Correlation between fission-time and culture-age in the Proliferation of Bacteria.*

By Jun Hirano**

A statistical treatment of the bacterial fission-time has already been made by Kelly & Rahn1 in 1932, and discussed later by Hinshelwood2, but in their considerations no account has been made of the change of proliferating activity of bacterial cells with the progress of culture. Since, as is well known, the bacterial cells gradually change their activity with the age of culture, it seemed worth while to investigate statistically in what manner the bacterial fission-time will be modified with the progress of culture.

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from the agar culture at an appropriate culture age was attached by means of sterile loop and the cell division was observed from above by a microscope with oil immersion. At the bottom of the cylinder a small quantity of the liquid culture medium was placed in order to keep adequate moisture in the chamber. (The contact surfaces of the glass pieces were sealed with vaseline.) During the observation the whole microscope as well as the chamber were kept at temperature of 33°-36°C.

Observation was made with a number of definite bacterial cells found in a suitable field under the microscope. For each individual cell marked, every division-time was recorded, which was defined as the time elapsed from the beginning of the original culture to the time when each fission had just completed. Based on these records, the family-trees are constructed, as was done by Kelly & Rahn. Two examples of such family-trees are shown in Fig. 2, in which the figures represent the “division-time” (in minutes) of successive generations. For example, the family-tree “A” was obtained from the following observation: a cluster of two bacteria was selected at culture-time \( t = 53 \) minutes; one of them divided at \( t = 66 \), while the other at \( t = 91 \); the daughters of the former cell divided at \( t = 133 \) and \( t = 135 \), while the daughters of the latter divided at \( t = 152 \) and \( t = 204 \); and so on. The figures given in small type indicated the “fission-time” which is the interval between two successive divisions.

Results

Based on the observations which were made during the period of seven months, about two thousand family-tree with 961 data for fission-time were obtained. As was anticipated, the fission-time was found to be, on the whole, a function of culture-time \( t \), though the values obtained were scattered rather widely. In Fig. 3, the
fission-time ($T$) is plotted against the culture-time. The number of observed cases are expressed by the area of each spot, the smallest squares representing one case observed. The count of the cases was made with the time units of 10 minutes of culture-time (abscissae) and 5 minutes of fission-time (ordinates). Therefore, those cases which fell just on the borderline of the time sections on either one of the coordinates were counted as $1/2$ each for the neighbouring sections, while those cases which fell just on the cross points of the borderlines were counted as $1/4$ each for the neighbouring 4 sections. On the abscissa, the approximate time-range of the lag- and logarithmic-phases are indicated. It may be seen that the fission-time tends to become smaller in going from lag-phase to logarithmic-phase, where the majority of the cells divided in about 40-50 minutes. The shortest fission-time observed in the
logarithmic-phase was indeed zero minute.

As regards the phenomenon which occurred after the logarithmic-phase, we could not collect a sufficient number of data, owing to the situation that the cases with large $\tau$-values could not easily be traced in our method, especially in later stages of culture. The distribution of the first division-times after the inoculation is shown in Fig. 4.

Fig. 4. Frequency of First Fission-time.

The author is indebted to express here his great gratitude for the kind guidances and encouragements of Prof. Dr. H. TAMIYA and Dr. T. YANAGITA, Plant Physiological and Microbiological Laboratory, Faculty of Science, Tokyo University, and Prof. Dr. A. TAKAMIYA, Biochemical Laboratory, Tokyo Institute of Technology; thanks are also due to Mr. H. TOYODA and Miss Y. FUKUDA, for their assistances in the investigation.

References

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