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Epidemiology of Bancroftian Filariasis in Nagate and Abumize Villages, Nagasaki Prefecture, Especially in Relation to Vector Mosquitoes

1. Considerations on the changes in the endemicity of the filariasis*

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Introduction

To analyze the epidemiological change in the intensity of filarial infection in a given community, Hayashi (1955) devised a new method. He divided the signs of the clinical development of filariasis into four categories; having microfilariae, lymphangitis, chyluria, and elephantiasis. The percentages of persons belonging to the categories in a given filariasis endemic community were compared with those of a standard, for which he used the comprehensive data of Saigo (1939) in Ryukyus. The trend of a line connecting four points or the ratios of the percentages in a community to those of the standard was considered by him to present the historical state of endemicity of filariasis in the community. Oshima (1955) tried to explain by a similar method the state of endemicity in the communities he had studied in Nagasaki Prefecture. Sasa (1959) attempted to account for the state by a method slightly modified from the Hayashi's method.

The author came to an idea that for the explanation of the historical change in the endemicity of the disease in a community, a simpler method or a triangular graph method might be useful, which has been used mostly by taxonomists to differentiate between closely allied races morphologically. As the three events applicable to the triangular graph, three clinical categories, symptomless stage, acute stage, and chronic stage, were used. On the area of an equilateral triangle, a point for each community may be obtained, putting the percentage numbers of persons belonging to the three categories against the total infected persons in the community in place of the three perpendiculars from the point to the three sides. Then, the situation of the point thus obtained may indicate the state of endemicity or historical change in the infection of filariasis in the community. Using the method the

*Contributions from the Research Institute of Endemics, Nagasaki University No. 439 and Contribution No. 125 from the Department of Medical Zoology, Nagasaki University School of Medicine.
The author tried to analyze the states of endemicity in some filariasis endemic districts and villages in Nagasaki Prefecture.

The author wishes to express his sincere appreciation to Prof. Nanzaburo Omori of the Department of Medical Zoology, Nagasaki University School of Medicine, who has constantly encouraged and has revised this manuscript.

Explanation of triangular graph method

The triangular graph method is based on the property of equilateral triangle that the sum of the three perpendiculars from a given point to each side is constant. When regarded the percentage constituents of the infected persons belonging to the respective clinical categories in combination of existence or non-existence of microfilariae and symptoms, M(+) S(-), M(+) S(+), and M(-) S(+), in a community as the three perpendiculars, then the rates of the persons in the community may be given as a point.

In view of the development in the clinical manifestations in an individual filaria patient, it may reasonably be said that when a community is at the beginning of filarial infection, persons having M(+) S(-) may appear first and with the advance in the infection those with M(+) S(+) secondly and those with M(-) S(+) finally may come to be found.

If filariasis infection has continued at the same intensity in a community for a long time, the percentage constituents of the three clinical categories would reach a certain state of equilibrium, and if the intensity has been or had been reduced for some years in recent, past, or far past years, the reduction in one of the percentage constituents would be seen. Accordingly it can be also said that higher percentage of M(+) S(-), M(+) S(+), or M(-) S(+) in the present time in a community may imply the intensity of filarial infection having been higher for some years in recent, past, or far past years.

In Fig. 1, a model of the triangular graph is presented in order to illustrate the states of endemicity of filariasis. The figure shows that the nearer to the M(+) S(-) : 0% side the point determined for a given community lies, the lower the intensity of the infection.

Fig. 1. A model of triangular graph showing the states of endemicity of filariasis. The distances from a point within the triangle to 0% lines or sides represent the percentage numbers of persons belonging to the three clinical categories to the total infected persons in a community.

Fig. 2. Subareas in a triangular graph showing the grade of filariasis endemicity against a standard or the point A calculated from the data of Hayashi (1962) in Amami-Oshima. For further explanation, see Table 1 and text.
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Table 1. Intensity of filariasis infection at the six subareas, presumable from their relative situation to the point A.

<table>
<thead>
<tr>
<th>Subarea</th>
<th>Infection in recent years</th>
<th>Infection in the past</th>
<th>Infection in the far past</th>
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<tbody>
<tr>
<td>1</td>
<td>Active</td>
<td>Inactive</td>
<td>Moderate</td>
</tr>
<tr>
<td>2</td>
<td>Active</td>
<td>Moderate</td>
<td>Inactive</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
<td>Inactive</td>
<td>Active</td>
</tr>
<tr>
<td>4</td>
<td>Moderate</td>
<td>Active</td>
<td>Inactive</td>
</tr>
<tr>
<td>5</td>
<td>Inactive</td>
<td>Moderate</td>
<td>Active</td>
</tr>
<tr>
<td>6</td>
<td>Inactive</td>
<td>Active</td>
<td>Moderate</td>
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In recent years is; the nearer to the M (+) S(+) : 0% side, the lower that of the infection in the past; and the nearer to the M (-) S (+) : 0% side, the lower that of the infection in the far past.

In Fig. 2, the point (A) for Amami-Oshima Island is given as a standard point to be comparable with points for any other communities. The percentage constituents of the point were 47.0% for M(+), 30.0% for M(+), and 23.0% for M(-). It seems quite adequate to adopt it as a standard, because the fairly highly endemic state of filariasis in the Island seems persistent for a long time, keeping an apparent equilibrium state in the percentage constituents.

By the lines connecting vertexes through the standard point A, the area of the triangle is divided into six subareas as shown in Fig. 2. The historical changes in the intensity of filariasis infection at the six subareas, in comparison with the standard point, are tabulated in Table 1.

Fig. 3. Points showing the grade of filariasis endemicity in some communities.
Oyama Village (No. 5) were said to have been fairly endemic with the disease and were examined without finding new infection in the present time. In Nos. 2, 3, and 4, filariasis is prevailing in varying grade. No. 6 includes all Oshima's data and therefore can be roughly said that the situation of this point represents the average state of endemicity in so-called filariasis endemic areas in Nagasaki Prefecture. Point N is of Nagate Village which is fairly highly endemic with the disease for Nagasaki Prefecture and is under examination by the author on the epidemiology of filariasis and ecology of vector mosquitoes, as will be reported in the next report.

From the situation of the points and with reference to the relative activity of filariasis infection in six subareas shown in Table 1, the historical changes of endemicity in these communities are understandable. Points No. 1 and 5 are in subarea 5 and others in subarea 3. The subarea 5 is characterized by active filariasis infection in the far past, moderate in the past, while inactive in recent years. The trend becomes more conspicuous, when a point is nearer to the vertex, $M(-)S(+) : 100\%$. No. 1 is the extreme case and No. 5 seems to be so in near future.

The subarea 3 is characterized by active infection in the far past, inactive in the past, and again rather active in recent years. In any of the subareas, however, the nearer a point is to the point A, the nearer the state of endemicity in a community approaches to the equilibrium state in the percentage constituents of the clinical categories as in Amami-Oshima Island. In the subarea 3, No. 4 is nearer to A, while No. 2 and No. 3 are somewhat apart from it. In general, however, in Nagasaki Prefecture the state of endemicity is represented by the point No. 6. The reason why the point for the state of endemicity in Nagasaki Prefecture in general is in about the middle of the subarea 3 is difficult to explain clearly, but it may have some relation to the movement of young people from their home communities before and during World War II, as far as our Nagasaki Prefecture was concerned. It may be true that filariasis had been highly endemic in these country villages in the far past, while during the above period, the chance of infection had probably been greatly reduced in the home villages, and after the War active infection must have taken place.

Fig. 4. Changes in filarial infection by age group in Amami-Oshima (from data of Hayashi) and in Nagasaki Prefecture in general (from data of Oshima).

Fig. 5. Changes in filarial infection by age group in Nagate Village in 1961.
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again under the worst living conditions. The point N for Nagate village of the same prefecture is also in the subarea 3 and is nearest to the point A, showing that the state of endemicity has been rather high and stable.

In Fig. 4 the changes with age group for Amami-Oshima and those for Nagasaki Prefecture in general are illustrated. In Amami where filariasis has long been highly endemic and stable, the line connecting the points standing on the three clinical components goes down roughly along the straight line connecting a vertex, M(+) S(-) : 100% through the point A. While in the case of Nagasaki Prefecture in general the line connecting the points goes down through the subarea 3 to 5, keeping to the left and being far from the line for Amami, and moreover points for 30—39 years or above gather in the left of the subarea 5. This may indicate that filarial infection had been very active in the past and seems to be on the way of becoming lower, although some active infection may be seen in younger ages in recent years. However, as seen in Fig. 5, in the case of Nagate village of the same prefecture the line connecting the points for age groups goes down nearer to the line connecting the M(+) S(-) : 100% point through the point A than the line for Nagasaki Prefecture in general. Strictly speaking, however, the points in Nagate Village in general are nearer to M(+) S(-) : 100% point when compared with those in Nagasaki Prefecture in general, suggesting that active infection may have been taking place in recent years; the point for 30—39 ages is markedly nearer to M(+) S(+): 0% side suggesting that low infection had taken place while they were young; the points for old years are near as usual to the M(-)S(+): 100% point showing heavy infection in the far past.

After due considerations on the relations between the historical change in the intensity of filariasis infection in some past 70 years and the living conditions of the villagers and movement of the youth from and into the home villages during and after the War, the author arrived at a conclusion that: During the war period of about 8 years covering the periods of the China Incidence and World War II, nearly all the youths and maidens, and most males and many females of middle ages, having been probably the highest in microfilarial incidence moved out from their home villages to battlefield or to the factories in the cities, fairly reducing the infection intensity to the younger and susceptible remainders (who are now in 30—39 or a little above ages) in the village. During the postwar period or 16 years, especially for some years following the end of the War, the living conditions of the villagers including the returners were under the worst conditions, causing an active infection of the disease again. In the prewar period or for 50 years before the outbreak of the China Incidence (the then 15 to 50 years old persons are now in 39 to 74 ages), very active infections seem to have been continued in this village nearly as same as in most of the filariasis endemic villages. It is obvious from the high percentage of M(-) S(+) constituent and through the talking of the old villagers.

Summary

To analyze the epidemiological changes in the intensity of filariasis infection, the triangular graph method was used and found to be as useful as and simpler than the methods having been reported by other authors. This is based on the property of equilateral triangle that the sum of three perpendiculars from a given point in the area to respective sides is constant. When regarded the percentage numbers of persons belonging to the three clinical categories in combination of existence or nonexistence of microfilariae and symptoms, M(+) S(-), M(+) S(+), and M(-) S(+),
against the total infected persons in a community, as the lengths of three perpendiculars, then the rates of persons being in such categories in the community may be given as a point.

In view of the development in the clinical signs in an individual filaria patient, it may be said that higher percentage of \( M(+)S(-) \), \( M(+) S(+) \), or \( M(-) S(+) \) in a community may imply that the intensity of filarial infection has been or had been higher in recent, past, or far past years, and that if filariasis infection has continued at the same intensity in a community for a long time, the percentage constituents of the infected persons for the categories would reach a certain equilibrium.

An example for the equilibrium or fairly high and stable endemic state is seen in Amami-Oshima Island (Hayashi, 1962), which the present author chose as a tentative standard (Point A in Fig. 2) and compared with the points for communities in Nagasaki Prefecture having been examined by a member of our Department and by the author himself.

From the situation of the points on the endemicity triangle and in comparison of those with the standard point A, it may be said that in the prefecture in general, the intensity of filariasis infection had been very high in the far past, while in the past or during the War period covering the China Incidence and World War II it had been rather low and again after the end of the War it became higher. However, in the prefecture there are some communities such as Nisisonogi district (Oshima, 1955) and Nagate village (now under examination by the author), where fairly high and rather stable endemic states of filariasis are persisting.

**Literatures**

た諸点との比較を行なった。
浸淫度三角形内の点の位置と標準のA点との比較から、長崎県下の余賀虫浸淫地方を全体としてみると、ずっと昔には本症の感染は非常に激しかったが、昔、即ち第二次世界大戦中には多少不活発となり、大戦後は再び激しくなったと考えられる。しかし、県下にも西彼杵半島（大島、1955）や長手村落（現在調査中）のように、かなり高い浸淫状況を示し、しかも、かなり安定した所もあることがわかる。