to considerable swelling followed by fever of more or less intensity; shortly afterwards everything disappears leaving only a slight swelling at the spot invaded. . . but the attacks are repeated and the swelling is always increasing: there comes a time when it becomes fixed and then one sees the disease in all its characters giving a monstrous shape to the parts where it is localized.

Dumont [3] (1875) devotes much space to the consideration of filarial diseases, especially lymphangitis and elephantiasis of the limbs and scrotum, and though he confuses these diseases with others, he furnishes much interesting information. He states that arriving slaves showed no signs of filariasis, but that the disease was more common among negroes locally born than among whites. He gives several instances of family incidence of elephantiasis, discusses the prevalence of hydrocele, and describes elephantiasis of the scrotum in detail. His account of the occurrence of extreme elephantiasis of this appendage is of special interest in view of its rarity at the present time. He recognized three kinds of elephantoid tumors of the scrotum: those in which the fibrotic elements predominate; those which are fibrotic and edematous at the same time, with or without hydroceles with fibrotic walls; those in which the vesicular capillary elements predominate, a variety called the erectile type. The second type may represent lymph scrotum, which is now comparatively rare, and the third suggests large hydroceles without true elephantiasis of the integuments.

Dumont, Betances and Andinot performed many operations for elephantiasis, their method being to make numerous incisions in the infected area in order to release the lymph. For cases of elephantiasis of the leg, Betances devised a high boot to be worn after the incisions had closed. This was made to cover the entire elephantoid area and was most effective in reducing the swelling as well as preventing its progress.

Dumont refers to the possible parasitic origin of filariasis, but only to show its improbability. He further clearly differentiates the local inflammatory reaction in filarial lymphangitis from true erysipelas. He emphasizes the existence

of focal pain developing before a chill and the tendency of the recurrent attacks to begin at the same spot.

According to Ashford [4] (1902), Dr. Jiménez Cruz of Caguas was the first to find microfilariae in the human blood in Puerto Rico (1893). In a personal communication, however, Dr. González Martínez [5] states that in 1890, Dr. Manuel Figueroa, at Arecibo, first observed the parasite in the blood and also in the urine of a patient suffering from haemochyluria. Ashford (1902) found microfolariae in the night blood of thirty out of two hundred and fifty soldiers examined.

Quevedo Báez [6], the authority on the medical history of Puerto Rico, gives some interesting information regarding the beliefs of the earlier physicians in Puerto Rico. They were convinced that the disease was hereditary, basing the theory on the fact that most of the members of the same family were infected. They also found elephantiasis to be more prevalent than lymphangitis, whereas the reverse seems to be true today.

Taking into account the scantiness of the early records and the limited knowledge of the clinical manifestations of filarial infection during the first centuries following the conquest of the Island, we may conclude that, as in other Caribbean islands, filariasis due to *W. bancrofti* was probably introduced into Puerto Rico by the African slaves and that its dissemination in the Island was at first certainly due to their presence.

Geography and Topography:—Puerto Rico lies in latitude 17°N., longitude, 65°W., and is bounded on the northern and eastern coasts by the Atlantic Ocean, and on the southern and western coasts by the Caribbean Sea. It is worth noting that the neighboring islands offer little protection from the prevailing trade winds which reach the eastern coast of Puerto Rico.

The Island has an area of 3,349 square miles, its length from east to west being about 100 miles and its maximum breadth from north to south, about 35 miles.

The coastal area is, in the main, flat. A range of mountains, the Cordillera Central, extending across the Island from east to west, divides it into northern and southern sections, the northern section being by far the wider. Most of the drainage from the interior of the Island is directed towards the northern coast, to which also flow the four largest

rivers. Their estuaries are bordered to a large extent by broad lagoons, so that there is much more ground water on the northern terrain than on the southern. It is significant that filariasis is more frequent at the present time in this section, than in the southern.

Flourishing sugar centrals and citrus fruit farms occupy most of the coastal plains and valleys. Extending west along the southern coast of the Island, from Ponce to Guánica, there is a rocky and sandy area where little agriculture is possible. Attempts are being made to improve this section by extensive irrigation, and at Guánica results have been especially successful; but on the whole this is an arid territory with very little filariasis.

Climate:—Use has been made of such observations in Dr. Fassig's [7] account of the climate of the Island as seem to have a bearing on the filarial situation (Fig. 1).

There is no striking seasonal variation in temperature in Puerto Rico, but there is a marked variation between day and night conditions.

Heat, moisture and rainfall are greatest on the northeast, the east and the eastern part of the south coast as far in as the foothills. Filariasis is prevalent here, but rare or absent in the hot, dry area of south and southwest. It is also practically non-existent in the higher humid but cool altitudes, as at Aibonito, where, however, the transmitting culex is found. The rarity of the disease at these altitudes may be due to atmospheric conditions, interfering with either the longevity of the transmitting insect or with the ability of the parasite to develop within it.

Winds:—Protection of an area from the prevailing winds is conducive to the spread of filariasis. In Puerto Rico the prevailing trade winds blow from the east and southeast throughout the year, and where these meet with no obstruction there is a minimum of filariasis. Thus, the disease is seldom found in the towns along the north coast which have a direct sea frontage, as for example on the cliff front at San Juan, where it is rare, even in the very congested and unsanitary suburb of La Perla. The southeast trades reach the southern coast more directly than the eastern trades reach the northern coast, and most of the towns on the southern coast, such as Guayama, Guánica, etc., have a low incidence. Fajardo and Ceiba on the east coast have a mod-

erate incidence of infection, but they are somewhat protected by El Yunque, which, standing west of these towns, retards the velocity of the winds in their upward sweep.

In those localities where there is definite obstruction to the circulation of wind, the filarial index is high. This is most graphically shown at Aguadilla, a town on the northern portion of the west coast, situated at the base of a cliff on the sea front which faces west and so is protected from both the east or southeast trade winds. Here filariasis abounds.

Water Supply:—The two main sources of domestic water are rain water and spring water, obtained from pumps and wells. In a few of the larger cities such as San Juan, Ponce, Arecibo and Mayagüez, reservoirs supply the majority of the houses; but even there, certain sections have no connections with the water main and rely on wells for water to drink and on streams and rivers for water in which to wash. In many places the wells are open, and these, together with the ditches in contact with them, furnish the chief breeding places for *C. fatigans*, the vector of filariasis.

In some towns, as for example, Aguadilla, where the poorer quarters are built on the steep sides of a cliff, the townspeople depend largely on the rainwater which collects in barrels placed to receive it from the roofs. In these barrels *C. fatigans* and *Aedes aegypti* are to be found breeding together. Other artificial containers, such as kerosene and meat cans and borrow pits, are frequently used by culex for depositing eggs, and in the houses of the better classes the small ponds in the patios are favorite depositories. From the standpoint of mosquito control these sources could all be dealt with satisfactorily, but unfortunately they do not constitute the main source of the insect host of filariasis.

It may be said that every town and city on the coastal belt of Puerto Rico, and every interior town as far back as the foothills, has a swamp or series of swamps in its vicinity, and it is in these, as well as in the stagnant water of the ditches which lead from them, that most of the culex mosquitoes breed. This condition is aggravated in some places, such as Puerta de Tierra in San Juan, where the muddy ground base of the district is excavated in all directions by the inhabitants with a view to draining off the flood waters. This end is not achieved because the ditches are heaped with

every kind of refuse, and in the stagnant water which accumulates, Culicines and Syrpids breed in large numbers.

Population:—The main population of Puerto Rico, as has been said, is of Spanish descent, although other European peoples have contributed to the present race, notably the Corsicans. The African race is an important factor, especially in view of its mixture with the Spanish element.

The estimated total population of the Island has shown a steady increase from the year 1765, of 45,000 people to 1,543,000, according to the last census (1930).

Filariasis in Puerto Rico is an urban rather than a rural problem, and only 27.3 per cent of the population is urban, but there is a growing tendency of country people to migrate to the towns. It is common, too, for working people to go from town to town in search of employment. This is important to bear in mind in studying the filarial incidence in different localities. For instance, filariasis was reported to occur in Guánica, which is in the dry section of the Island, but on investigation, it was found that the few patients there had all suffered from filarial lymphangitis before coming to the town some years earlier.

Hereditary Spanish influence dominates the social life and customs of the people, not only in language and religion but also in relation of the sexes; woman has not been emancipated actually, and she remains more confined to the house and domestic duties than the woman of the continental United States or of northern Europe. European dress is worn by all classes, and with the exception of the young people of the country districts who go barefooted, and the poorest children, all persons are completely clothed. Thus, many of the women as well as the men have the body well protected against mosquitoes, with the exception of the head, hands and ankles.

The screening of houses against mosquitoes is rare; the poor people cannot afford it, and even the wealthy discard it as being too hot.

The people usually remain in the neighborhood of the house in the early evening, sitting on the verandahs, in the patios or in the large central hall room of the house. This custom has an important bearing on filarial infection in view of the biting habits of the mosquito vector.

Town Distribution and Planning:—Filarial infection in Puerto Rico is definitely urban. The location of a town, however, determines the presence or absence of the disease.

While towns and cities of varying size are placed at short intervals from each other all along the coast, they are equally numerous in the plains, valleys, foothills and mountains, and connected by an admirable system of up-to-date roads.

Most of the principal cities of the Island, notably San Juan, the capital, Mayagüez, Ponce, Fajardo and Arecibo, are on the seacoast, the first and last being on the north side. San Juan, with its suburb, Santurce, is built on a peninsula terminating in a cape, El Morro, which points west (Fig. 2). From the high cliffs on the ocean side of the peninsula, the land slopes steeply to the bay on the south. Along the sea front of the cape no cases of filariasis are found, but in the lee of the cliffs where the city slopes to the level of the lagoon, cases are increasingly common. As the peninsula and the main land recede from the sea they are occupied by Santurce, a residential section of the better classes which covers the entire isthmus from the seacoast, where there is considerable elevation, to the bay, where it is at sea level. The houses of the more wealthy, closer to the seashore, are spacious bungalows, sometimes enclosing a patio, all with verandahs and for the most part cool and well spaced. Nevertheless, those towards the bay in the low lying lands are surrounded by swampy ground where mosquitoes are abundant. Amongst the residents of this section, of whatever class, there is a high incidence of filariasis.

On the bayside of the peninsula is the extensive slum district, Puerta de Tierra (Fig. 2). This land was formerly a mangrove swamp, but in 1921, in order to make anchorage for large steamers, it was dredged, and the mud and silt deposited on the edge of the swamp. On this foundation Puerta de Tierra stands. Inlets of the bay, especially at high tide, flood the streets or alleys between the houses. Irregular ditches, which receive all kinds of material, including house refuse and even excreta, intersect the district at sea level. Full of stagnant, foul water, they contain enormous numbers of mosquito larvae, mostly *C. fatigans*. The homes, dark and hot, are at best two-room shacks; often there is only one room containing a large bed. These hovels are built so close together that in many cases they exclude the light from the alleys in the locality. Families of six persons or more are crowded together in them. It is in this section that filariasis is most rife.

Across the bay from San Juan, well sheltered by the city itself, are the towns of Palo Seco and Cataño. In poverty and overcrowding these are somewhat similar to Puerta de Tierra, and they share with it an evil reputation for filariasis.

Between San Juan and Arecibo there is a chain of towns, Bayamón, Vega Alta, Vega Baja, Manatí and Barceloneta, which are situated from one to two miles from the shore. They are well sheltered from the sea and the east winds, and are all notorious centers of filariasis.

West of Arecibo the towns are again close to the sea, and these communities, together with Arecibo, which has a population of 43,604, have a comparatively low incidence of filariasis. On the west coast all the important towns are near the shore, but they are sheltered, lying either beneath high cliffs, as does Aguadilla, or under spurs of the central mountain range which slope steeply towards the coast. The visitor is strongly impressed by the heat and airlessness of these western towns, all of which, and especially Aguadilla, Aguada and Mayagüez, have an unenviable reputation for filariasis.

On the southwestern coast there are no towns of importance. Sabana Grande and Yauco lie within the "dry belt" and have very few cases of filariasis. Further east, and two miles from the sea coast is Ponce, the second largest city of Puerto Rico, with an urban population of 87,604. It is built beneath the steep slopes of the central mountain range and is sheltered on each side by spurs from this range. Filariasis is very prevalent here, especially in the poorer sections which are behind the main city and nearer to the mountains. Still to the east are Salinas and Patillas, which are sheltered from the southeast trade winds by mountain spurs, and in consequence have a fair number of cases of infection, and Guayama, which though some distance from the sea, is more exposed, and has little filariasis.

On the east coast the larger towns, such as Naguabo, Yabucoa and Humacao, are for the most part in broad valleys, and in consequence filariasis abounds.

Coming again to the north coast, Fajardo, Río Grande, Carolina and Río Piedras, all well removed from the sea, are centers of filariasis. It is true that Fajardo straggles down to the sea front, but the main town is well back and is protected by low hills. Between these coastal towns and the

Across the bay from San Juan, well sheltered by the city itself, are the towns of Palo Seco and Cataño. In poverty and overcrowding these are somewhat similar to Puerta de Tierra, and they share with it an evil reputation for filariasis.

Between San Juan and Arecibo there is a chain of towns, Bayamón, Vega Alta, Vega Baja, Manatí and Barceloneta, which are situated from one to two miles from the shore. They are well sheltered from the sea and the east winds, and are all notorious centers of filariasis.

West of Arecibo the towns are again close to the sea, and these communities, together with Arecibo, which has a population of 43,6[illegible], have a comparatively low incidence of filariasis. On the west coast all the important towns are near the shore, but they are sheltered, lying either beneath high cliffs, as does Aguadilla, or under spurs of the central mountain range which slope steeply towards the coast. The visitor is strongly impressed by the heat and airlessness of these western towns, all of which, and especially Aguadilla, Aguada and Mayagüez, have an unenviable reputation for filariasis.

On the southwestern coast there are no towns of importance. Sabana Grande and Yauco lie within the "dry belt" and have very few cases of filariasis. Further east, and two miles from the seacoast is Ponce, the second largest city of Puerto Rico, with an urban population of 87,604. It is built beneath the steep slopes of the central mountain range and is sheltered on each side by spurs from this range. Filariasis is very prevalent here, especially in the poorer sections which are behind the main city and extend to the mountains. Still to the east are Salinas and Patillas, which are sheltered from the southeast trade winds by mountain spurs, and in consequence have a fair number of cases of infection, and Guayama, which is through some distance from the sea, is more exposed, and has little filariasis.

On the east coast the larger towns, Humacao, Naguabo, Yabucoa and Humacao, are for the most part in broad valleys, and in consequence filariasis abounds.

Coming again to the north coast, Fajardo, Río Grande, Carolina and Río Piedras, all well removed from the sea, are centers of filariasis. It is true that Fajardo straggles down to the sea front, but the main town is well back and is protected by low hills. Between these coastal towns and the

FIG. 2. San Juan, Puerto Rico. No filariasis found along the sea front.
A. Filariasis endemic.
B. Puerta de Tierra. Filariasis endemic with some hyperendemic areas.
C. School of Tropical Medicine in 1928, before extension.
F. La Perla.

GRABADO 2. A. *Parte baja de San Juan donde la filariasis es endémica.*
B. *Barrio de Puerta de Tierra. Filariasis endémica, con algunas zonas hiperendémicas.*
C. *Escuela de Medicina Tropical. Fotografía tomada en 1928 antes de la ampliación del edificio.*
F. *Barrio La Perla.*

FILARIASIS O'CONNOR AND HULSE

higher altitudes, in the valleys of the lower foothills, are many towns where filariasis is prevalent. The most notorious in this respect are Caguas, San Lorenzo and Gurabo in the east, and Morovis and Corozal in the central region. As one approaches the populous cities of Aibonito, Barranquitas and Lares, at the higher levels, indigenous cases of filariasis become extremely rare.

The plan of the Puerto Rican city or town is uniform. In the center is a large open square, the *plaza,* from which streets run parallel east, west, north and south. The principal stores are scattered among the groups of residences of the better type which line the four sides of the *plaza.* Throughout this section the streets are broad, well kept and of cheerful aspect. A short distance away they become narrower and are badly paved. This portion merges into areas of absolute poverty and destitution, where the very poor with their large families herd together in dark, single-roomed, ill-ventilated shacks with no sanitation. Débris, pools of water and all kinds of filth are scattered in the gloomy alleys between the hovels, and the odors which result are distressing. In this neighborhood live street vendors, laundresses and the destitute. In the houses of this section *C. fatigans* is to be found in large numbers hiding behind clothing and under the beds. These conditions obtain at their worst in the Puerta de Tierra section of San Juan, and in the poorer sections of Aguadilla and Ponce. It is in such areas that filariasis, however estimated, is found to be most prevalent.

Occupational Liability to Infection with Filariasis:—In Puerto Rico the relationship between occupation and filarial infection was carefully investigated. In Polynesian countries, such as Samoa and the Tokelau and Ellice Islands, it has not been possible to learn anything concerning occupational liability to this infection, since in these places, where the communal system exists, one person is as likely to contract the disease as another. Manson's studies [8] in China suggested to him that:

> No particular kind of occupation with perhaps the exception of those of a seafaring character, secures exemption from filaria.

Nevertheless, a study of sixty-three persons on whom Manson found microfilariae shows that many followed employment below or adjacent to the premises where they lived.

Dr. Carlos González [9] stated that in his experience clinical filariasis was most prevalent amongst professional laundresses and their families. A study of the cases recorded in this survey confirmed this observation. Of twenty-seven patients with microfilariae in the blood, seventeen were either laundresses or inmates of the houses of such. The incidence of infection amongst laundresses was then closely investigated in Aguada, Puerta de Tierra and other places and was found to be uniformly high. In Aguada it was suspected that this high rate of infection was due to the fact that most of the laundresses lived in the vicinity of two local wells; but in Puerta de Tierra, where there are a few such wells, other reasons had to be sought. Inquiry showed that the professional laundresses invariably bring the clothes into the house for drying. Always at night, and when rain threatens, the damp clothes are stacked in the dark interiors of the houses, thus adding moisture to the heat and darkness of the rooms. Culex mosquitoes were found in greater numbers in the vicinity of such quarters than elsewhere, and dissection of those collected in and under these houses showed a higher average incidence of infection than usual. Moreover, parasites in the advanced stages of development were found more frequently in such mosquitoes than in those from other habitations. These facts are considered to have an important bearing on the distribution and spread of filariasis in Puerto Rico. It should be emphasized that there is no evidence that similar circumstances contribute thus in other countries.

Family Incidence of Filariasis:—In the Samoan and Ellice Islands it was found that there was a greater tendency to filarial infection in some families than in others, and that this liability to infection in any family depended largely upon house construction. Thus, amongst the native population living in open houses there seemed to be no greater tendency to infection in one family than in another; but among Eurasians, who live in tropical bungalows of European construction, which give greater protection to the transmitting mosquito, there appeared to be a definite liability to infection within the family.

In Puerto Rico, where the houses are all constructed on the European plan and where amongst the poorer classes

there is much overcrowding, conditions are ideal for the study of family incidence of filariasis. Burke [10] made such a study. She states that:

> Many households were found in which there was only a single person with microfilariae in the blood in spite of apparently optimum conditions for a spread of the infection, that is, a striking tendency to spread in families was not seen. On the other hand, among households in which one member had elephantiasis there were several families in which some evidence of filariasis was noted in every member; and in eighteen of thirty-three families in which one member had elephantiasis, a second member showed some other evidence of filariasis.

During the present investigations particular attention was paid to this matter, and in many localities there was noted a very definite tendency to family infection and a high family incidence of filariasis.

Thus of a total of four hundred and ninety-three patients showing definite evidence of clinical filariasis, two hundred and five, or 41.5 per cent, gave confirmative reports of filariasis in one or more members of the family.

The following cases and family histories illustrate this point:

CASE H. A woman of 35 years had for 9 years annual febrile attacks with a red streak descending from the left groin to the ankle and palpable superficial glands in the left groin and enlargement of the left leg. No one else in the family suffered from filariasis. Her blood and that of her 9 children and an adopted child examined for microfilariae at 11 p. m. gave the following results:

Name	Sex	Age	Number of Microfilariae Present in 20 cmm. of Blood
Mrs. H.	Female	35 years	None
E.	Male	9 years	None
C.	Male	11 years	89
C.	Male	13 years	153
C.	Female	14 years	85
A.	Male	15 years	101
J.	Female	6 years	None
R.	Male	3 years	1
A.	Male	7 years	None
R.	Male	1 month	None
B. H.	Female	18 years	None (adopted daughter)

CASE F. C., a housewife, aged 37 years had recurrent inflammation in the legs for 10 years. Her father had elephantiasis. She had no microfilariae in her blood. Examination of her children at 10 p.m. gave the following results:

Name	Sex	Age	Number of Microfilariae Present in 20 cmm. of Blood
A. C.	Male	18 years	None
J. C.	Male	10 years	111
S. C.	Male	12 years	161
E. C.	Male	13 years	113
M. C.	Male	15 years	None
V. C.	Male	16 years	None
M. C.	Male	17 years	None

CASE J. R. Sr., aged 40 years, had inflammation in the left side of the scrotum. His son, J. R. Jr., aged 4 years, suffered from lymphangitis of the leg.

CASE B. C., a male, aged 16 years, was born in Puerta de Tierra where he still lives. He was admitted to the Presbyterian Hospital, Santurce, with filariasis.

Family History.—Three of the 10 members of the patient's family have microfilariae in the blood at night. The mother, who is a laundress, has had lymphangitis of one leg.

History of Present Condition.—The patient's mother says that when the patient was six months old he had fever accompanied by swelling and redness of the scrotum. The patient states that his first attack occurred two months ago and that since then, every 15 days, he has had an attack similar to the present one. The first sign is pain in the lumbar region. This spreads down toward the cord and the scrotum of the left side, where there is acute pain. Soon the scrotum becomes enlarged, red and tender. He then has several chills, followed by high fever which lasts from 3 to 4 days and which is accompanied by headache, vomiting, anorexia and constipation. The urine is dark and concentrated. The redness lasts 5 days. The attacks end with sweating. The left subinguinal glands become enlarged, tender and painful. The skin over them becomes red.

The patient rapidly improved at the hospital, and the inflammation disappeared leaving, however, a hydrocele and a definite enlargement of the cord on the left side.

Dr. G. R. Burke performed an operation on this patient. An incision was made along the right inguinal canal and the cord was exposed. The latter was found to contain a varicocele, a small hernial sac which was empty, and two small hydroceles of the cord. One of the hydroceles was tapped and clear fluid was withdrawn in which no microfilariae were found. The hernial sac was excised. Following operation a small hydrocele developed on the right side.

On September 11th, 1929, the patient was admitted to the San Juan District Hospital with an attack of lymphangitis, the first since his discharge from the hospital in March of the same year. The attack began at 1 a.m. when he was seized with severe pain in the back and in both groins; at the same time he noticed swellings and redness in these regions. Pain was followed by a chill and then by fever which continued for three days. There was headache but no nausea or vomiting. The attack ended with sweating. The skin became red from Poupart's ligament to midway along Hunter's canal on the left side only. The area of most severe pain was in the center of this region. The redness remained for 5 days.

On September 13th, 1930, the patient had another attack. He awoke with slight pain in the left thigh. He went to work, but after an hour he had to go home to bed. He then had a chill which was followed by fever; there was headache but no nausea. Pain was most severe in the back and in the left side of the scrotum. He was admitted to the hospital on the second day of the attack.

The patient was seen again in December, 1930. He stated that since his last admission to the hospital he had had similar attacks practically every month. At this time the scrotum was X-rayed, but no shadows suggestive of calcified filariae were seen.

Urine Examination.—The urine was turbid, yellow, acid, with a specific gravity of 1.015. There were traces of albumin but no sugar.

Stool Examination.—Ova of *Necator americanus* were found in the stool.

Blood Examination.—The Kahn and Wassermann tests were negative. The hemoglobin was 75 per cent (Sahli); the total red cell count was 3,680,000. No microfilariae were found in the night blood. (Chart I).

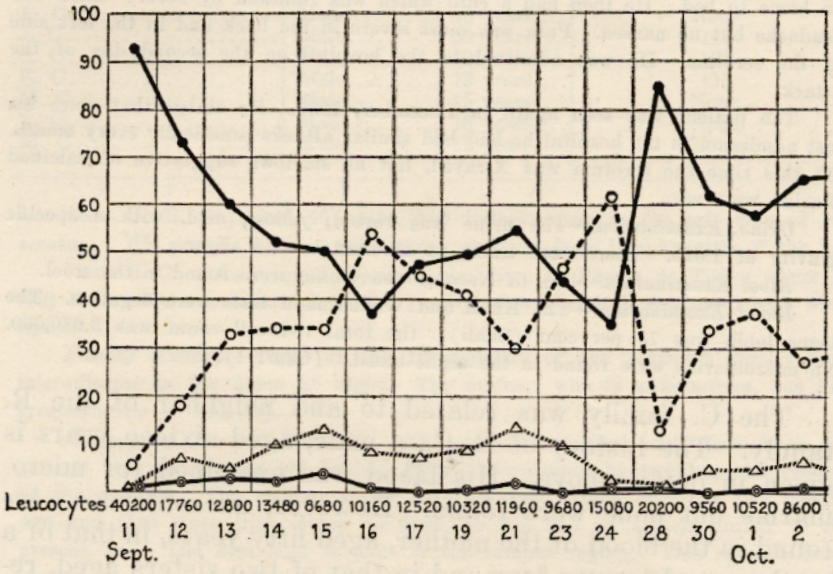
The C. family was related to and neighbor of the R. family. The history of B. C., a male, aged sixteen years is given in detail above. His blood was examined for microfilariae but none were found. However, microfilariae were found in the blood of the mother, aged fifty years, in that of a brother aged twenty-four and in that of two sisters aged, respectively, seven and five years.

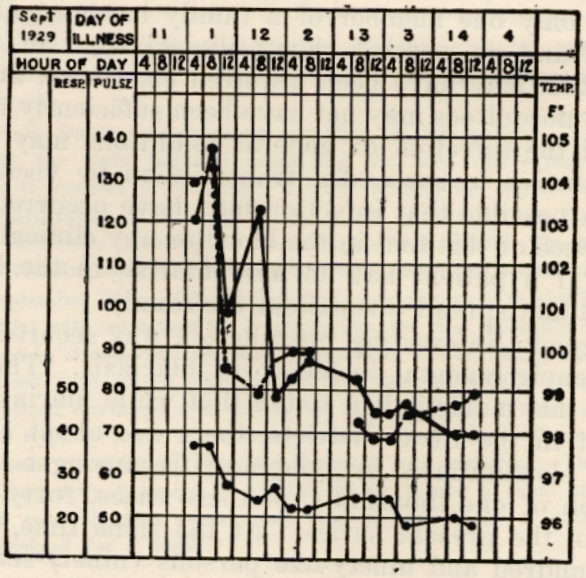
Dissection of many female *C. fatigans* taken within and underneath the houses of the R. and C. families revealed numerous larval filariae in various stages of development.

When only one member of a family has microfilariae in the blood and no member shows clinical signs of filariasis, the infection may have been acquired elsewhere, and at the home the mosquitoes may not have been sufficiently numerous to spread the infection or general conditions may not have been conducive to successful transmission by vector. Further, it is possible that infection may have occurred without any evidence of this fact in the blood or any clinical manifestations. If a patient has no microfilariae in the blood, infection cannot spread throughout the family.

In Aguada, interesting information was secured with regard to environmental incidence of filariasis. The medical officer of this municipality stated that while filariasis is rare or absent in the rural districts, there are about a hundred cases of elephantiasis or lymphangitis amongst the urban population of one thousand; of these cases, forty-two were studied in the present series. At the same time, the blood of one hundred and ninety-one persons (ninety-seven males

Chart I


100
90
80
70
60
50
40
30
20
10
Leucocytes 40200 17760 12800 13480 8680 10160 12520 10320 11960 9680 15080 20200 9560 10520 8600
11 12 13 14 15 16 17 19 21 23 24 28 30 1 2
Sept.
Oct.
Polymorphonuclear leucocytes
Large Mononuclears including Transitionals
Eosinophiles
Lymphocytes


Sept 1929
DAY OF ILLNESS
11 1 12 2 13 3 14 4
HOUR OF DAY 4 8 12 4 8 12 4 8 12 4 8 12 4 8 12 4 8 12 4 8 12 4 8 12
RESP.
PULSE
TEMP. F°
140
130
120
110
100
90
80
70
60
50
50
40
30
20
105
104
103
102
101
100
99
98
97
96

and ninety-four females) was examined at night; microfilariae and parasites were found in the blood of twenty-seven (14 per cent) of these (twenty-one males and six females). While taking clinical histories it became clear that clinical cases of filariasis were collected together in certain limited areas of the towns. From the total figures an analysis was made of the relationship in families and amongst neighbors, of both clinical signs and blood evidence of infection.

Where signs of infection were most marked, it was found that forty-five persons showed evidence of having become infected from each other. They were from twenty-eight houses in two or three sections of the town and were grouped in eleven families and their immediate neighbors. Twenty-eight of the forty-five persons (five males and twenty-three females) exhibited definite clinical signs of filariasis. The symptoms of these infected persons are tabulated below:

Total patients	Males	Females	Symptoms
6.....	3	3	Recurrent attacks of lymphangitis without elephantiasis.
16.....	1	15	Elephantiasis with or without inflammatory reaction in the same limb.
4.....	0	4	Lymphangitis of one limb and elephantiasis of another, with or without inflammatory reaction in the same limb.
1.....	1	0	Hydrocele.
1.....	0	1	Considerably enlarged epitrochlear gland.

The blood of thirty-nine of the forty-five persons was examined at night. Microfilariae were found in that of twenty (fourteen males and six females). The ages of these persons were as follows:

Sex	Years of age
Males	8, 14, 16, 18 (3 cases), 19, 20, 22, 26, 27, 30, 36, 37
Females	10, 13, 18, 30, 36, 80

Only two persons, one male and one female, with microfilariae in the blood had symptoms of filariasis. Of the families in which persons with microfilariae were found, there were nine in which one person or more had clinical signs of filariasis and eleven in which no one had such signs. In one family the blood was not examined. In another, although three persons had microfilariae in the blood, no one suffered from lymphangitis or elephantiasis. In two families no parasites were found in the blood of patients or their relatives.