FILARIASIS AMONG AMERICAN TROOPS IN A SOUTH PACIFIC ISLAND GROUP*

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Buxton[1] noted the relative frequency of elephantiasis among white residents of this island group, and he commented on the unusual facilities for the transmission of "filaria" provided by non-periodic embryos and an ideal vector which bites at all hours and is most difficult to control. He also described a clinical entity, for which he used the native term *mumu*, which occurred in Europeans within a few months of their arrival in the area and which he believed to be filarial. This clinical entity has constituted a major problem to medical officers with the Navy and Marine troops in the area, and further study has corroborated Buxton's belief as to its etiology. The discovery that the incidence of filarial infestation in mosquitoes is relatively high adjacent to native huts and is zero 75 yards distant[2] has shown that the quartering of troops in native villages, though unavoidable at first, was unfortunate. It is to be hoped that the new policy of segregation of troops and natives, and intensive anti-mosquito measures in villages and camps, will protect the troops in the future.

Search for adult "filaria"† in biopsied lymphatic cords and nodes from Marine and Navy patients with *mumu* has been successful in 8 of 24 cases in the area, in 42 of 140 returned patients at the Naval Hospital at Oakland,[4] and in 4 of 10 cases at other hospitals. Since the pieces of tissue are small, the technical procedures difficult,

* This paper is based on observations by all the authors in the island group, and on further observations made by three of us (R. W. H., R. H. F., and S. E.) upon ourselves and other victims of the disease after return to the United States. We are most grateful to Commander Paul Michael (MC), USNR., Pathologist at the U. S. Naval Hospital, Oakland, for permitting reference to some of his unpublished data, and to numerous other colleagues both in the field and the hospitals who have shared their observations with us. The views expressed are those of the authors and do not necessarily reflect the official views of the Navy Department or the Naval Service at large. This paper was read at the annual meeting of the American Society of Tropical Medicine.

† In order to avoid controversy as to the identity of filariae with non-periodic embryos it seems better to use this term rather than *W. bancrofti.*

and the worms prone to disintegration in the host, these figures show that filarial infection was widespread, and provide strong support for belief in the filarial etiology of *mumu*.

Further support is found in the histological picture in practically all of these tissues, which is identical with that described by O'Connor[5] as characteristic of filariasis; a granuloma with lymphoid and eosinophilic infiltration.

Pertinent data were also obtained from skin tests with an extract of the dog heartworm, *Dirofilaria immitis*, as suggested by the work of Taliaferro and of Fairley.[6] Details of this test will be discussed elsewhere. Since a forearm with a strong 24-hour reaction closely resembled a forearm involved in severe clinicial *mumu*, the 24-hour reaction was considered at least as significant as the immediate wheal, and the test was considered positive only if both immediate and delayed reactions were positive. The two checked fairly well, though a few controls showed immediate positive reactions and 24-hour negative reactions, and 17 *mumu* patients had immediate negative, 24-hour positive reactions. The test was not entirely specific for the filarial group, since 6 of 128 newly arrived controls gave positive reactions, and in some of these, previous contact with filariasis could be excluded. One such man had hookworm disease the year before. Tests with Ascaris extract showed some degree of cross-reactivity between Ascaris and Dirofilaria. Then, too, the test, like most skin tests, did not correlate closely with clinical activity, since many men who had been in the area for many months had positive skin tests for some time before they developed clinical *mumu*. Nevertheless, the test yielded information of some cogency, for 168 of 202 *mumu* patients who had not been previously tested gave positive immediate and 24-hour reactions. Retests on three men who developed *mumu* and whose previous tests had been negative showed two complete positives and one immediate negative, 24-hour positive response. It was clear that as contrasted with the control group the *mumu* patients were sensitized to filarial substance. That this sensitization to filarial substance was induced by filarial rather than by other helminths was suggested by the relatively low incidence of intestinal parasitism among the troops. Thus, among 57 patients with *mumu* who had both skin tests and stool examinations, only 6 showed evidence of intestinal parasitism. Finally, it is of interest that a particularly severe case of *mumu* seemed to produce desensitization, and most of the negative reactors

in the patient group could be accounted for on this basis. In a few instances the desensitization was shown to be sharply localized to the involved arm.

Two other relevant considerations deserve mention. First, the disease was observed only in troops who were veteran to the area. Among cases under our observation, the shortest interval between arrival and the development of *mumu* was 3½ months. The rising incidence after six months of residence is very striking. Second, there seems to be no plausible non-filarial hypothesis. Thus, regional superficial infection has been absent, and bacteriological examinations have been negative. Dr. Michael obtained growth from only one of 40 excised tissues cultured both aerobically and anaerobically, and in this case there was obvious secondary infection.

In no case have we succeeded in demonstrating microfilariae in the blood. However, this negative finding does not constitute substantial evidence against the filarial etiology of *mumu*. O'Connor's[5] figures for filariasis in Puerto Rico suggest that filaremia and clinical manifestations of filariasis tended to be almost mutually exclusive, and, as Buxton[1] and others[6] have pointed out, marked tissue reaction around an adult worm must hinder access of microfilariae to the circulation. Studies by one of us (J.G.D.) on native children show that the finding of microfilariae would be against all precedent during the first year of exposure and is most unusual within three years. In other words, filaremia is a late manifestation of infection. The finding of microfilariae in a blood film must mean that the total number in the circulation is enormous. We have no data to indicate whether such a number is within the productive capacity of one female, or whether many are required. Certainly one female hookworm does not produce enough ova for routine detection in the stools. Our ignorance of the mating habits of *W. bancrofti* does not permit us to speculate as to the number of males and females which the host must harbor in order to make the chance of a mating a reasonable one.

As we have seen it, *mumu* is a subacute and relapsing disease, with characteristic local and constitutional manifestations. The principal constitutional symptoms are fatigability, anorexia, headache, and blurring of vision. Fever is generally slight or absent, even with very angry local lesions. The local manifestations may be persistent nodules and cords, or acute diffuse transient swellings. Suppuration is most unusual.

In our experience, the genitalia are the commonest site of involvement. In this respect our experience with *mumu* parallels that of Buxton and O'Connor in males with more chronic filarial manifestations. The first requisite for the recognition of *mumu* is an ability to recognize enlargement of the spermatic cord. In a typical case this enlargement is first noted above the external ring, then descends to within the scrotum, to be followed by swelling and tenderness of the epididymis and testis. In some instances fluid, rich in lymphocytes and eosinophils, has been aspirated from the testis. Such a "symptomatic" hydrocele usually disappears within a few weeks, but after repeated attacks the hydrocele may be permanent. A boggy incompressible consistency of the testes, doubtless due to edema, is one of the most persistent and regular findings. Nodular epididymitis may outlast other involvement of the genital structures. In the acute phase there may be decided edema of the scrotal skin.

In sections from an individual with filarial funiculitis, dying from an unrelated cause, Dr. Michael has found diffuse edema and infiltration of the cord, epididymis, and testis, with cuffing and some nodular accumulations of lymphocytes about lymphatic vessels. Some of these lymphatic vessels are dilated and thickened to such a degree that they are best described as varices.

Clinically these lymphatic varices may first become recognizable as such during subsidence of an acute funiculitis. They differ from venous varices (the ordinary varicocele) in a number of respects. They extend the full length of the spermatic cord and cannot be drawn away from it. They are edematous and indurated. They may appear, completely disappear, then reappear, within the course of a week. They are often associated with nodular epididymitis and with edema of the testis. Operative removal of such varices has been found to result in extensive damage to the cord and is to be condemned. Indeed, any elective operative procedure in the inguinal area is to be avoided in a man who may have *mumu*. Thus, it has not been possible to make a systematic study of histological changes in this region.

Second in frequency of involvement was the arm, which provided most of the biopsy material. As noted by Buxton, the epitrochlear is particularly prone to involvement. A typical acute process in the arm starts with adenitis or soft tissue swelling in the axillary or epitrochlear region, continues as a descending (retro-

grade) lymphangitis and finally appears as a diffuse soft tissue swelling of the forearm, often with striking erythema. The lymphangitis may be superficial with brilliant red streaks which fade proximally as they extend distally, or it may be deep, with deep indurated cords and without erythema.

Tabulation of the sites of involvement, based on the diagnoses in 251 *mumu* patients evacuated to U. S. Naval Mobile Hospital No. 3 between October, 1942, and February, 1943, has been recorded elsewhere. Involvement of the genitals was noted in 185 patients, of whom 57 had lesions of the extremities also. There were 66 patients recorded as having involvement of the extremities only. Involvement of the leg was noted in but 10 patients. This figure is undoubtedly too low, for the lesion in the leg is seldom as striking as is that in the arm, and must often have escaped recognition by our inexperienced eyes. Subsequent study of men returned to the United States has shown that leg involvement is common and that multiple involvement is even commoner than is indicated by the above figures. It is probable that at least 50 per cent of the patients have involvement both of the genitals and of the extremities.

Important manifestations, other than those just described, are circumscribed soft tissue swellings, sometimes urticarial in character, edema and spasm of particular muscles, lymphangitis and lymphadenitis of the neck, and abdominal pain and tenderness. Pain of a pleuritic type is common; in some instances pleural rubs have been heard, and in two instances the clinical and radiographic pictures raise a suspicion of filarial involvement of the pulmonary lymphatics.

The disease may continue active for some time after removal from the endemic area. Thus, a man now under the care of one of us (R.W.H.) continues to show marked activity 10 months after leaving the area. However, present experience suggests that the activity is subsiding in most of those who have been away from the area for 4 months or more. A great variety of drugs have been employed in an attempt to hasten cure, but the results have been discouraging.

Summary and conclusions

We have presented clinical and other data on the clinical entity for which Buxton chose the native term *mumu*, and which has been very prevalent among Marine and Navy troops in the South Pacific Island group where we were stationed. Our data are strongly in

favor of Buxton's view that *mumu* is filariasis, and provide direct support for O'Connor's belief that the substance of the worm itself is of great pathogenic importance and that vulnerability to this substance depends upon allergic sensitization.

References

1 Buxton, P. A.: Researches in Polynesia and Melanesia. Memoir London School of Hygiene and Tropical Medicine. (London 1928).
2 Byrd and St. Amant: Unpublished observations.
3 Dickson, J. G., Huntington, R. W., and Eichold, S.: Filariasis in Defense Force, Samoan Group. U. S. Naval Medical Bulletin, September, 1943.
4 Michael, Paul: Unpublished observations.
5 O'Connor, F. W., and Hulse, C.: Studies in Filariasis. (1) (2) Filariasis in Puerto Rico. Puerto Rico Med. J., 1935.
6 Stitt: *Tropical Medicine*, sixth edition, revised by R. P. Strong, Philadelphia, Pennsylvania. Blakiston's Sons. 1941.

Appendix

This record of his own case, compiled by Corporal W. J. M., U.S.M.C., illustrates all of the usual features of *mumu* together with some unusual ones. We saw this man in most of his attacks, and can vouch for the accuracy of his chronicle. Aside from correction of a few misspellings, no editorial revision has been attempted, for we think that just as it was written it is a document of some scientific value and human interest.

Filariasis case history

(Corp. W. J. M., U.S.M.C.)

Enlisted—Jan. 16, 1942.
Left U. S.—July 19, 1942.
Arrived Wallis Island—Aug. 1942.
First attack of filariasis—Feb. 1, 1943.
Left Wallis for hospital—Feb. 21, 1943.
Left Mob. No. 3 American Samoa—Mar. 28, 1943.
Arrived U. S. Naval Hosp., San Diego, Apr. 10, 1943.
Went home to Pittsburgh, Pa.—Apr. 21, 1943.
Returned to U. S. Naval Hospital—May 31, 1943.
Returned to duty at Marine Base—June 4, 1943.
Returned to U. S. Naval Hospital—July 10, 1943.

The first attack of Filariasis was really four distinct subsequent overlapping attacks lasting from Feb. 1, 1943 to April 15, 1943.

1. Right arm—Feb. 1, 1943 to Mar. 20, 1943.
2. Left arm—Feb. 11, 1943 to Mar. 31, 1943.
3. Scrotum (left spermatic cord) groins and right leg—Feb. 19, 1943 to Mar. 20, 1943.
4. Left leg—Mar. 10, 1943 to Apr. 15, 1943.

Progress of the disease

Feb. 1, 1943.

FIRST APPEARANCE in right armpit with a kernel and soreness. Over a period of 11 days, during which regular duty was performed, the soreness, accompanied by hard swelling and red streaks, had spread down as far as the elbow. At this stage it was almost impossible to raise the arm above the shoulder level or straighten it at the elbow. It was at this time that a kernel and soreness appeared in the left arm-pit. The red streaks continued with the swelling and soreness down across the inside of right forearm and into the hand. This all took place over a period of 30 days and was still noticeable in the hand and forearm for about 15 or 20 days following that period, after which there remained several inflamed nodes which became swollen and more noticeable with any exercise of the arms.

Feb. 11, 1943.

SECOND APPEARANCE in left arm followed almost identically the progress in the right arm, being not quite so acute due to little or no activity over that period.

Feb. 19, 1943.

THIRD APPEARANCE in groins and right thigh in the form of a tired feeling followed by dull aching in the left testicle which on the following day was greatly swollen and extremely painful. The pain subsided somewhat after a day or so, the swelling remaining for about 20 days when it subsided some leaving a greatly thickened spermatic cord which remained so for about 15 days more. Although the cord returned to almost normal there still remained a snakey mass just above and surrounding the left testicle. The groins remained swollen and sore during this entire period, gradually subsiding as did the spermatic cord.

Mar. 10, 1943.

FOURTH APPEARANCE in the left thigh, at the same time appearing in the lower right leg with red streaks accompanying the soreness from the knee to the foot over a period of 10 days. The left leg followed almost identically the progress in the right leg, but again was much less acute and minus the noticeable red streaks. Swelling was slight in both cases.

(During this same period there occurred frequently a tired, aching feeling around the right shoulder, noticeable mostly at night. This aching some-

times moved down the back to the region of the lower ribs and other times seemed to center in the chest, in the region of the heart.)

Mar. 28, 1943.

A relapse occurred with the physical exertion of loading gear and boarding transport for evacuation to the United States. This was noticed in a tired, aching feeling in the groins and lower back, testicles and legs. This lasted about two days.

Apr. 1, 1943.

An aching about the left shoulder developed into a soreness in the back at the lower ribs on the left side. This was accompanied by sharp pains shooting through the entire chest cavity at the slightest quick movement or deep breath. This lasted for about 8 or 10 days and was diagnosed by the doctors aboard ship as pleurisy. There was no sign of a cold or abnormal temperature.

May 1, 1943.

A second attack of this pleurisy, very similar to the first, occurred, this time lasting about 7 or 8 days. Again there was no cold or temperature. These attacks in milder form have occurred frequently since, lasting from 2 to 10 days.

June 4, 1943.

Upon returning to duty at the Marine Corps Base, and being assigned to a Guard Company, I stood two 4-hour watches every other day as turnkey in the Base Prison. This watch required being on the feet all of the time, which alone was noticeably tiring.

June 10, 1943.

After about one week of duty numerous relapses occurred. These were in the form of swelling of the left spermatic cord and scrotum, aching in the groins and legs, and a constant feeling of being just worn out. With the required morning exercises, drills, etc., the arms and legs showed frequent flare-ups with lumps, stiffness and swelling. With these relapses also comes a feeling of depression with a decided bad effect on the digestive system and a loss of appetite.

July 10, 1943.

To prevent transfers back into the Fleet Marine Force the Filariasis cases were sent back to the hospital, where they would do light guard duty under constant observation by the doctors.

July 30, 1943.

A third and most painful attack of this pleurisy appeared, this time in the lower right lung area and centered in a spot in the back at the lower ribs. Again there were sharp shooting pains across the back and into the chest with even normal breathing or movement. There was no cold or temperature. After a week of sleepless nights the sharp pains subsided somewhat leaving a painful area in the back on the right side and also in the left side near the

heart. Pain in these areas was noticed with deep breathing for three weeks following. An X-ray plate showed hazy areas in the regions of most pain. No diagnosis was made, or any treatment administered.

Aug. 8, 1943.

A red streak with slight swelling and soreness appeared in the lower right leg. An inflamed node, which had remained noticeable since the first attack in the right leg, became sore and festered and broke open. One in the upper right leg had done the same thing some months earlier. In both cases there remained a red spot or scar.

Aug. 14, 1943.

A soreness and swelling in the left groin was followed by a relapse in the left testicle and the first swelling and tenderness ever noticed in the right spermatic cord. The tenderness left after a few days, but the left testicle seemed to be worse with each relapse and remained so for some time.

Aug. 30, 1943.

Another X-ray was made after pains persisted in the chest and back for a full month. This one also showed hazy areas as did the first. Again no definite diagnosis was made or any treatment administered.

Sept. 6, 1943.

A thorough check-up with a stethoscope revealed a pleural rub and a dead stop in the area of most pain. The X-ray fluoroscope showed everything to be clear and working normally in spite of the fact there was unquestionably some congestion in the lung. Another X-ray plate showed improvement over the previous two.

Sept. 7, 1943.

A red spot (4 in. long and 3 in. wide) appeared on the inside of the biceps of the left arm. There was slight swelling but very little pain or stiffness. The redness was still apparent the next day and there was considerable stiffness in the forearm and at the elbow.

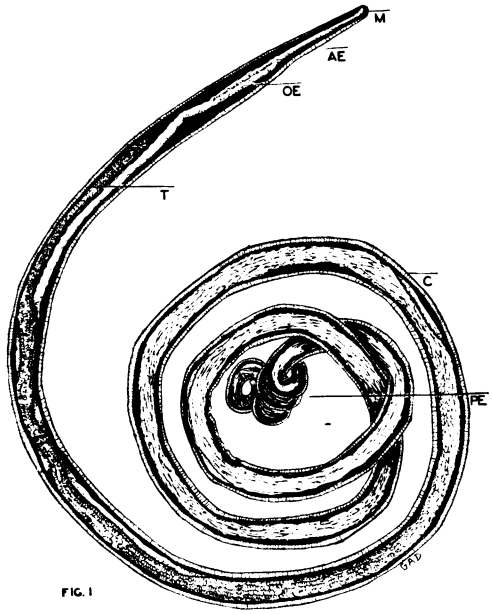
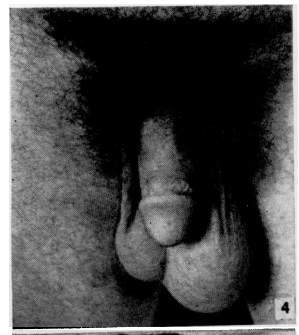


FIG. 1



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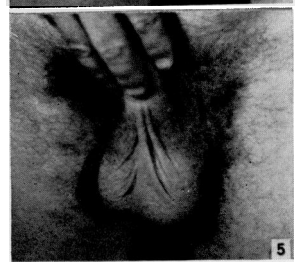

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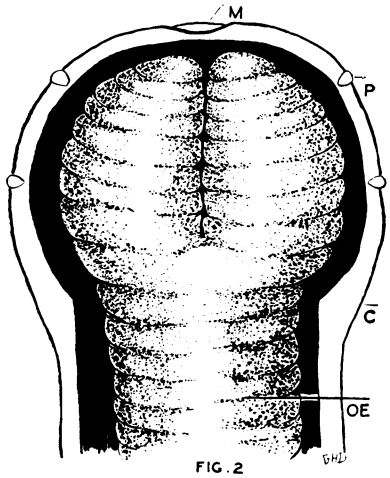

FIG. 2

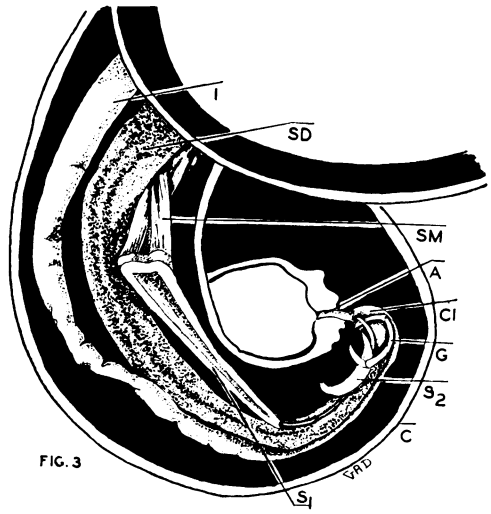

FIG. 3

FIG. 1. Diagrammatic sketch of adult male "Filaria."
FIG. 2. Anterior of worm.
FIG. 3. Posterior end of worm.
(These sketches, enlarged, were made of the adult male recovered from Cpl. D. E. W. Sketches made by Lieut. Byrd (HC) USNR.)
FIG. 4. Showing marked enlargement of left testis. (Cpl. W. J. M., USMC.)
FIG. 5. Showing bilateral hydrocele, most marked on left. (Case of Pfc. J. F. F., USMC.)

Legend:

A—anus
AE—anterior end of worm
C—cuticle
CI—cloaca
G—gubernaculum
I—intestine
M—mouth
OE—esophagus
P—papillae
PE—posterior end of worm
S_1—long spicule
S_2—short spicule
SD—sperm duct
SM—muscle of spicule
T—testis