



1957

## Manner of Growth of Listeria Using the Flagella as Markers

Robert Lee Muldoon  
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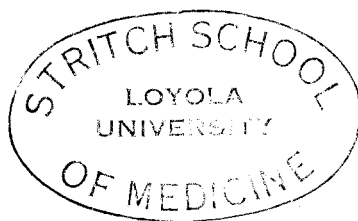


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MANNER OF GROWTH OF LISTERIA  
USING THE FLAGELLA  
AS MARKERS

by

Robert Lee Muldoon



A Thesis Submitted to the Faculty of the Graduate School  
of Loyola University in Partial Fulfillment of  
the Requirements for the Degree of  
Master of Science

1957

## LIFE

Robert Lee Muldoon was born in Chicago, Illinois, February 19, 1932.

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## CHAPTER I

### INTRODUCTION

Bisset, in his book, *The Cytology and Life History of Bacteria*<sup>1</sup> states: "In multicellular bacteria the main growth of the cell wall is at the junction of the cell wall and cross walls." This is interpreted as referring to the growth of the whole organism. Unfortunately, there is no reference to experimental data to support this theory.

This was the only reference seen that pertained to the mode of growth of an individual bacterium.

The purpose of this thesis is to present data to show the mode of growth of the bacterial cell. As a corollary, data is presented concerning the rate of flagellar growth.

## CHAPTER II

### MATERIALS AND METHODS

The organism used in these experiments is a strain of Listeria monocytogenes, which is characterized by straight flagella. This strain was used because 1) the type of flagellation is conducive to accurate measurement and 2) this organism has good peritrichous flagellation at 20° C., and is atrichous at 38° C.

The mode of isolation of the filamentous organisms is as follows: a nutrient agar plate is streaked across the center. Upon incubation heavy growth is seen along the line of inoculation which is surrounded by a light film of growth. Cultures obtained by fishing from the light periphery show ninety to one hundred percent as filamentous. The genetic stability of these filaments (larger than 5.6 microns) appear, but this may be due to the presence of visible rods which, with a more active metabolism, soon outgrow the filamentous form.

The media used throughout the experiments consisted of .5% caseitone; .5% yeast extract; .1%  $K_2HPO_4$  in distilled water. Sterilization of media was carried out at 15 pounds for 15 minutes. For filament isolation and plate counts, 1.5% agar was added to the above media.

The procedure for staining was carried out according to the method of Helseon.<sup>2</sup>

Measurements were made with a Bausch & Lomb micrometer. Data on the length of flagella was obtained by measuring from the tip of the flagellum to the point of origin on the cell. Data labelled in the tables "Distance between Flagella" was the distance between any two flagella regardless of the side of the organism from which they appeared.

The method employed had the same general outline in each experiment where details, when necessary for clarification of the experiment, are listed before individual experiments. The basic procedure was to inoculate 1 loopful of stock culture of L. monocytogenes kept at 4° C. into 200 ml. of caseitone broth. This broth was placed in an incubator of desired temperature until a slight turbidity was evident. This culture was then transferred to a second incubator of different temperature. It is from this latter incubator that aliquots were taken at designated times for staining.

After a set of preliminary tests aliquots were taken for plate counts at the same time the stain aliquot was removed. The aliquot for the plate count was diluted to the desired concentration using caseitone broth as the diluent. A portion of the diluted culture was then inoculated into 20 ml. of caseitone agar. After mixing, the culture was poured into a petri dish. After 48 and 72 hours, counts were made with the aid of a Quebec Colony Counter.

CHAPTER III

RESULTS



Experiment No. 1

A portion of the stock culture of L. monocytogenes was inoculated into 200 ml. of caseitone broth and placed in a 38° C. incubator. When a heavy density was observed, new broth was added until the original culture was barely turbid. The diluted culture was then placed in a 16° C. water bath for five minutes, after which it was placed in a 20° C. incubator. Samples were taken hourly for an eight hour period.

In these aliquots, both filaments (greater than 5.6 microns) and short rods (1.4 - 2.7 microns) were present. When the measurements were made, these two types were separated. The intermediate form, i.e. 2.7 to 5.6 microns was not measured.

Experiment Number: 1 Filaments

Incubation Time at 1-1/2 Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
Length	Number	Length	Distance Between
No measurements were taken. Organisms in this period were non-flagellated.			

Experiment Number: 1

Filaments

6

Incubation Time at 5th Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length Distance Between
5.9	5	1.3 - .7 - 1.5 - 1.1	
7.1	6	.7 - 1.1 - .9 - 1.4 1.1	
7.2	5	1.4 - .6 - 1.5 - 0	
6.7	7	.6 - .7 - .4 - 2.8 .3 - 0	
8.1	5	1.3 - 1.4 - 1.1 - 3.9	
6.7	8	.6 - 1.0 - 1.2 - .6 0 - 2.1	
8.4	7	1.3 - 1.2 - .6 - 2.9 1.3 - 0	
11.8	9	.4 - 3.4 - .5 - 1.6 .5 - 1.1 - 8	
5.9	7	1.5 - 1.4 - 1.2 - 1.6 0 - 0	
8.9	6	1.7 - 2.0 - 0 - 0 - 0	
<b>Average: 7.65</b>	6.5	1.29	

Experiment Number: 1

Filaments

7

Incubation Time at 6th Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
14.8	17	.4 - 1.0 - .8 - 0 - 0 1.0 - .9 - 1.5 - 2.0 .4 - 2.8 - 1.0 - 2.1 .5 - .9 - .5	
7.6	10	.4 - .3 - 2.1 - .4 - .9 1.8 - 1.6 - 0	
7.7	9	.9 - .5 - 3.2 - 1.6 1.1 - .4 - 0 - 0	
11.9	9	.7 - 1.8 - .5 - 4.1 1.0 - .9 - 1.7 - 0	
7.8	6	.8 - 2.6 - 1.6 - .7 - 0	
9.0	11	4.0 - 2.4 - .4 - .5 .6 - .4 - .7 - 0	
6.2	9	1.0 - 1.4 - .2 - .7 2.7 - 0	
10.9	16	.7 - .4 - .6 - 1.1 1.1 - 1.2 - .4 - .7 1.2 - 0	
7.7	11	1.1 - 1.3 - .8 - .1 1.3 - .9 - .1 - 1.4 .5	
7.6	10	.4 - .8 - .9 - 1.3 - .5 .5 - 0	
<b>Average:</b> 9.1	10.8	1.12	

Experiment Number: 1

Filaments

8

Incubation Time at 7th Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
<u>Length</u>	<u>Number</u>	<u>Length</u>	<u>Distance Between</u>
9.1	8		1.0 - 4.1 - .7 - 1.1 1.4 - 0 - 0
5.8	7		2.5 - 1.1 + .4 - 0 - 0 1.3
7.6	17		.7 - .5 - .6 - .5 - .7 .7 - .9 - .4 - .7 - .4 0 - .8
8.5	18		.3 - .5 - .5 - .7 - .6 .3 - .5 - 1.3 - .5 1.1 - 1.8 - .4 - .5 - 0
8.1	10		.7 - .9 - .6 - .9 - .8 .9 - .7 - 1.0 - .4
7.9	14		.7 - .7 - .8 - .6 - .8 .4 - 1.2 - .8 - .6 - 0 1.0
6.6	10		.4 - .4 - .7 - 2.3 1.6 - .8 - .3 - 0 - 0
7.6	16		.7 - 1.3 - .6 - 1.0 1.1 - .9 - 1.0 - .7 .3 - 0
10.1	12		1.5 - .9 - 1.4 - .3 .5 - .8 - .8 - 1.3 - .8 0 - 1.7
7.0	7		.7 - .9 - .7 - 1.8 - 0 2.5
<b>Average:</b> 7.78	11.9		.90

Experiment Number: 1

Filaments

9

Incubation Time at 8th Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
6.3	13		0 - .6 - .4 - .6 - 1.1 1.7 - .4 - .5 - .4
8.6	15		0 - .7 - .6 - 1.2 - .7 .7 - 1.0 - .6 - .4 - .7 1.0 - 1.0
7.4	13		1.0 - .5 - 1.4 - 1.0 4.0 - 1.5 - 1.5 - 0
8.0	14		.5 - 0 - 1.2 - .5 - .4 1.3 - .7 - .7 - .4 1.2 - .5 - .4
7.0	15		0 - 1.6 - 1.3 - .4 - .5 .3 - .5 - .4 - 1.0 - .6 .4
10.0	20		.6 - .4 - 1.0 - .9 - .5 .5 - .6 - .5 - .7 - .7 2.0 - .4 - .9 - .2
6.8	17		.6 - .7 - .3 - 0 - 1.0 .7 - .9 - .4 - .5 - .3 .3 - .3 - .4
6.6	16		.3 - 1.1 - .3 - 0 - .4 1.1 - .3 - .4 - .5 - 1.3 - .6 - .3 - 0
7.7	14		.8 - 0 - .3 - 0 - .6 .6 - 2.1 - .7 - .7 1.0 - .6 - .6 - .3
7.1	14		1.3 - .6 - .8 - .5 - .5 .6 - .6 - 0 - .5 - .5 0
Average: 7.6	15.1		.71

Experiment Number: 1

Filaments

10

Incubation Time at 9th Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
17.7	25		.9 - 1.0 - .6 - 1.8 .6 - 1.5 - 1.0 - .4 .6 - 1.5 - 1.0 - .4 1.2 - .8 - .9 - 1.1 0 - 0 - 0
7.4	19		.2 - .2 - .8 - 0 - 1.0 .7 - .2 - .2 - 0 - 1.3 .4 - 1.6 - .5 - .3
10.5	23		0 - .2 - .2 - .8 - .3 .3 - .3 - .4 - 1.3 1.5 - .3 - .3 - 1.5 - 0 .3 - .6 - .4
8.9	14		0 - .9 - .8 - .6 - .8 .4 - 1.9 - .6 - .2 - .5 .9 - .9 - 0
6.3	12		.2 - .5 - .4 - 1.0 - .5 .6 - .7 - .5 - 1.0 - .6 .3
9.4	21		.4 - .7 - .3 - .9 - .2 1.3 - .9 - .8 - .4 - .4 1.4 - 0 - .8 - .3 - .5 0
7.3	15		0 - .5 - .3 - .5 - .3 .6 - .8 - .9 - 1.8 - .4 .2 - .4 - .6
8.2	20		0 - .6 - 0 - .9 - .4 .5 - 1.3 - .4 - 1.4 .5 - .4 - .3 - .6 - .3 .6

Experiment Number: 1                      Filaments  
 Incubation Time at 9th Hour at 20° C. Continued  
 Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
7.7	14		.6 - .2 - .5 - 0 - .7 .1 - 1.7 - .7 - .3 - 1.8 .2 - .4 - .5
6.7	10		.6 - 1.5 - 1.4 - .3 - 0 .6 - 1.1 - 0
Average: 9.0	17.3		.69



## TABLE 1 - A

## Filaments

Appearance of Flagella at 20° C.; Original Incubation - 38° C.

## Summary of Values

Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count M/ML	% Flagellated
	Microns		Microns	Microns		
1						
2						
3						
4						
5	7.65*	6.5		1.29		
6	9.10	10.8		1.12		
7	7.78	11.9		.90		
8	7.60	15.1		.71		
9	9.00	17.4		.69		

\*Based on the measurement of 10 individual bacteria.

Experiment Number: 1 Short Rods

Incubation Time at 1-1/4 Hour at 20° C.

Plate Count:

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
No measurements were taken. Organisms in this period were non-flagellated.			

Experiment Number: 1

Short Rods

14

Incubation Time at 5th Hour at 20° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
3.6	4		1.1 - .7 - 1.2
3.2	4		1.7 - .7 - .5
2.6	3		1.0 - 1.1
3.4	4		1.3 - 1.8 - 0
3.6	4		.5 - 1.9 - 1.1
3.1	5		2.5 - .6 - 0*
3.3	7		.6 - .9 - .5 - .8 - .4
3.0	3		1.2 - .7
3.4	3		2.3 - 1.1
2.9	3		1.6 - 1.3
3.1	4		2.1 - 1.0 - 0
2.9	3		1.0 - 1.0
3.0	4		.7 - .6 - 1.2
2.9	4		1.6 - .3 - 1.0
2.7	5		.8 - .8 - 1.0 - 0
2.6	5		1.1 - .5 - .6
3.0	6		1.0 - .3 - 1.3 - .2 - 0
3.5	5		.7 - .8 - 1.3 - 0

Experiment Number: 1 Short Rods  
 Incubation Time at 5th Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.5	5		.9 - .7 - .7 - 0
2.5	3		1.1
Average: 3.03	4.2		1.02
<p>*It does not necessarily follow that the number of measurements "Distance Between Flagella" always be one less than the actual number of flagella per individual. This is due to the fact that two or more flagella arise at the pole of a cell and do not affect measurements pertaining to the increase in length. This statement is true for all of the following experiments.</p>			

Experiment Number: 1

Short Rods

16

Incubation Time at 6th Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
3.6	3		.8 - 1.8
3.3	4		.6 - 1.6 - .5
2.9	6		.7 - 1.2 - .4
3.4	5		.6 - .7 - .4
2.5	5		.4 - 1.5 - .6 - 0
3.7	5		.4 - .5 - .9 - 1.5
2.9	6		.6 - .6 - .4 - .5
3.1	6		1.2 - .7 - 1.0 - 0
3.6	8		.6 - .6 - .5 - .8 - 1.1 0
3.2	4		1.1 - .8 - 0
3.3	4		1.0 - 1.0 - 0
2.5	4		1.0 - 0
2.5	5		1.0 - 0
3.5	5		.9 - .4 - .9
2.6	3		1.0 - 1.5
2.8	4		1.1 - 1.3 - .1
3.3	4		.9 - .1 - .6
2.6	3		.9 - .6

Experiment Number: 1

Short Rods

17

Incubation Time at 6th Hour at 20° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.3	5		.7 - .9 - 1.3 - .3
2.8	7		.4 - .8 - .7 - .2 - 0
Average: 3.05	4.8		.82

Experiment Number: 1

Short Rods

18

Incubation Time at 7th Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.7	2		.7
2.8	5		2.1 - .3 - 0 - .4
3.3	4		.1 - 2.0 - .3
2.7	6		.2 - .2 - 1.7 - .4 - .2
2.7	4		1.2 - .5 - 1.0
2.6	7		.4 - .8 - .3 - 1.1 - 0
2.8	6		.8 - .2 - 1.4 - 0 - .4
3.6	5		1.3 - .7 - .5 - 1.0
3.2	5		.7 - 1.7 - .4 - .4
3.3	5		.5 - .7 - 1.1 - .5
2.5	4		.7 - 1.2 - 0
2.6	6		1.1 - .4 - .3 - 0
2.6	4		.7 - 1.4 - 0
2.4	6		1.2 - .3 - 0
3.5	8		1.9 - .4 - .5 - .3 - 0 .5
2.6	5		.3 - 1.1 - .5 - .4
2.6	6		.3 - .4 - 1.0 - .5 - 0
2.9	4		.5 - 1.2 - 1.2

Experiment Number: 1

Short Rods

19

Incubation Time at 7th Hour at 20° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.1	7		.4 - .5 - .6 - .9 - .4 0
3.3	5		1.0 - 1.1 - .6 - 0
<b>Average: 2.89</b>	<b>5.2</b>		<b>.75</b>



Experiment Number: 1

Short Rods

20

Incubation Time at 8th Hour at 20° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
3.5	5		.5 - .6 - .7 - 1.5
2.9	5		.5 - 1.6 - .4 - .3
3.0	6		.3 - .6 - .4 - .3 - 1.1
2.9	5		.5 - 0 - 1.4 - .7
3.0	7		.3 - .6 - 1.6 - .5 - 0
2.6	4		.3 - .4 - .5
3.5	9		1.1 - 1.6 - .4 - 0 - .3 0
3.6	8		.4 - .5 - .8 - .5 - .4 0 - .9
2.9	7		.6 - 1.6 - .4 - .3 - 0 0
3.2	7		.0 - .7 - .5 - 1.1 - .5 .3
2.8	8		.4 - .6 - .9 - 0 - .3 .6
2.8	6		0 - 1.3 - 0 - .7 - .7
3.2	8		.8 - .3 - 1.3 - 0 - 0 .6
2.9	6		.3 - .9 - .6 - .6 - .5
3.3	9		1.7 - .8 - .3 - .4 - 0 0

Experiment Number: 1

Short Rods

Incubation Time at 8th Hour at 20° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.7	5		.7 - .7 - .4 - .4
2.9	8		0 - .6 - .6 - .6 - .8 .2
2.7	8		1.0 - .3 - 0 - 1.0 - .3 0
2.5	4		.7 - .4 - 1.4
2.8	8		0 - .6 - .4 - .6 - .9 .3
<b>Average: 3.0</b>	<b>6.7</b>		<b>.67</b>

Experiment Number: 1

Short Rods

22

Incubation Time at 9th Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
3.5	5		.5 - 1.3 - .4 - 1.3
2.9	5		1.0 - .8 - .3 - .4
2.8	5		.3 - 2.0 - .3 - .2
2.9	4		.6 - .4 - 1.2
3.3	5		1.2 - 1.0 - .8 - 0
2.8	10		.5 - .6 - .2 - .3 - 1.0 0
3.4	8		.6 - 1.0 - .7 - 0 - .4 .7
3.3	10		.8 - .3 - .5 - .3 - .6 .2 - .6 - 0
3.0	8		.4 - .6 - .4 - 0 - .4 - .9
2.8	7		.7 - .6 - .3 - .9 - 0 - .3
3.0	8		0 - 1.2 - .6 - .7 - .4 0
3.1	6		1.2 - 1.6 - .3 - 0 - 0
3.1	11		.4 - .3 - .2 - .9 - .8 0
3.4	8		1.3 - .3 - 1.0 - 0 - .3 0

Experiment Number: 1

Short Rods

23

Incubation Time at 9th Hour at 20° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.0	9		.5 - .2 - .5 - .6 - 0
3.2	9		.4 - .8 - .9 - .8 - .3 .2 - 0
2.6	7		.7 - .3 - .2 - .6 - .8 0
3.0	9		.3 - .4 - .3 - .2 - .8 .8 - 0
3.3	7		.7 - .4 - .4 - 0 - 1.1 0
3.5	7		.6 - .5 - .6 - 1.2 - .4 0
Average: 3.1	7.4		.62

TABLE 1 - B

## Short Rods

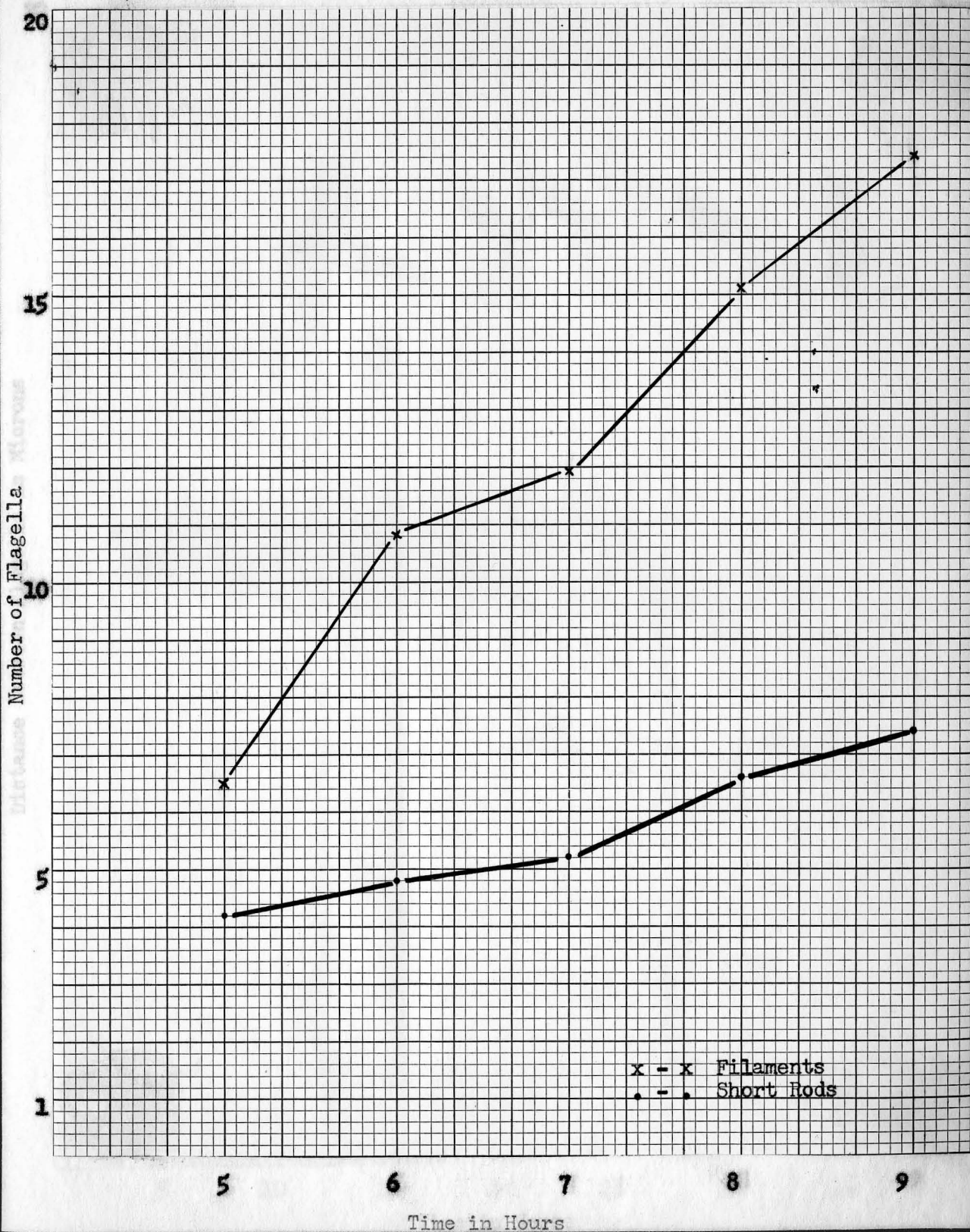
Appearance of Flagella at 20° C.; Original Incubation - 38° C.

## Summary of Values

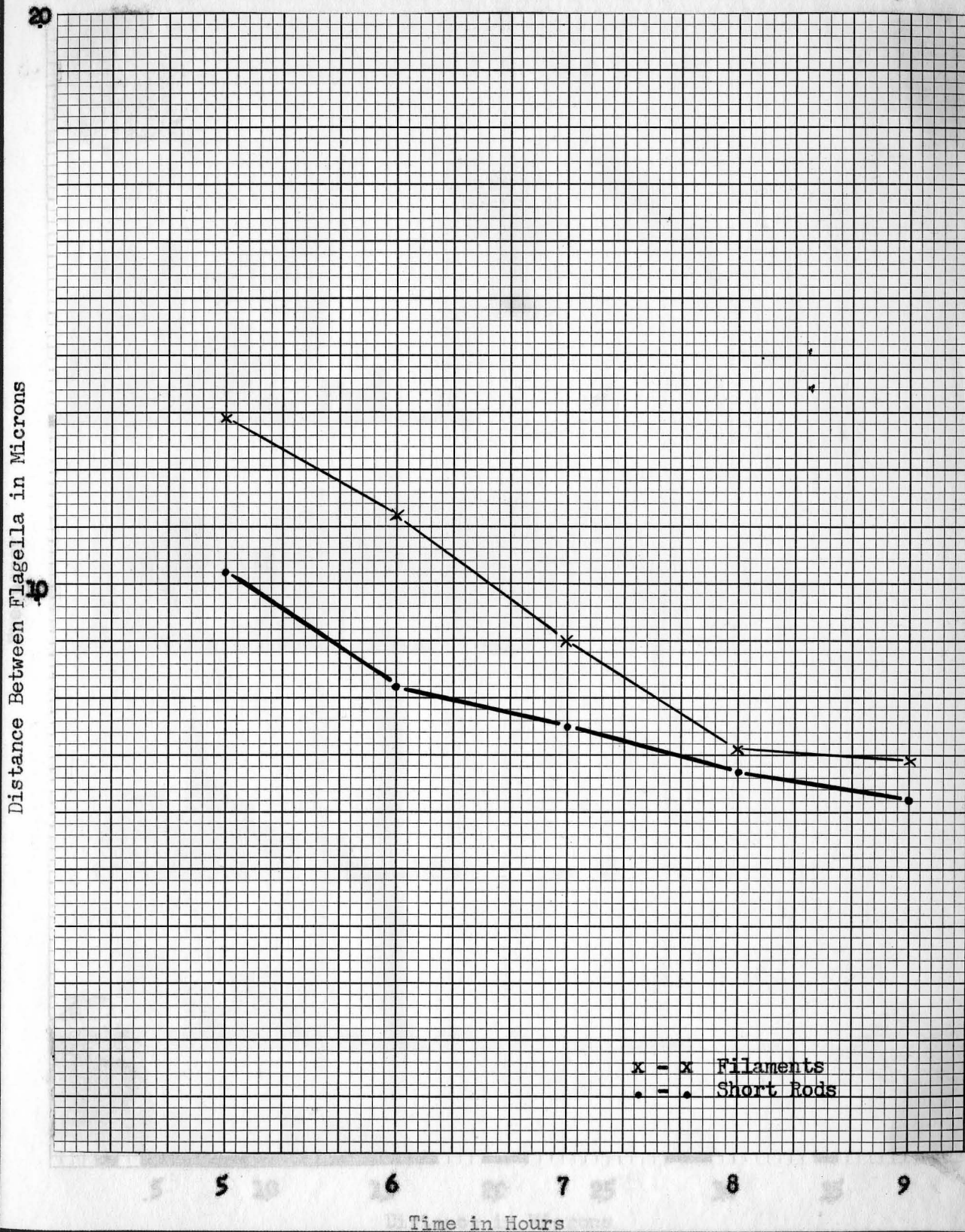
Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count	% Flagellated
	Microns		Microns	Microns	M/ML	
1						
2						
3						
4						
5	3.03*	4.2		1.02		
6	3.05	4.8		.82		
7	2.89	5.2		.75		
8	3.00	6.7		.67		
9	3.10	7.4		.62		

\*Based on the measurement of 20 individual bacteria.

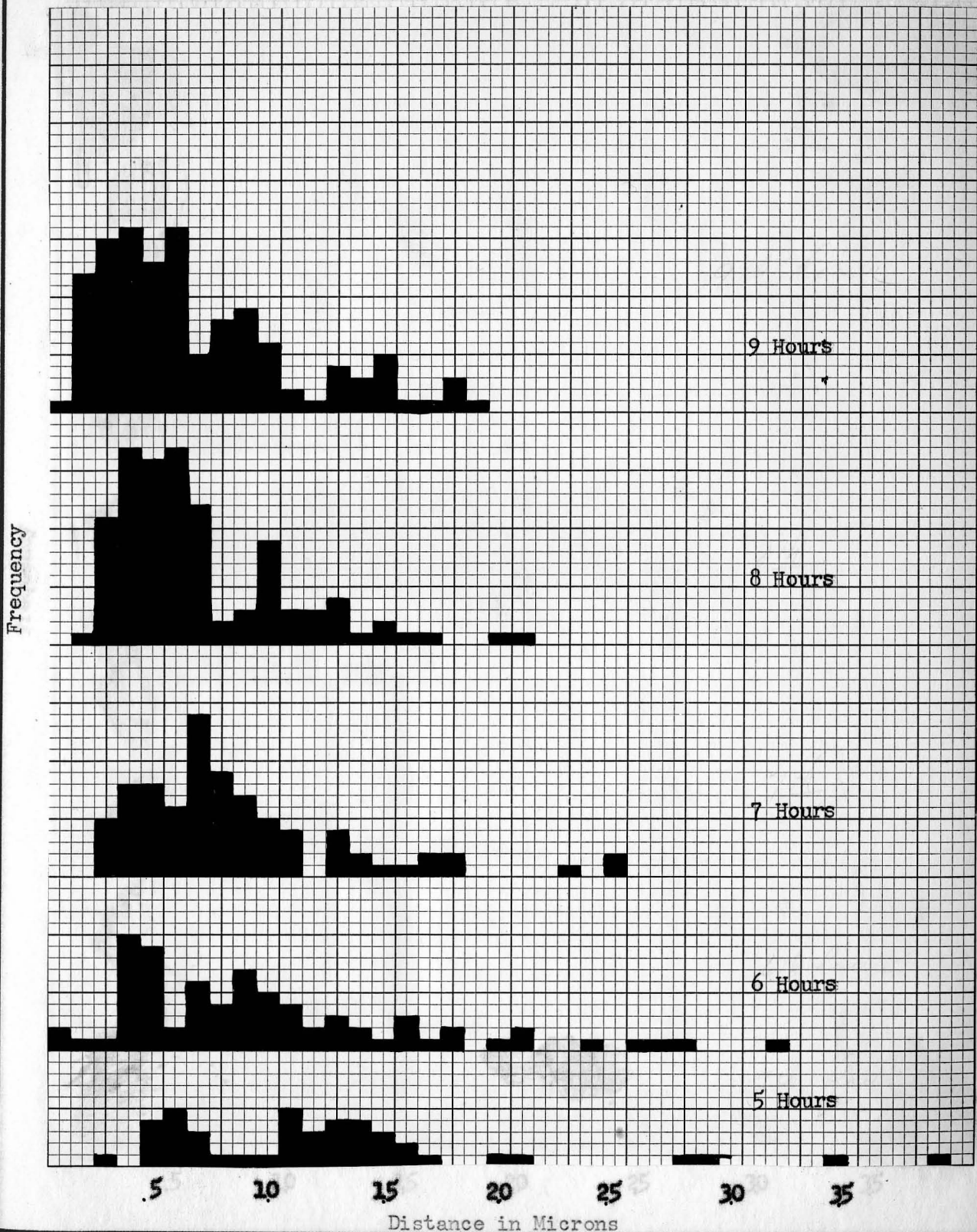
Graph 1-A Primary Temperature 38C; Secondary Temperature 20C  
Average Number of Flagella per Individual



Graph 1-B Primary Temperature 30C; Secondary Temperature 20C  
Average Distance Between Flagella

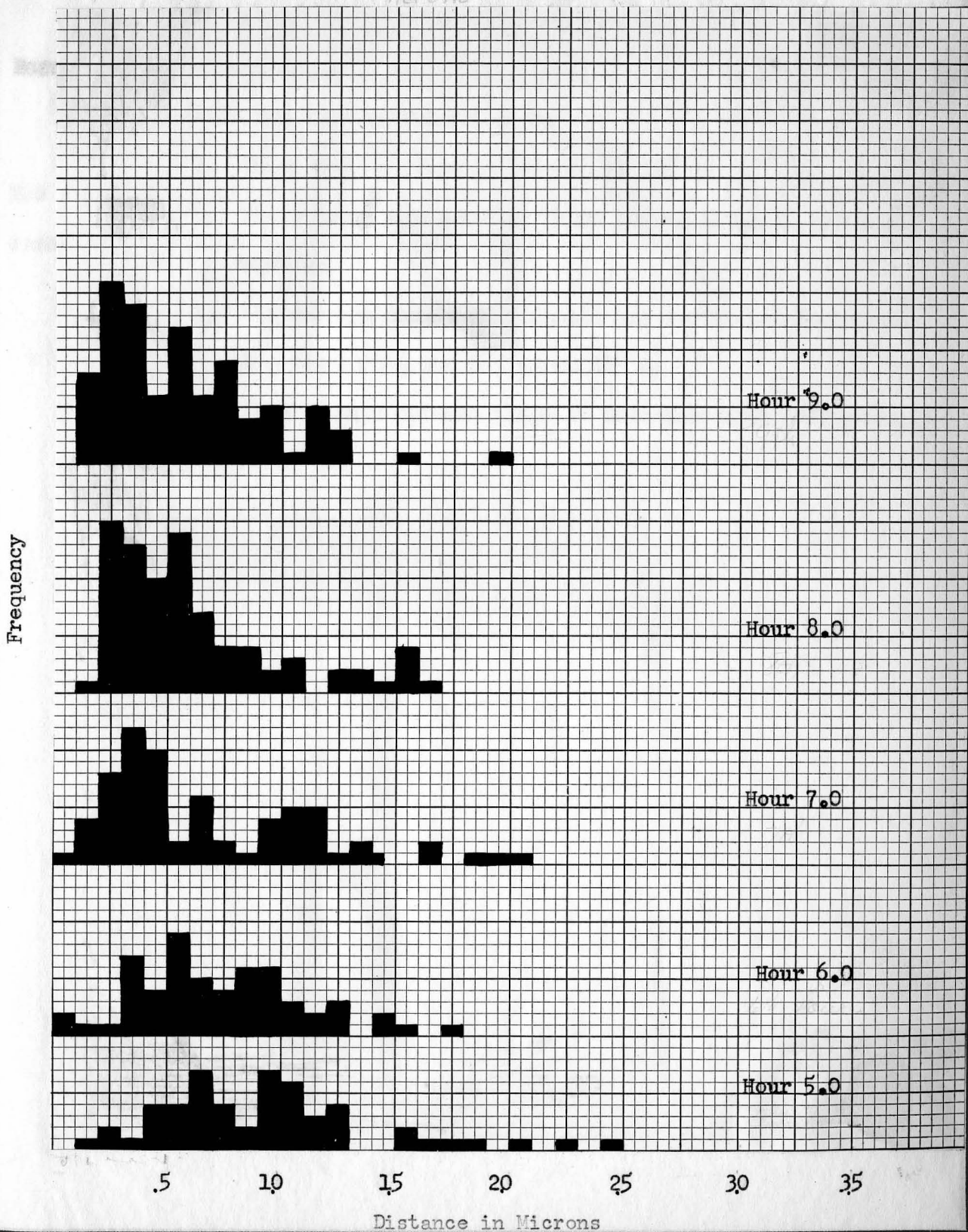


Graph 1-C Filaments Secondary Temperature 20C  
Frequency Distribution of Distance Between Flagella





Graph 1-D Short Rods Secondary Temperature 20C  
Frequency Distribution of Distance Between Flagella



Results of Experiment No. 1:

The data from this experiment shows

1. There are no flagella present at 38° C.
2. There is an apparent lag phase before flagella become visible.
3. The average number of flagella per individual bacterium increases with incubation at 20° C.
4. The distance between flagella decreases with incubation at 20° C.

Experiment No. 2

A loopful of stock culture of L. monocytogenes was inoculated into 200 ml. of casitone broth. The procedure was the same as in Experiment No. 1 except the secondary incubation temperature was 30° C.

Experiment Number: 2 Filaments

Incubation Time at 1-2 Hour at 30° C.

Plate Count:

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
No measurements were taken. Organisms in this period were non-flagellated.			

Experiment Number: 2

Filaments

32

Incubation Time at 3rd Hour at 30° C.

Plate Count:

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
8.9	1		
9.0			
6.8			
6.2			
6.0			
9.0			
6.5			
11.7	3		4.0 - 3.1
6.0			
10.1			
<b>Average: 8.0</b>	.4		3.55

Experiment Number: 2

Filaments

33

Incubation Time at 4th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
6.6	5		.9 - 1.3 - 1.4 - 2.9
7.9	7		.6 - 0 - .6 - 1.2 - 1.1 .7 - 2.1 - 1.6
9.8	9		.4 - .7 - .7 - 1.2 - 2.2 2.3 - 1.2 - 1.0
8.4	12		.4 - .5 - 1.2 - 1.2 - 0 .4 - 1.0 - .8 - 1.0 - .7 1.1
9.3	11		.3 - .2 - 1.3 - 1.2 - .8 .2 - .8 - .4 - 0 - 1.1 1.7 - .4
14.6	23		.4 - 1.4 - .5 - .5 - 1.6 .4 - .3 - .7 - .4 - .7 1.3 - 1.2 - .3 - .7 - .2 1.2 - 0 - .7 - 0 - .7 .4 - .6
7.1	8		.6 - 1.4 - 1.8 - .9 - 1.3 - .7 - .3
8.4	9		.2 - 1.6 - 2.0 - .6 2.0 - .4 - .5 - 1.1
6.3	4		1.5 - 1.9 - .3
6.8	6		0 - 3.4 - 1.2 - 1.4 - .3
Average: 8.5	9.4		1.00

Experiment Number: 2

Filaments

34

Incubation Time at 5th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
6.1	8		.3 - 2.1 - 1.0 - 1.0 .4 - 0 - .5
11.7	13		1.7 - .5 - .3 - .8 - 0 .7 - 2.6 - .7 - 1.4 1.1 - 1.4 - 0 - .5
6.5	14		.5 - .8 - .6 - .9 - 0 1.2 - .2 - 1.0 - .5 - 0 1.0 - .2 - .1
14.7	18		.3 - 1.2 - .7 - 1.3 - .8 .8 - .5 - 1.2 - 1.1 - 1.3 - 1.9 - .4 - 1.6 .4 - .4 - .3 - 0
7.0	9		.6 - .7 - 0 - .3 - .1 1.0 - 1.5 - 1.7
6.0	8		1.3 - .6 - 0 - .8 - .5 1.9 - .2
9.9	12		0 - 1.7 - .8 - .6 - .5 1.0 - 2.0 - .8 - .8 1.5 - .4 - .3
10.9	13		0 - .8 - 1.1 - .4 - .2 .4 - 2.0 - 1.0 - .8 .5 - 1.4 - 1.5
7.0	10		.6 - .6 - 1.2 - .8 - .6 .9 - .5 - .2
6.2	11		.1 - .5 - 1.3 - .4 1.0 - 1.2 - .4 - .1 .9 - 0
Average: 8.6	11.5		.88

Experiment Number: 2

Filaments

35

Incubation Time at 6th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
6.6	10		.3 - .4 - .5 - .6 - 1.0 1.1 - 1.9 - .4 - .3
7.4	9		.7 - 1.8 - .3 - 1.2 - 0 1.7 - .6 - 1.8
6.2	9		.1 - .6 - 1.5 - .5 - .2 .9 - 0 - .9 - .8
11.9	16		.2 - .5 - 1.5 - .7 - .9 .8 - 1.0 - .6 - 1.2 - .2 - 1.1 - 1.6 - .7 - .8 0
6.1	10		.9 - .6 - .4 - 1.1 - .2 0 - 2.9 - 0 - 0
6.1	7		.9 - .7 - .7 - .2 - 1.1 .7
6.7	9		.7 - .9 - .3 - .7 - .2 1.4 - .7 - 1.6
7.2	9		.2 - .6 - .6 - .4 - 2.4 0 - 1.3 - .4
6.3	9		.2 - .9 - .4 - 1.0 - .2 1.7 - 1.0 - .5 - .4
8.9	11		1.0 - 1.8 - 0 - 0 - .4 1.0 - 1.3 - .2 - .7 - 0
Average: 7.3	9.9		.83



Experiment Number: 2

Filaments

36

Incubation Time at 7th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
9.1	14	.4 - 1.5 - .5 - 0 - .2 .6 - .7 - .6 - .5 - 2.0 .4 - .5	
6.0	9	.7 - .3 - 1.4 - 1.9 - 0 .1 - .5 - .7 - 0	
6.3	11	.2 - 0 - .9 - .3 - .7 .6 - .6 - .4 - 0 - .3	
5.9	11	.7 - .5 - 0 - 1.1 - .8 .1 - 1.9 - .1 - .3 - 0	
11.2	17	1.3 - .2 - 0 - 1.7 - .5 0 - .4 - 1.0 - .9 - .7 .3 - .7 - .7 - .7 - 2.0 0	
7.4	14	.3 - .3 - .3 - 1.0 - 1.0 .2 - .2 - 1.6 - .6 - .7 .4 - .6 - .3	
6.2	10	0 - 1.2 - .3 - .9 - .7 .8 - .7 - .6 - .1	
Average: 7.4	12.3	.73	

Experiment Number: 2

Filaments

37

Incubation Time at 8<sup>th</sup> Hour at

30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
5.9	10	1.2 - 0 - .6 - 1.1 - .2 1.5 - .4 - .3 - .3	
9.3	15	1.2 - .4 - .9 - 1.0 1.2 - .5 - .3 - .4 - .4 .5 - .7 - .3 - 0 - .2	
6.7	11	.5 - .6 - .3 - .9 - 1.0 1.1 - 0 - .5 - 1.2 - 0	
6.4	11	.8 - .8 - 0 - .7 - .6 .5 - 1.3 - 1.5 - 0 - 0	
6.7	10	1.2 - .5 - .5 - .8 1.6 - .6 - 1.1 - 0	
7.0	8	1.3 - 0 - 0 - .3 - .3 .7 - 1.1	
6.8	12	.8 - .5 - .5 - 1.1 - .5 0 - 1.2 - .2 - 1.4 - .3 0	
10.3	15	.3 - 1.1 - .4 - 2.1 - 0 .7 - 1.4 - .2 - .2 - .3 .5 - .8 - .9 - .6	
11.4	14	.8 - 1.3 - 0 - .4 - .9 .8 - 1.7 - 1.9 - .1 .5 - .5 - .8 - .6	
6.5	10	.5 - .9 - .4 - 0 - .9 1.0 - .9 - 1.6 - 0	
Average: 7.7	11.6	.76	

TABLE 2 - A

## Filaments

Appearance of Flagella at 30° C.; Original incubation - 38° C.

## Summary of Values

Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count M/ML	% Flagellated
	Microns		Microns	Microns		
1						
2						
3	8.0*	.4		3.55		
4	8.5	9.4		1.00		
5	8.6	11.6		.88		
6	7.3	9.9		.83		
7	7.4	12.3		.73		
8	7.7	11.6		.76		

\*Based on measurement of 10 individual bacteria.

Experiment Number: 2

Short Rods

Incubation Time at 1-2 Hour at

30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
Length	Number	Length	Distance Between
No measurements were taken. Organisms in this period were non-flagellated.			

Experiment Number: 2

Short Rods

40

Incubation Time at 3rd Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.1	1		
2.6	1		
2.9	1		
2.6	1		
2.8			
2.5			
3.3	1		
2.6			
2.9			
2.7			
3.1			
3.1			
2.5			
3.0			
2.9	1		
2.7			
2.5			
2.5			
3.0			

Experiment Number: 2

Short Rods

41

Incubation Time at 3rd Hour at 30° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.5			
Average: 2.8	0.3		

Experiment Number: 2

## Short Rods

42

Incubation Time at 4<sup>th</sup> Hour at 30° C.

Plate Count:

Soma	Flagella		
	Length	Number	Distance Between
2.8	4		.7 - 1.4 - .4
2.6	4		.5 - 1.1 - .9
2.5	4		.5 - .8 - .2
2.7	3		.7 - .9
2.5	4		1.0 - .8 - .6
2.9	3		.7 - .9
3.1	3		1.2 - .7
2.9	4		.4 - .8 - 1.1
2.9	4		.4 - .6 - 1.6
2.5	3		.2 - .9
3.3	3		.5 - 1.9
2.9	3		1.0 - 1.3
2.5	3		.4 - 1.0
3.0	3		1.5 - .3
2.9	5		.4 - .8 - .7 - .1
2.7	3		1.0 - .7
2.8	4		1.1 - .9 - .1
3.0	4		.3 - 1.5 - .9
2.7	4		1.3 - 0 - .8

Experiment Number: 2

Short Rods

43

Incubation Time at 4th Hour at 30° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.7	4		1.0 - .5 - .7
Average: 2.8	4.6		.82



Experiment Number: 2

Short Rods

44

Incubation Time at 5th Hour at 30° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
3.1	8		1.0 - .1 - 0 - .1 - .7 .5 - .1
2.9	5		0 - .9 - .3 - .5
2.6	4		.3 - .4 - 1.2
2.6	5		.3 - .6 - 1.4 - .1
3.3	5		.4 - .6 - 1.0 - .6
2.5	5		.9 - 1.2 - .4 - 0
2.9	5		.2 - 0 - 1.0 - 1.1
2.7	4		.7 - 1.3 - .2
3.1	6		.2 - 1.6 - 0 - .2 - 1.1
2.9	4		.7 - .7 - 1.3
2.6	5		.2 - .4 - 1.7 - .1
3.1	7		.0 - .3 - .6 - 1.0 - .6 .2
3.0	6		.4 - 1.3 - .3 - .8 - .1
2.6	4		.4 - .8 - 1.1
2.9	5		.2 - 0 - 1.1 - .7
2.6	4		.6 - .8 - .8
2.6	4		.1 - 1.1 - 1.2
2.9	6		.4 - 0 - .7 - 1.8 - 0

Experiment Number: 2

Short Rods

Incubation Time at 5th Hour at

30° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.3	5		.7 - 0 - .7 - 1.3
3.2	5		.2 - .7 - .1 - 1.9 1
Average: 2.9	5.1		.76

Experiment Number: 2

Short Rods

Incubation Time at 6th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.7	5		.8 - 1.2 - .6 - .1
3.4	7		.4 - .6 - 1.1 - .4 - .6 .3
2.8	5		.8 - 0 - 1.3 - .6
2.9	6		.0 - .7 - .9 - .6 - .5
3.3	6		.8 - .5 - .6 - .3 - 0
2.7	5		.2 - .3 - 0 - 1.2
3.4	5		1.1 - 0 - 1.3 - .2
3.2	7		.7 - 1.0 - .5 - .4 - .3 .2
3.0	6		.6 - .7 - .9 - .4 - .2
2.9	5		1.0 - .9 - .8 - 0
3.1	6		.5 - .7 - .3 - 0 - .1
3.0	5		.0 - 1.9 - .6 - .2
2.5	5		.7 - .3 - .3 - .4
3.5	5		.4 - 1.4 - .5 - .5 - .4
2.8	4		0 - 1.2 - .4
3.4	5		.2 - 1.1 - 0 - 1.6
3.3	7		.4 - .6 - .6 - 1.4 - 0 .3



Experiment Number: 2

Short Rods

48

Incubation Time at 7th Hour at 30° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
3.0	4		1.9 - .5 - 0
3.4	6		.8 - .9 - 1.0 - .1 - .4
3.2	6		.9 - .7 - .2 - 0
3.2	5		.6 - .7 - 1.0 - .5
2.9	4		.1 - .5 - .8
2.9	5		.4 - 0 - 1.0 - .9
2.6	4		.4 - 2.0 - .3
2.8	4		.4 - .4 - .7
2.8	5		.3 - .3 - 0 - 1.4
3.0	5		1.0 - 1.2 - 0 - .1
2.5	4		.2 - .6 - 1.1
2.9	5		2.1 - 0 - .3 - 0
2.5	5		.4 - .5 - .9 - .2
3.3	6		1.1 - 1.1 - .5 - .3 - .2
2.7	4		.8 - .4 - .5
2.8	6		.4 - .3 - .7 - .6 - 0
2.8	6		.3 - .8 - .3 - 1.4
2.5	6		.5 - .1 - 1.1 - .7

Experiment Number: 2      Short Rods  
 Incubation Time at 7th Hour at 30° C.    Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.0	6		.5 - .8 - 1.1 - .3 - .4
2.8	4		1.4 - .7 - '0 1
Average: 2.9	5.0		.71

Experiment Number: 2

Short Rods

50

Incubation Time at 8th Hour at 30° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
3.0	5		1.4 - 1.1 - .3 - 0
2.9	5		.6 - 0 - 1.6 - 0
3.3	5		.8 - .8 - 1.4 - .4
2.9	5		.5 - .6 - .3 - 0
2.8	6		.2 - 1.3 - 0 - .7 - 0
3.3	7		.4 - 0 - .9 - 0 - .6 - .3
2.9	6		0 - .9 - .2 - .5 - .8
2.6	5		.6 - .1 - .8 - .4
2.7	5		.4 - .6 - .7 - 0
2.5	4		.7 - 1.7 - 0
2.9	6		.4 - .6 - 1.4 - .3 - .2
2.9	7		.3 - 0 - .5 - 1.3 - .8 0
2.7	5		4 - 0 - 1.3 - .6
2.7	5		1.3 - .2 - .6 - .6
3.0	5		.1 - .6 - .9 - 0
2.6	4		1.0 - 1.4 - .1
3.1	6		.7 - .3 - 1.0 - .8 - 0
2.6	4		.9 - .7 - .7

Experiment Number: 2

Short Rods

51

Incubation Time at 8th Hour at 30° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.0	5		.6 - 0 - 1.5 - .5
2.9	5		.3 - 1.5 - .6 - 0 1
Average: 2.9	5.3		.74



## TABLE 2 - B

## Short Rods

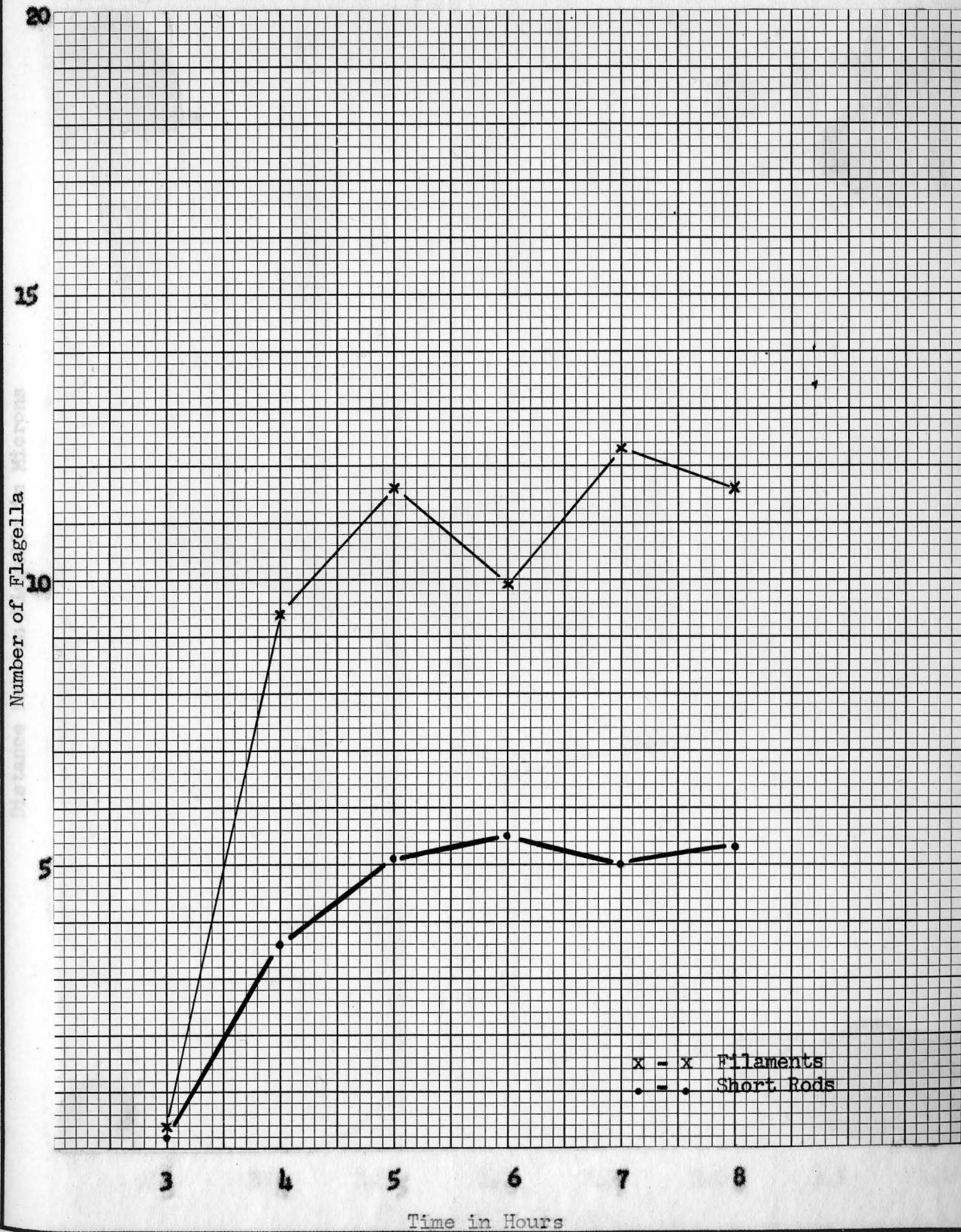
Appearance of Flagella at 30° C.; Original incubation was 38° C.

## Summary of Values

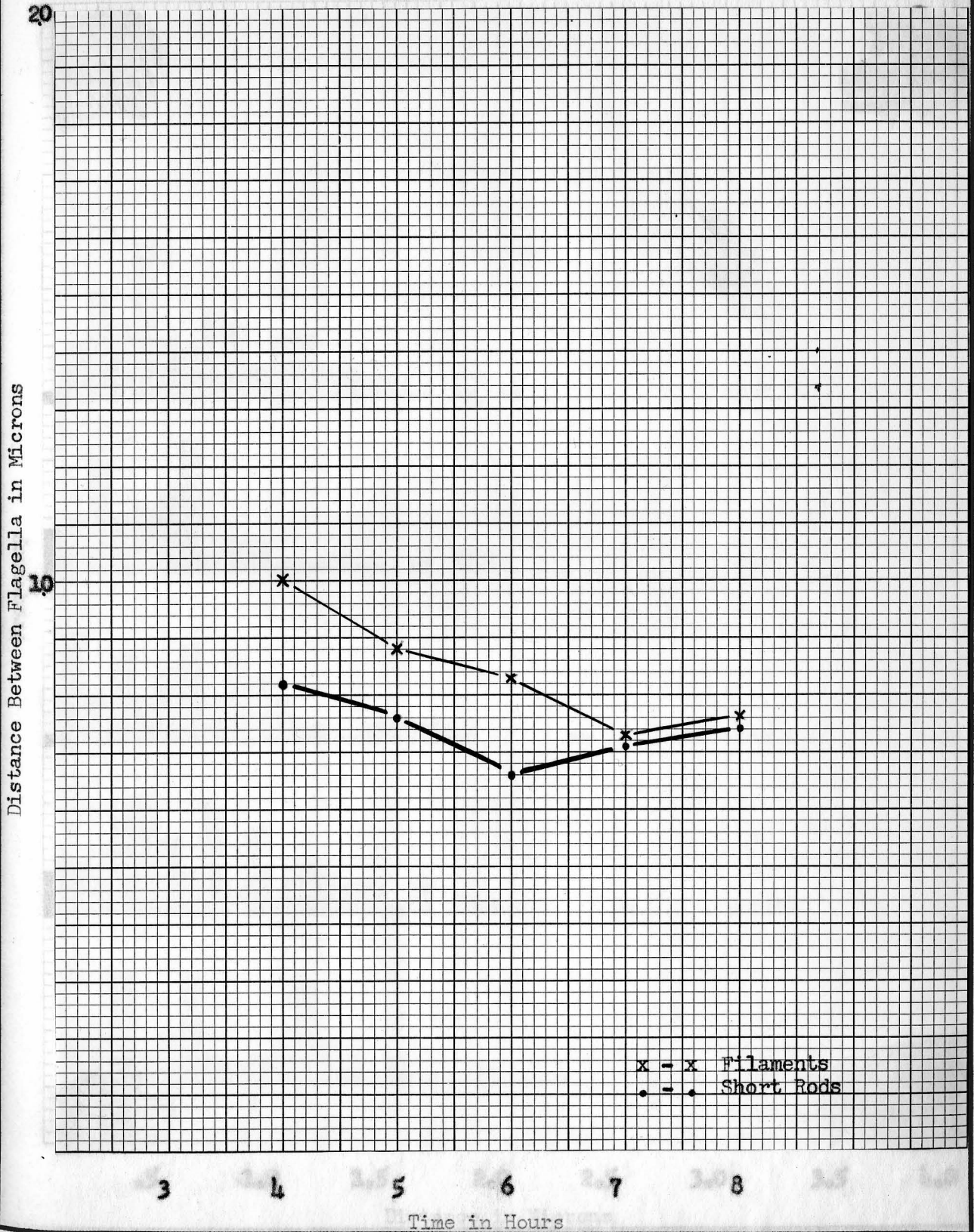
Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count M/ML	% Flagellated
	Microns		Microns	Microns		
1						
2						
3	2.8*	.3				
4	2.8	3.6		.82		
5	2.9	5.1		.76		
6	3.0	5.5		.66		
7	2.9	5.0		.71		
8	2.9	5.3		.74		

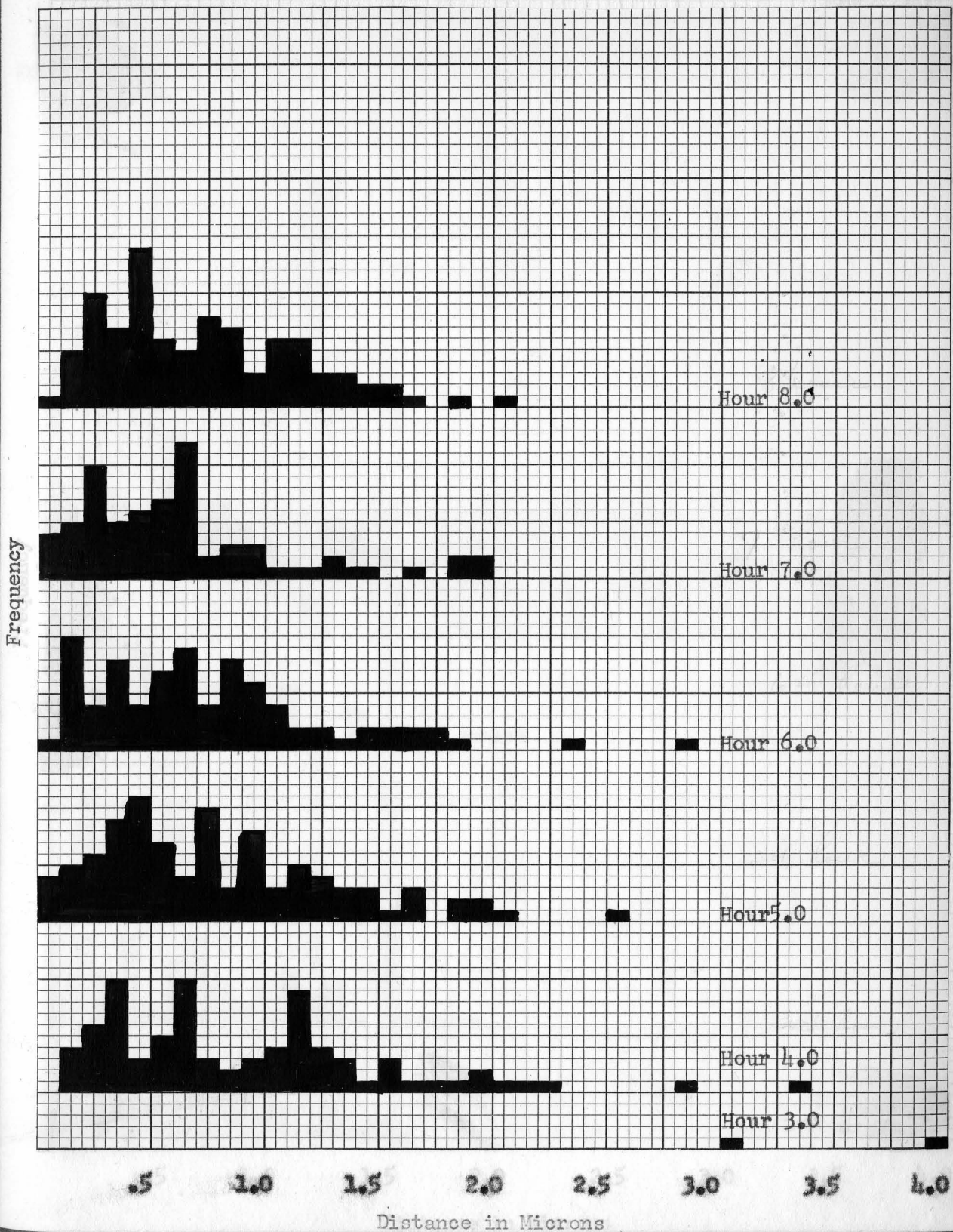
\*Based on measurement of 20 individual bacteria.

Graph 2-A Primary Temperature 38C; Secondary Temperature 30C  
Average Number of Flagella per Individual

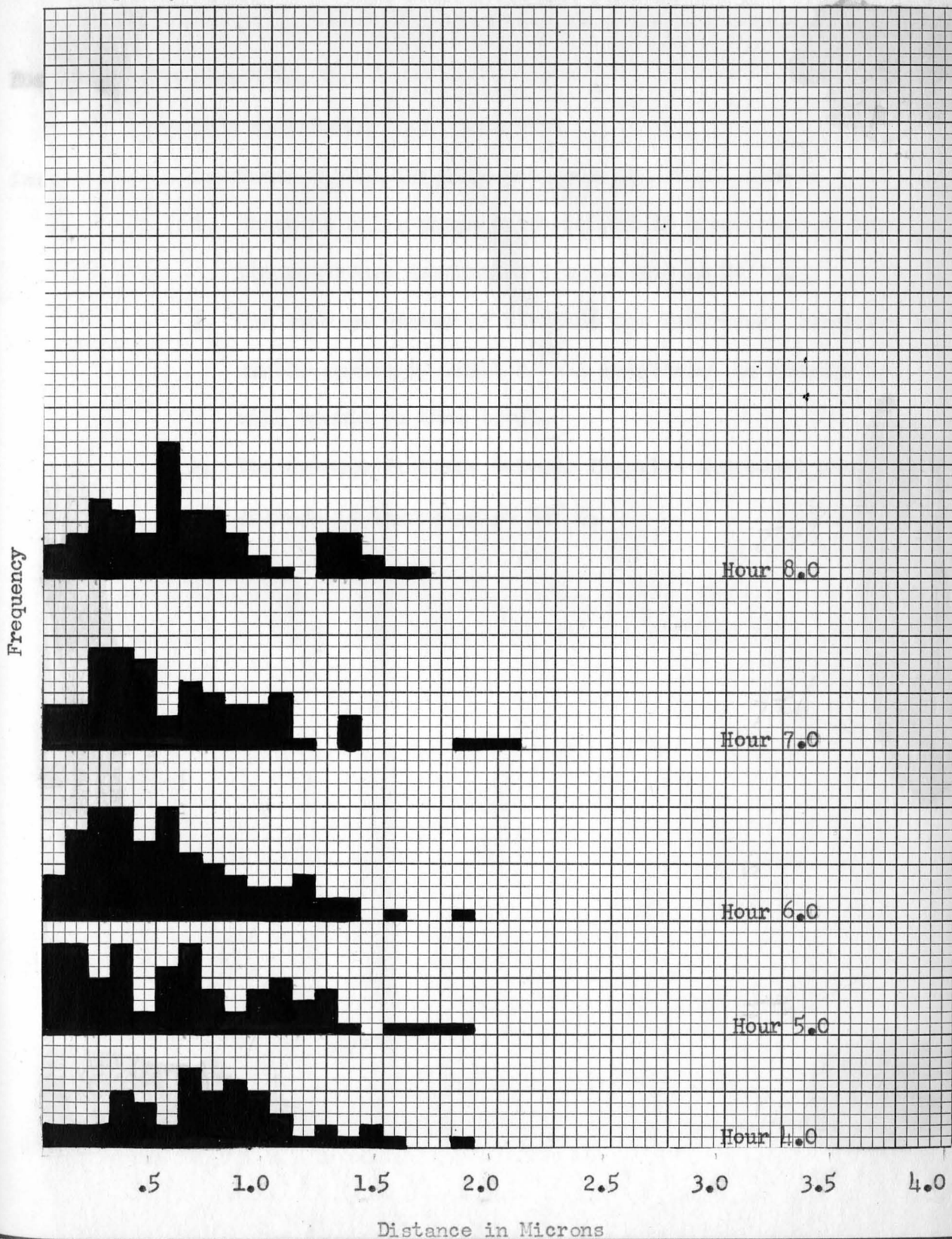


Graph 2-B Primary Temperature 38C; Secondary Temperature 30C  
Average Distance Between Flagella





Graph 2-D Short Rods Secondary Temperature 30C  
Frequency Distribution of Distance Between Flagella



**Results of Experiment No. 2:**

From this experiment it is seen that

1. There are no flagella produced at 38° C.
2. There is a lag phase which is not as pronounced as when the secondary incubation temperature is 20° C.
3. The average number of flagella per individual increases in number seemingly until a full complement is reached and will remain at that level.
4. The average distance between flagella decreases when the culture is incubated at 30° C.

Experiment No. 3

The procedure is the same as for Experiment No. 2. The primary incubation temperature was 38° C; the secondary temperature was 30° C.

Experiment Number: 3

Filaments

59

Incubation Time at 1-2 Hour at 30° C.

Plate Count:

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
No measurements were taken. Organisms in this period were non-flagellated.			



Experiment Number: 3

Filaments

60

Incubation Time at 3rd Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
9.1			
14.7			
16.2			
11.5			
12.2			
9.7			
12.3			
10.0			
12.0			
7.2	1		
Average: 11.5	.1		

Experiment Number: 3 Filaments

61

Incubation Time at 4th Hour at 30° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
9.0	8		.3 - 3.4 - 2.3 - .5 - 0 1.1 - .8
11.5	12		1.8 - .6 - 1.8 - 1.1 - 1.3 - .5 - 1.6 - 1.8 .8 - 0
8.0	1		
6.5	7		2.0 - .7 - .8 - 1.7 .2 - 1.1
6.7	8		.2 - .8 - 2.3 - 1.8 1.0 - .6 - 0
6.6	5		2.9 - 1.5 - 1.4 - .8
7.6	8		.5 - .4 - 2.7 - .7 1.6 - 1.7 - 0
6.4	6		1.5 - .8 - 1.6 - 1.2 1.0
9.9	10		1.0 - 1.1 - 1.5 - 1.0 2.2 - 1.2 - .5 - .8 .4
8.2	11		1.6 - .6 - 1.0 - .8 1.1 - 1.2 - .9 - .3 .4 - 0
9.1	12		.3 - 1.3 - 1.0 - 1.9 1.3 - .2 - .8 - 0 - .3 0
Average: 8.1	8		1.15

Experiment Number: 3

Filaments

62

Incubation Time at 5th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
8.4	8		.5 - .2 - 1.0 - 1.1 2.1 - 2.0 - 0
6.6	10		.3 - .5 - 1.2 - .4 1.0 - 1.2 - 1.0 - .7 .2
13.6	17		.3 - .9 - .5 - 1.4 .3 - 1.8 - 1.0 - 1.1 1.3 - .8 - .8 - 0 1.4 - .6 - 0 - 1.2
7.5	6		2.7 - 3.1 - 0 - .7 .8
6.7	10		.2 - .4 - 1.1 - .4 .3 - 1.1 - 1.3 - .8 1.1
6.1	11		.4 - 1.7 - .2 - 1.0 1.1 - .4 - .2 - .6 - 0 .3
11.6	9		1.1 - .5 - 2.6 - 3.2 9 - 1.8 - 0 - 0
7.1	8		.1 - .3 - 1.5 - 1.3 .5 - 1.7 - 1.0
6.9	8		.5 - 0 - 1.1 - .9 - 3.6 .5 - .3
6.8	7		0 - .3 - 3.2 - .7 - 1.2 1.2
Average: 8.1	9.4		1.04

Experiment Number: 3

Filaments

63

Incubation Time at 6th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
7.4	9		.8 - 1.8 - .2 - 1.3 - 0 1.8 - .6 - .8
6.0	10		.7 - .9 - .2 - 1.0 - .1 .5 - 1.7 - .5 - .2
6.0	6		.5 - .5 - 1.8 - 2.6 .2
7.5	11		.4 - .2 - 2.1 - .9 - .3 1.5 - .9 - .8 - .2 - .6
7.1	8		1.7 - 2.2 - .5 - 1.0 .4 - .6 - .5
6.0	10		.1 - .8 - 1.6 - .6 - .4 .8 - 0 - .7 - .7
7.1	10		1.0 - .2 - 1.2 - .4 - 0 0 - 2.5 - .6 - .9
6.8	9		1.4 - 1.1 - .5 - 1.2 .6 - 1.0 - .9 - .3
7.9	10		.2 - 2.9 - .3 - .6 .7 - 1.1 - .7 - .5 - .8
7.0	8		.3 - .8 - .5 - 2.3 - .7 .6 - .4
<b>Average: 6.9</b>	<b>9.1</b>		<b>.90</b>

Experiment Number: 3

Filaments

64

Incubation Time at 7<sup>th</sup> Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
8.3	11	.4 - .6 - .5 - 2.2 .7 - .2 - 2.1 - .4 .8 - 0	
6.3	10	1.2 - .4 - 1.0 - .1 1.0 - .9 - .7 - .4 .2	
6.4	6	.7 - .4 - 0 - 3.3 - 0	
9.7	10	.4 - .3 - .8 - .6 - .7 1.9 - 1.5 - .7 - 1.9	
11.3	12	2.0 - .3 - .8 - .4 .2 - 1.5 - .5 - .8 - 1.2 - 1.1 - 1.4	
11.0	13	.4 - .3 - .5 - 2.1 .6 - .8 - 1.0 - 1.2 1.2 - .7 - 1.3 - .8	
6.4	10	.6 - .2 - .4 - .3 1.1 - 1.4 - .3 - .1 1.8	
6.0	9	.8 - .7 - 1.0 - .3 - 0 .3 - 1.5 - .5	
10.7	15	1.1 - .2 - 1.9 - .1 .5 - .2 - .5 - .8 - .9 .6 - .5 - .6 - .5 - 1.9	
6.5	10	1.0 - .6 - .8 - .3 1.0 - .8 - .6 - .3 - .4	
Average: 8.3	10.6	.84	

Experiment Number: 3

Filaments

65

Incubation Time at 8th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
15.6	27		.5 - .8 - .1 - 1.0 - .1 1.0 - .5 - .2 - 1.1 .4 - .5 - 1.1 - .6 - .3 .9 - .6 - .2 - 1.3 - .6 .5 - .3 - 1.0 - .4 - .2 .5
6.9	12		1.9 - 0 - 1.1 - .6 - .4 .9 - 0 - .5 - .2 - .8 .2 - .5
14.0	17		.2 - 1.2 - .3 - .3 - 0 1.7 - .8 - .8 - 1.4 .6 - .4 - .7 - 1.5 - .7 1.3 - .4
22.1	19		.5 - .8 - .3 - 1.5 1.4 - .3 - 1.4 - .2 1.3 - 3.6 - 2.4 - .3 .4 - .5 - 1.0 - .9 .7 - 1.8
11.6	16		.3 - .6 - .4 - 1.6 1.0 - 1.2 - .5 - .2 1.0 - .9 - .4 - 2.1 .4 - 1.5
24.8	36		.4 - .4 - 1.1 - .5 - .7 .9 - .6 - 1.3 - .5 - .3 .4 - 1.1 - .7 - .4 - .5 2.7 - .3 - .2 - .4 1.4 - .4 - .4 - 1.0 .8 - .5 - .4 - .2 - .3 .3 - .9 - .7 - .3 - .5 0
9.6	15		.9 - .3 - .9 - .5 - 1.1 1.7 - .6 - .6 - .7 - 0 1.1 - .5 - 0 - .5

Experiment Number: 3

Filaments

Incubation Time at 8th Hour at 30° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
7.9	13		.3 - .6 - .8 - .2 - .6 1.3 - .7 - .3 - .4 .3 - .7 - 1.1
10.0	11		0 - .4 - 2.5 - .2 - 1.6 1.0 - 1.5 - .8 - 2.1 1.0
Average: 13.61	18.4		.78

## Filaments

Appearance of Flagella at 30° C.; Original temperature was 38° C.

## Summary of Values

Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count	% Flagellated
	Microns		Microns	Microns	M/ML	
1						
2						
3	11.5*	.1				
4	8.1	8.0		1.15		
5	8.1	9.4		1.04		
6	6.9	9.1		.90		
7	8.3	10.6		.84		
8	13.6	18.4		.78		

\*Based on measurement of 10 individual bacteria.



Experiment Number: 3 Short Rods

Incubation Time at 1-2 Hour at 30° C.

Plate Count:

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
No measurements were taken. Organisms in this period were non-flagellated.			

Experiment Number: 3      Short Rods

Incubation Time at 3rd Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>			
	Length	Number	Length	Distance Between
2.6				
2.6	1			
2.5				
2.6				
3.3	1			
3.1	1			
2.6				
2.7				
2.6				
3.5				
3.5	1			
3.4				
2.6				
2.7	1			
3.0				
2.9				
3.0				
2.7				
3.1	2			2.4

Experiment Number: 3

Short Rods

70

Incubation Time at 3rd Hour at 30° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
Length	Number	Length	Distance Between
2.5			
Average: 2.9	.4		2.4

Experiment Number: 3 Short Rods

71

Incubation Time at 4th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.8	4		.2 - 1.2 - .7
3.0	5		1.0 - .2 - .2 - .3
2.8	3		1.5 - .3
2.9	5		1.7 - .5 - .5 - .2
2.9	3		.5 - 1.1
2.6	1		
3.0	2		1.0
3.5	4		2.2 - 1.0 - .3
2.6	2		1.5
2.5	1		
3.5	3		.4 - .5
2.8	2		1.4
2.6	3		1.0 - 1.3
2.8	4		1.2 - 1.3 - 0
3.4	1		
2.7	3		2.0 - .6
3.1	5		.8 - .6 - 1.4 - .3
2.7	4		.7 - 1.2 - .4
3.4	4		.7 - 1.5 - .4

Experiment Number: 3

Short Rods

Incubation Time at 4th Hour at 30° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.9	3		1.7 - .8
Average: 2.9	3.1		.89

Experiment Number: 3

Short Rods

73

Incubation Time at 5th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
3.4	6		1.3 - .5 - 0 - .8 - .2
2.5	4		.7 - 1.4 - .3
3.3	4		1.4 - 1.8 - 0
3.3	5		1.7 - .1 - .5 - .6
3.0	2		1.9
2.9	4		.6 - .6 - 1.1
2.6	4		1.5 - .6
3.3	4		.7 - .2 - .8
3.2	6		.4 - 1.5 - 0 - .7 - 0 .5
2.6	6		0 - .2 - 1.0 - .3 - .5
2.5	4		.8 - .7 - .4
2.8	4		1.5 - 0 - .2
2.8	4		.2 - .8 - .9
2.8	4		1.6 - 0 - 1.0
2.8	3		2.1 - .5 - .6
2.5	4		.2 - .3 - 1.7
3.2	6		.2 - .6 - 1.3 - .3 - .5
3.0	6		.4 - .4 - 1.0 - .8 - .4

Experiment Number: 3

Short Rods

74

Incubation Time at 5th Hour at 30° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.5	4		.7 - .6 - .6
2.5	5		.9 - .4 - .6 - 0 1
Average: 2.9	4.6		.78

Experiment Number: 3

Short Rods

75

Incubation Time at 6th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.8	6		.3 - .3 - 0 - 1.5 - .3
2.8	4		.5 - 1.2 - .6
3.1	6		.5 - .2 - .7 - .4 - .7
2.9	4		.6 - 0 - 1.5
2.9	5		1.0 - .3 - .3 - 1.3
2.9	5		1.1 - 0 - .5 - .8
2.5	5		.2 - .8 - 0 - .8
2.8	6		.3 - .5 - .2 - 0 - .9 .4
2.6	4		.4 - .6 - 1.2
2.8	6		.2 - .5 - .4 - .6 - .3
2.7	5		0 - 1.1 - .3 - .8
2.5	4		.5 - .8 - .9
3.3	7		.7 - 1.4 - 0 - .3 - 0 .8
3.1	4		2.3 - .5 - .3
3.2	5		1.1 - .9 - .5 - .7
3.2	5		.3 - 1.5 - .4 - .6
2.5	5		.3 - .5 - 1.6 - 0
2.8	5		2.0 - 0 - .4 - 0



Experiment Number: 3

Short Rods

Incubation Time at 6th Hour at 30° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.7	6		.3 - .7 - .9 - .4 - .4
2.7	6		0 - .4 - .4 - 1.1 - .6
Average: 2.8	5.2		.69

Experiment Number: 3      Short Rods  
 Incubation Time at 7th Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.5	7		.2 - .3 - .5 - 1.0 1.1 - .3
2.7	5		.4 - .5 - .4 - .9
3.2	7		.4 - .2 - .4 - .9 - .3 .6
2.7	5		0 - .7 - 1.6 - .3
2.7	5		.4 - 1.0 - .3 - .5
2.8	5		.3 - 1.0 - .6 - .4
3.4	5		1.1 - .6 - .7 - .4
3.4	6		.4 - .8 - .5 - .8 - 1.0
3.5	6		.5 - .4 - 2.7 - .2 - 0
3.4	5		.5 - .4 - 1.4 - .6
3.3	5		0 - .3 - 1.3 - .7
3.0	6		.3 - 1.2 - .2 - 1.1 .3
2.7	5		.3 - .3 - 1.0 - .4
2.6	5		.4 - .8 - .5 - .7
3.0	4		.3 - 1.2 - 1.7
3.1	6		.5 - 1.5 - 0 - .4 - .5
2.6	4		.6 - .6 - .2

Experiment Number: 3

Short Rods

78

Incubation Time at 7th Hour at 30° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.8	6		1.0 - 0 - 1.0 - .7
2.7	6		.1 - .3 - 2.5 - .2 - .1 1
Average: 3.0	5.4		.68

Experiment Number: 3 Short Rods

Incubation Time at 8<sup>th</sup> Hour at 30° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.4	6		.3 - .8 - .7 - 1.0 - .6
2.8	5		.7 - .6 - 1.0 - .4
2.7	5		.2 - .5 - 1.2 - .4
3.0	7		.5 - .1 - .8 - .2 1.0 - .4
3.5	3		.8 - 1.1
3.2	5		1.0 - .9 - .2 - .6
2.8	6		.2 - .4 - 1.2 - .6 .4
2.9	6		.1 - .5 - .2 - .6 - .3
3.0	4		1.0 - .6 - .8
2.8	5		.4 - 1.4 - .6 - .4
2.9	5		.5 - 0 - 1.4 - .3
2.7	5		.2 - 1.1 - .7 - .2
2.8	4		.5 - .7 - .8
3.5	6		.4 - 1.5 - 1.0 - .4 - .1
3.0	7		0 - .5 - 0 - .7 - .8 - .9
2.9	5		.4 - .1 - .5 - 0
2.9	5		.9 - .6 - .4 - .6

Experiment Number: 3

Short Rods

80

Incubation Time at 8th Hour at

30° C.

Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.5	10		.2 - 1.0 - 0 - .4 - .8 .3 - 0 - .3 - .5
3.0	6		.4 - .7 - .3 - .9 - 0
3.0	5		.8 - .6 - .5 - .6
Average: 3.0	5.5		.62

TABLE 3 - B

## Short Rods

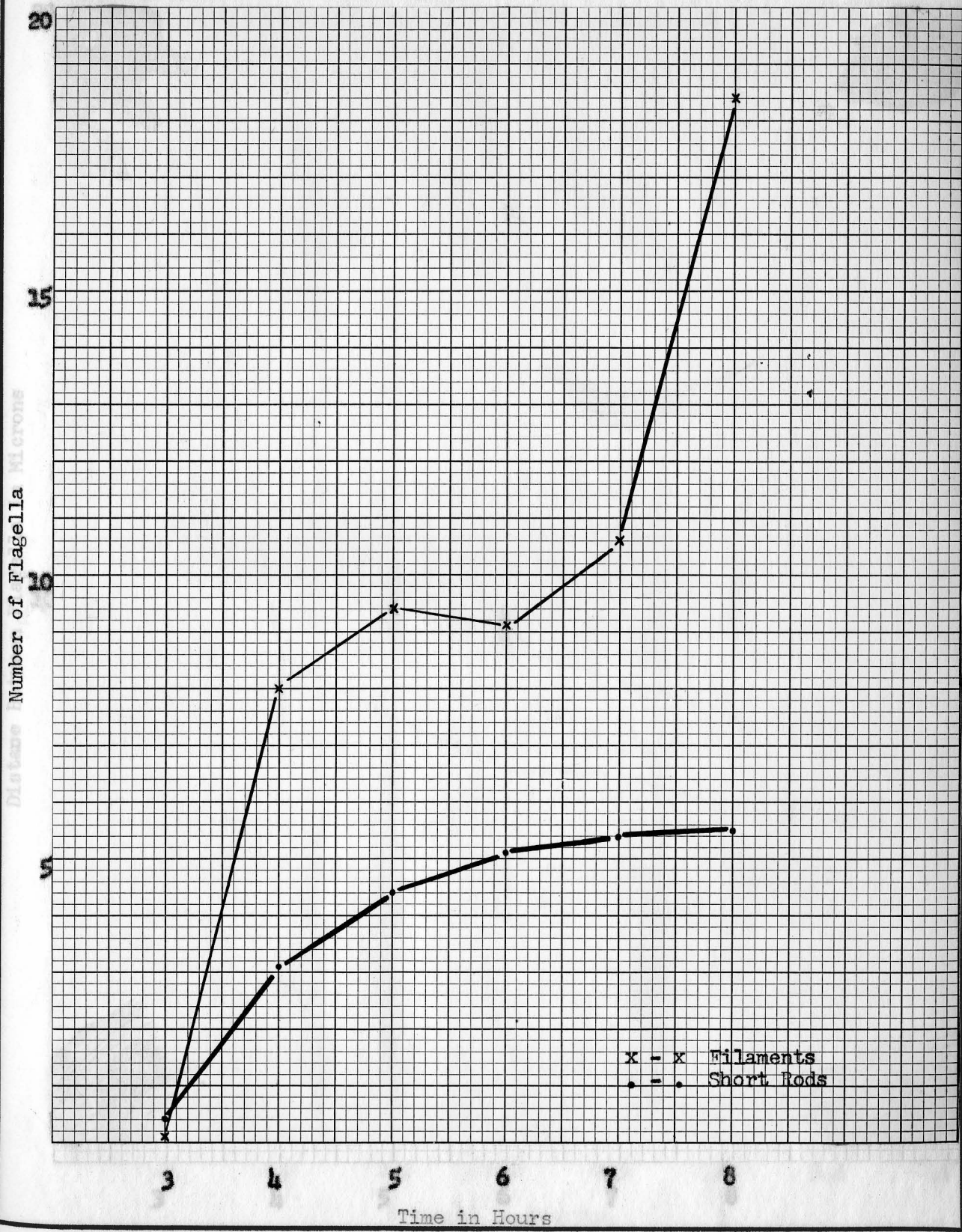
Appearance of Flagella at 30° C.; Original temperature was 38° C.

## Summary of Values

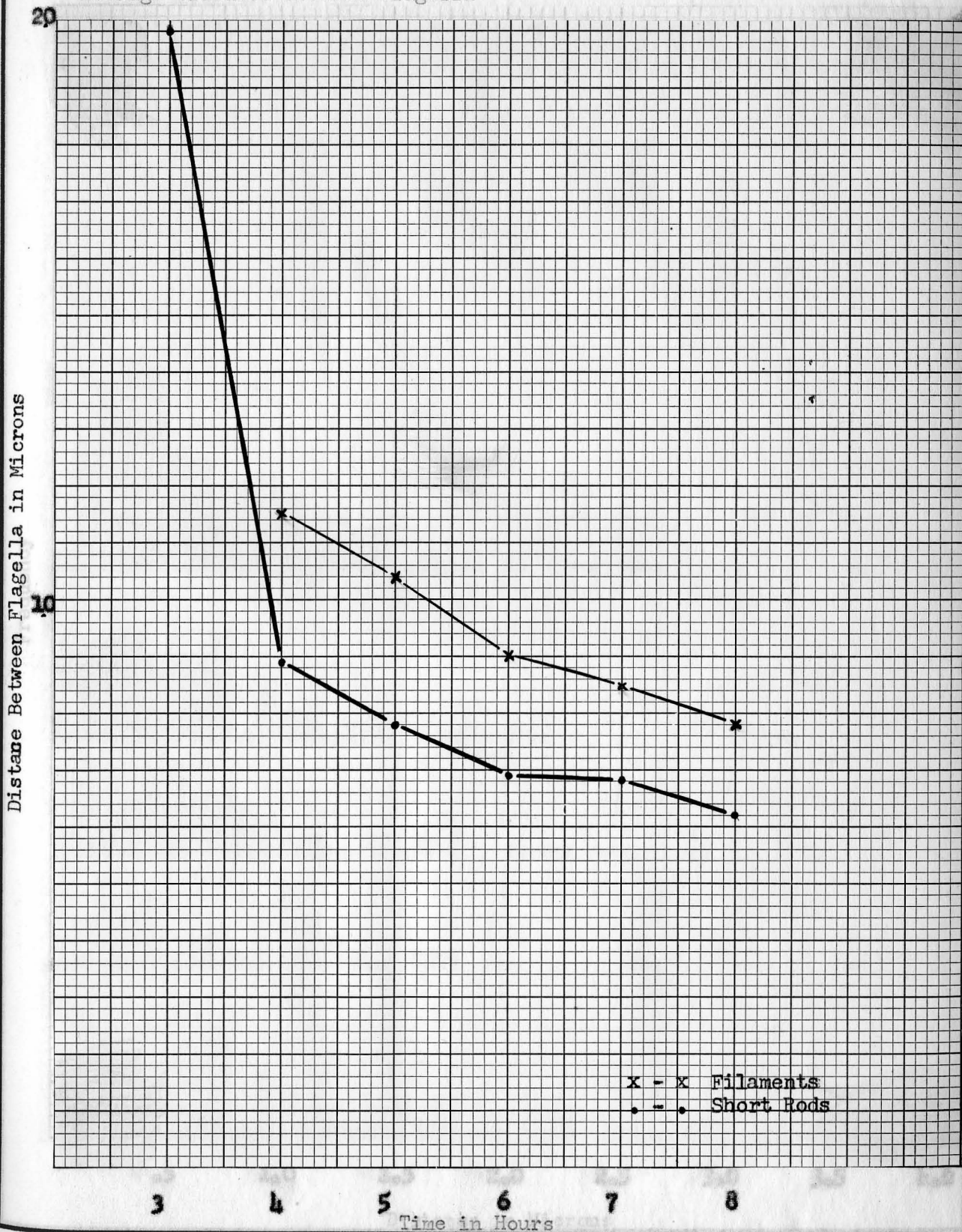
Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count M/ML	% Flagellated
	Microns		Microns	Microns		
1						
2						
3	2.9*	.4		2.40		
4	2.9	3.1		.89		
5	2.9	4.4		.78		
6	2.8	5.1		.69		
7	3.0	5.4		.68		
8	3.0	5.5		.62		

\*Based on measurement of 20 individual bacteria..

Graph 3-A Primary Temperature 38C; Secondary Temperature 30C  
Average Number of Flagella per Individual

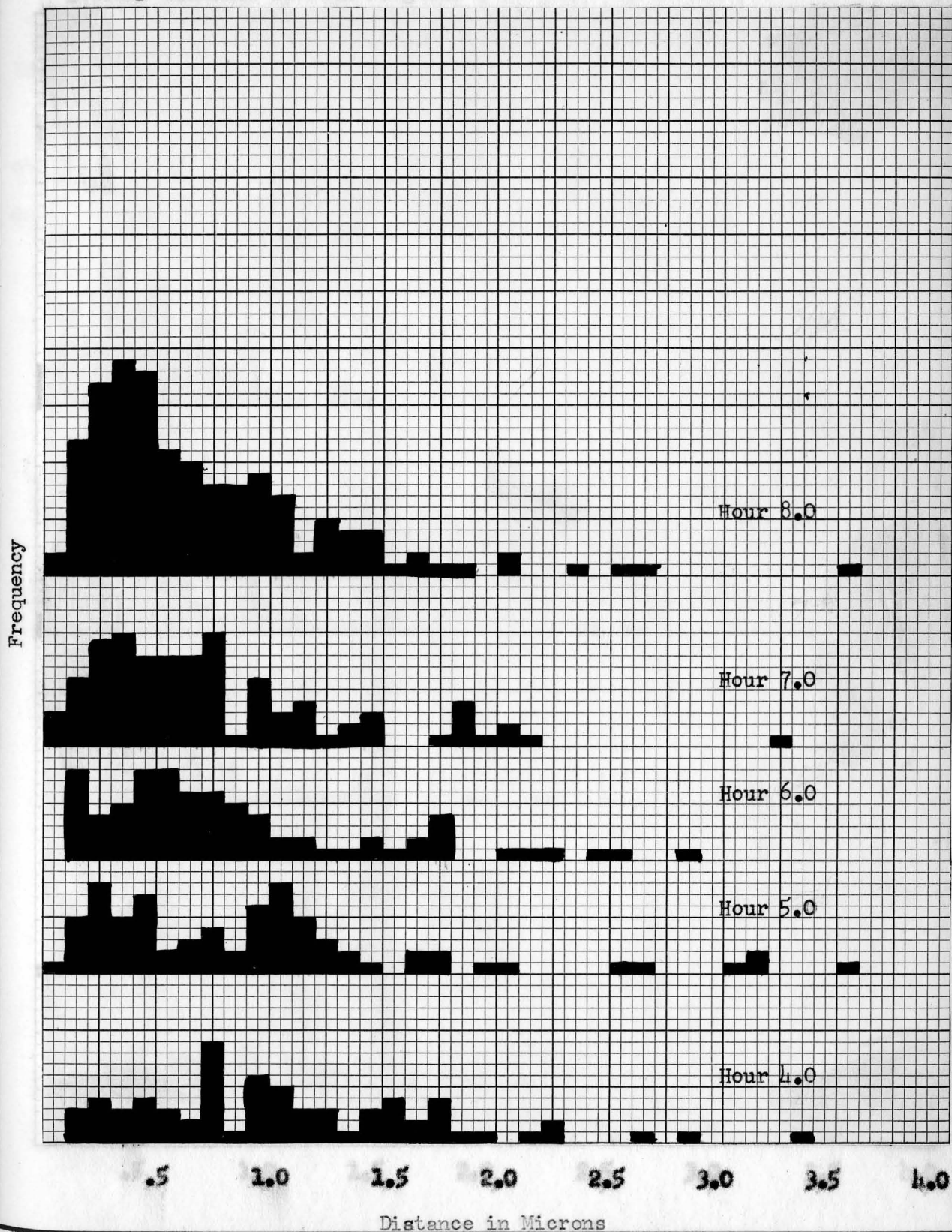


Graph 3-B Primary Temperature 38C; Secondary Temperature 30C  
Average Distance Between Flagella

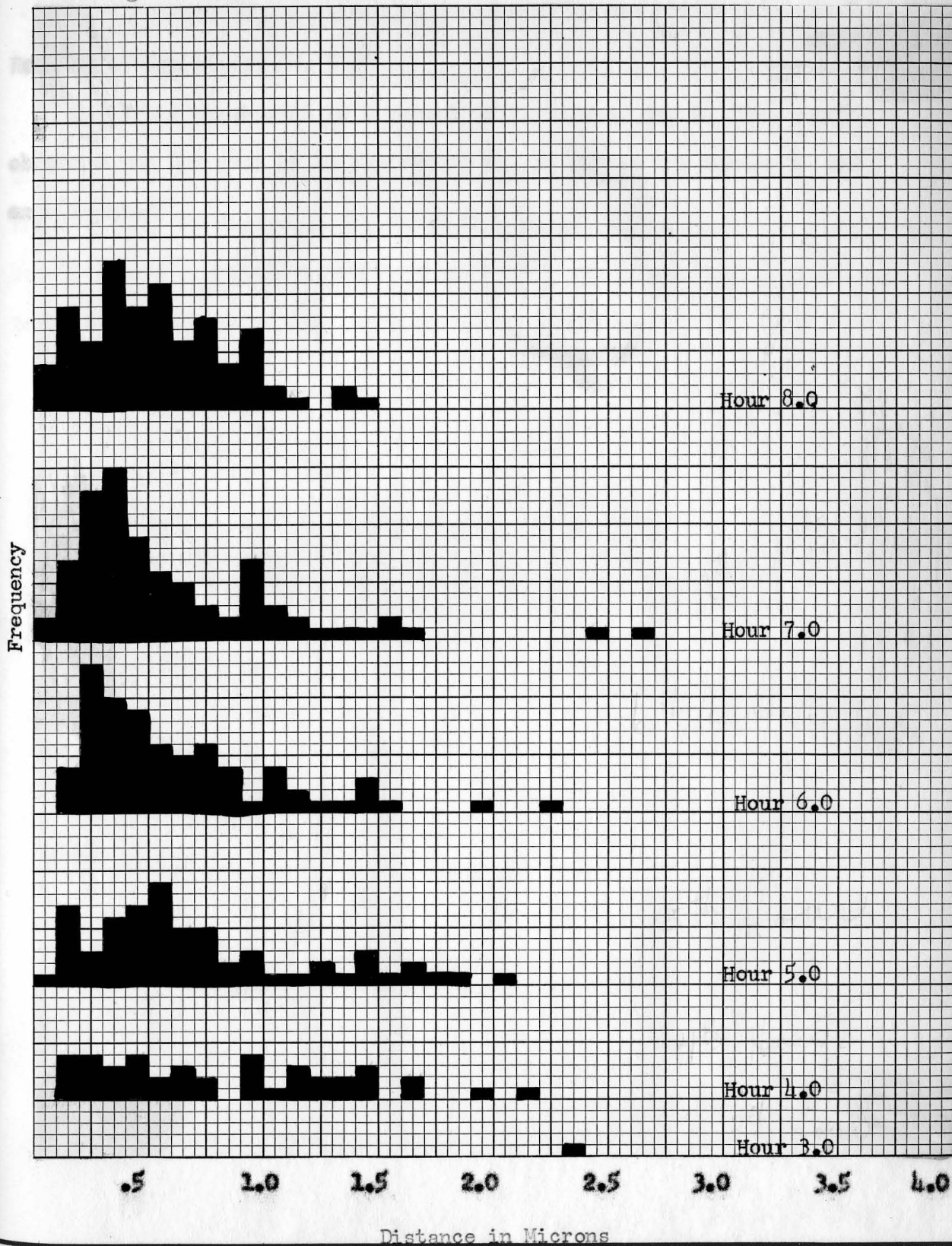




Graph 3-0 Filaments Secondary Temperature 30C  
Average Distance Between Flagella



Graph 3-D Short Rods Secondary Temperature 300  
Average Distance Between Flagella



### Results of Experiment No. 3

This experiment is a repeat of Experiment No. 2. The results obtained are the same as in Experiment No. 2, within the bounds of the experiment.

## Experiment No. 4

A loopful of stock culture of L. monocytogenes was inoculated into 200 ml. of caseitone broth and placed in the 20° C. incubator. When turbidity was evident, the culture was diluted with fresh medium until the culture was barely turbid. It was then placed in a 38° C. incubator and aliquots were taken for stain every hour for a period of eight hours.

Experiment Number: 4

Filaments

88

Incubation Time at 1st Hour at 38° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
7.4	13		.6 - .5 - 2.1 - 1.1 .2 - .4 - .6 - 1.8 .5 - 0
17.9	21		.8 - .5 - 1.4 - .2 - .8 2.1 - .4 - 1.5 - .3 2.4 - 1.9 - 2.8 - .8 0 - 1.2 - 0 - .8
7.8	10		.8 - .3 - .9 - .6 - .5 1.1 - .6 - .2
25.8	33		.6 - 1.9 - .3 - .6 1.2 - .4 - 1.8 - 1.0 .5 - .5 - .4 - 1.8 - .8 1.1 - .7 - .6 - .6 - .8 .6 - .6 - 1.5 - .3 - .8 1.3 - .5 - 2.4 - 0 - .4 .4 - 0
12.3	14		1.7 - .4 - 1.4 - .4 1.4 - .8 - 1.1 - .7 - 0 2.2 - 0 - .6
16.4	26		.5 - 1.4 - 1.1 - 1.2 0 - .8 - 1.0 - .8 - .9 0 - 1.6 - .6 - 1.2 1.8 - .4 - .8 - .6 - .4 0 - .3 - 1.0
8.5	11		.6 - .5 - 1.1 - 1.2 - 3.0 - 1.1 - .9 - 1.0 1.6
13.9	19		2.1 - .4 - .4 - 2.0 .3 - .7 - .6 - .6 - .6 .1 - .4 - 1.4 - .5 - .4 .4 - 1.1 - 1.2

Experiment Number: 4

Filaments

89

Incubation Time at 1st Hour at 38° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
16.2	24		0 - .6 - 1.0 - 1.2 .5 - 1.1 - .2 - .7 - .3 1.3 - 1.6 - .3 - 1.2 .9 - .4 - .8 - .1 - 1.0 0 - .6 - .7 - .8 - 1.0
16.6	23		0 - 1.5 - 1.7 - .7 2.0 - .9 - .7 - .7 1.4 - 0 - 1.6 - 1.1 1.1 - .9 - 1.3 - .6 .1 - 0
Average: 14.3	19.4		.94

Experiment Number: 4

Filaments

90

Incubation Time at 2nd Hour at 38° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
8.6	12		.4 - .5 - .5 - 3.5 - .4 .5 - .8 - 0 - 1.3 - 0
7.0	4		3.1 - .9 - 3.0
17.4	16		1.3 - .3 - 2.0 - .3 - 1.3 - .3 - 1.8 - .6 1.3 - .4 - 2.0 - 1.4 - 0 1.0 - 2.0
9.2	9		.3 - .3 - 2.0 - 2.5 - 0 .9 - .4 - 1.9
21.8	27		.9 - .2 - .5 - .5 - .4 .5 - 1.5 - .3 - .7 1.4 - .6 - .6 - 1.1 1.2 - 1.2 - .5 - .3 1.8 - 1.5 - .9 - 1.6 4.4
7.1	7		2.2 - 1.8 - .8 - 1.1 .6
9.0	10		.8 - .5 - .3 - 2.3 - .3 3.8 - .6 - .4 - 0
21.1	18		1.2 - 3.1 - .4 - .3 - .2 .3 - .2 - .2 - 2.2 - .7 2.2 - 2.1 - 2.0 - .9 2.0 - 1.4 - 0
11.2	15		1.0 - 1.5 - 1.6 - .9 1.7 - 1.2 - .9 - 1.2 .1 - .6 - .6 - 0
8.9	8		.6 - 0 - 1.8 - 1.4 - 1.2 1.4 - 2.4 - 0

Experiment Number: 4

Filaments

Incubation Time at 2nd Hour at 38° C. Continued

Plate Count:

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
Average: 12.1	12.6		1.18



Experiment Number: 4 Filaments  
 Incubation Time at 3rd Hour at 38° C.

Plate Count:

Soma	Flagella		
	Length	Number	Distance Between
38.3	19		3.3 - .9 - 6.4 - .9 4.6 - 2.6 - 2.5 - 1.0 0 - .6 - 4.4 - .6 - 0 .4 - 2.3 - 3.6 - 1.9
14.9	9		2.9 - 2.3 - 1.2 - 1.5 .1 - 2.2 - .7 - 2.0
15.9	9		1.4 - .7 - 1.3 - 2.3 4.1 - .8 - 2.3 - 1.6
13.4	6		3.2 - 2.7 - .3 - 2.9 2.1
12.4	9		.3 - 1.7 - 1.4 - 3.5 - 0 .6 - 2.3
18.6	8		2.6 - .6 - 1.5 - 4.3 1.8 - 4.4 - 1.5
22.5	10		1.4 - 4.0 - 4.1 - 2.4 2.3 - 3.1 - 3.3 - 0 2.1
19.8	10		2.7 - .7 - .6 - 1.7 - 6.6 - 2.9 - 0 - 4.2 - .5
10.0	5		2.9 - 1.3 - 1.9 - 4.0
<b>Average:</b> 18.4	9.4		2.26

Experiment Number: 4  
 Incubation Time at 4th Hour at

Filaments  
 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
7.8	3		6.0 - .5
13.4	2		3.2
14.4	7		.6 - 3.7 - 1.2 - 3.3 - 0 3.1
24.2	7		.6 - 7.4 - 1.6 - 0 - 2.2 6.6
18.7	4		1.3 - 9.9 - 3.1
9.0	4		3.3 - 2.6 - .2
12.8	3		1.4 - 1.3
31.0	8		4.8 - 1.8 - 4.3 - 1.2 2.4 - 6.7 - 6.7
11.0	2		4.1
16.8	3		3.3 - 5.1
<b>Average: 15.9</b>	<b>4.3</b>		<b>3.40</b>

Experiment Number: 4 Filaments

Incubation Time at 5th Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
15.2	1		
20.2	1		
25.0			
15.0			
13.5			
15.4			
12.6			
21.0	3		10.3 - .9
14.6	1		
11.6	1		
<b>Average: 16.4</b>	<b>.7</b>		<b>5.54</b>

Experiment Number: 4 Filaments

Incubation Time at 6th Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
14.2	2		1.4
12.7	1		
20.4			
9.2			
19.7			
6.8			
11.8			
11.5			
22.2	1		
25.7	1		
Average: 15.5	.5		

Experiment Number: 4 Filaments

Incubation Time at Hour at 20° C.  
7th & 8th

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
Length	Number	Length	Distance Between
No measurements were taken. Organisms were non-flagellated.			

TABLE 4 - A

## Filaments

Loss of Flagella at 38° C.; Original temperature was 20° C.

## Summary of Values

Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count	% Flagellated
	Microns		Microns	Microns	M/ML	
1	14.3*	19.4		.94		
2	12.1	12.6		1.18		
3	18.4	9.4		2.26		
4	15.9	4.3		3.40		
5	16.4	0.7				
6	15.5	0.5				
7						
8						
9						

\*Based on measurement of 10 individual bacteria.

Experiment Number: 4

Short Rods

98

Incubation Time at 1st Hour at 38° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
3.4	6		1.5 - 1.1 - .6 - .2 - 0
3.1	6		1.2 - 0 - 1.9 - 0
3.5	5		.8 - .8 - 1.5 - .1
3.0	8		.3 - .2 - 1.5 - .5 - .5 0
3.4	6		1.6 - .2 - .7 - 0 - .9 0
3.4	6		1.0 - 1.0 - .3 - .9 - 0
2.9	5		0 - 1.0 - 1.0 - .2
3.6	5		1.7 - 1.1 - .5 - .3
3.0	4		.7 - 1.1 - 1.0
2.9	7		.5 - .6 - .3 - 1.1 - .4
3.3	6		1.0 - 0 - .7 - 1.0 - .3
3.0	7		1.2 - .5 - .2 - 1.0 - .3 0
3.2	8		.6 - .9 - 1.0 - .5 - 0
3.6	8		.4 - .2 - .2 - .3 - 1.0 .2
3.4	4		.8 - .7 - .4
3.1	5		.8 - .8 - 1.0 - .4
3.5	8		.8 - 1.1 - .5 - .7 - 0

Experiment Number: 4

Short Rods

Incubation Time at 1st Hour at

38° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.4	6		0 - 2.2 - .5 - .7 - 0
2.9	8		.2 - .6 - .4 - 0 - 1.0 .4 - .3
2.9	6		0 - 0 - .6 - 1.2 - .9
<b>Average: 3.2</b>	<b>6.2</b>		<b>.77</b>



Experiment Number: 4

Short Rods

100

Incubation Time at 2nd Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.4	4		.7 - 1.0 - 1.4
3.3	4		0 - 1.1 - 1.3
3.0	3		1.7 - 0
3.0	2		2.0
3.4	4		.8 - 0 - 1.1
2.7	4		.5 - .7 - .9
3.6	7		.7 - 1.1 - .7 - 0 - .8
3.3	4		1.0 - 1.0 - .5
3.6	4		0 - 1.8 - 1.0
3.5	4		1.2 - .2 - 1.0
3.5	5		2.3 - 0
3.1	5		.5 - .6 - .3
3.3	6		.2 - .8 - .8 - 1.1 - .4
3.5	6		1.0 - 1.6 - 0 - .6
3.6	5		1.0 - 0 - .3 - 2.1
3.5	3		1.0 - .9
3.6	5		.9 - .8 - 1.5 - .3
3.3	4		.6 - .7 - 2.0
2.6	5		.5 - .7 - 0 - 1.2

Experiment Number: 4 Short Rods  
 Incubation Time at 2nd Hour at 38° C. Continued

101

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
Length	Number	Length	Distance Between
3.5	4		1.9 - .4 - 1.0
Average: 3.3	4.4		.97

Experiment Number: 4      Short Rods

Incubation Time at 3rd Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.5	4		3.5 - 0 - .3
3.1	4		0 - 1.6 - 1.5
2.8	2		1.6
2.9	2		2.8
3.6	2		1.6
3.1	2		1.1
3.2	3		1.1 - 1.1
3.2	3		1.9 - 1.0
2.6	2		.4
2.8	2		2.1
3.3	3		1.1 - .5
3.0	2		2.2
2.6	3		2.4 - 0
2.9	2		1.5
3.0	2		1.2
3.0	3		1.2 - 0
3.5	3		.3 - 1.3
3.4	3		1.0 - 1.1
2.6	4		.2 - .8 - 1.2

Experiment Number: 4

Short Rods

103

Incubation Time at 3rd Hour at 38° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.3	2		1.4
Average: 3.1	2.6		1.33

Experiment Number: 4 Short Rods

Incubation Time at 4th Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.7	3		2.1 - .2
3.1	3		2.5 - .1
2.6	3		2.6 - 0
2.7	3		1.1 - .1
2.7	2		1.0
2.5	3		.9
3.5	3		.2 - 1.7
3.5	2		1.9
2.7	2		.6
3.6	2		2.6
3.1	2		1.0
3.5	4		1.9 - .8
2.9	2		.6
2.6	3		1.4 - .3
3.1	2		2.0
3.4	3		.8 - 2.0
3.3	3		1.7 - .1
3.5	2		2.1
3.5	2		1.1

Experiment Number: 4

Short Rods

105

Incubation Time at 4th Hour at 38° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.4	2		3.1
Average: 3.1	2.6		1.45

Experiment Number: 4      Short Rods  
 Incubation Time at 5<sup>th</sup> Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.5	1		
3.2			
3.2			
2.9			
2.6			
3.4			
3.4			
3.5			
3.1			
2.6	2		2.3
3.5			
2.9	1		
2.6			
2.8			
2.6			
3.3			
3.3			
3.1			
2.7			
3.4			
Average: 3.0	.2		

Experiment Number: 4 Short Rods

107

Incubation Time at 6<sup>th</sup> Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.7			
2.6			
3.3			
3.6	1		
2.6	1		
2.7	1		
2.9			
3.3			
2.6			
3.3	1		
3.0			
2.5			
2.5			
2.9			
3.2			
2.5			
2.9			
3.2			
3.0	1		



Experiment Number: 4      Short Rods  
 Incubation Time at 6th Hour at 38° C.      Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
Length	Number	Length	Distance Between
2.8			
Average: 2.9	.25		

Experiment Number: 4

Filaments

109

Incubation Time at 7-8 Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
Length	Number	Length	Distance Between
No measurements were taken. Organisms were practically non-flagellated.			

TABLE 4 - B

## Short Rods

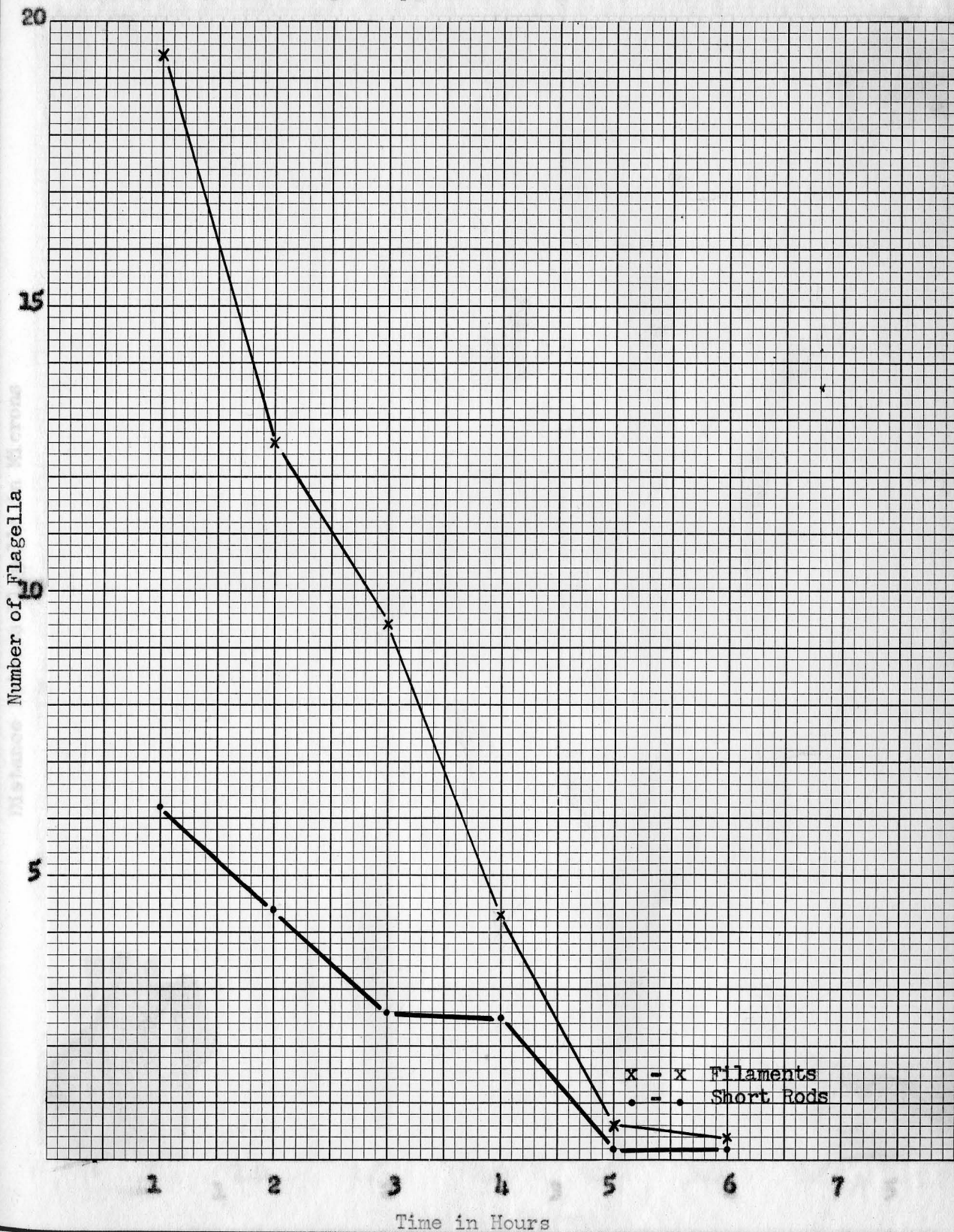
Loss of Flagella at 38° C.; Original Temperature was 20° C.

## Summary of Values

Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count M/ML	% Flagellated
	Microns		Microns	Microns		
1	3.2*	6.2		.77		
2	3.3	4.4		.97		
3	3.1	2.6		1.33		
4	3.1	2.5		1.45		
5	3.0	.20		2.30		
6	2.9	.25				
7						
8						

\*Based on measurement of 20 individual bacteria.

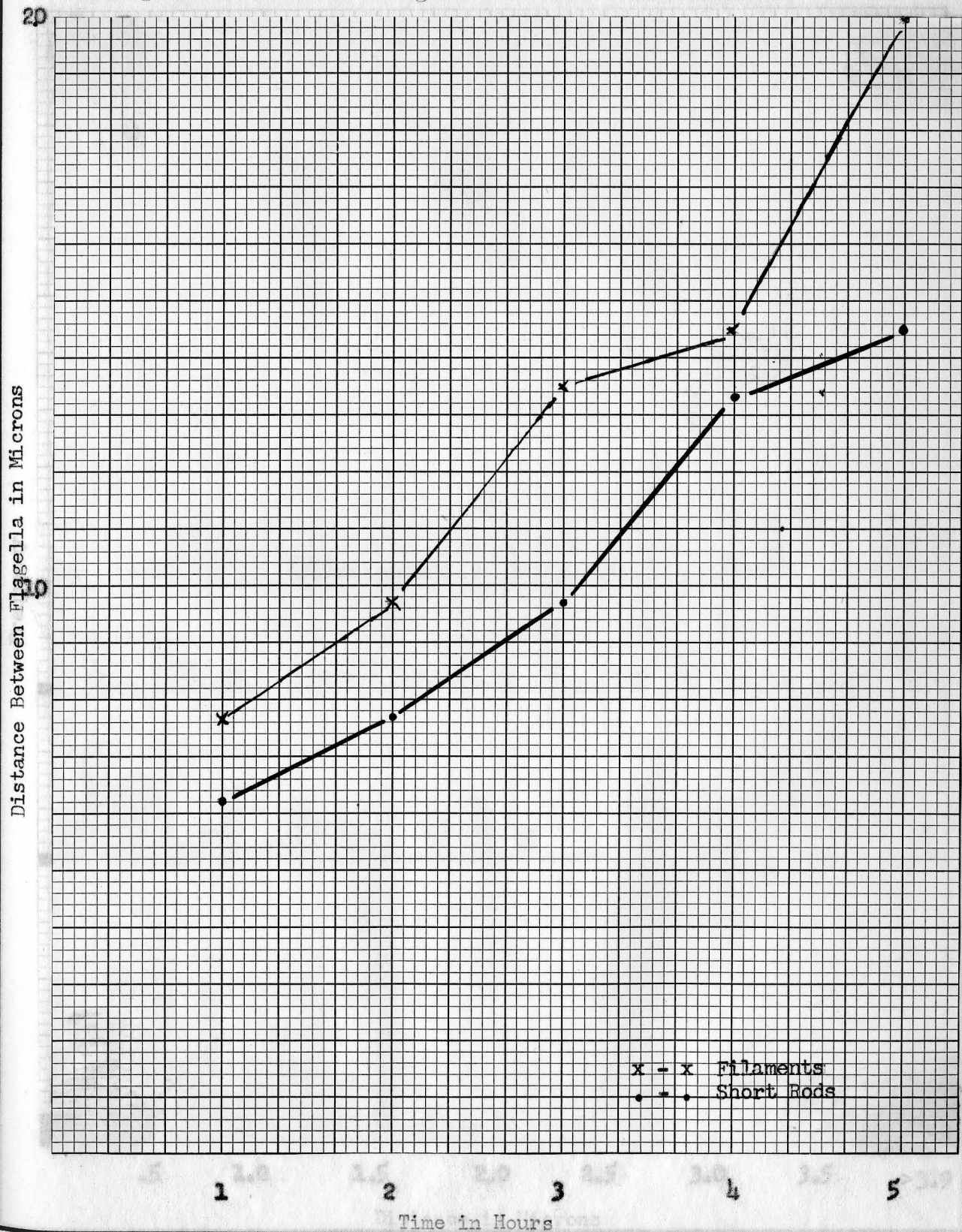
Graph 4-A Primary Temperature 20C; Secondary Temperature 38C  
Average Number of Flagella per Individual



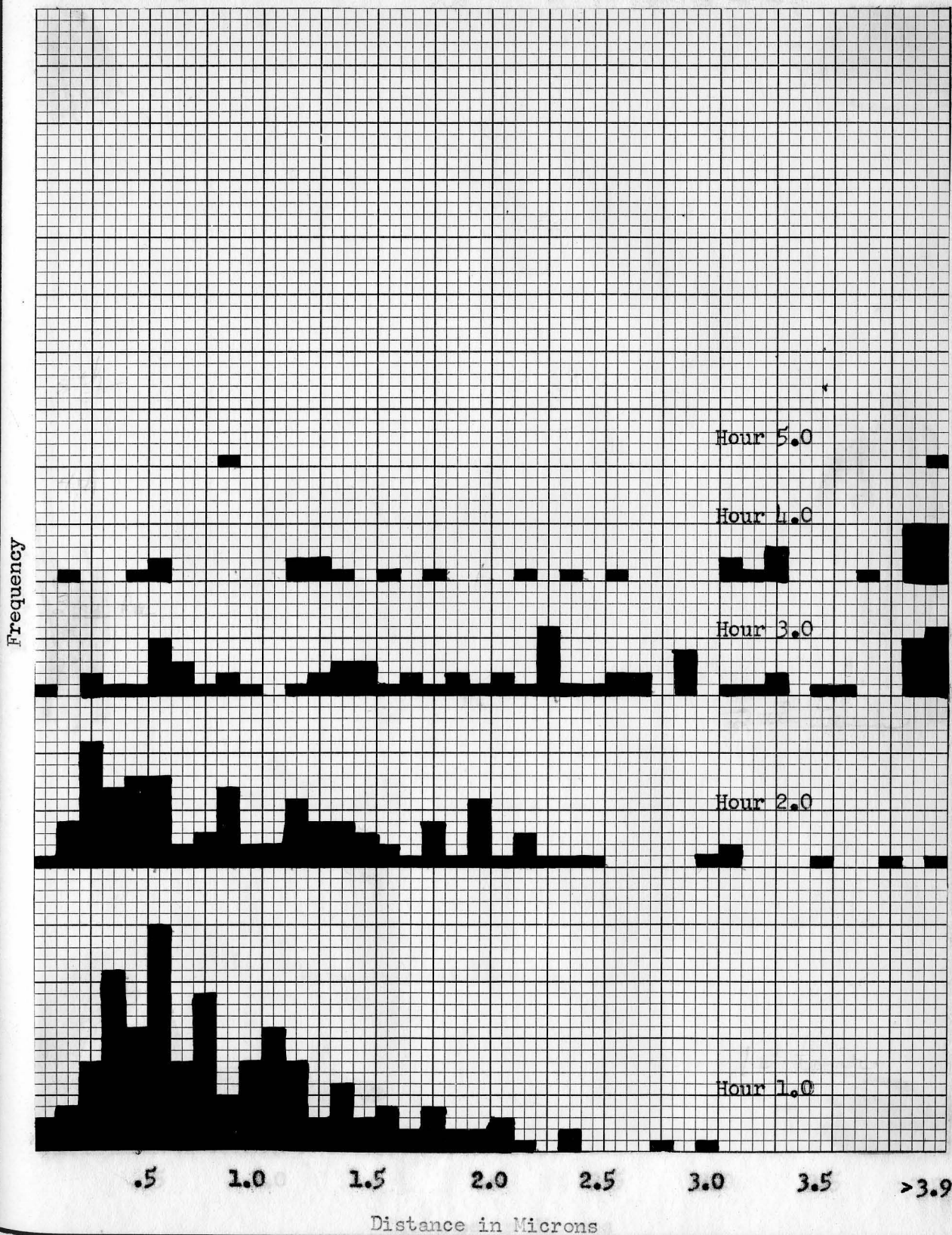
Graph 4-B

Primary Temperature 20C; Secondary Temperature 38C

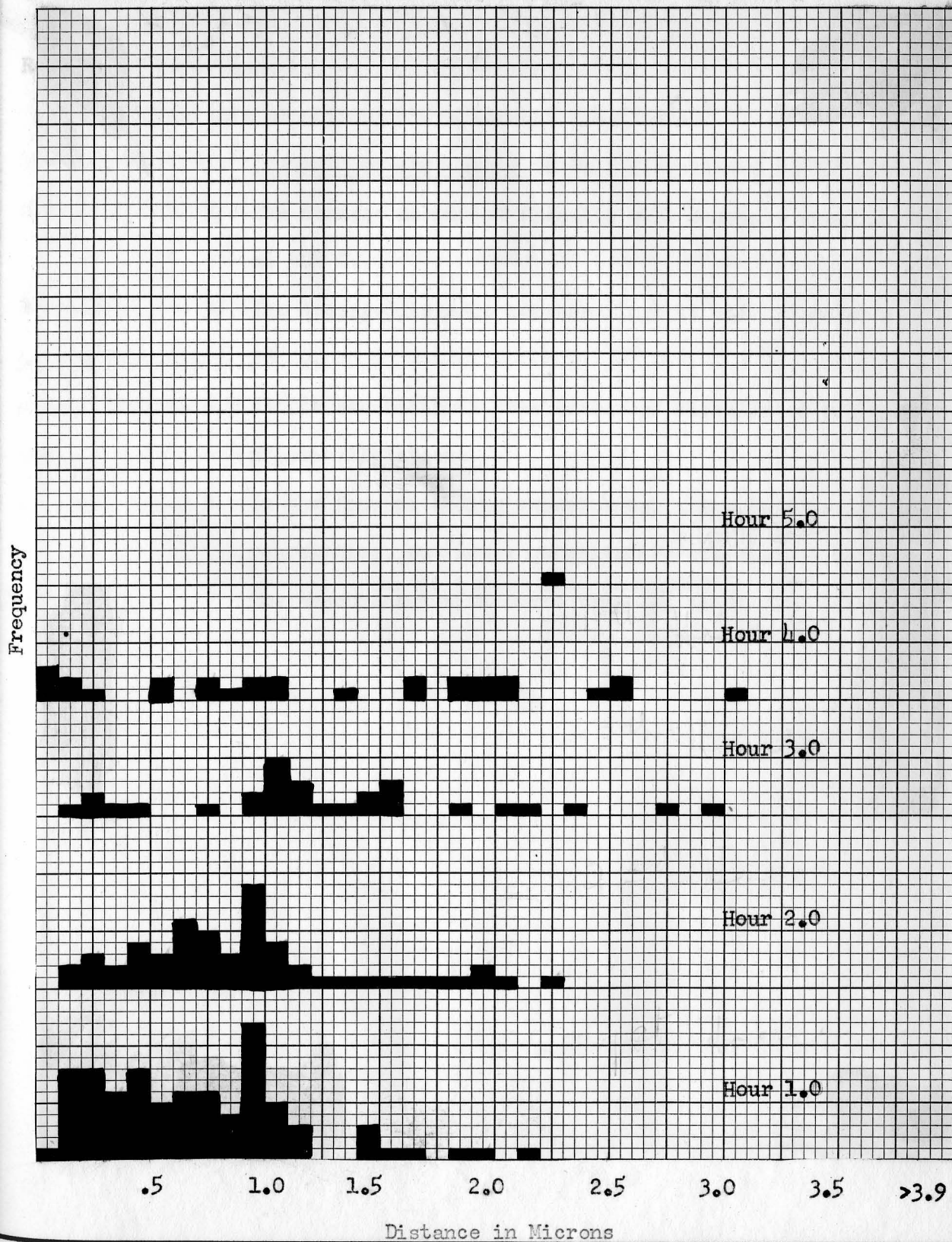
Average Distance Between Flagella



Graph 4-C Filaments Secondary Temperature 38C  
Frequency Distribution of Distance Between Flagella



Graph 4-D Short Rods Secondary Temperature 38C  
Frequency Distribution of Distance Between Flagella



Results of Experiment No. 4:

From this experiment it is demonstrated that:

1. Listeria monocytogenes is well flagellated at 20° C.
2. The average number of flagella will decrease when incubated at 38° C.
3. The average distance between flagella will increase at 38° C.
4. At the seventh hour, the number of flagellated cells were practically absent.
5. In the four preceding experiments, there is a qualitative correlation, but not a quantitative correlation between the measurement with short rods and those with filaments.



Experiment No. 5

After completion and analysis of the four preceding experiments, it was concluded that the increase in the number of viable cells, if any, should be determined.

The first series of plate counts were performed as follows: Into 200 ml. of casitone broth was placed a loopful of a stock suspension of L. monocytogenes. This was incubated at either 20° C. or 38° C. until a slight turbidity was evident. Without any change in incubation temperature, samples were removed hourly for a nine hour period. The purpose was to have a normal growth curve at this phase of the growth cycle in which the experiment was run.

## A. Original Temperature 38° C.; Secondary Temperature 38° C.

## Dilutions

Hour	1:100 Thousand	1:1 Million	Average $\times 10^6$
1	280 - 213 - 197	21 - 25 - 20 - 21	21.8
2		35 - 49 - 38 - 38	40
3		108 - 93 - 105 - 93	99.7
4		137 - 130 - 136 - 137	135
5		197 - 167 - 165	170.3
6		211 - 198 - 229 - 206	211
7		206 - 199 - 198 - 226	207.2
8		225 - 227 - 209 - 226	221.7
9		272 - 271 - 285 - 281	277.2

## B. Original Temperature 38° C.; Secondary Temperature 38° C.

## Dilutions

Hour	1:100 Thousand	1:1 Million	Average $\times 10^6$
1	190 - 198	25 - 20 - 23 - 18	23
2		37 - 48 - 35 - 30	37.5
3		95 - 98 - 89	94
4		195 - 186 - 182 - 180	185.5
5		196 - 192 - 188	192
6		251 - 243 - 244 - 251	243
7		290 - 283 - 286 - 280	284.2
8		261 - 269 - 253 - 284	266.7
9		393 - 376 - 319 - 374	378

Experiment No. 5 (Continued)

119

C. Original Temperature 20° C.; Secondary Temperature 20° C.

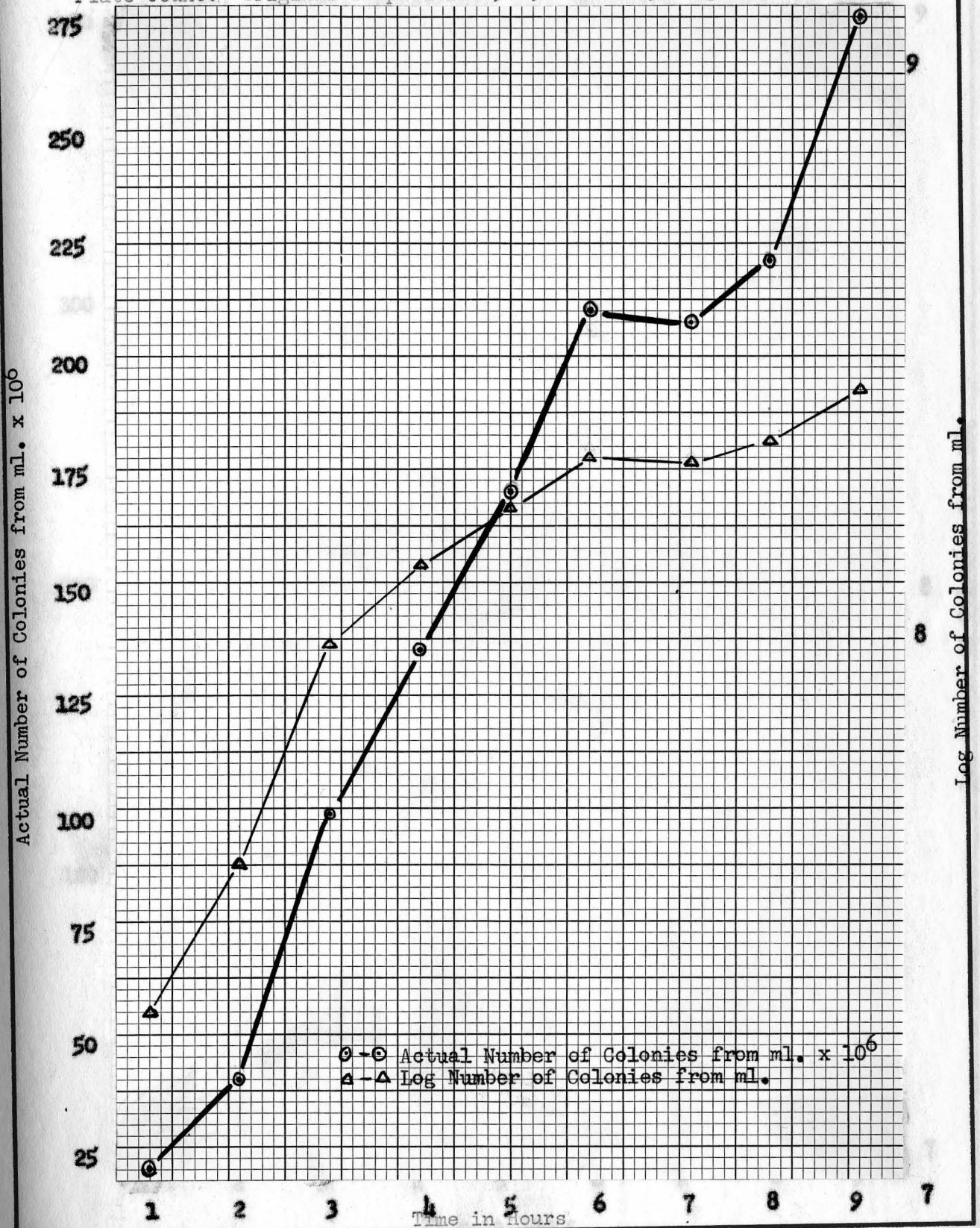
Dilutions			
Hour	1:100 Thousand	1:1 Million	Average $\times 10^6$
1	32 - 40 - 46		2
2		54 - 66 - 66	62
3		62 - 81 - 53	65.3
4		95 - 96 - 95 - 93	94.7
5		115 - 113 - 115 - 110	113.2
6		124 - 100 - 127	119
7		121 - 187 - 176	120.5
8		196 - 213 - 202 - 190	200.5
9		234 - 233 - 250	239

D. Original Temperature 20° C.; Secondary Temperature 20° C.

Dilutions			
Hour	1:100 Thousand	1:1 Million	Average $\times 10^6$
1	36 - 24 - 34 - 29		30.7
2	38 - 37 - 40 - 37		38
3	61 - 39 - 70 - 70		60
4	73 - 57 - 62 - 53		61.2
5	73 - 40 - 41 - 76		57
6	120 - 90 - 95 - 115		105
7	118 - 82 - 107 - 95		100.5
8	172 - 178 - 140 - 233		180.7

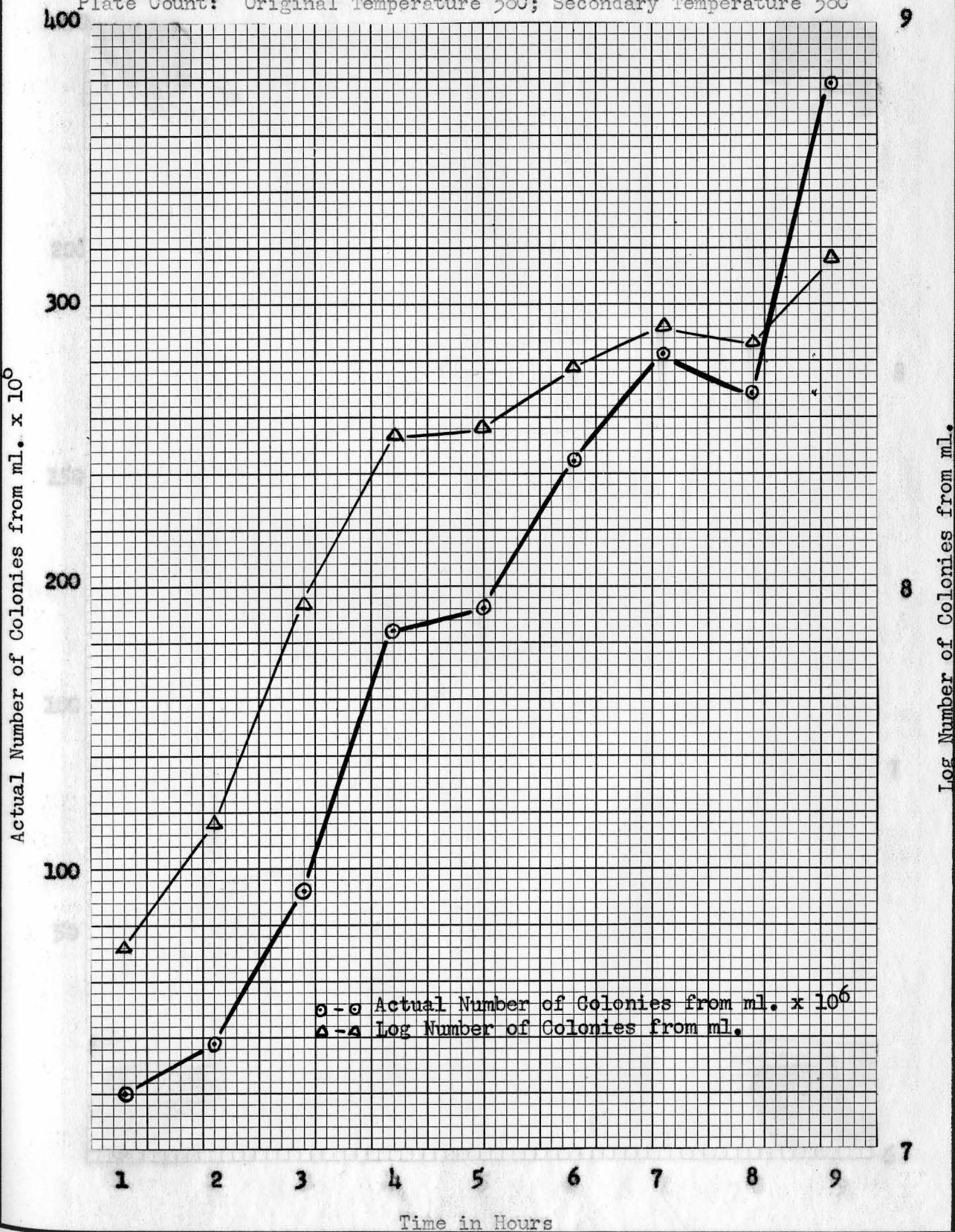
Graph 5-A

Plate Count: Original Temperature 38C; Secondary Temperature 38C



Graph 5-B

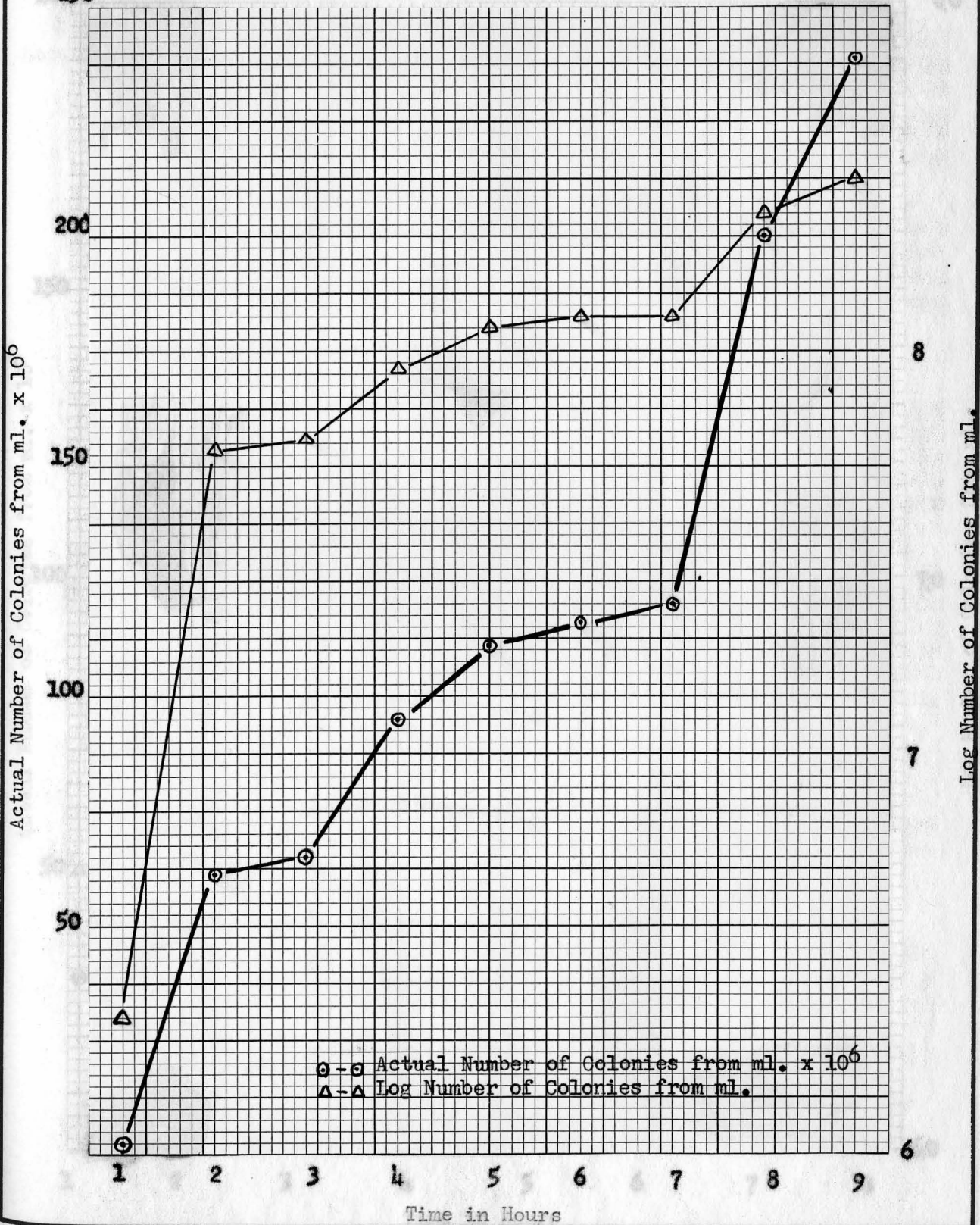
Plate Count: Original Temperature 38C; Secondary Temperature 38C



Graph 5-0

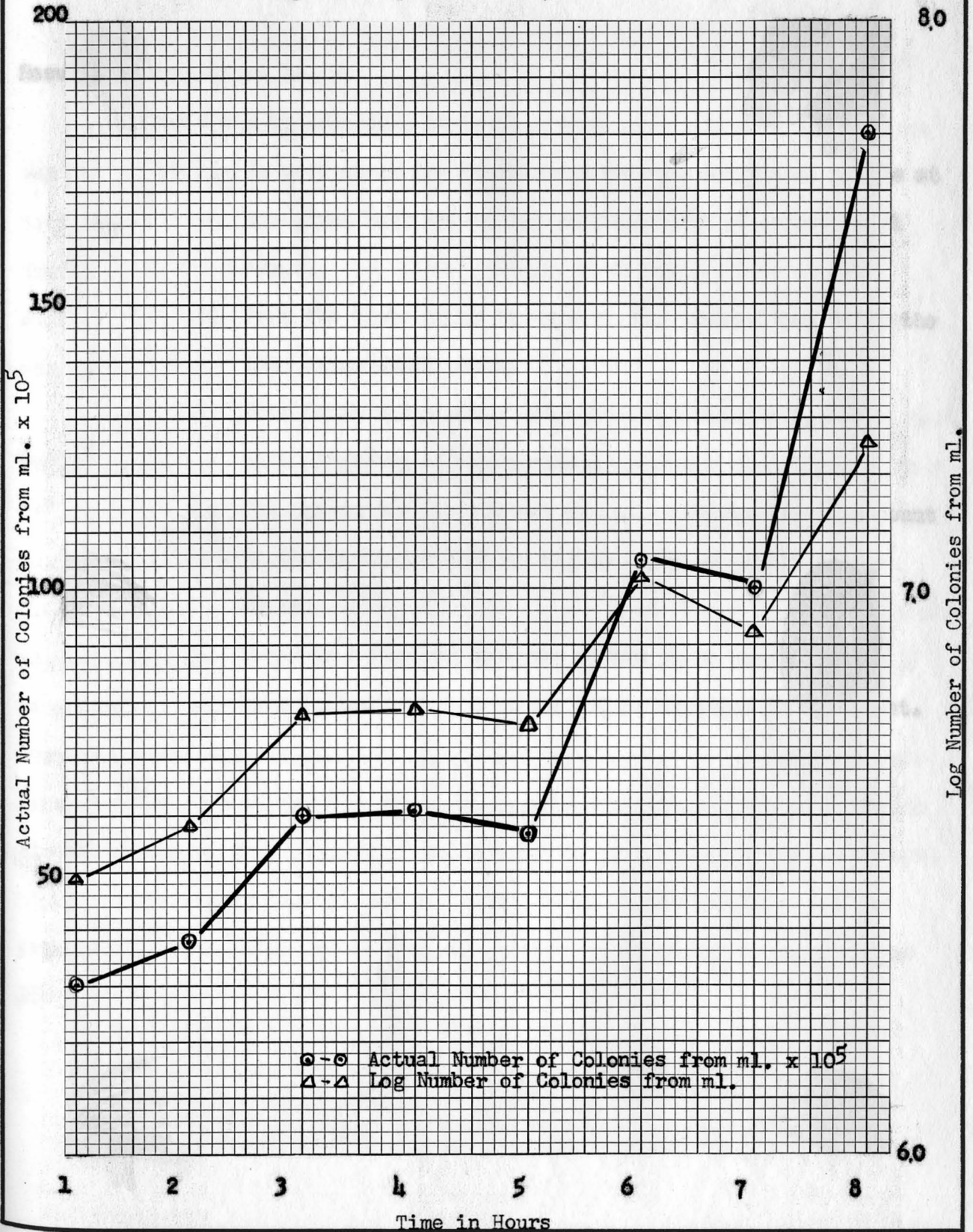
Plate Count: Original Temperature 200; Secondary Temperature 200

250



Graph 5-D

Plate Count: Original Temperature 20C; Secondary Temperature 20C



**Results of Experiment No. 5:**

From these experiments, it is seen that

1. In most cases the correlation between individual plates at any given hour is not beyond the limits of experimental error.
2. From the plate count it appears that the culture is in the late exponential phase.
3. Upon further incubation at the same temperature, the multiplication of the organisms proceeds normally.
4. The reason for the plateau or even decrease in plate count in the sixth, seventh or eighth hours of growth is not clear.
5. There is a further increase in the plate counts in the hour following the leveling off or decrease in the count.



Experiment No. 6

A plate count was made in which the primary incubation temperature was 38° C. and the secondary temperature was 20° C. The change in incubation temperature was made after a slight turbidity was evident in the culture incubated at 38° C. After the first aliquot was removed, the undiluted culture was placed in a 16° C. water bath for 5 minutes. Then the culture was placed in the 20° C. incubator.

Three plates were poured and upon solidification were placed in the 20° C. incubator. Two other plates were poured, one of which was placed in a 37° C. incubator, the other was left at room temperature. The purpose of this was to find if the incubation temperature would affect the plate count.

At each hour, four and one-half ml. of culture was added to one-half ml. of formalin. After one washing with distilled water at 3,500 g for 15 minutes the sediment was suspended in 5 ml. of distilled water. To four inch tubes was added one ml. of the washed suspension. Using the first tube as a standard, the turbidity of the other tubes was matched by dilution with distilled water. The measurement of density was roughly approximated by eye.

The same procedure was followed for the experiment in which the primary incubation temperature was 20° C. and the secondary temperature was 38° C.

Experiment No. 6-A

125

Plate Count: Original Temperature 38° C.; Secondary Temperature 20° C.

Hour	Incubation Temperature 20° C.	Average Incubation Temperature 37° C.	Room Temperature
------	----------------------------------	------------------------------------------	------------------

Counts Given in Million per ml.

1	36 - 41 - 36	37.6	35	31
2	41 - 50 - 43	43.6	35	33
3	50 - 47 - 53	50.0	61	54
4	85 - 55 - 60	66.6	75	67
5	86 - 66 - 09	80.3	76	79
6	96 - 80 - 97	91.0	101	91
7	142 - 110 - 115	122.3	150	114
8	178 - 196 - 177	183.6	184	207
9	229 - 233 - 228	230	227	222

**Dilutions**

Tube 1	2	3	4	5	6	7	8	9
1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.
		0.5	1	1.5	4	4	5	5
				1.0		1	1	2.5
						1		

**Totals:**

1 ml.    1 ml.    1.5 ml.    2 ml.    3.5 ml.    5 ml.    7 ml.    7 ml.    8.5 ml.

Relative number of cells per ml., based on turbidity.

38            38    57            76            103            190            266            266            323

Relative number of viable cells per ml., indicated by plate count.

38            44    50            66.6            80.3            91            122            183.6            230

Plate Count: Original Temperature 20° C.; Secondary Temperature 38° C.

Hour	Incubation Temperature 20° C.	Average Incubation Temperature 37° C.	Room Temperature
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## Counts Given in Million per ml.

1	38 - 36 - 30	34.5	26	37
2	74 - 74 - 95	81.0	88	77
3	189 - 199 - 200	196.0	189	186
4	210 - 212 - 230	217.3	228	219
5	285 - 281 - 295	287.0	289	270
6	351 - 361 - 348	353.3	353	350
7	429 - 417 - 430	419.0	No Count	418
8	370 - 378 - 410	386.0	400	399

## Dilutions

Tube 1	2	3	4	5	6	7	8
1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.
	1	1	3	3	4	4	5
		1		1		1	
		1					

## Total:

1 ml.	2 ml.	4 ml.	4 ml.	5 ml.	5 ml.	6 ml.	6 ml.
-------	-------	-------	-------	-------	-------	-------	-------

Relative number of cells per ml., based on turbidity.

35	70	140	140	175	175	210	210
----	----	-----	-----	-----	-----	-----	-----

Relative number of viable cells per ml., indicated by plate count.

34.5	81	196	217.3	287	353.3	419.0	386.0
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Plate Count: Original Temperature 38° C.; Secondary Temperature 20° C.

Incubation Temperature 20° C.

Hour	Dilutions		Average
	1:100 Thousand	1:1 Million	
1	6 - 10 - 9 - 13		9.5
2	6 - 13 - 12 - 10		10.2
3	16 - 13 - 22 - 18		17.2
4	32 - 23 - 24 - 31		28.0
5	40 - 51 - 46 - 47		46.0
6	40 - 60 - 75 - 65		60.0
7		13 - 11 - 7 - 13	11.0
8		14 - 15 - 11 - 12	13.0
9		21 - 25 - 23 - 24	23.2

**Dilutions**

Tube 1	2	3	4	5	6	7	8	9
1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.
			.25	.5	1	2	3.5	5
						1	1	1

**Total:**

1 ml. 1 ml. 1 ml. 1.25 ml. 1.5 ml. 2 ml. 4 ml. 5.5 ml. 7 ml.

**Relative number of cells per ml., based on turbidity**

10 10 10 12.5 15 20 40 55 70

**Relative number of viable cells per ml., indicated by plate count.**

9.5 10.2 17.2 28.0 46.0 60.0 110 130 232

Experiment No. 6-D

128

Plate Count: Original Temperature 20° C.; Secondary Temperature 38° C.

Hour	Incubation Temperature 20° C.	Average
	Counts Given in Million per ml.	
1	31 - 20 - 31 - 26	27
2	42 - 33 - 38 - 31	36
3	47 - 44 - 45 - 40	44
4	55 - 40 - 42 - 51	47
5	70 - 72 - 56 - 50	62
6	60 - 58 - 60 - 70	62
7	64 - 58 - 62 - 40	56
8	60 - 66 - 40 - 44	52.4

Dilutions

Tube 1	2	3	4	5	6	7	8
1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.	1 ml.
	.5	1	1.5	1.5	1.5	2.5	2
		.5		.5	1		.5

Totals:

1 ml.	1.5 ml.	2.5 ml.	2.5 ml.	3 ml.	3 ml.	3.5 ml.	3.5 ml.
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Relative number of cells per ml., based on turbidity.

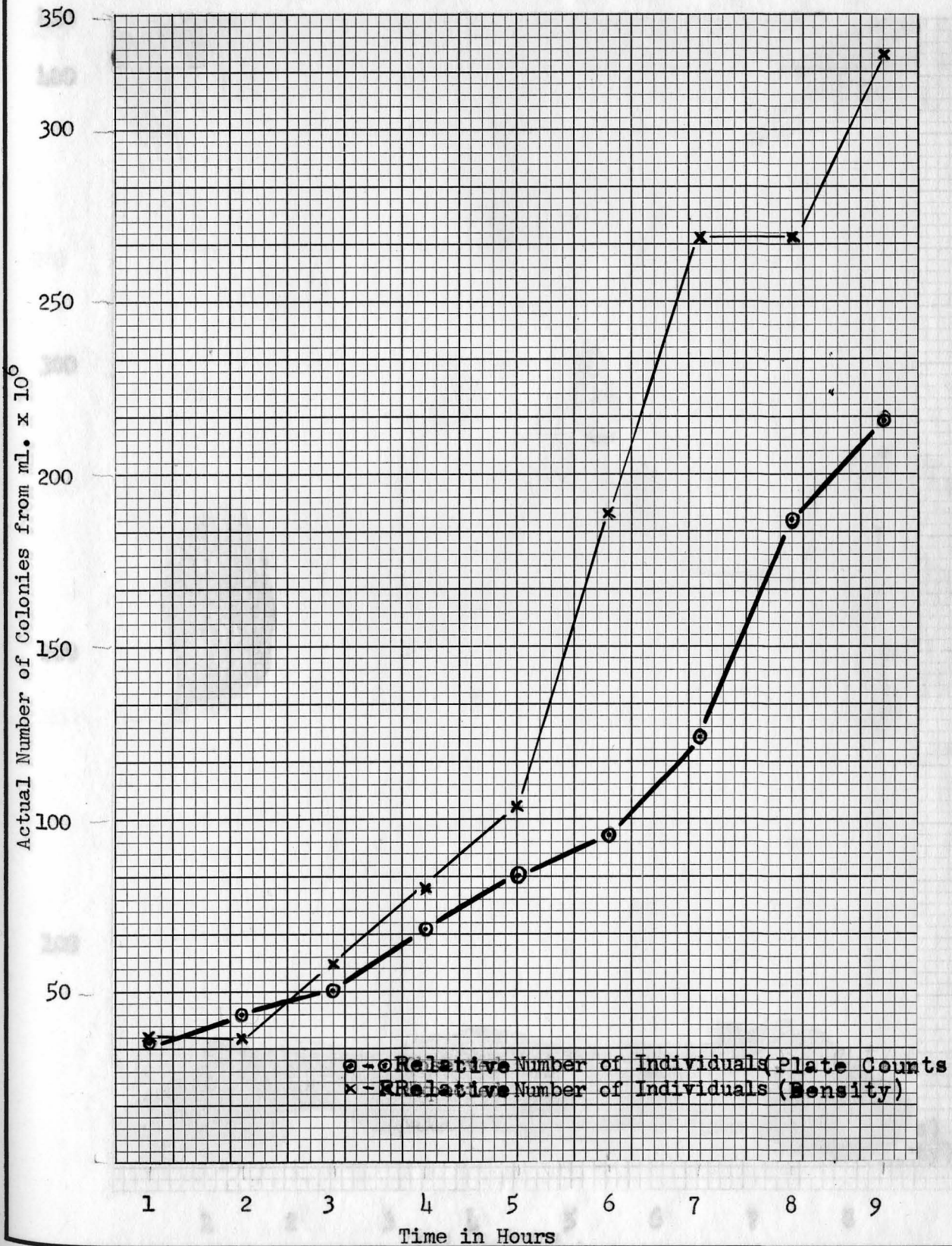
27	41	68	68	81	81	95	95
----	----	----	----	----	----	----	----

Relative number of viable cells per ml., indicated by plate count.

27	36	44	47	62	62	56	52.5
----	----	----	----	----	----	----	------

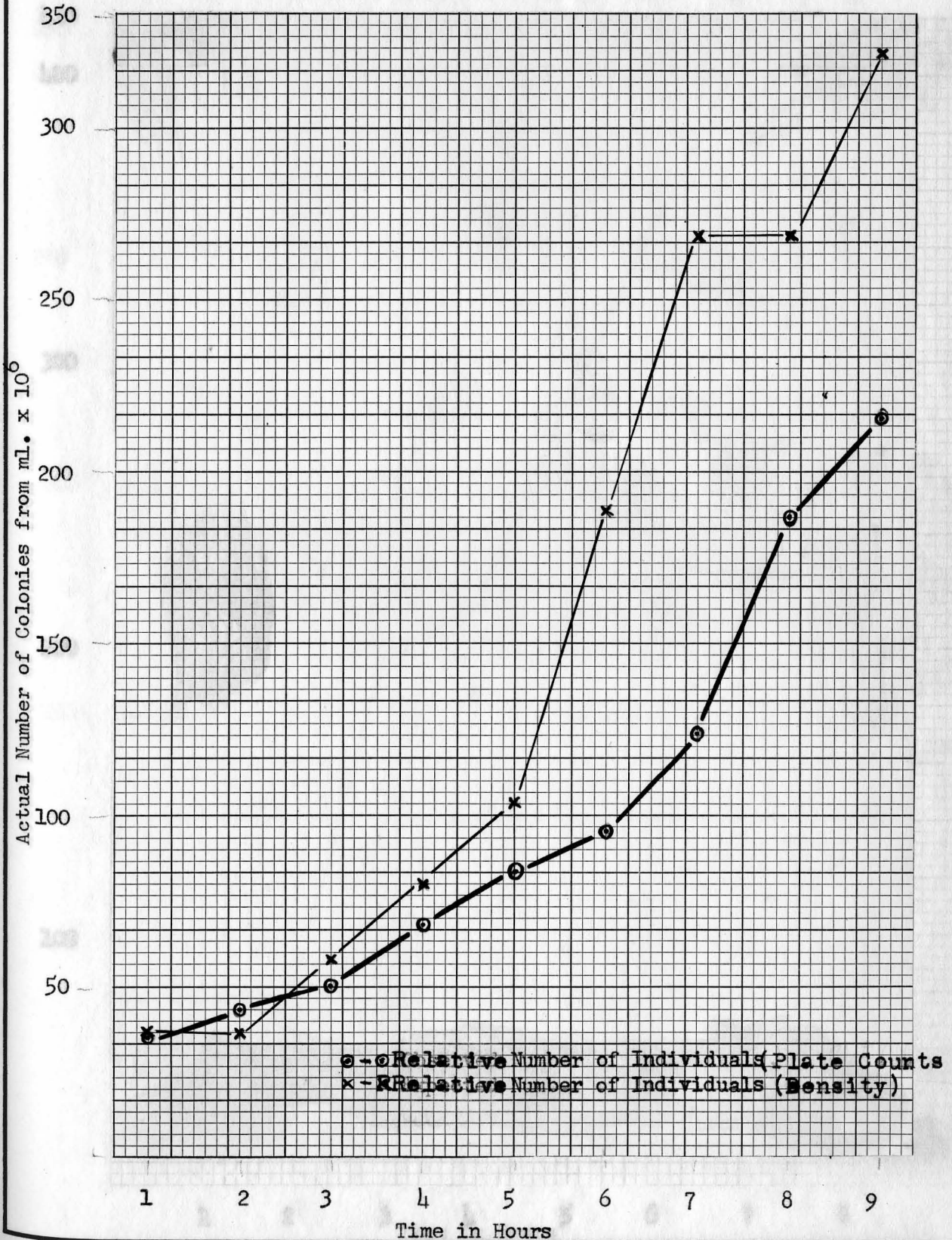
Graph 6-A

Plate Count: Original Temperature 38C; Secondary Temperature 20C



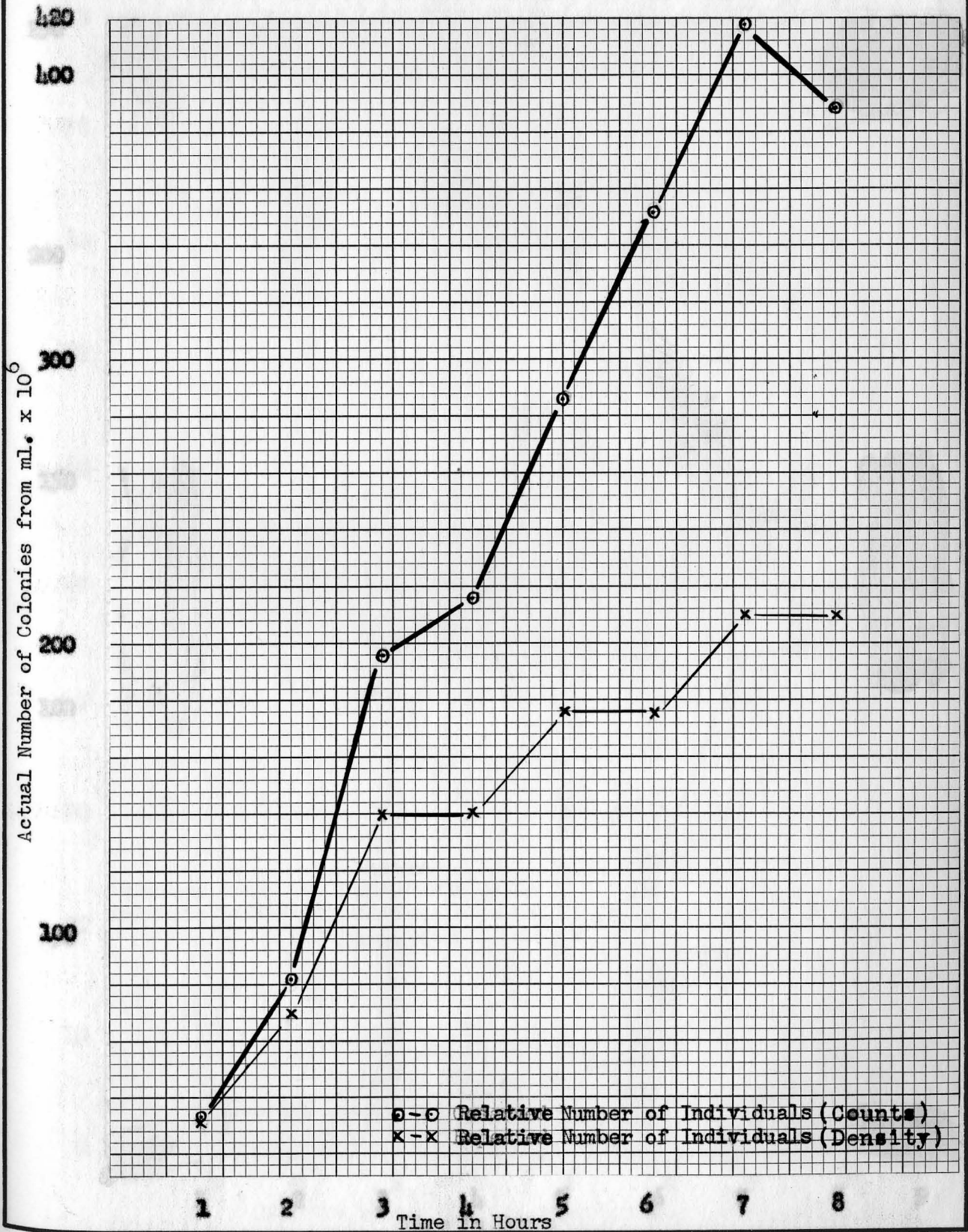
Graph 6-A

Plate Count: Original Temperature 38C; Secondary Temperature 20C



Graph 6-B

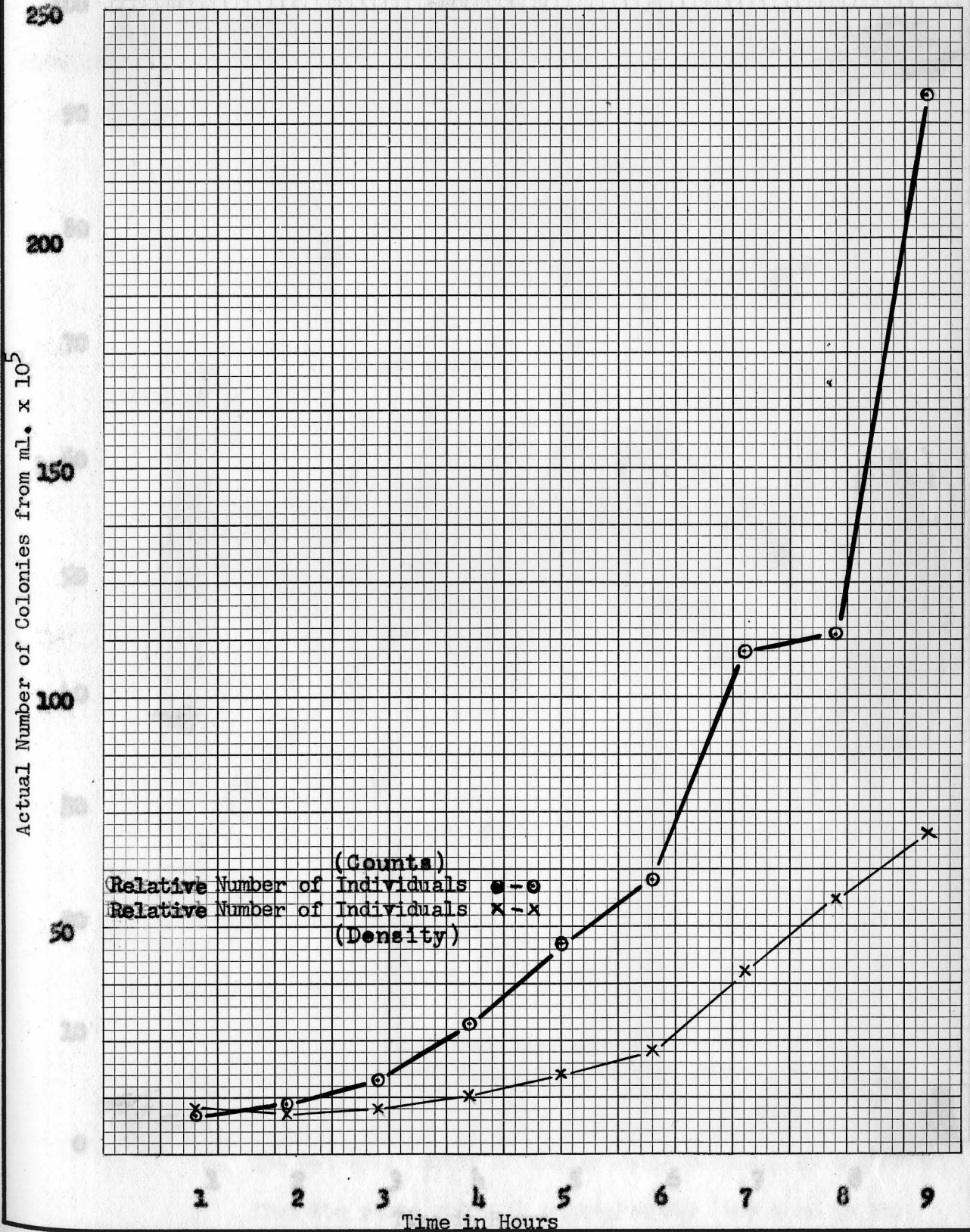
Plate Count: Original Temperature 20C; Secondary Temperature 38C





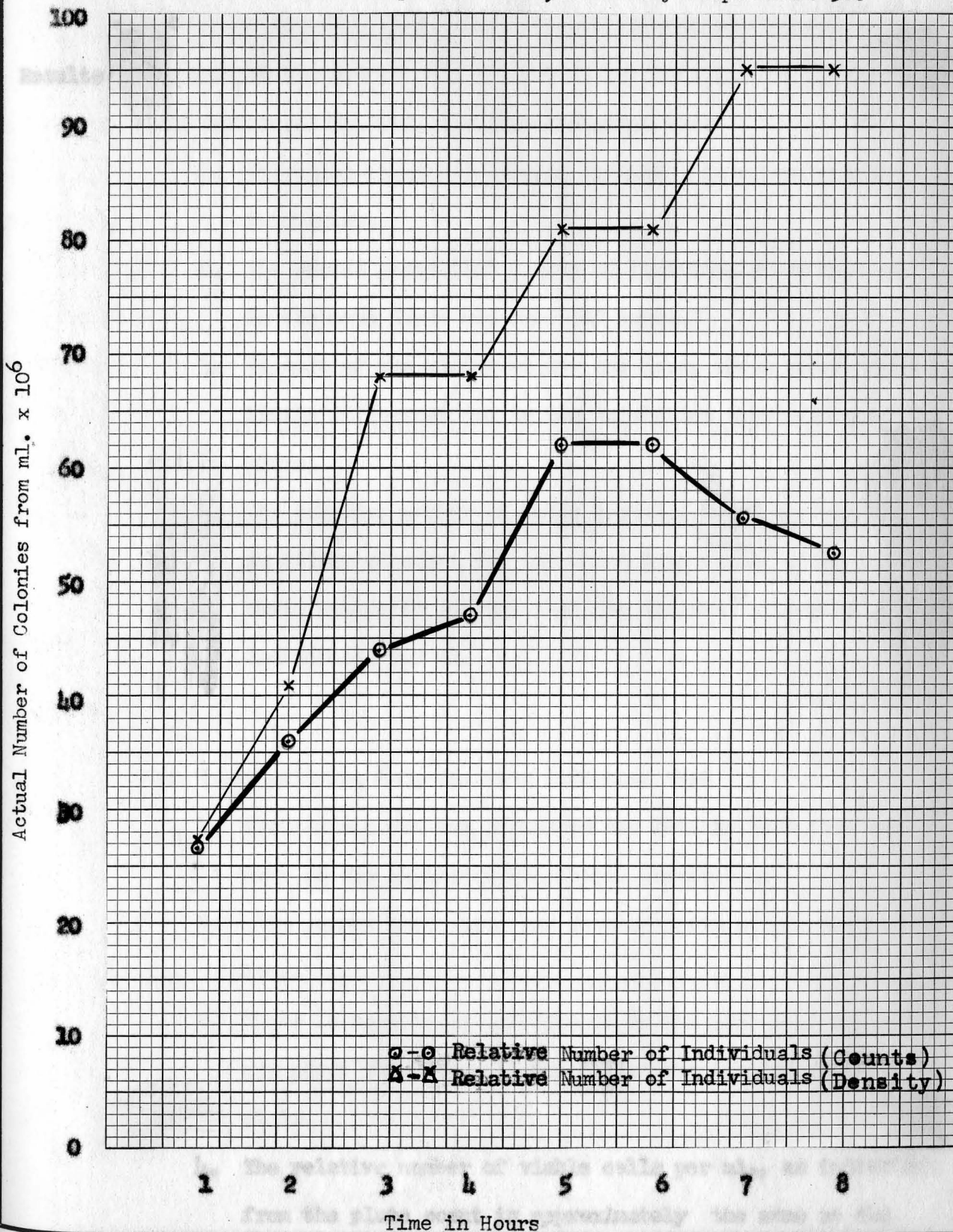
Graph 6-C

Plate Count: Original Temperature 38C; Secondary Temperature 20C



Graph 6-D

Plate Count: Original Temperature 20C; Secondary Temperature 38C



**Results of Experiment No. 6:**

From Experiment No. 6-A, the data indicates that

1. The plate count has doubled in number in approximately four hours.
2. The second generation number of individuals has doubled in the next three and one-half hours.
3. In most of the plates at any one hour, there seems to be little difference due to the incubation temperature of the plate.
4. The relative number of cells per ml., based on density, is fairly constant for the first four tubes, after which their number is greater than the observed number of individuals per ml.

From Experiment No. 6-B, the data indicates that

1. The plate count has increased two fold in less than one hour at the secondary incubation temperature.
2. This second generation has doubled again within the next hour.
3. There is no apparent difference in the number of colonies per plate regardless of the incubation temperature of the plate.
4. The relative number of viable cells per ml., as indicated from the plate count is approximately the same as the

relative number of cells per ml. based on density for the first two hours after which the latter is less than the relative number of viable cells per ml.

From Experiment No. 6-C, it seems that

1. The plate count has doubled in number in less than four hours.
2. The second generation has again doubled before the fifth hour.
3. The relative number of cells per ml. based on turbidity, is almost the same as the relative number of viable cells per ml. based on plate count for the first two hours. After the first two hours the latter is greater than the relative number of cells per ml., based on density.

From Experiment No. 6-D, it seems that

1. The plate count has doubled in number between the fourth and fifth hours.
2. The relative number of cells per ml. based on density is always greater than the relative number of viable cells per ml. based on plate counts except for the first hour.

NOTE: From the total experiment, it is seen that the relative number of cells per ml., based on density, is greater than the relative viable count in two tests. The first is when the original incubation temperature was 38° C. and the secondary temperature is 20° C. The other occurred when the primary temperature was 20° C. and the secondary temperature was 38° C. It is felt that with slight modification in technic that the procedure of matching turbidity may be a relative effective way of determining the approximate number of total cells per ml. at any given hour.

Experiment No. 7

A loopful of *L. monocytogenes* was inoculated into 200 ml. of caseitone broth at 38° C. When slight turbidity was evident, the bottle was removed from the 38° C. incubator to a water bath at 16° C. After five minutes, the culture was placed in a 20° C. incubator, and samples for staining and plate counts were removed hourly. The first sample was removed before placing the culture in the 16° C. water bath.

Experiment Number: 7

Incubation Time at 1st Hour at 20° C.

Plate Count: 24 million per cc.

<u>Soma</u>					<u>Flagella</u>			
Length					Number	Length	Distance Between	
2.1	2.2	2.5	1.8	2.2		All organisms observed were non-flagellated.		
3.8	2.8	2.5	1.5	2.1				
2.2	2.8	2.7	2.4	2.6				
2.5	2.3	2.5	2.2	3.2				
3.1	2.7	2.3	2.5	2.0				
1.9	1.9	2.7	2.4	13.6				
2.7	3.6	2.6	1.6	2.3				
2.2	1.9	2.4	1.6	1.9				
2.2	2.1	4.6	1.8	1.8				
2.6	1.7	8.2	3.5	1.8				
3.9	2.7	1.7	2.1	2.7				
1.8	2.5	1.7	10.2	2.1				
3.1	2.9	1.6	2.6	2.4				
1.7	1.6	1.9	1.8	2.3				
2.2	2.8	2.8	2.2	2.7				
3.5	3.8	3.9	2.1	1.8				
1.6	2.0	2.2	11.3	2.9				
2.0	1.8	2.1	3.9	2.3				
2.3	2.3	12.7	1.7	3.0				
1.5	2.1	1.6	1.8	3.4		Average: 2.7		

Experiment Number: 7

Incubation Time at 1.5 Hour at 20° C.

Plate Count:

<u>Soma</u>					<u>Flagella</u>		
					Number	Length	Distance Between
3.6	2.6	2.0	2.0	1.8	All organisms observed were non-flagellated.		
3.5	1.8	2.4	2.5	2.2			
1.6	2.0	4.6	2.4	2.4			
2.1	1.9	2.1	1.7	1.7			
1.7	2.3	2.4	1.9	1.7			
1.5	2.5	3.1	2.2	2.4			
3.3	1.9	3.0	2.1	2.2			
2.5	4.8	4.1	1.9	1.7			
2.0	2.4	2.6	2.3	1.9			
2.4	4.1	2.1	2.3	2.6			
1.9	1.7	1.6	2.4	1.8			
4.9	1.8	2.0	2.3	1.7			
1.9	1.8	3.3	2.8	1.8			
1.8	4.7	1.5	2.4	2.6			
1.7	2.3	2.8	2.3	2.2			
4.1	2.2	3.3	1.8	2.7			
1.7	2.4	2.4	3.1	2.2			
2.5	2.8	2.0	2.2	3.3			
2.0	1.6	2.1	2.5	1.8			
1.8	2.4	2.4	2.1	2.3			
					Average:	2.4	



Experiment Number: 7

Incubation Time at 2nd Hour at 20° C.

Plate Count: 18 million per cc.

<u>Soma</u>					<u>Flagella</u>		
Length					Number	Length	Distance Between
2.6	2.9	2.4	2.6	1.4		All organisms observed were non-flagellated.	
2.9	2.0	2.8	1.8	2.4			
2.5	2.7	2.8	2.0	1.8			
3.2	3.1	2.1	2.0	2.3			
1.6	1.9	2.2	2.5	2.4			
2.6	2.2	2.0	2.2	2.0			
2.9	2.3	2.5	1.5	3.4			
4.0	1.9	2.3	2.0	2.0			
2.3	2.0	2.9	2.8	3.8			
1.6	2.0	3.8	1.9	2.1			
2.0	2.7	2.3	3.2	2.6			
2.4	2.1	3.7	3.0	2.0			
2.4	3.5	2.0	1.7	2.0			
2.2	2.1	2.2	2.1	2.7			
2.0	2.6	2.0	1.6	4.8			
2.5	2.5	2.6	2.0	2.8			
3.0	2.2	2.8	2.5	1.9			
2.2	2.6	2.1	2.1	2.6			
2.0	2.9	1.9	2.0	3.0			
2.2	1.8	2.5	3.5	3.3			
					Average: 2.4		

Experiment Number: 7

Incubation Time at 2.5 Hour at 20° C.

Plate Count:

<u>Soma</u>					<u>Flagella</u>		
Length					Number	Length	Distance Between
2.7	3.0	1.9	2.8	2.3	All organisms observed were non-flagellated.		
2.8	2.8	8.3	2.4	2.0			
2.2	2.2	2.4	2.3	2.8			
2.7	4.4	2.3	2.8	5.3			
2.8	3.3	2.7	1.5	3.4			
1.5	2.2	2.1	4.6	2.2			
2.4	1.9	3.9	2.1	1.5			
1.7	1.8	4.3	2.0	2.5			
2.1	1.9	2.1	5.4	2.2			
4.1	2.1	1.5	2.6	2.1			
2.8	2.0	2.3	3.5	3.0			
4.2	1.8	1.8	2.1	2.2			
2.9	1.2	1.6	2.2	2.2			
2.3	2.5	2.0	3.0	1.5			
2.2	3.2	3.5	3.3	1.8			
1.8	2.2	3.0	2.4	2.1			
1.7	2.5	2.9	2.0	2.7			
3.1	3.2	3.0	2.0	1.6			
1.4	2.8	2.7	2.6	2.5			
2.6	2.7	2.6	2.8	2.0	Average: 2.6		

Experiment Number: 7

Incubation Time at 3rd Hour at 20° C.

Plate Count: 13 million per cc.

<u>Soma</u>					<u>Flagella</u>		
Length					Number	Length	Distance Between
2.3	2.7	2.3	4.0	2.0		All organisms observed were non-flagellated.	
2.3	3.2	2.9	2.3	4.1			
2.6	3.8	4.1	2.8	1.8			
2.3	1.9	2.5	2.1	2.7			
3.0	2.8	3.3	3.1	2.1			
2.1	3.2	3.5	2.3	2.3			
2.3	2.3	1.9	2.7	2.2			
2.1	4.0	1.9	3.7	1.3			
2.1	2.2	3.1	3.0	3.2			
2.2	3.9	2.8	2.3	1.8			
Average: 2.7							

Experiment Number: 7

Incubation Time at 3.5 Hour at 20° C.

Plate Count:

<u>Soma</u>				<u>Flagella</u>		
				Number	Length	Distance Between
2.7	3.3	3.3	2.5	All organisms observed were non-flagellated.		
2.4	2.2	2.9	3.6			
2.5	3.2	2.4	2.4			
2.1	4.2	4.3	7.0			
2.1	4.0	2.5	2.7			
3.3	3.2	2.7	2.6			
2.0	3.1	2.1	2.1			
2.7	2.0	2.3	3.3			
2.5	3.3	2.1	3.2			
2.8	3.0	5.7	3.3			
4.6	2.9	3.5	2.0			
2.8	2.1	2.5	2.1			
2.0	2.4					
Average: 2.9						

Experiment Number: 7

Incubation Time at 4<sup>th</sup> Hour at 20° C.

Plate Count: 23 million per cc.

<u>Soma</u>					<u>Flagella</u>		
					Number	Length	Distance Between
3.1	3.8	2.5	2.5	2.5	All organisms observed were non-flagellated.		
2.1	3.2	2.7	1.9	2.5			
2.5	3.3	2.9	3.5	2.4			
2.6	2.1	2.5	2.4	3.8			
2.0	1.8	2.7	1.6	3.4			
4.4	2.9	4.7	4.1	3.7			
2.9	2.6	3.0	2.9	2.1			
2.0	1.8	1.6	2.7	3.6			
4.2	3.4	1.8	2.8	2.8			
2.3	2.1	5.0	2.8	5.2			
1.7	6.4	2.8	2.8	2.4			
2.4	2.3	2.2	2.6	1.7			
2.3	1.8	2.8	2.3	2.3			
2.1	2.8	2.4	3.1	2.5			
2.8	5.8	2.4	2.0	1.4			
Average: 2.8							

Experiment Number: 7

Incubation Time at 4.5 Hour at 20° C.

Plate Count:

<u>Soma</u>					<u>Flagella</u>		
Length					Number	Length	Distance Between
3.2	1.9	1.4	2.1	3.2		All organisms observed were non-flagellated.	
2.9	5.3	2.8	2.2	3.0			
2.9	3.0	1.9	3.5	2.0			
4.4	2.2	2.4	1.6	2.2			
3.1	2.0	2.1	2.1	3.2			
2.0	4.9	2.5	2.0	3.1			
2.9	3.0	3.3	2.1	1.5			
5.4	3.3	1.6	4.1	3.6			
3.0	2.3	3.7	2.7	3.1			
2.3	3.0	2.6	2.0	2.1			
3.2	2.7	6.4	2.4	2.9			
1.7	4.7	2.4	1.9	2.2			
3.5	1.7	5.5	3.7	3.6			
3.8	1.7	3.0	1.3	3.0			
3.5	3.2	3.4	1.6	2.5			
Average: 2.9							

Experiment Number: 7

Incubation Time at 5th Hour at 20<sup>0</sup> C.

Plate Count: 31.5

<u>Soma</u>				<u>Flagella</u>		
				Number	Length	Distance Between
			1.6	1	.3	
2.1	1.6	3.0	2.0			
1.7	2.0	2.0	3.0			
2.5	2.1	2.9	2.0			
2.3	3.1	2.7	2.0			
2.3	3.1	3.2	3.0			
2.4	1.8	2.5	2.3			
3.1	2.0	3.1	2.5			
1.9	1.7	1.7	1.4			
2.0	2.8	2.8	2.1			
2.5	2.9	2.7	1.8			
2.8	5.4	2.5	2.0			
3.1	1.9	2.4	2.2			
2.3	2.1	4.5				
Average: 2.4				.02	.3	

Experiment Number: 7  
 Incubation Time at 5.5 Hour at 20° C.

Plate Count:

<u>Soma</u>				<u>Flagella</u>		
Length				Number	Length	Distance Between
			5.2	1	.4	
			2.8	1	.3	
			2.8	1	.9	
			3.0	1	.3	
			1.8	1	.8	
1.6	2.4	1.6	2.8			
1.9	2.8	2.7	3.9			
2.1	3.6	2.3	2.7			
2.2	2.3	3.0	2.4			
2.6	2.7	2.1	2.0			
2.4	2.2	2.8	3.0			
2.5	1.5	3.3	2.2			
2.2	3.8	1.4	2.0			
2.3	2.1	3.5	2.0			
2.1	2.1	2.5	1.9			
2.3	1.7	2.3	3.6			
2.7						
<b>Average: 2.5</b>				<b>.1</b>	<b>.5</b>	



Experiment Number: 7

Incubation Time at 6th Hour at 20° C.

Plate Count: 44.5 million per cc.

<u>Soma</u>				<u>Flagella</u>		
Length				Number	Length	Distance Between
			3.4	1	.7	
			1.9	1	.6	
			1.6	1	.4	
			2.2	1	1.6	
			2.3	1	.8	
			1.7	2	2.4 - 1.2	1.2
			2.7	1	.7	
			2.5	2	1.7 - .4	1.6
			2.0	1	.6	
			2.8	1	.7	
			3.5	1	.6	
1.3	1.9	2.3	2.2			
2.6	3.0	1.9	2.4			
2.2	1.9	3.8	1.2			
2.0	2.6	2.2	2.3			
3.0	3.6	1.7	1.7			
2.8	2.0	1.6	2.4			
1.5	2.8	2.5	2.4			
2.0	2.0	2.4	3.4			
1.4	2.0	2.1	1.8			

Experiment Number: 7

Incubation Time at 6th Hour at 20° C. Continued

Plate Count: 44.5 million per cc.

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
Average: 2.3	.2	1.0	1.4

Experiment Number: 7  
 Incubation Time at 6.5 Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
5.5	2	2.1 - .7	2.6
2.7			
2.3	2	3.0 - .6	1.6
1.9	1	1.0	
1.9	1	1.0	
1.9	1	1.3	
2.7	2	2.3 - .9	1.5
2.7	2	1.9 - .3	
1.9	1	.4	
2.1			
2.7	1	1.8	
2.6	1	.3	
3.9	2	1.3 - 1.2	1.5
2.9	1	1.1	
1.5	1	.5	
2.4	1	.3	
3.2	1	.5	
2.4	2	2.6 - 1.4	1.5
2.3	1	.8	
2.4			

Experiment Number: 7

Incubation Time at 6.5 Hour at 20° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>			
	Length	Number	Length	Distance Between
1.9	1	.8		
1.8	1	.5		
2.8	1	1.3		
2.3	1	2.0		
1.7	2	1.5 - .3		1.1
1.2	1	.3		
2.4				
2.1	1	1.1		
2.0	1	1.1		
1.6	2	.8 - .4		.4
2.6	1	1.1		
1.8	1	2.0		
1.7	2	2.5 - 2.2		
5.0	1	.5		
3.1	1	.5		
1.8				
1.8	2	1.7 - .5		.8
1.4	1	.9		
2.9	1	.4		
4.9				

Experiment Number: 7

Incubation Time at 6.5 Hour at 20° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>			
	Length	Number	Length	Distance Between
2.3	1	1.9		
2.5	1	1.0		
2.9	1	.3		
2.5	2	2.3 - .3		1.4
2.2	1	.8		
2.6	2	2.5 - 2.0		1.7
2.2	1	1.3		
2.1	1	.4		

Experiment Number: 7  
 Incubation Time at 6.5 Hour at 20° C.

150

Plate Count:

<u>Soma</u>					<u>Flagella</u>			
Length					Number	Length	Distance Between	
1.8	2.1	1.8	3.0	1.9	No flagella observed.			
2.5	2.0	2.3	1.8	2.5				
2.3	2.9	2.3	2.2	2.6				
2.7	2.4	2.3	1.4	2.1				
2.0	2.4	3.0	1.5	2.2				
2.1	2.2	3.0	2.4	2.0				
3.2	2.0	2.1	2.0	2.1				
2.6	1.5	3.0	1.7	2.0				
2.3	2.4	2.1	2.1	4.0				
3.1	2.6	1.4	2.3	2.8				
2.0	2.1	3.0	2.8	2.0				
Average: 2.4								

Experiment Number: 7

Incubation Time at 7th Hour at 20° C.

Plate Count: 59 million per cc.

<u>Soma</u>	<u>Flagella</u>			
	Length	Number	Length	Distance Between
2.0	2	4.4 - 2.6		.4
2.7	1	1.4		
1.8	1	.5		
1.6	2	3.1 - 1.5		.7
2.6	1	1.3		
2.3				
1.6	2	3.4 - .5		1.1
2.9	4	2.4 - 4.4 - 1.2 - .9		.4 - .5 - .6
2.6	1	.9		
2.7				
2.0	1	.5		
2.6				
1.9	1	.2		
2.0	1	2.9		
1.7	1	2.0		
2.7				
1.6				
1.9	1	1.4		
1.6	1	1.7		
1.9	1	1.8		

Experiment Number: 7

Incubation Time at 7th Hour at 20° C. Continued

Plate Count: 59 million per cc.

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
2.8	2	1.1 - .3	.5
3.8	3	1.9 - .3 - .7	1.4 - .8
2.3	2	3.6 - 1.2	1.0
2.7	2	3.5 - .5	1.3
2.1	2	2.4 - .7	1.0
1.7	1	2.0	
1.7	1	2.1	
2.1	1	.4	
2.2	1	.9	
2.6	1	2.1	
2.3	1	1.7	
2.6	1	2.1	
2.6	2	2.4 - 1.0	1.3
4.0	1	.3	
2.4	2	1.6 - .5	.5
1.9	3	3.4 - 1.5 - 3.3	.4 - .6
1.5	2	3.3 - .7	.4
3.0	3	3.0 - 1.0 - .7	.8 - .3
5.2	3	2.8 - 1.3 - .4	1.8 - .7
6.3	2	4.0 - 2.3	1.3



Experiment Number: 7

Incubation Time at 7th Hour at 20° C. Continued

Plate Count: 59 million per cc.

<u>Soma</u>					<u>Flagella</u>		
					Number	Length	Distance Between
2.0					3	2.6 - 1.9 - .8	.6 - 0
2.1					1	1.6	
2.5					2	1.6 - .5	.5
2.2					2	2.3 - .7	0
1.9					1	2.1	
2.3					2	1.0 - .3	.5
2.1					1	.8	
1.8					1	1.9	
2.6	2.2	2.5	2.6	3.6			
1.7	2.1	2.7	1.7	2.6			
1.7	2.3	2.3	3.6	3.0			
2.2	2.7	3.5	2.0	2.0			
2.6	1.8	2.1	1.9	3.9			
3.2	2.2						
Average: 2.4					.93	1.7	.78

Experiment Number: 7  
 Incubation Time at 7.5 Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
2.3	2	2.0 - .5	.4
2.1	1	4.2	
2.1	2	2.7 - .9	.7
3.0	2	.8 - .6	1.8
2.2	2	3.1 - 1.1	0
3.1	7	3.4 - .4 - 3.4 - .5 3.3 - 1.0 - .6	0 - .5 - 0 - 1.4 - .6
2.1	2	3.1 - 1.8	.4
2.3	2	2.5 - .4	1.0
2.6	3	1.6 - 2.0 - .4	.9 - .4
3.7	6	2.8 - .5 - 2.7 - 1.4 2.5	
1.9	3	4.0 - 2.2 - 1.1	1.2 - 0 - .4
2.8	2	2.1 - .3	.7
4.7	7	2.2 - .6 - 3.2 - .9 3.5 - 1.2 - 1.8	1.4 - .4 - 1.5 - .8 0 - .2
2.0			
1.9	1	1.6	
2.5	1	1.8	
3.2	2	1.8 - 1.6	1.9

Experiment Number: 7

155

Incubation Time at 7.5 Hour at 20° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.7	3	1.8 - 1.9 - 1.9	2.9 - .3
2.0	2	4.3 - 2.4	.8
4.0	4	4.7 - .4 - 2.5 - 2.8	2.3 - .5
1.8			
2.2			
2.4	3	1.6 - 2.7 - 1.8	1.0 - .8
3.6			
2.8			
2.7	3	3.3 - 3.2 - 2.3	1.6 - 1.1
2.2	4	.6 - 4.5 - 3.2 - 1.9	.9 - 0 - 1.1
2.3	1	1.2	
2.9	3	2.2 - 2.6 - 1.4	1.4 - 0
2.7			
2.6	2	2.2 - 1.6	.6
4.4	7	1.3 - 3.8 - .3 - 1.5 2.6 - 3.1 - 2.7	1.2 - 2.0 - .7 - 0 - 0 0
3.2	1	1.0	
1.9	1	2.0	
2.1	1	1.7	
3.1	2	3.4 - .6	2.2

Experiment Number: 7

156

Incubation Time at 7.5 Hour at 20° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
2.3	2	2.3 - .2	1.4
2.1	3	4.1 - 1.7 - 2.5	.7 - 0
2.7	2	2.1 - 1.1	.4
2.4	2	3.1 - .7	.6
3.0	1	2.0	
1.7	1	.9	
1.5	2	2.5 - .4	0
5.6	6	2.1 - .2 - 1.5 - 1.0 1.6 - .8 - 1.5	1.5 - .7 - 1.6 - .4 - 0
1.8	1	.7	
2.0	1	1.9	
2.9	1	2.4	
2.3	2	2.6 - .8	1.8
2.4	3	2.9 - .4 - .8	1.1 - 0
1.7 2.5 3.6 2.2			
1.9 2.4			
Average: 2.6	2.0	1.9	1.04

Experiment Number: 7

Incubation Time at 8th Hour at 20° C.

Plate Count: 81 million per cc.

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
2.0	3	4.4 - .7 - 2.8	.1 - 1.6
1.6	1	1.8	
2.2	1	.2	
1.7	3	3.5 - .5 - 1.1	0 - 0
2.1	1	2.7	
2.8	3	1.7 - 3.2 - 2.3	1.4 - .9
1.4	1	2.2	
1.8	3	.7 - 1.4 - 4.1	.4
2.1	2	3.4 - 2.4	0
2.8			
2.7	2	1.3 - .5	1.0
2.3			
2.3	2	1.3 - .8	.9
1.9			
2.2	3	4.8 - 2.9 - .6	0 - 1.0
2.3	1	2.5	
1.9	4	3.2 - 4.8 - 1.2	.5 - 0
3.4	3	4.2 - 3.7 - 2.1 - 1.0	.6 - 1.1
2.0			
3.1			

Experiment Number: 7  
 Incubation Time at 8th Hour at 20° C. Continued  
 Plate Count: 81 million per cc.

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
1.8	2	1.9 - 1.9	.9
2.7	4	2.3 - 1.6 - 1.8 - 4.3	2.0 - .7 - 0
2.6	3	2.5 - 3.4 - 2.5	1.6 - 1.7
1.8	1	1.4	
2.1			
2.0	2	3.9 - .3	1.2
1.7	2	3.4 - 2.7	0
2.0	2	2.1 - 3.9	.6
2.5	6	2.7 - .4 - 1.7 - 1.4 3.3 - 3.1	.7 - 0 - .9 - .3 - .4
2.7	2	2.3 - 1.0	1.9
2.5	3	3.8 - 3.4 - 3.5	.4 - 0
1.6	1	2.9	
2.0	3	1.0 - 2.8 - 5.8	.3 - .8
1.7	2	2.7 - 3.6	1.2
2.2	1	.7	
2.9	3	3.9 - 2.1 - .9	1.9 - .5
2.5	3	3.6 - 1.0 - .3	1.2 - .7
1.9	2	1.2 - 2.7	.8
3.7	4	2.8 - .7 - 3.1 - 1.8	.8 - 1.2

Experiment Number: 7

Incubation Time at 3<sup>rd</sup> Hour at 20° C. Continued

Plate Count: 81 million per cc.

<u>Soma</u>				<u>Flagella</u>		
				Number	Length	Distance Between
2.9		5	4.5 - 1.4 - 1.6 - 1.5 4.0	1.3 - 0 - 1.4		
1.5		3	.9 - 2.2 - 2.5	1.1		
2.6		2	3.2 - 1.0	.9		
2.4		2	1.9 - 1.0	1.3		
1.7		1	2.1			
3.2		2	4.5 - 3.5	1.5		
3.0		2	3.8 - 3.8	2.1		
3.2		4	2.8 - 2.6 - .4 - 1.9	.9 - .9 - .4		
2.8		3	2.5 - 2.5 - 2.3	.5 - 1.0		
2.3		4	1.6 - 4.5 - .4 - 1.6	1.1 - .6		
2.1	3.4	3.0	2.2			
1.9	2.5	1.9	1.9			
2.4	2.2	2.7	3.4			
<b>Average:</b> 2.3				1.75	2.3	1.00

Experiment Number: 7

160

Incubation Time at 2.5 Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.6	4	2.4 - 4.2 - 2.1 - 5.6	.7 - .8 - 0
2.1	3	5.5 - 2.3 - .9	.7 - .6
2.4	1	2.0	
2.0	2	3.7 - 2.1	.9
2.3	3	3.1 - 2.6 - .9	1.5 - 0
3.0	2	.5 - 3.3	2.6
1.7	3	2.5 - 1.2 - 1.7	.8 - .5
1.9	2	2.8 - .3	.2
1.5	2	2.3 - 2.5	.5
2.1	1	1.3	
2.9	4	2.8 - 4.1 - 1.0 - 1.2	.7 - .5 - 1.0
3.0	5	3.0 - 1.5 - 5.2 - 3.2 1.5	0 - .7 - 0 - 1.6
1.8			
1.6	3	2.5 - 1.7 - 4.5	.9 - 0
1.5	2	5.6 - 2.8	.6
2.3	3	2.7 - 2.2 - 1.0	.8 - .7
2.0	3	3.0 - 3.4 - 5.2	1.2 - .8
3.1	1	1.8	
5.3	4	2.7 - 1.2 - 2.5 - 5.0	.7 - 1.8 - 2.2



Experiment Number: 7  
 Incubation Time at 8.5 Hour at 20° C. Continued

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
2.0	2	1.6 - 1.7	.9
2.3	2	3.9 - 2.5	0
2.4	4	3.6 - 4.9 - 4.7 - 2.8	.4 - .5 - .6
2.6	1	1.9	
2.3	1	2.3	
2.3			
2.2	6	5.5 - .4 - 3.3 - .8 3.5 - 2.3 - 2.4 - .3	.7 - .5 - 0 - .4 - .5 .6
2.0	2	2.4 - .3	.6
2.2	2	2.7 - 3.9	1.3
3.2	2	1.4 - 3.5	2.6
2.9	3	3.1 - 1.3 - 4.8	.7 - 1.0
2.4	3	3.5 - 4.5 - .9	1.0 - 1.0
2.5	3	5.6 - 2.9 - 5.7	.7 - 1.3
2.9	5	4.5 - 3.3 - 1.1 - 2.3 3.3	.7 - 0 - .4 - .5
2.3	1	.4	
2.0	0		
1.9	5	4.4 - .6 - 1.2 - 5.9 2.9	.9 - 0 - .6 - .3
4.2			

Experiment Number: 7

Incubation Time at 8.5 Hour at 20° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
1.8	4	2.9 - 5.0 - .5 - .3	0 - .9 - .6
3.0	2	3.6 - 1.9	
1.7	3	.7 - 5.0 - 2.4	1.0 - 0
2.1	1	3.6	
2.5	1	.6	
3.0	3	2.0 - 5.4 - 3.0	1.0 - .8
2.5	1	3.6	
2.5	2	.7 - 1.6	1.3
2.4			
2.6	2	.5 - 4.3	.6
2.1	2	2.3 - 4.1	1.0
2.1	3	.5 - 3.4 - 2.2	1.5 - .3
2.7			
Average: 2.4	2.3	2.8	.88

Experiment Number: 7

Incubation Time at 9th Hour at 20° C.

Plate Count: 99 million per cc.

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
2.2	3	4.8 - 2.0 - 1.7	1.3 - .2
3.4	6	2.7 - 2.1 - 2.9 - 1.5 1.9 - .9	.7 - .2 - .3 - .4 - 1.2
1.9	1	1.7	
2.7	4	2.7 - 2.7 - 1.0 - 1.0	2.0 - .3
2.5	1	.6	
3.1	6	2.7 - 1.1 - 1.9 - 3.2 1.3 - .9	.4 - 0 - .7 - .9
2.7	2	2.5 - .5	0
2.4	2	2.5 - 1.2	.4
2.5	2	3.0 - 3.4	.2
2.9			
1.5	2	2.9 - 2.0	.8
2.4	4	.6 - 1.1 - 1.6 - 1.8	1.4 - 0 - .2
2.2	2	1.0 - .7	0
2.2	4	.7 - 1.9 - 3.1 - 4.6	.7 - .7 - 0
2.5	1	.6	
2.6	5	.3 - 4.0 - 4.0 - 1.6 1.3	1.1 - 1.1 - 0
4.7			
1.7	3	5.5 - .8 - 3.6	.4 - .9

Experiment Number: 7

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Incubation Time at 9th Hour at 20° C. Continued

Plate Count: 99 million per cc.

Soma Length	Flagella		
	Number	Length	Distance Between
2.4	2	1.7 - 3.5	1.5
2.3	2	2.3 - 4.6	1.1
2.6	3	2.0 - 5.8 - 4.2	1.4 - 0
1.7	2	3.4 - 1.1	.8
2.3	2	1.8 - 3.2	.6
2.8	4	3.0 - 3.6 - .8 - 1.3	1.5 - 0
3.0			
2.4	2	3.2 - .4	1.2
2.6	1	2.1	
2.5	2	4.7 - 1.0	1.6
3.3	3	2.0 - 2.8 - .9	1.4 - 0
2.7	1	2.0	
1.8	3	2.8 - 2.5 - 2.9	
3.8	4	2.5 - .2 - 4.3 - .6	.4 - .6 - 1.0
2.7			
1.9	3	2.0 - 4.2 - 1.4	.4 - .3
2.3	4	.9 - 3.5 - 1.9 - 3.0	.9 - .6 - 0
1.9	3	2.3 - .9 - 3.0	.8
3.7	1	1.1	
3.2	1	.9	

Experiment Number: 7

Incubation Time at 9th Hour at 20° C. Continued

Plate Count: 99 million per cc.

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
2.5	2	2.2 - 1.1	1.1
2.6			
3.2	2	1.3 - .8	1.6
1.7	3	1.9 - 1.3 - 2.6	.4 - .4
2.4	5	2.1 - 1.6 - 4.4 - 3.7 4.7	1.4 - 0 - .7
2.3	3	2.1 - .9 - 3.1	1.0 - 0
2.0	5	.9 - 4.5 - 1.6 - 2.5 5.5	1.5 - .5 - 0
2.1	2	5.0 - 3.1	1.0
1.7	3	4.7 - 2.6 - 4.4	.8 - .5
2.7	3	4.7 - 3.2 - 1.3	0 - 1.0
2.0	1	3.1	
2.2			
Average: 2.5	2.4	2.2	.84

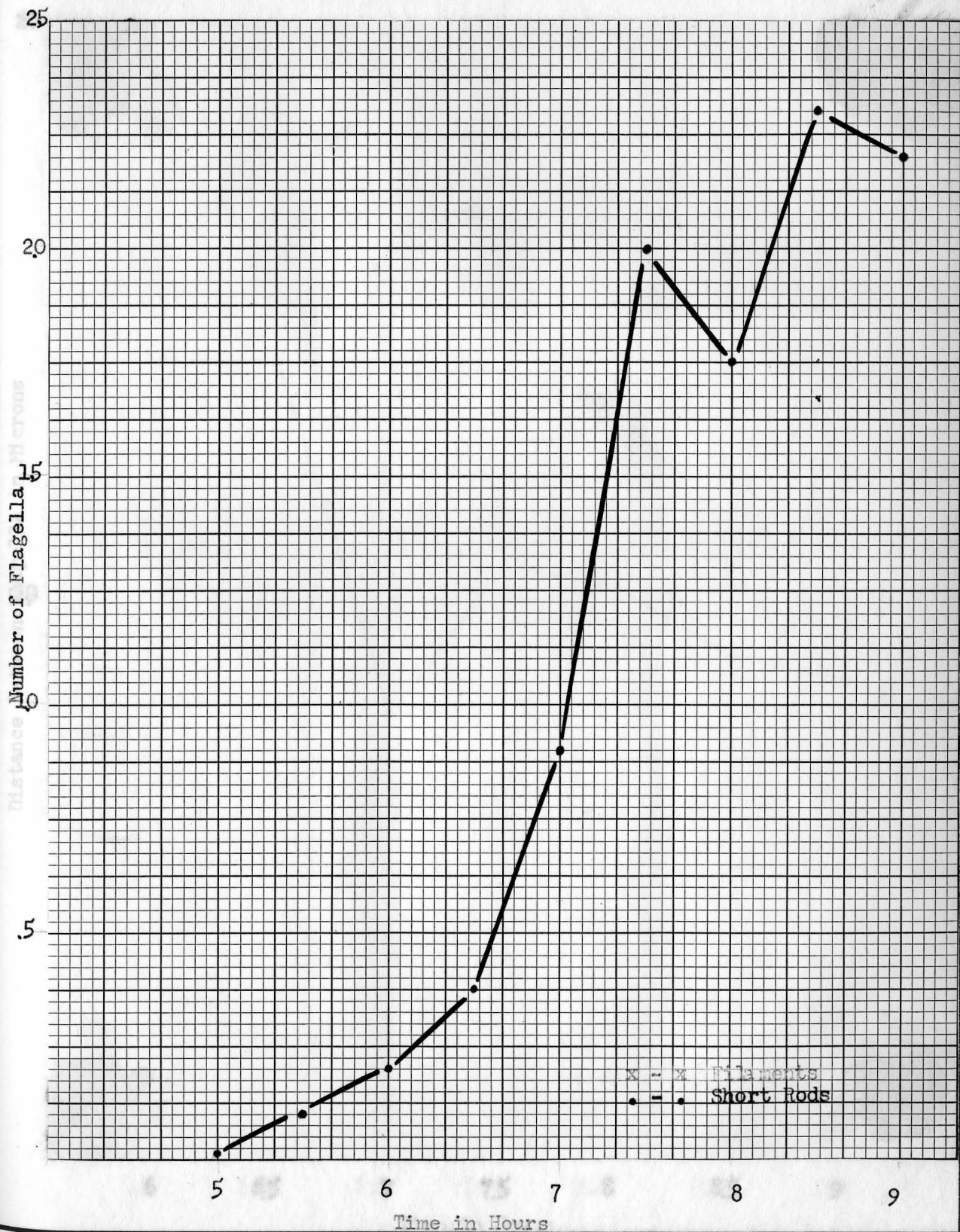
Loss of Flagella at 38° C.; Original Temperature was 20° C.

## Summary of Values

Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count	% Flagellated
	Microns		Microns	Microns		
1.0	2.7*				24	0
1.5	2.4					0
2.0	2.4				18	0
2.5	2.6					0
3.0	2.7				13	0
3.5	2.9					0
4.0	2.8				23	0
4.5	2.9					0
5.0	2.4	.02	.3		31.5	2
5.5	2.5	.1	.5			10
6.0	2.3	.2	1.0	1.4	44.5	22
6.5	2.4	.5	1.1	1.4		41
7.0	2.4	.93	1.7	.78	59	66
7.5	2.6	2.0	1.9	1.04		79
8.0	2.3	1.75	2.3	1.00	81	71
8.5	2.4	2.3	2.8	.88		90
9.0	2.5	2.4	2.2	.84	99	90

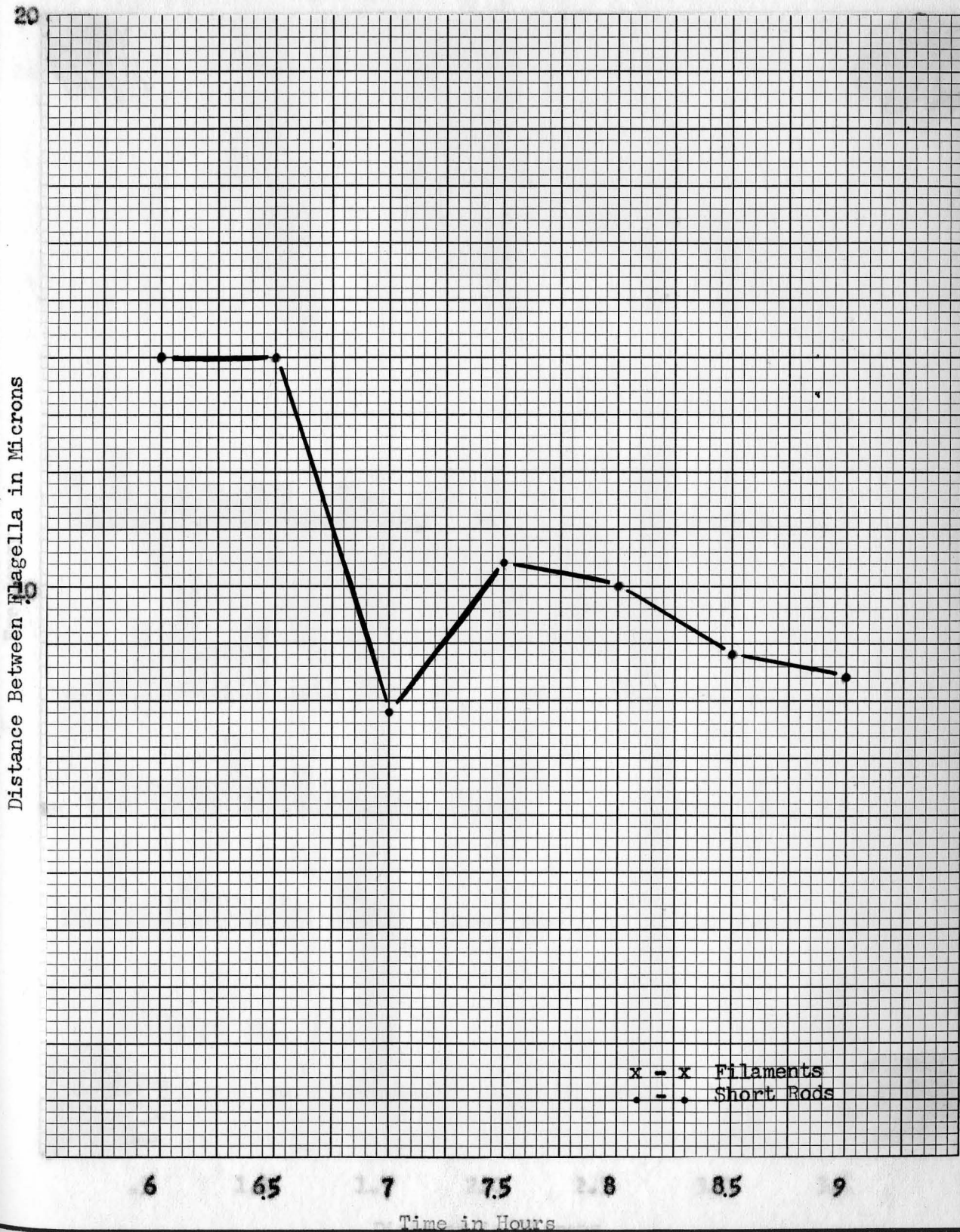
\*Based on measurement of 50 to 100 individual bacterium.

Graph 7-A Primary Temperature 38C; Secondary Temperature 20C  
Average Number of Flagella per Individual



Graph 7-B

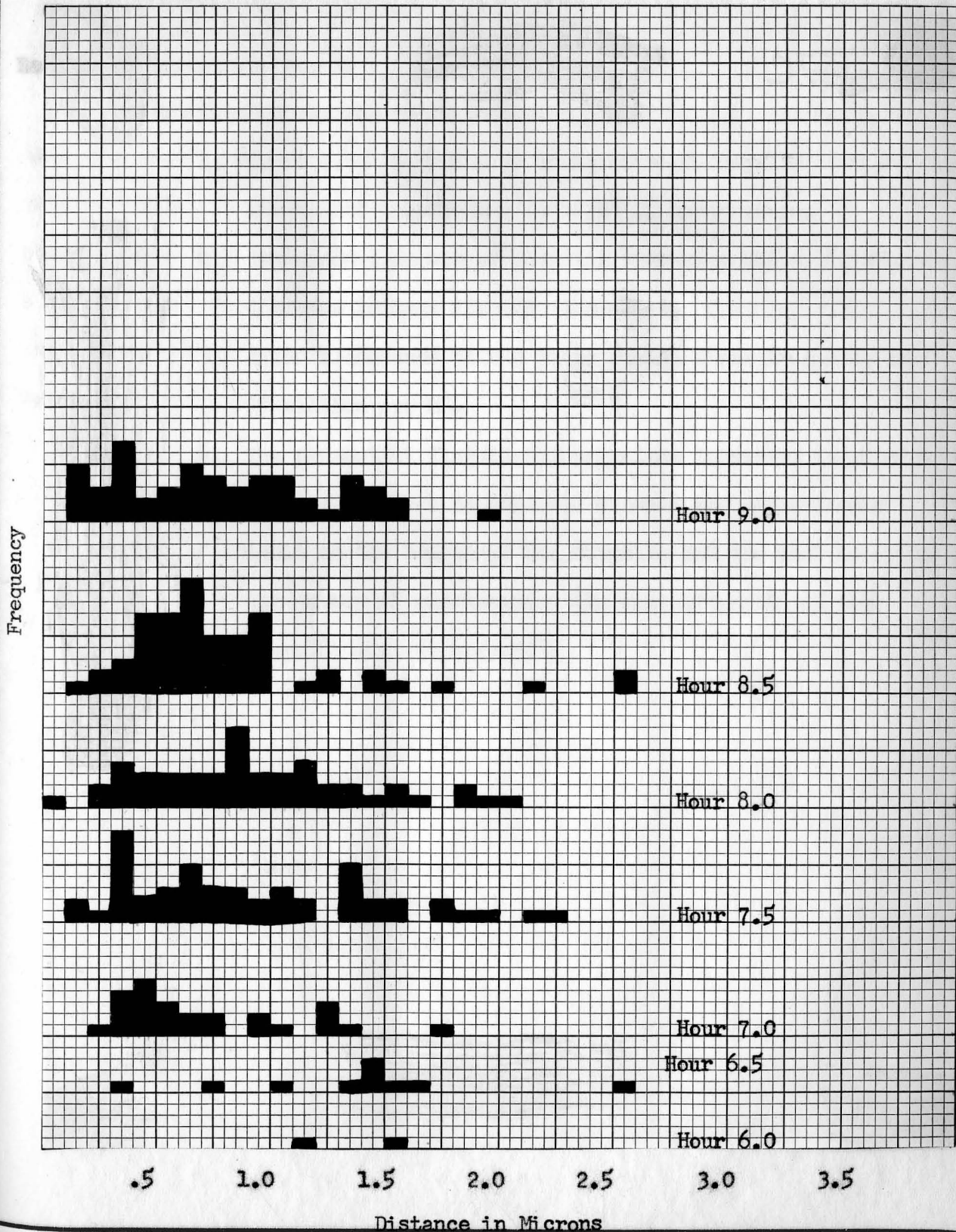
Primary Temperature 38C; Secondary Temperature 20C  
Average Distance Between Flagella





Graph 7-C Secondary Temperature 20C  
 Frequency Distribution of Distance Between Flagella

Short Rods



### Results of Experiment No. 7:

From this experiment it is indicated that

1. There is a lag phase in the growth of flagella from 38° C. incubation temperature to a 20° C. temperature.
2. The average number of flagella increases while the average distance between flagella decreases.
3. After a decrease in the plate count, there is a rise to 99 million per ml.
4. The percent of flagellated organisms increases to ninety.
5. Because of the time interval between the measurements taken on the length of the flagella and the deficiency in the number of measurements the rate of growth of the flagella was not computed.

Experiment No. 8

A portion of the stock culture of *L. nanocytogenes* was inoculated into 200 cc. of caseitone broth and placed in a 36° C. incubator. After fourteen to fifteen hours a slight turbidity was evident and an aliquot was removed for stains and plate count. Undiluted the culture was transferred to a 16° C. water bath for five minutes after which it was placed in a 20° C. incubator. Aliquots were removed at the given times for staining and plate count.

Experiment Number: 8

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Incubation Time at 1st Hour at 20° C.

Plate Count: 23.7 million per cc.

<u>Soma</u>				<u>Flagella</u>		
Length				Number	Length	Distance Between
2.8	3.3	10.6	10.3		No flagella observed.	
6.6	6.3	5.1	6.0			
14.9	2.5	3.7	3.3			
7.0	2.6	16.5	4.8			
7.3	3.3	4.0	2.7			
3.3	3.1	24.6	6.5			
8.0	2.4	4.5	9.7			
8.0	7.7	16.3	5.3			
18.9	5.1	3.0	3.7			
3.8	8.2	7.1	2.6			
Average: 6.9						

Experiment Number: 8  
 Incubation Time at 2nd Hour at 20° C.  
 Plate Count: 31.6 million per cc.

<u>Soma</u>				<u>Flagella</u>		
Length				Number	Length	Distance Between
22.7	6.8	11.7	16.7		No flagella observed.	
6.6	27.9	22.3	3.7			
3.9	54.7	7.4	52.9			
9.8	16.6	6.5	8.1			
23.0	9.4	27.2	5.3			
14.4	4.4	7.1	4.0			
9.6	8.2	7.4	7.7			
23.1	4.1	3.2	4.7			
5.1	8.4	4.1	12.7			
16.3	15.6	4.5	4.9			
Average: 12.8						

Experiment Number: 8

Incubation Time at 2.5 Hour at 20° C.

Plate Count:

<u>Soma</u>				<u>Flagella</u>		
Length				Number	Length	Distance Between
10.3	3.6	7.1	4.7		No flagella observed.	
17.4	7.2	13.8	7.9			
4.9	9.7	6.1	6.3			
7.5	7.2	5.2	15.9			
6.0	2.4	10.8	2.7			
5.4	4.0	6.1	14.7			
5.9	14.7	12.0	8.3			
7.9	2.4	18.2	3.8			
6.2	6.1	5.6	11.1			
5.3	9.2	22.9	6.1			
Average: 8.3						

Experiment Number: 8  
 Incubation Time at 3rd Hour at 20° C.  
 Plate Count: 71 million per cc.

<u>Soma</u>				<u>Flagella</u>		
Length				Number	Length	Distance Between
3.5	13.0	5.6	3.8		No flagella observed.	
13.6	17.6	8.3	12.2			
9.4	2.5	7.4	4.0			
9.4	9.6	4.7	2.6			
5.9	5.0	11.8	7.4			
5.5	4.3	6.6	3.4			
2.2	5.0	7.8	5.3			
6.4	7.4	7.8	13.2			
8.5	4.8	12.8	5.5			
5.4	2.1	22.1	2.2			
Average: 7.4						

Experiment Number: 8

Incubation Time at 3.5 Hour at 20° C.

Plate Count:

<u>Soma</u>					<u>Flagella</u>				
Length					Number	Length			Distance Between
				6.1	2	1.0 - 1.1			4.0
				5.4	1	.6			2.9
				6.8	2	.8 - 1.2			
9.8	6.6	7.9	8.9	3.3					
6.2	4.5	4.6	5.0	10.2					
4.7	6.7	5.7	11.0	5.6					
12.8	11.6	3.7	18.0	3.1					
7.0	6.5	8.5	8.7	12.2					
4.8	8.3	12.3	12.0	5.9					
6.4	11.7	6.0	2.9	3.6					
3.3	4.5	12.2	9.0	5.1					
10.8	8.2	4.6	2.5	6.0					
3.1	4.5	3.7	5.6	6.8					
9.9	10.7	12.1	2.5	9.4					
6.4	7.8								
Average: 7.2					.08	.94			3.5



Experiment Number: 8

Incubation Time at 4<sup>th</sup> Hour at 20° C.

Plate Count: 128.6 million per cc.

<u>Soma</u>					<u>Flagella</u>		
					Number	Length	Distance Between
				7.0	2	1.9 - .9	1.2
				3.0	1	3.5	
				3.1	1	1.1	
				4.8	3	.7 - 1.0 - .9	3.6 - .5
				4.7	1	.5	
				9.1	2	.9 - 1.0	1.0
				19.9	3	.9 - .5 - .3	2.7 - 10.0
				2.5	2	1.0 - .7	1.9
				7.4	2	1.4 - .7	2.9
9.0	3.4	2.6	2.2	5.7			
11.3	7.4	2.9	6.5	6.1			
2.8	10.8	8.1	8.7	3.1			
3.4	4.4	12.6	7.3	3.6			
6.7	15.7	3.6	9.0	3.7			
3.8	7.3	7.3	10.9	5.0			
17.5	4.5	4.8	4.5	9.5			
7.1	11.9	2.9	8.1	9.6			
9.0	19.2	4.4	9.6	5.2			
6.6	5.6	6.6	4.0	6.1			
3.0	8.5	9.0	6.6	20.2			

Experiment Number: 8

Incubation Time at 4th Hour at 20° C. Continued

Plate Count: 128.6 million per cc.

<u>Soma</u>					<u>Flagella</u>		
Length					Number	Length	Distance Between
2.7	16.2	3.9	15.0	6.6			
4.9	6.9	7.0	6.8	7.2			
3.3	11.0						
Average: 7.2					.25	1.1	3.6

Experiment Number: 8

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Incubation Time at 4.5 Hour at 20° C.

Plate Count:

<u>Soma</u>		<u>Flagella</u>		
Length	Number	Length	Distance Between	
5.1	3	1.0 - 1.5 - .7	2.1 - .3	
13.1	4	.7 - .9 - 2.7 - .7	2.7 - 4.0 - 4.2	
4.2	4	2.0 - .9 - 1.5 - .4	1.4 - 1.8 - .4	
4.8	1	.5		
4.4	1	1.0		
6.3	3	1.3 - 1.8 - .7	1.4 - .5	
7.0	2	1.1 - 2.0	1.0	
2.2	1	1.2		
12.6	5	1.0 - 1.4 - 1.2 - .5 .6	3.1 - 2.9 - 5.9 - .6	
6.7	2	1.3 - .4	5.5	
6.2	1	.5		
12.9	7	1.8 - .3 - 1.0 - 1.2 1.1 - 1.1 - .8	3.2 - 2.1 - .5 - 1.7 2.5 - 1.2	
6.8	1	.8		
8.2	5	1.2 - .3 - 1.0 - 2.2 1.3	2.4 - 1.5 - 2.4 - 0	
5.2	1	2.4		
13.3	3	.4 - .7 - .8	8.8 - 1.5	
8.8	2	1.1 - 1.4	5.0	
4.3	3	.7 - 1.1 - 1.5	2.7 - 0	

Experiment Number: 8

Incubation Time at 4.5 Hour at 20° C. Continued

Plate Count:

<u>Soma</u>					<u>Flagella</u>			
Length					Number	Length	Distance Between	
				9.6	5	1.7 - .9 - 1.9 - 2.0 .4	1.8 - 2.7 - 3.1 - 2.5	
7.0	7.2	5.3	4.1	2.4				
11.3	4.5	3.2	6.1	2.9				
4.1	4.6	7.4	10.4	9.0				
5.0	9.3	4.3	8.3	4.0				
11.4	14.8	9.7	4.5	10.5				
6.3	2.2	14.0	5.5	2.9				
3.1	20.1	3.8	5.0	6.4				
6.7								
Average: 7.1					.98	1.12	2.53	

Experiment Number: 8  
 Incubation Time at 5<sup>th</sup> Hour at 20° C.  
 Plate Count: 253.6 million per cc.

<u>Soma</u>		<u>Flagella</u>		
Length	Number	Length	Distance Between	
3.5	1	.7		
6.4	6	.8 - 2.5 - 3.9 - 1.5 1.0 - 1.4	1.8 - 1.3 - 1.1 - 0	
2.6	4	2.9 - 1.2 - .9 - 2.8	1.4 - 0 - .3	
14.1	3	1.9 - 1.6 - .8	11.2 - 0	
6.2	3	1.7 - 3.7 - 1.5	2.0 - 3.5	
3.0	1	.8		
5.5	4	2.1 - 1.7 - 1.2 - 1.5	1.3 - 2.7 - 0	
9.7	4	1.6 - 2.1 - 1.9 - 1.7	4.0 - 1.6 - 2.7	
9.5	4	1.6 - 1.4 - .6 - 1.3	1.2 - 5.0 - 2.6	
5.6	2	.7 - 2.0	2.7	
8.4	1	1.3		
6.7	3	1.2 - 1.0 - .7	3.5 - .3	
4.4	2	1.4 - .8	3.6	
11.8	1	.7		
7.5	1	3.1		
5.9	6	3.1 - 3.2 - 1.1 - .6 .3	2.0 - 1.5 - .7	
10.1	5	1.3 - 1.5 - 2.3 - 1.1 .7	4.3 - 2.6 - 1.6 - 2.0	
4.7	2	.9 - .5	3.5	

Experiment Number: 8

Incubation Time at 5th Hour at 20° C. Continued

Plate Count: 253.6 million per cc.

<u>Soma</u>					<u>Flagella</u>				
Length					Number	Length			Distance Between
				7.8	3	1.9 - 1.5 - 1.0			1.2 - 0
				8.0	6	1.3 - 2.6 - 1.8 - 1.6 2.3 - 2.3			2.4 - 1.8 - .6 - 2.0 .6
				3.3	1	1.8			
				9.0	5	1.1 - 2.1 - 2.1 - .8 .7			2.8 - 1.0 - 3.3 - .8
				8.1	3	1.2 - 2.3 - .7			1.1 - 1.3
				6.0	2	1.7 - .8			6.0
2.8	3.9	6.2	4.5	2.0					
8.5	6.6	4.7	3.5	2.6					
9.9	3.2	4.2	3.7	5.2					
9.1	6.4	6.3	9.1	3.7					
4.4	14.1	6.0	3.9	5.9					
8.1	1.7								
Average: 6.2					1.43	1.54			2.44

Experiment Number: 8

Incubation Time at 5.5 Hour at 20° C.

Plate Count:

<u>Soma</u>		<u>Flagella</u>		
Length	Number	Length	Distance Between	
6.5	1	.4		
10.2	4	1.9 - 1.7	1.5	
8.9	6	1.7 - 2.8 - 1.0 - 2.2 .7 - 1.3	1.4 - 2.1 - 4.5 - .7	
5.3	3	2.5 - .6 - .7	3.6 - 0	
3.3	2	.6 - 1.5	3.0	
7.3	1	.4		
3.6	3	3.8 - 4.2 - 1.5	1.9 - 0	
3.0	1	1.3		
6.9	1	.8		
22.7	2	.6 - 1.0	1.2	
6.3	5	1.8 - 1.1 - 3.9 - 3.4 1.2	0 - 1.9 - 1.1 - 2.8	
4.8	3	4.5 - 2.8 - 2.2	2.1 - 0	
9.0	3	3.4 - 3.7 - 2.0	3.5	
10.1	5	2.4 - 1.1 - 1.2 - .8 1.3	4.2 - .7 - 0 - 2.7	
2.8	1	.9		
9.6	6	3.7 - 1.6 - .6 - 1.7 .5 - 1.0	1.3 - 1.4 - 3.5 - 1.1 .6	
7.8	6	4.6 - 2.5 - 1.9 - .6 .7 - 2.6	1.6 - 0 - 1.4 - .6 3.2	

Experiment Number: 8

Incubation Time at 5.5 Hour at 20° C. Continued

Plate Count:

<u>Soma</u>		<u>Flagella</u>		
Length		Number	Length	Distance Between
	3.0	1	.5	
	29.7	7	2.2 - 2.5 - 2.3 - 2.0 1.1 - .9 - .6	4.2 - 1.2 - 4.6 - 0 3.7 - 1.0 - 2.4
	5.7	2	2.2 - .8	3.2
	5.5	2	2.1 - 1.4	3.7
	6.0	4	2.3 - .7 - 3.4 - 2.2	4.0 - 0 - 2.1
	6.0	4	2.5 - 1.9 - 1.1 - .7	1.2 - .7 - 3.1
	9.7	5	.7 - .9 - 1.7 - 1.2 1.9	1.9 - 3.0 - 2.6 - 1.4
3.3	3.3			
	3.0			
	2.4			
	11.0			
10.4	2.9			
	4.8			
	2.8			
	11.7			
Average: 7.3		2.3	1.75	2.27



Experiment Number: 8  
 Incubation Time at 6th Hour at 20° C.  
 Plate Count: 221.3 million per cc.

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<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
7.5	2	.8 - 1.4	0
4.8	4	1.9 - 2.3 - 3.5 - 2.3	.9 - .9 - .2
9.7	4	1.5 - 1.4 - 1.1 - 1.9	4.6 - 2.2 - 1.0
8.4	6	3.9 - 2.0 - 3.6 - 2.0 1.0 - 1.1	0 - 2.3 - 0 - 1.9 - 1.0
3.7	1	.8	
13.6	5	.7 - .7 - .3 - 1.7 2.3	3.7 - 5.1 - 1.5 - 2.3
3.6	2	3.8 - 1.0	1.8
5.1	3	3.8 - .5 - 3.1	1.9 - 3.0
15.7	10	4.8 - 1.7 - 1.8 - 2.2 1.9 - .8 - 1.0 - 1.7 1.8 - 1.0	1.8 - 3.3 - 2.5 - 1.9 0 - 1.4 - 0 - 2.8
4.5	1	.5	
9.2	4	2.0 - .6 - 2.3 - 3.9	1.8 - 4.7 - .3
3.0	1	1.7	
7.7	4	1.2 - 2.3 - 1.1 - 2.8	.9 - 2.6 - .8
5.0	3	2.3 - .3 - 1.6	1.3 - 2.4
6.2	4	1.0 - 3.1 - .7 - 3.5	2.9 - 1.9 - 1.9
2.9	2	3.3 - 1.0	1.4
3.1	1	2.7	
6.7	5	1.4 - 1.4 - .6 - 1.8 2.3	2.3 - 2.4 - 0

Experiment Number: 8

185

Incubation Time at 6th Hour at 20° C. Continued

Plate Count: 221.3 million per cc.

<u>Soma</u>					<u>Flagella</u>			
Length					Number	Length	Distance Between	
				5.8	2	1.2 - 2.6	2.5	
				7.4	3	1.2 - 1.3 - 3.8	4.7 - 1.5	
				11.8	5	1.8 - .8 - 3.4 - 2.8 1.8	1.4 - 4.6 - 2.5 - 2.3	
				8.5	4	2.3 - 1.2 - 1.9 - 1.6	1.7 - 3.3 - 1.6	
3.9	5.7	2.0	4.8	10.2				
3.7	9.0	2.6	1.5	10.9				
3.8	4.8	6.2						
<b>Average:</b>				6.4	2.17	1.86	2.21	

Experiment Number: 8

186

Incubation Time at 6.5 Hour at 20° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>			
	Length	Number	Length	Distance Between
3.5	1	1.6		
3.1	1	2.5		
2.1	1	2.5		
3.9	3	1.3 - 3.0 - 2.0	3.5 - 0	
8.9	6	3.3 - 2.8 - 1.5 - .9 1.4 - 1.7	0 - 3.4 - 3.8 - 1.1	
5.5	3	4.7 - 3.2 - 1.4	0 - 4.8	
3.9	2	3.3 - 1.2	2.2	
3.9	1	3.4		
17.2	2	1.3 - .7	8.9	
6.4	2	1.5 - 1.4	.9	
16.9	5	2.3 - 2.7 - 2.8 - 2.0 1.2	2.4 - 6.2 - 3.2 - 2.3	
13.6	4	.6 - 3.0 - 2.4 - .9	2.2 - 5.7 - 6.2	
5.3	3	1.5 - 1.7 - 1.5	0 - 3.7	
2.3	3	1.7 - 2.0 - 2.0	1.6 - .4	
8.3	4	2.6 - 3.4 - 1.1 - 1.1	2.0 - .8 - 3.9	
3.3	1	1.3		
2.8	2	2.9 - 2.4	1.2	
7.3	1	1.6		
7.0	2	2.3 - 1.1	4.0	

Experiment Number: 8

Incubation Time at 6.5 Hour at 20° C. Continued.

Plate Count:

<u>Soma</u>					<u>Flagella</u>		
					Number	Length	Distance Between
	8.4	6	2.5 - 2.4 - 1.9 - 1.1 2.7 - .9	.6 - 2.4 - 1.5 - 0 - 1.8			
	10.7	4	2.1 - 1.7 - 1.6 - 2.3	5.7 - .7 - 1.0			
	6.8	1	.9				
	5.5	3	1.7 - .7 - 1.1	2.0 - 2.9			
	3.8	2	2.0 - 1.6	1.6			
	7.4	4	2.4 - .5 - 1.6 - 2.1	4.0 - 3.1 - .3			
	1.8	1	2.5				
	2.3	4	5.6 - 3.5 - .8 - 1.3	.5 - .7 - .7			
	15.2	5	1.9 - 1.7 - 4.1 - .9 1.9	1.8 - 4.1 - 1.4 - 3.6			
	3.3	2	3.4 - 1.4	3.3			
	18.6	10	1.5 - .9 - 3.1 - 3.2 2.2 - 3.7 - 1.9 - 1.8 3.6 - 1.6	1.4 - 1.6 - 1.4 - 1.4 1.7 - 2.6 - 3.9 - 2.3 1.5			
8.5	2.1	2.8	6.2	3.6			
4.9	3.2	4.6	3.3	5.4			
5.8	3.3	4.1	4.6	7.4			
4.2	19.1	2.7	29.0				
<b>Average: 6.7</b>							
		1.82	2.0	2.48			

Experiment Number: 8

Incubation Time at 7th Hour at 20° C.

Plate Count: 327.3 million per cc.

<u>Soma</u>		<u>Flagella</u>		
Length	Number	Length	Distance Between	
11.2	8	.4 - 2.3 - 1.2 - .9 1.0 - 1.6 - .8 - 1.0	1.7 - 1.0 - 1.1 - .4 1.3 - 3.0 - 2.6	
4.8	2	2.0 - .5	4.1	
2.8	1	2.2		
3.8	2	2.0 - 1.2	3.0	
3.5	2	4.5 - 2.3	.4	
12.5	2	.4 - 3.1	7.0	
18.3	13	1.0 - 1.0 - 1.4 - 3.2 3.1 - 1.0 - 3.3 - 2.1 1.1 - 1.0 - 1.4 - 2.4 3.0	3.1 - 1.5 - 3.1 - 1.7 0 - 2.3 - 1.4 - .6 2.0 - 2.4 - .4	
8.4	2	.8 - 1.1	3.8	
5.8	3	1.0 - 2.6 - 1.7	4.5	
2.4	3	.5 - 1.8 - 3.6	1.8	
5.8	1	1.9		
5.8	4	1.7 - 2.4 - 2.1 - 1.6	1.3 - 1.1 - 2.8	
3.5	3	.8 - 1.0 - 2.6	.5 - 1.6	
6.2	3	2.7 - 2.6 - 2.0	.6 - 3.3	
4.3	1	2.4		
6.9	7	3.9 - .8 - 1.1 - 1.8 3.0 - 4.2 - 1.1	0 - 1.4 - .4 - 2.6 1.0	
4.1	1	2.5		

Experiment Number: 8

189

Incubation Time at 7th Hour at 20° C. Continued

Plate Count: 327.3 million per cc.

<u>Soma</u>		<u>Flagella</u>		
Length		Number	Length	Distance Between
	10.2	5	.7 - 2.7 - .8 - 4.0 2.9	4.3 - 1.6 - 1.4 - 1.7
	4.0	2	2.7 - 2.6	2.0
	3.0	1	1.2	
	2.8	1	1.0	
	4.3	1	1.9	
	4.2	2	2.8 - 1.6	2.4
	18.7	2	1.3 - 2.0	9.0
	12.8	6	1.3 - 1.0 - 1.8 - 1.5 1.6 - 1.1 -	5.4 - .5 - 1.7 - 0 - .6
	6.0	3	3.6 - 1.7 - .5	.3 - 1.5
9.8	3.2	5.9	3.9	2.3
2.7	3.8	1.9	4.8	2.0
2.8	2.2			
<b>Average: 5.8</b>		<b>2.13</b>	<b>1.85</b>	<b>2.02</b>

Experiment Number: 8

Incubation Time at 7.5 Hour at 20° C.

Plate Count:

<u>Soma</u>		<u>Flagella</u>		
Length	Number	Length	Distance Between	
3.6	3	1.9 - 3.3 - 2.2	2.1	
2.7	1	2.6		
10.1	5	4.4 - 2.3 - 1.9 - 3.6 1.1	3.3 - 3.8 - .7 - 0	
2.2	1	3.5		
5.9	4	5.5 - 1.9 - 1.7 - 1.0	1.2 - 2.4 - 0	
2.5	3	2.1 - 2.9 - 1.2	1.2 - 0	
9.1	3	1.9 - 1.4 - .5	2.5 - 2.8	
3.2	3	2.0 - 2.2 - .4	.9 - .7	
5.3	3	1.8 - 2.0 - 1.8	.9 - 4.5	
6.4	6	2.7 - 2.8 - 3.6 - 1.1 2.5 - 2.1	.9 - 0 - 1.4 - .6 - 3.1	
3.0	2	.8 - 3.4	2.5	
2.7	3	2.2 - 3.2 - 2.1	1.6 - 0	
7.8	6	2.4 - 3.6 - 1.5 - .5 3.1 - 2.0	1.7 - 3.7 - 1.5	
2.2	1	3.6		
3.1	2	3.8 - 1.1	2.4	
2.9	1	2.5		
5.6	2	2.5 - 2.4	1.2	
2.2	2	.7 - 1.6	1.9	

Experiment Number: 8

191

Incubation Time at 7.5 Hour at 20° C. Continued

Plate Count:

<u>Soma</u>		<u>Flagella</u>		
Length		Number	Length	Distance Between
	3.5	1	1.8	
	10.2	2	1.1 - 2.4	.7
	10.9	8	1.4 - 2.0 - 4.4 - 3.3 2.3 - 2.4 - 2.8 - 4.0	1.2 - .6 - 1.5 - 1.9 1.2 - 2.7 - 1.9
	6.0	1	2.2	
	3.8	1	2.4	
	15.6	6	1.8 - 2.0 - 1.2 - .6 2.8 - 1.8	1.4 - 5.2 - 1.9 - 5.1 .8
	8.7	8	2.9 - 1.7 - 5.6 - 1.4 1.9 - 2.1 - 1.3 - 1.4	1.4 - 0 - .7 - 3.1 1.4 - 1.3 - .6
	2.6	1	.3	
	8.8	5	2.1 - 2.6 - 2.1 - 2.5 2.7	2.9 - 2.8 - 1.0 - 1.2
3.5	3.4	14.1	2.9	2.9
2.8	2.8	2.5	7.2	
Average: 5.4		2.31	2.24	1.92



Experiment Number: 8

Incubation Time at 8th Hour at 20° C.

Plate Count: 303.5 million per cc.

<u>Soma</u>		<u>Flagella</u>		
<u>Length</u>	<u>Number</u>	<u>Length</u>	<u>Distance Between</u>	
8.0	5	4.4 - 5.8 - 3.9 - 1.5 1.1	1.0 - 1.8 - 2.1 - 1.0	
4.1	1	4.8		
9.1	7	3.1 - 2.4 - 1.4 - 1.7 1.7 - 4.6 - 1.2	0 - 2.6 - 1.5 - .7 2.4 - .8	
4.6	2	2.1 - .4	1.2	
6.8	4	.6 - 1.3 - 1.0 - .5	3.7 - .9 - 2.2	
2.3	2	1.9 - 3.6	2.3	
8.3	5	.5 - 1.5 - 1.1 - 2.7 2.0	1.5 - 2.2 - 1.8 - 1.3	
3.2	3	2.7 - 4.3 - 3.0 -	.7 - 0	
15.4	1	.6		
4.9	4	.3 - 2.5 - 2.0 - 1.2	1.3 - 3.3 - .4	
5.7	5	.5 - 2.5 - 2.4 - 2.3 4.6	3.0 - 1.0 - .7	
2.5	3	.3 - 2.9 - 2.7	.4 - 2.0	
3.3	1	4.5		
11.8	2	2.8 - 1.6	0	
3.5	3	4.7 - 2.8 - 1.0	.4 - .8	
6.2	1	.8		
4.7	4	3.1 - 2.8 - .4 - .5	3.3 - .5 - .5	
5.6	1	.6		

Experiment Number: 8

Incubation Time at 8th Hour at 20° C. Continued

Plate Count: 303.5 million per cc.

<u>Soma</u>					<u>Flagella</u>			
Length					Number	Length	Distance Between	
				6.6	1	2.3		
				7.8	4	1.0 - 1.8 - 1.4 - 1.0	2.9 - .9 - 1.7	
				10.0	3	1.9 - 1.7 - 2.3	5.7 - 3.6	
				10.3	7	2.5 - 2.6 - 1.2 - 2.1 .8 - 4.1	.6 - .8 - 1.7 - .8 - .8 4.0	
				11.0	4	.8 - .3 - 3.3 - .2	2.3 - 4.5 - 4.2	
				4.9	2	1.9 - .3	1.7	
				6.6	3	1.2 - .6 - .5	3.2 - 2.4	
				5.3	2	2.4 - 1.0	1.9	
				12.3	3	1.5 - .8 - 2.4	4.9 - 1.8	
2.2	2.1	2.7	3.6	3.9				
9.8	4.6	3.0	4.4	4.3				
3.1	9.6	12.0	4.7	2.5				
2.6								
Average:				6.1	1.93	1.99	1.88	

Experiment Number: 8  
 Incubation Time at 8.5 Hour at 20° C.

Plate Count:

<u>Soma</u>		<u>Flagella</u>		
Length	Number	Length	Distance Between	
8.7	7	1.1 - 4.8 - 5.5 - 1.8 .8 - 1.0 - 4.2	2.0 - 1.0 - 1.2 - 1.7 1.3 - 0	
11.4	6	1.6 - 5.5 - 1.9 - 2.2 .4 - 1.8	1.1 5.0 - 1.5 - 2.0 - .6	
2.1	2	2.6 - 2.9	0	
10.4	6	5.5 - 3.3 - 4.4 - 2.0 3.0 - .7	1.1 - 1.2 - 2.4 - 0 2.4	
2.8	2	2.7 - 3.4	1.7	
3.8	1	4.7		
3.0	3	1.3 - 1.5 - 5.2	0 - 2.4	
3.5	3	4.2 - 3.0 - .6	1.2 - .9	
8.4	4	2.2 - 3.5 - .9 - 2.7	2.4 - 2.2 - 1.8	
7.8	5	2.0 - 1.4 - 1.0 - 4.3 2.8	2.5 - .9 - 2.9 - 0	
4.7	1	1.5		
4.9	2	3.3 - 1.0	2.1	
14.8	10	5.3 - 3.1 - 4.3 - 3.5 .3 - 2.1 - 2.8 - 3.5 1.3 - 2.1	0 - 1.9 - 1.6 - 1.4 1.5 - 2.1 - .9 - 3.3 0	
6.6	4	2.0 - 2.4 - 4.6	.3 - 3.4 - 2.4	
12.2	6	2.9 - 1.5 - 1.1 - 1.2 2.5 - .4	1.1 - 1.2 - 1.4 - 1.9 1.0	
11.9	6	4.7 - 1.6 - 1.8 - 2.4 .4 - 1.6	2.1 - .8 - 2.0 - 1.6 4.8	

Experiment Number: 8

Incubation Time at 8.5 Hour at 20° C. Continued

Plate Count:

<u>Soma</u>					<u>Flagella</u>		
					Number	Length	Distance Between
		3.2	2	2.6 - 3.0		.4	
		11.2	8	4.4 - 1.8 - 4.1 - .9 3.6 - 4.2 - 1.9 - 1.5		1.8 - 1.4 - 0 - 4.0 - .8 - 1.5 - .9	
		8.5	8	1.9 - 2.4 - 5.8 - 1.2 4.4 - 1.3 - 1.1 - 4.3		1.6 - 1.2 - 1.6 - 1.4 1.5 - 0 - 0	
		7.5	5	5.3 - 1.4 - .8 - 2.7 2.4		.4 - 3.0 - 0 - 1.0	
26.7	3.3	3.3	3.7	7.8			
2.6	4.0	3.1	1.9	3.9			
Average: 6.9				3.36	2.52	1.74	

Experiment Number: 8  
 Incubation Time at 9th Hour at 20° C.  
 Plate Count: 301.5 million per cc.

Soma Length	Flagella		
	Number	Length	Distance Between
3.8	4	1.8 - 4.4 - 2.0 - .9	0 - 2.6 - 0
4.6	5	1.7 - 2.4 - 2.2 - 5.2 6.8	1.6 - 1.9 - 1.2
14.1	5	2.6 - 1.2 - .4 - .6 2.4	1.5 - 1.0 - 5.6 - .9
2.3	3	4.3 - 2.3 - 1.1	1.1 - .2
4.8	6	3.6 - 2.8 - 3.0 - 3.7 .3 - 1.1	.8 - 0 - 1.3 - 2.1 - 0
12.7	5	1.7 - 2.5 - 2.4 - 2.5 1.1	1.7 - .5 - 4.4 - 2.8
8.2	2	2.0 - 2.1	6.2
3.7	3	2.6 - 1.0 - .5	1.5 - 2.0
3.5	1	1.3	
9.4	8	1.8 - .5 - 1.6 - 1.7 1.9 - .5 - .5 - 3.4	.7 - .8 - 1.6 - 0 - 2.5 1.2 - 1.5
3.6	2	4.1 - 3.0	3.0
6.0	6	1.1 - 4.0 - 1.1 - 3.3 5.9 - 2.8	1.4 - .8 - 1.3 - 1.0 1.0
6.5	7	3.9 - 5.0 - 1.4 - 1.6 5.0 - 1.8 - 1.9	2.1 - 0 - 1.5 - .7 1.5 - .6
2.7	2	.5 - 2.5	2.6
4.7	3	4.0 - 3.0 - 1.1	3.1 - 0
9.9	8	1.2 - 5.7 - 2.8 - 3.2 2.8 - 1.7 - 1.5 - 2.2	1.4 - 2.3 - 2.1 - 1.1 .5 - 0 - 0

Experiment Number: 3

Incubation Time at 9th Hour at 20° C. Continued

Plate Count: 301.5 million per cc.

<u>Soma</u>					<u>Flagella</u>		
Length					Number	Length	Distance Between
				5.5	7	1.7 - .5 - 3.0 - 4.5 3.9 - 2.0 - 1.6	1.3 - 1.6 - .6 - 0 1.6 - .4
				2.6	6	2.1 - 5.5 - 3.4 - 1.4 2.4 - 2.6	1.7 - 0 - 0 - 1.2 - 0
				8.5	3	2.9 - 2.6 - 4.1	.6 - 4.8
				3.4	3	1.8 - 3.4 - 2.0	2.7 - 0
				3.1	1	3.5	
				3.2	4	3.2 - 3.3 - 1.7 - 1.1	1.3 - .5
				4.8	3	2.0 - 2.2 - 3.8	4.3 - 3.3
				10.7	7	1.2 - 1.9 - 1.7 - 4.8 1.3 - 1.8 - 2.7	.4 - 1.8 - 1.1 - 2.2 2.9 - 1.0
7.5	2.6	3.3	3.1	14.2			
3.0	4.5	5.8	2.6	10.2			
7.2							
Average:				5.9	2.91	2.45	1.42

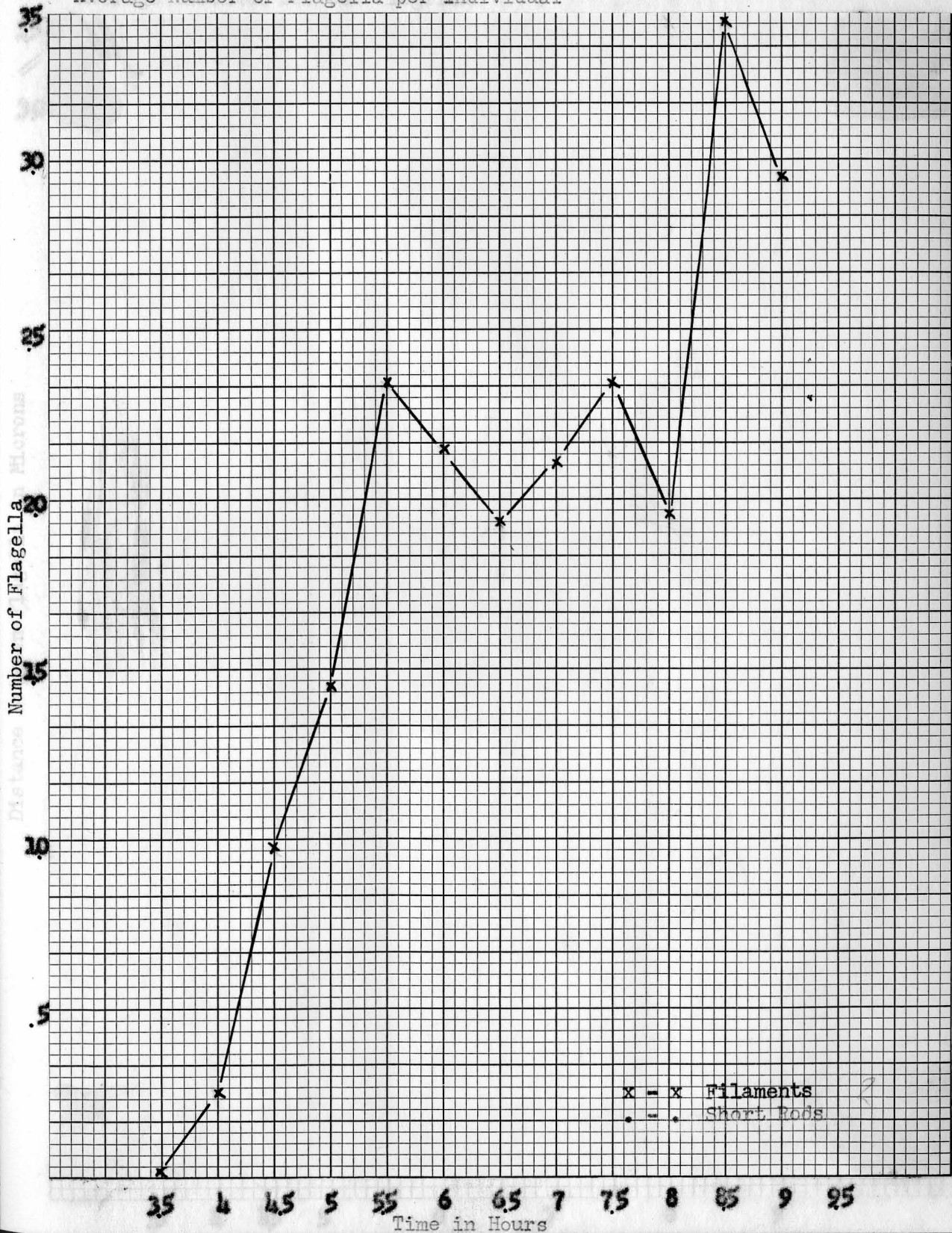
Appearance of Flagella at 20° C; Original temperature was 38° C.

## Summary of Values

Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count	% Flagellated
	Microns		Microns	Microns		
1.0	6.9*				23.7	0
7.5						
2.0	12.8				31.6	0
2.5	8.3					0
3.0	7.4				71	0
3.5	7.2	.08	.94	3.5		
4.0	7.2	.25	1.10	3.6	128.6	11
4.5	7.1	.98	1.12	2.53		34
5.0	6.2	1.43	1.54	2.44	253.6	43
5.5	7.3	2.3	1.75	2.27		70
6.0	6.4	2.17	1.86	2.21	221.3	62
6.5	6.7	1.82	2.00	2.48		61
7.0	5.8	2.13	1.85	2.02	327.3	67
7.5	5.4	2.31	2.24	1.92		75
8.0	6.1	1.93	1.99	1.88	303.5	62
8.5	6.9	3.36	2.52	1.74		66
9.0	5.9	2.91	2.45	1.42	301.5	69

\*Based on measurement of 40 to 76 individual bacterium.

Graph 8-A <sup>377</sup> Primary Temperature 38C; Secondary Temperature 20C  
 Average Number of Flagella per Individual



x - x Filaments  
 . - . Short Rods



Graph 8-B <sup>38.0</sup> <sup>38.5</sup> Primary Temperature 38C; Secondary Temperature 20C  
Average Distance Between Flagella <sup>between flagella</sup>

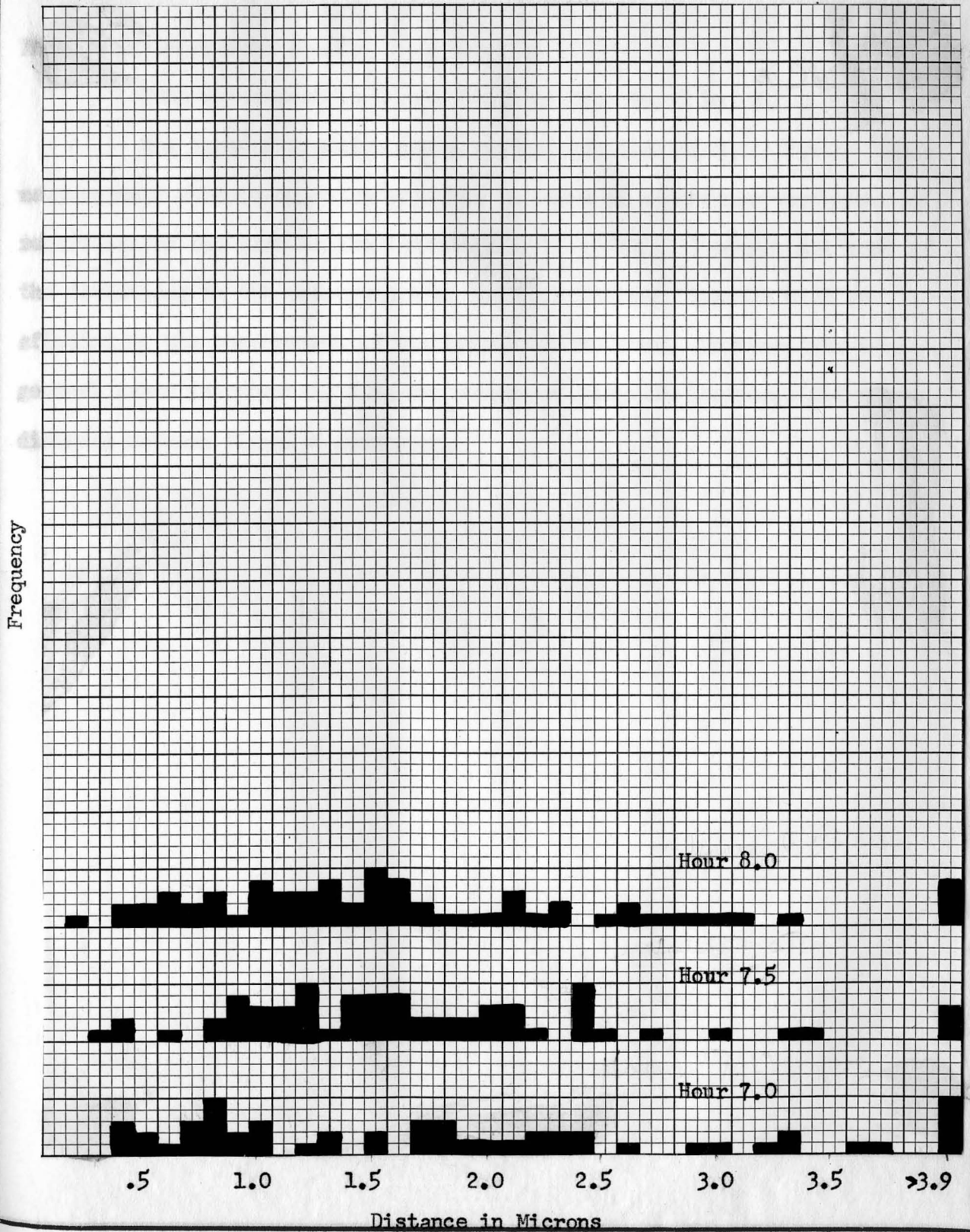


Graph 8-C Secondary Temperature 20C  
 Frequency Distribution of Distance Between Flagella



Graph 8-C (Continued)

Frequency Distribution of Distance Between Flagella



Results of Experiment No. 8:

This experiment is a repetition of Experiment No. 7.

The type of organism grown was mainly filamentous. However, when measurements were taken, each organism in order of appearance was measured regardless of the size of the individual. Therefore, it seems that some of the deviations in the measurement of distance between flagella will be affected by the measurement of the length of the soma. However, the same general trend is apparent, i.e. the number of flagella increases and the distance between flagella decreases.

Experiment No. 9

The procedure was essentially the same as in Experiment No. 8. The primary incubation temperature was 20° C., and the secondary temperature was 35° C.

Experiment Number: 9  
 Incubation Time at 1st Hour at 38° C.

Filaments

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
4.3	5	1.5 - 3.0 - 5.0 - 4.9 6.9	0 - .8 - 1.7 - 1.3
4.1	7	2.1 - 2.5 - 3.1 - 1.3 .5 - 4.8 - 3.3	-1.9 - .5 - .9 - 0 - .6
3.5	2	4.6 - 3.1	2.5
2.9	4	3.7 - 7.0 - 4.5 - 2.9	1.3 - .7 - 0
3.8	2	3.4 - 1.3	.6
14.7	20	1.3 - 1.9 - 2.0 - 2.3 2.2 - 4.2 - .5 - 5.5 1.4 - 1.0 - 2.4 - 1.6 1.3 - 1.4 - 1.8 - 3.2 2.2 - 1.3 - 3.5 - 1.3	1.0 - .5 - 0 - 1.8 - .5 0 - 2.2 - 1.6 - .4 - .6 0 - 1.6 - .7 - .8 - 0 .8 - .8 - .6 - .8
18.0	21	1.2 - 1.1 - 1.8 - 2.3 5.5 - 2.4 - 2.2 - 4.9 5.1 - 2.8 - 2.2 - 5.7 1.8 - 1.6 - .5 - .5 3.4 - 1.7 - 1.1 - .8 4.6	.3 - .5 - .3 - .5 - 2.6 .5 - 2.0 - 1.2 - 0 - .5 .4 - 3.3 - 1.6 - 2.8 0 - 0 - .8 - 0 - 0
8.9	13	.9 - 7.0 - 1.8 - 3.4 3.3 - .6 - 2.2 - 1.1 7.2 - 9.5 - 4.6 - 6.6 6.7	.7 - 0 - .6 - 0 - 0 2.6 - .8 - .7 - .9 - 1.3 - 0 - .5
21.9	32	.7 - 4.8 - 2.6 - 1.8 1.1 - 4.9 - 4.9 - 4.9 4.7 - 5.6 - 4.6 - 6.0 3.7 - 1.6 - 4.1 - 7.8 5.9 - 2.0 - .7 - 1.9 2.0 - 1.6 - 3.2 - 1.9 2.2 - 2.5 - .9 - 1.5 1.7 - 3.0 - 3.9 - 3.9	.6 - 1.7 - .9 - .5 - .9 1.2 - .9 - 2.4 - 0 - .2 .9 - .4 - 0 - 1.5 - .6 0 - 1.7 - 1.2 - .6 - .5 .4 - 0 - .8 - 1.3 - .7 0 - 2.0 - .8 - 0 - 0

Experiment Number: 9

Filaments

206

Incubation Time at 1st Hour at 38° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
Length	Number	Length	Distance Between
4.0	5	1.6 - 2.0 - 4.1 - 5.0 4.4	1.1 - 1.7 - 1.0 - .6
Average: 8.6	11.1	3.06	1.06

Experiment Number: 9

## Filaments

Incubation Time at 1.5 Hour at 38° C.

Plate Count:

<u>Soma</u>		<u>Flagella</u>		
Length	Number	Length	Distance Between	
3.4	5	1.1 - 5.0 - 6.2 - 4.1 2.9	.4 - 0 - .8 - 1.5	
11.1	16	1.3 - 6.7 - 7.1 - 2.0 2.9 - 2.1 - 1.1 - 3.3 2.2 - .8 - 1.9 - 3.4 5.5 - 2.1 - 5.0 - 2.0	.5 - .7 - 1.5 - 1.8 1.4 - 1.7 - .8 - 0 - .7 .8 - 0 - .4 - .6 - 0 0	
3.3	3	4.5 - 4.5 - 1.7	.4 - 2.2	
9.9	3	2.5 - 3.8 - 2.7	1.7 - .9	
5.4	5	1.5 - 1.4 - 2.6 - 5.4 4.1	2.4 - 1.7 - .6 - .7	
11.7	13	3.8 - 8.6 - 2.3 - 2.5 .7 - .4 - 6.0 - 4.1 6.8 - 5.3 - .5 - 1.7 4.4	0 - .8 - 1.0 - 0 - 1.0 2.7 - 1.5 - .9 - 0 - 1.0 - 1.0 - 1.0	
5.3	7	7.0 - 3.6 - 7.3 - .9 1.8 - .5 - 2.3	.6 - .6 - 1.3 - 0 - 1.4	
6.0	7	5.4 - .6 - 2.7 - 4.0 1.5 - 4.7 - .5	1.1 - 1.8 - 0 - 0 - 2.0	
6.9	8	3.6 - 2.1 - 4.8 - 1.8 4.4 - 3.2 - 3.1 - .4	1.0 - 1.1 - 2.5 - 0 - .9 - .7	
8.1	11	.7 - 4.9 - 5.6 - 7.4 5.3 - 4.4 - 3.4 - 5.0 2.9 - 5.0 - 4.1	1.3 - .4 - .7 - 1.2 - 0 1.1 - 1.8 - 1.9 - 0 .8	
Average: 7.1	7.8	3.47	1.16	



Experiment Number: 9  
 Incubation Time at 2nd Hour at 38° C.

Filaments

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
4.9	7	5.8 - 6.4 - 1.0 - 4.8 2.5 - 3.4 - 1.9	1.2 - 1.1 - 1.1 - .7 .6 - .2
2.8	4	3.4 - 1.9 - 2.1 - 3.3	0 - 1.3 - 1.3
4.7	4	7.1 - .5 - 1.8 - 6.0	.9 - 3.0 - .5
13.9	10	3.6 - 5.6 - 5.9 - 7.8 5.3 - 3.2 - 4.1 - 1.0 1.7 - 6.4	2.8 - .7 - .8 - 1.3 - 0 1.2 - .6 - 2.4 - 1.9
21.8	14	2.0 - 2.4 - 5.3 - 3.6 3.8 - 4.9 - 3.1 - 2.2 2.5 - 1.9 - 2.9 - 5.4 1.7 - 2.1	.4 - .4 - .2 - 3.9 1.1 - 1.7 - .6 - .6 1.5 - .4 - 3.4 - 3.0 4.6
4.8	5	4.0 - 3.2 - 2.7 - 2.8 2.1	.6 - 2.0 - 1.7
21.4	16	1.5 - 4.6 - 4.2 - .8 1.2 - .5 - .5 - 1.0 1.9 - .9 - 1.0 - 2.0 1.4 - 1.3 - .8 - 2.3	.5 - 2.5 - 3.1 - 0 - 0 1.5 - 3.8 - .8 - 1.2 .5 - 1.1 - .5 - 2.3 2.2
6.1	7	5.8 - 4.0 - 1.0 - 3.0 3.0 - 6.0 - 1.6	1.4 - 1.3 - 2.0 - .5 .9
20.1	13	2.3 - 1.7 - 4.4 - 2.2 1.2 - 2.1 - 2.7 - 1.7 .5 - .6 - 6.4 - 5.2 4.4	.4 - .6 - .9 - 1.4 - 2.4 - 1.6 - 1.8 - 5.9 1.4 - 3.3 - 1.3
37.5	14	1.9 - 2.7 - 1.6 - 2.6 3.4 - 5.9 - 1.1 - 4.4 6.0 - 3.8 - 2.4 - 5.2 2.3 - 1.9	2.2 - 3.2 - 8.0 - 3.4 0 - .8 - 4.5 - .9 - 2.4 4.6 - 2.0 - .6 - 4.8
<b>Average: 13.8</b>	9.4	3.04	1.80

Experiment Number: 9  
 Incubation Time at 2.5 Hour at 38° C.

Plate Count:

<u>Soma</u>		<u>Flagella</u>		
Length	Number	Length	Distance Between	
43.5	5	2.3 - 4.0 - .7 - 1.4 1.0	13.3 - 6.7 - 1.9 - 2.8	
6.7	10	1.3 - 5.6 - 2.0 - 5.4 .5 - 2.5 - .4 - 5.2 1.3 - 2.0	.6 - 1.4 - 0 - .7 - 1.2 1.5 - 1.6 - .7 - 0	
3.0	4	5.3 - 2.5 - 1.3 - 2.3	1.1 - 1.0 - .9	
31.5	13	1.7 - 1.2 - 3.4 - 5.2 5.9 - 4.2 - 6.7 - .8 .5 - .5 - .8 - .6 - .6	2.2 - 0 - 1.4 - 4.5 .9 - 0 - 3.4 - 1.0 - 0 10.0 - .6 - 5.5	
4.4	3	4.8 - 1.5 - 2.1	1.9 - 0	
9.0	5	1.4 - 1.1 - 7.3 - 2.5 2.0 - .4	0 - 1.4 - 3.9 - .4 4.3	
3.2	2	10.5 - 5.8	2.0	
52.0	3	3.7 - 4.2 - 4.9	3.1 - 1.0	
7.0	4	1.8 - 3.2 - 3.1 - 2.2	3.2 - .8 - 3.5	
5.4	0			
7.9	8	5.7 - 1.1 - 4.0 - 7.0 2.0 - 2.0 - 1.8 - 3.1	1.6 - .8 - 1.6 - 2.7 .7 - 0 - 0	
27.9	11	1.9 - 1.9 - .6 - 4.4 2.0 - 5.0 - .8 - 2.6 2.3 - 1.4	5.1 - 2.8 - 0 - 2.8 1.3 - 3.3 - .6 - 6.2 1.3 - 2.2	
<b>Average: 16.8</b>	<b>5.7</b>	<b>2.82</b>	<b>2.57</b>	

Experiment Number: 9

210

Incubation Time at 3rd Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
6.7	8	5.7 - 4.4 - 4.7 - 1.7 1.9 - .7 - 2.7 - 1.9	1.3 - 0 - 2.1 - 1.3 2.7 - 0 - .6
10.2	7	2.1 - 1.4 - 2.9 - 1.2 5.7 - 4.5 - 3.5	1.0 - 1.0 - 1.4 - 2.7 0 - 1.9
23.3	5	3.9 - .9 - 1.3 - 1.7 1.0	.7 - 4.4 - 9.0 - 5.6
9.6	6	1.4 - 4.4 - 4.3 - 1.6 3.7 - 4.5	2.5 - 0 - 2.1 - 1.2
13.3	6	5.4 - 3.6 - 3.4 - 1.1 4.0 - .9	7.8 - 1.3 - 3.5 - .7
29.3	12	1.5 - 3.4 - 5.6 - 4.1 2.0 - .7 - 1.1 - 3.0 3.6 - 2.0 - 1.8 - 0	3.0 - 0 - 1.1 - 2.4 10.1 - 4.8 - 2.7 - 0 3.1
31.8	5	3.5 - 3.2 - 6.1 - 1.8 .9	3.4 - 3.2 - 16.0
19.0	6	4.9 - 1.9 - 1.4 - 3.2 5.2 - 3.2	3.0 - 2.7 - 4.0 - 4.9 7.1
4.2	1	.8	
5.6	4	.5 - 2.7 - 4.4 - 5.2	2.9 - 1.3 - .7
10.6	7	1.5 - 5.7 - 3.2 - 5.4 5.2 - 3.4 - 5.9	2.7 - 3.1 - 2.4 - 0 1.6 - 1.3
Average: 15.1	6.09	3.01	3.23

Experiment Number: 9  
 Incubation Time at 3.5 Hour at 38° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
5.6	7	4.7 - 3.8 - 1.9 - 2.1 2.5 - .7 - 1.0	.4 - .6 - 0 - 2.0 - .8 1.8
10.7	3	.9 - 4.2 - 1.0	2.2 - 2.4
10.7	6	2.6 - 4.9 - 1.7 - 2.4 1.3 - 2.4	1.6 - 0 - 1.6 - 4.4 1.1
47.8	11	.6 - .5 - 1.2 - 2.6 1.6 - .7 - 6.4 - 2.7 .5 - 1.5 - 2.7	0 - .4 - 5.0 - 0 - 18.2 - 7.5 - 4.8 - 2.8 7.5 - 1.6
7.7	2	4.8 - 3.2	6.1
4.5	3	3.8 - 1.8 - 1.8	1.2 - 2.7
6.9	6	.6 - 6.9 - 4.6 - 1.6 1.6 - 2.1	0 - 2.4 - 1.7 - 2.8
16.7	10	6.5 - 1.2 - 6.5 - 2.6 1.3 - 2.2 - 5.6 - 2.6 2.0 - 2.2	1.7 - 3.0 - 1.9 - 2.7 1.4 - 1.4 - 1.9 - .6 2.1
11.6	6	2.7 - 1.9 - 1.7 - 6.4 1.8 - .5	1.0 - 2.3 - 3.3 - 2.8
47.5	6	1.3 - 4.4 - 1.3 - 1.4 3.4 - 1.0	6.8 - 6.4 - 1.0 - 5.0 5.2
16.5	11	4.0 - 5.5 - 3.1 - 1.8 1.7 - 2.2 - .8 - 1.0 .8 - 2.0 - 4.2	
Average: 16.9	6.45	2.53	3.02

Experiment Number: 9

Incubation Time at 4th Hour at 38° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
10.7	6	3.0 - 2.5 - 4.6 - 4.5 1.5 - 3.5	.6 - 4.2 - .3 - 2.1 2.4
5.8	5	2.4 - 3.6 - 8.7 - 5.4 3.0	0 - 0 - 3.4 - .3
10.4	4	6.9 - 3.1 - 1.6 - .7	4.0 - .9 - 1.4
6.7	1	4.8	
12.5	3	1.6 - 1.1 - 1.1	3.1 - 1.6
11.9	2	.5 - 1.7	3.9
6.1	5	1.9 - 5.9 - 4.7 - 6.0 .6	1.3 - 1.4 - 1.7 - 1.0
22.1	11	.4 - .6 - 2.5 - 1.2 1.6 - 5.6 - .6 - 4.6 4.9 - 2.1 - 3.9	3.9 - .8 - 1.1 - .7 2.3 - 2.2 - 3.8 - 0 2.7 - 4.6
41.2	4	.9 - .9 - 1.1 - .3	8.0 - 4.4 - 14.4
5.9	2	3.4 - 2.7	5.5
6.0	2	5.5 - 1.7	2.4
9.8	6	6.7 - 3.8 - 6.8 - 5.5 4.3	3.1 - 0 - 1.7 - 2.9 1.0 - 2.0
22.9	11	5.3 - .7 - .7 - 1.5 7.4 - .4 - 3.0 - 1.8 5.0 - 4.8 - 3.3	2.5 - 0 - 1.1 - 4.9 0 - 6.1 - 1.8 - 2.9 2.2 - .6
Average: 13.0	4.28	3.00	2.75

Experiment Number: 9  
 Incubation Time at 4.5

Filaments

214

Hour at 38° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
24.7	7	1.8 - 2.2 - 1.0 - 3.5 4.8 - 1.4 - 4.8	11.5 - 3.7 - 0 - 5.4 3.3 - .2
8.3	5	6.1 - 3.8 - 1.9 - 2.1 5.0	1.2 - .7 - 2.9
5.6	2	4.0 - 1.5	
10.5	4	2.4 - 7.6 - 1.2 - 2.8	
4.6	0		
31.6	11	4.1 - 1.5 - 1.5 - 1.1 7.0 - 1.1 - 2.9 - 5.1 5.1 - 4.0 - 3.6	3.7 - 6.0 - .9 - 2.9 2.7 - 1.4 - 2.4 - 5.4 0 - 1.6
3.5	0		
6.6	6	.6 - 3.4 - 3.0 - 3.9 .5 - 1.1	1.5 - 2.0 - 1.9 - .8 .4
32.4	1	1.2	
30.3	4	1.9 - 6.1 - .6 - 2.2	4.6 - 9.5 - 8.2
5.4	3	5.5 - 1.2 - .5	1.5 - 3.3
8.3	2	2.0 - .4	2.3
5.8	0		
9.2	1	4.0	
9.7	5	.3 - 5.6 - 2.9 - 7.5 1.5	4.1 - 2.2 - 3.4
13.2	5	2.1 - 2.8 - .5 - 1.3 .7	4.3 - 1.8 - 1.0 - 4.9

Experiment Number: 9

Filaments

215

Incubation Time at 4.5 Hour at 38° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
6.0	3	2.2 - 3.3 - 4.3	2.6
11.2	3	1.8 - 1.0 - 4.8	3.0 - 6.2
12.3	7	4.6 - 6.9 - .5 - 4.3 2.1 - 1.6 - 1.7	1.5 - .6 - 2.9 - 1.7 1.5 - 2.3
5.3	3	1.6 - 1.9 - 2.2	4.0 - 0
<b>Average:</b> 12.2	3.6	2.76	3.07

Experiment Number: 9 Filaments

Incubation Time at 5th Hour at 38° C.

Plate Count:

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
16.9	9	.3 - 2.2 - 1.8 - 1.3 .8 - 6.2 - 1.1 - 4.3 1.7	1.5 - 1.8 - 3.4 - 0 3.0 - .5 - 1.4 - .8
15.9	9	8.3 - 3.1 - 2.0 - .5 1.2 - 5.5 - 6.0 - 2.6 5.0	4.4 - .6 - .9 - 2.5 - 0 2.0 - 1.0 - 3.3
15.4	4	1.4 - 1.6 - 2.7 - 1.7	4.3 - .7 - 4.5
41.5	9	1.2 - .8 - 1.3 - 3.3 2.9 - 1.8 - 2.5 - 1.2 .5	6.0 - 3.5 - 1.2 - 4.6 1.7 - 5.1 - 4.0 - 6.5
4.9	1	4.9	
5.5	0		
15.2	9	4.7 - 3.9 - 6.5 - 8.2 .8 - 1.5 - 2.1 - 2.3 2.3	5.5 - 2.6 - 1.7 - 2.2 0 - 0 - 1.8
8.4	8	4.0 - 3.3 - 2.0 - 2.1 2.3 - 2.7 - 4.2 - .6	1.0 - 0 - 1.4 - 0 - 4.8 0 - 1.2
7.3	1	1.0	
7.6	1	2.2	
4.3	3	.9 - 2.3 - 1.0	3.3 - .7
8.6	2	4.9 - 1.1	4.1
21.8	6	2.2 - 2.1 - 1.7 - .9 .8 - 1.0	1.5 - 0 - 7.4 - 2.1 3.8
7.7	0		



Experiment Number: 9 Filaments  
 Incubation Time at 5<sup>th</sup> Hour at 38° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>			
	Length	Number	Length	Distance Between
9.7	6	2.0 - 1.9 - 1.7 - 1.6 2.0 - .9	1.8 - 2.5 - 1.5 - 1.4 1.6	
Average: 12.7	4.53	2.46	2.68	

Experiment Number: 9  
 Incubation Time at 5.5 Hour at

Filaments  
 38° C.

218

Plate Count:

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
13.7	2	2.6 - 8.5	8.5
8.2	2	3.4 - 1.6	1.1
8.5	1	1.0	
9.9	3	5.3 - 5.1 - 1.2	1.4 - 2.2
18.4	1	.8	
8.5	0		
7.3	4	.7 - 3.5 - 2.4 - 3.4	.6 - 5.3
9.2	2	1.8 - 1.5	1.3
11.7	3	4.7 - 1.9 - 2.2	1.0 - 3.4
6.0	0		
29.0	2	2.1 - 2.2	10.7
7.2	1	3.9	
11.0	3	6.9 - 2.4 - .4	6.6 - 3.5
7.5	2	.7 - .8	1.4
22.7	9	1.9 - 1.7 - 1.8 - 2.1 3.9 - 1.5 - 4.5 - 4.6 1.0	2.3 - 5.0 - 1.5 - 3.9 4.7 - 0 - 2.5
9.8	6	1.4 - .6 - 4.7 - 2.8 2.8 - 5.7	3.3 - 3.0 - 1.3 - 1.6 0
54.4	14	6.5 - .8 - .9 - 3.4 - 2.6 - .7 - 2.2 - 2.4 4.1 - 2.1 - 2.8 - 4.8	1.3 - 2.3 - 2.7 - 5.9 2.4 - 1.5 - 2.9 - 3.2 2.2 - 2.5 - 5.4 - 3.8

Experiment Number: 9

Filaments

219

Incubation Time at 5.5 Hour at 38° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
Length	Number	Length	Distance Between
19.0	3	3.2 - 2.9 - 1.4	5.8 - 1.2
9.5	3	.8 - 5.3 - 3.7	9.5
8.5	7	1.4 - 2.7 - 3.0 - 5.7 5.5 - 4.5 - 3.0	1.9 - 0 - 2.1 - 1.7 2.8
6.8	1	5.0	
9.7	0		
5.6	2	4.5 - 3.7	2.9
4.9	2	3.3 - 1.3	2.4
33.8	10	2.5 - 2.4 - 1.9 - 1.4 .7 - 2.9 - 3.2 - 2.3 4.2 - .5	6.8 - 1.8 - 2.3 - 3.1 3.3 - 4.3 - .6 -
<b>Average: 13.6</b>	<b>3.3</b>	<b>2.88</b>	<b>3.11</b>

Experiment Number: 9  
 Incubation Time at 6th Hour at

Filaments  
 38° C.

Plate Count:

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
11.1	10	1.4 - 1.4 - 1.4 - 1.3 .6 - 3.0 - 1.7 - 2.1 1.5 - 1.7	.3 - 1.0 - 2.6 - 2.4 - 0 1.2 - 2.6 - 0 - .6
6.0	5	1.5 - 3.8 - 4.1 - 1.6 5.0	2.7 - 0 - .8 - .6
34.2	6	1.9 - 1.6 - 2.3 - .5 7.4 - 4.0	10.8 - 2.7 - .7 - 9.5 2.1
6.1	3	1.2 - 2.1 - 7.3	.5 - 2.4
12.1	2	2.1 - 1.7	3.0
18.5	1	.5	
5.4	2	3.5 - 3.7	3.3
7.8	0		
6.5	0		
14.5	3	1.4 - 2.2 - 1.3	4.9 - 4.1
5.1	3	4.4 - 2.8 - 3.9	3.4 - 0
7.7	3	5.0 - 3.8 - .4	3.7
7.2	3	3.3 - 4.8 - 4.0	.6 - 4.7
7.9	6	1.8 - 4.0 - 6.9 - 4.8 2.0 - .7	1.6 - 1.0 - 2.3 - 1.0 0
24.1	1	.7	
8.0	4	2.4 - 5.8 - 2.2 - .4	2.3 - 0 - 0

Experiment Number: 9

Filaments

Incubation Time at 6th Hour at 38° C. Continued.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
39.7	7	2.0 - 5.1 - 1.6 - 1.4 1.8 - 2.0 - 1.6	1.4 - 1.9 - 5.2 - 1.0 11.3 - 3.9
42.3	13	2.6 - 2.1 - 1.0 - 1.1 .6 - .8 - 4.5 - 5.4 4.6 - 1.5 - 3.8 - 1.6 1.2	.3 - 4.1 - 1.1 - 1.9 7.0 - .3 - 5.6 - 0 - .4 5.1 - 11.8 - 1.1
Average: 14.7	3.94	2.47	3.10

Experiment Number: 9

Filaments

Incubation Time at 6.5 Hour at 38° C.

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
8.9	2	4.0 - 1.4	6.0
10.8	3	1.0 - .4 - .7	2.4 - .4
5.7	0		
8.9	2	.9 - .7	6.9
7.6	2	.6 - 1.7	1.2
36.2	15	1.1 - 1.2 - 2.0 - 2.3 1.0 - .3 - 7.9 - 3.2 1.4 - 1.0 - 1.0 - 4.1 2.1 - 3.2 - 4.0	2.6 - 2.8 - 3.4 - .9 .8 - .8 - 3.2 - 4.8 1.0 - 1.2 - 4.2 - 0 4.8 - 3.5
6.5	1	3.0	
8.1	1	.7	
26.6	0		
9.3	1	3.5	
11.2	3	3.2 - 1.4 - .6	0 - 4.9
7.4	1	1.0	
35.7	9	2.6 - 1.4 - 3.9 - 1.9 2.2 - .8 - 1.2 - 1.3 1.6	.5 - 5.3 - 0 - 2.9 5.5 - 5.5 - 4.3 - 1.2
5.8	0		
18.7	6	.9 - 1.3 - 1.3 - 1.1 1.6 - 2.8	.7 - 7.2 - 3.6 - 4.6
24.2	9	3.5 - 3.1 - 3.3 - 2.1 3.2 - 5.1 - .9 - .8 2.1	1.2 - 2.9 - .6 - 0 7.0 - 3.7 - 0 - .9

Experiment Number: 9

Filaments

223

Incubation Time at 6.5 Hour at 38° C. Continued

Plate Count:

<u>Soma</u>		<u>Flagella</u>		
Length	Number	Length	Distance Between	
3.9	0			
5.1	0			
8.2	3	1.8 - 2.0 - 2.1	4.4 - 3.8	
4.3	0			
5.0	0			
4.0	1	6.0		
4.8	1	4.4		
<del>4.8</del>	0			
6.4	2	4.0 - 1.4	5.1	
15.7	2	3.0 - 1.3	3.2	
13.0	6	1.6 - 3.7 - 2.6 - 2.3	0 - 3.7 - 1.1 - 2.6 - .6	
	.8	2.8		
<b>Average: 11.7</b>	<b>2.59</b>	<b>2.15</b>	<b>3.13</b>	

Experiment Number: 9

Filaments

224

Incubation Time at 7th Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
12.6	3	1.9 - 1.0 - 2.0	9.6 - 1.2
10.9	2	1.1 - 5.6	7.4
7.2	0		
5.8	2	4.0 - 3.9	4.9
12.8	3	4.7 - 2.5 - .6	4.7 - 5.2
5.0	2	6.4 - 2.0	1.0
14.3	4	.6 - 4.2 - .5 - .4	0 - 4.6 - 3.4
11.2	1	4.5	
32.7	4	2.0 - 4.1 - 5.5 - 1.1	11.7 - 5.1 - 5.4
5.6	0		
7.7	0		
21.3	2	1.5 - 2.9	8.5
8.1	3	3.7 - 1.4 - 2.7	1.5 - 2.5
10.2	1	1.3	
7.1	5	1.8 - 1.5 - 1.4 - 5.2 1.7	2.4 - 1.4 - 0 - 0
20.3	4	1.3 - 1.3 - .9 - 1.7	7.3 - 1.2 - 10.0
4.2	1	.3	
4.7	0		
6.2	2	3.6 - 2.9	3.3



Experiment Number: 9

Filaments

225

Incubation Time at 7th Hour at 38° C. Continued

Plate Count:

Soma Length	Flagella		
	Number	Length	Distance Between
5.7	1	3.3	
4.6	2	1.2 - .9	2.5
24.2	7	4.7 - 1.2 - 1.3 - .8 .9 - .9 - 1.9	1.6 - 5.5 - 6.9 - 2.2 1.9 - .6
16.3	5	.8 - 1.0 - 1.1 - 1.2 1.4	1.2 - 8.2 - .6
9.5	2	1.9 - 1.3	3.9
8.0	3	.7 - 2.7 - .5	4.0 - 1.0
17.2	3	.9 - 1.1 - 1.5	7.5 - 4.6
4.4	0		
6.0	0		
8.9	3	.7 - .7 - .7	0 - 5.7
7.4	2	3.2 - .6	2.9
10.0	0		
10.0	1	1.4	
6.9	3	3.0 - 2.4 - 1.2	0 - 1.9
18.3	3	2.7 - 2.0 - .6	6.9 - 9.0
22.3	0		
5.9	4	2.5 - 3.1 - 4.9 - 2.0	2.0 - 1.3 - .4
Average: 11.5	3.18	2.01	4.69

Experiment Number: 9 Filaments

Incubation Time at 7.5 Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>			
	Length	Number	Length	Distance Between
9.0	1	1.0		
22.9	6	2.1 - .7 - 1.2 - 2.6 .8 - .6	2.8 - 7.0 - 2.6 - 5.3 0	
3.8	2	6.3 - 3.0	1.5	
11.0	3	3.2 - 1.0 - 1.0	2.4 - 5.5	
45.8	4	1.0 - 1.1 - .8 - .5	2.9 - 3.4 - 3.9	
13.1	0			
10.1	2	.6 - .8	4.5	
20.0	6	3.6 - 2.2 - 3.7 - 2.3 1.7 - 1.1	2.2 - 3.1 - 0 - 3.9	
12.6	1	.6		
6.9	4	2.3 - 3.7 - 2.0 - 2.6	2.7 - 0 - 3.6	
28.0	4	2.3 - 2.5 - 1.8 - 4.6	3.6 - 3.0 - 3.4	
9.0	2	3.2 - 3.8	3.2	
11.1	4	1.7 - 7.0 - 2.4 - 1.6	2.0 - 1.4 - 7.9	
16.5	5	1.1 - 1.0 - 3.1 - 3.8 1.5	3.0 - .8 - 7.2 - 1.6	
5.7	4	5.3 - 4.7 - .6 - 4.0	1.2 - 1.9 - 0	
9.2	3	2.6 - 2.6 - .9	0 - 6.8	
3.7	2	2.8 - .7	2.3	
7.5	3	6.2 - 1.5 - 2.6	3.6 - 1.8	

Experiment Number: 9

Filaments

227

Incubation Time at 7.5 Hour at 38° C. Continued

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
6.0	2	2.2 - 1.0	6.0
23.4	2	.7 - 1.1	4.1
10.6	1	.9	
8.3	3	1.2 - 1.0 - 1.2	1.8 - 5.4
7.6	1	3.7	
4.6	0		
7.9	1		
18.4	6	2.5 - 1.4 - 1.7 - 6.4 5.6 - .9	2.7 - 3.8 - 1.7 - 10.0
7.3	4	1.5 - 4.2 - 1.0 - 3.8	2.5 - 1.9 - 1.5
6.3	0		
17.4	4	1.7 - 3.6 - 1.0 - 1.0	10.4 - 1.3 - 3.0
14.8	0		
8.8	1	1.3	
9.7	2	1.4 - 1.8	0
6.4	0		
<b>Average: 12.2</b>	<b>2.5</b>	<b>2.24</b>	<b>3.58</b>

Experiment Number: 9

Filaments

228

Incubation Time at 8th Hour at 38° C.

Plate Count:

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Length
11.6	5	.8 - 1.1 - 1.2 - 1.1 1.4	5.2 - 2.4 - 2.4
8.0	0		
10.0	2	.4 - .8	7.6
7.9	0		
5.2	1	1.1	
8.8	1	3.0	
5.1	2	2.2 - .8	1.4
15.0	0		
4.1	0		
7.1	3	2.0 - 1.3 - .6	2.1 - 3.0
12.4	3	2.1 - 1.0 - .9	5.5 - 2.9
5.6	1	1.1	
3.8	2	4.9 - 1.2	1.9
6.4	0		
9.1	2	3.3 - .9	7.9
19.0	10	3.0 - 1.5 - 1.6 - 1.2 3.0 - 2.5 - 2.4 - 1.7 1.0 - 3.6	2.8 - 1.9 - 3.1 - 3.7 3.6 - 0 - .9 - 1.0
9.5	2	.4 - .3	6.0
7.1	0		

Experiment Number: 9

Filaments

229

Incubation Time at 8th Hour at 38° C. Continued

Plate Count:

<u>Soma</u>		<u>Flagella</u>		
Length	Number	Length	Distance Between	
6.3	4	2.5 - 7.6 - 5.8 - 5.9	2.5 - .8 - 1.6	
8.4	4	3.5 - 1.7 - 1.1 - .6	1.9 - 3.6 - .7	
6.9	0			
16.5	3	7.0 - 3.1 - 2.3	11.0 - 1.4	
11.0	2	3.5 - 4.6	3.0	
6.3	2	3.2 - 2.1	4.9	
7.0	0			
32.0	12	1.4 - 1.6 - 2.3 - 1.2 3.8 - 2.0 - 4.8 - 5.3 3.2 - 1.3 - 1.6 - 1.2	1.3 - 1.4 - 2.5 - 4.5 2.3 - 3.5 - 5.4 - 2.4 1.6 - 1.2 - 1.1	
12.3	4	1.0 - 1.2 - 1.6 - 1.8	1.6 - 2.1 - 4.4	
7.6	1	1.1		
11.8	1	1.8		
24.7	6	2.0 - 2.0 - 2.3 - .8 .6 - 1.7	0 - 3.0 - 1.0 - 8.1 8.3	
11.7	3	1.9 - 4.2 - 1.0	6.2 - 5.5	
20.4	5	3.0 - 1.1 - 1.4 - 2.8 1.6	2.9 - 0 - 4.6 - 3.9	
<b>Average: 10.6</b>	<b>2.53</b>	<b>2.17</b>	<b>3.37</b>	

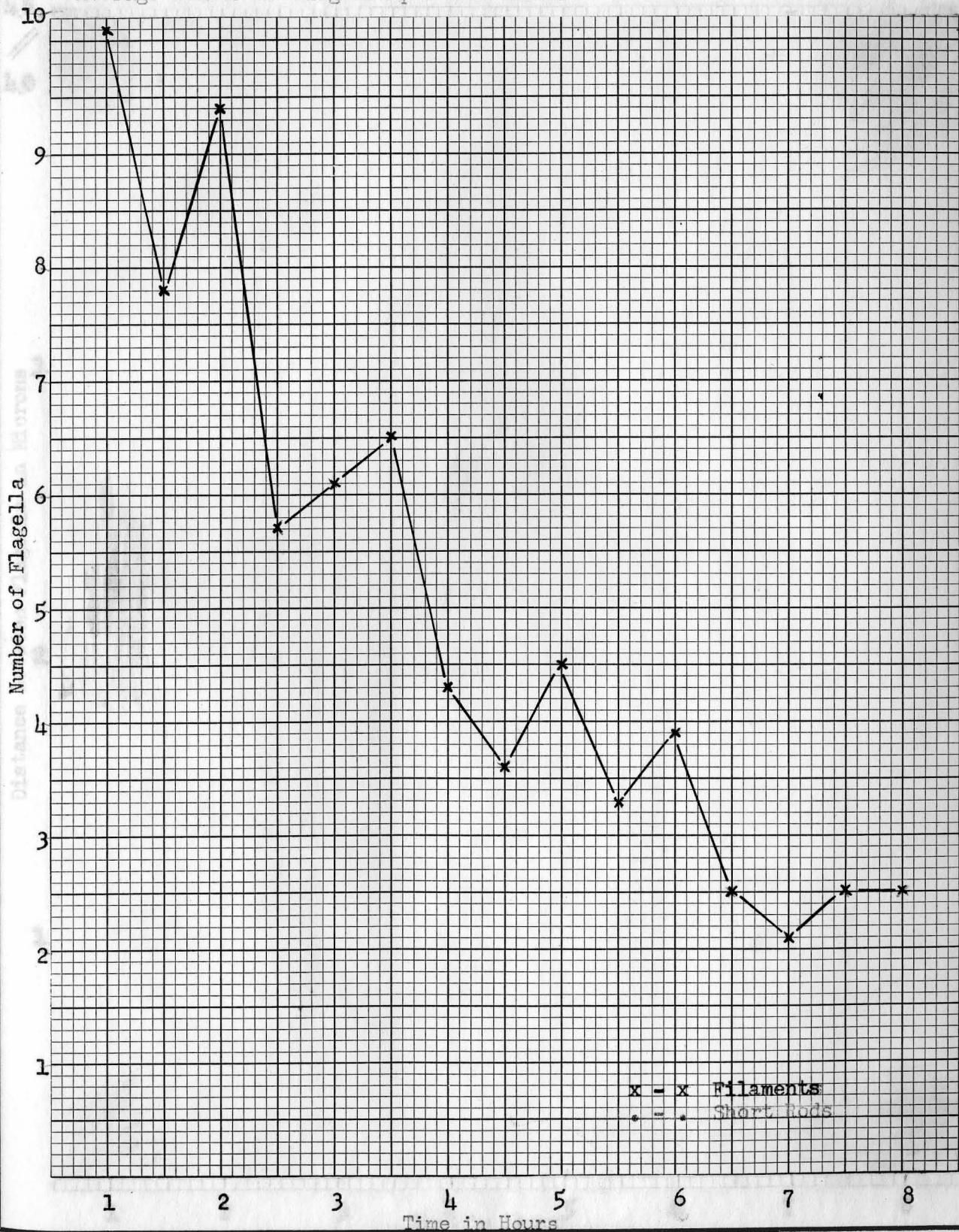
Loss of Flagella at 38° C.; Original Temperature was 20° C.

Summary of Values

Hours of Incubation	Av. Length of Soma	Av. No. of Flagella/ Individual	Av. Length of Flagella	Av. Distance Between Flagella	Plate Count	% Flagellated
	Microns		Microns	Microns		
1	8.6*	11.1	3.06	1.06	10.8	100
1.5	7.1	7.8	3.46	1.16		100
2.0	13.8	9.4	3.04	1.80	15.2	100
2.5	16.8	5.7	2.82	2.57		91
3.0	15.1	6.1	3.01	3.23	25.0	100
3.5	16.9	6.45	2.53	3.02		100
4.0	13.0	4.28	3.00	2.75	44.3	100
4.5	12.2	3.60	2.76	3.07		85
5.0	12.7	4.53	2.46	2.68	100.0	86
5.5	13.6	3.30	2.88	3.11		88
6.0	14.7	3.94	2.47	3.10	110.6	88
6.5	11.7	2.59	2.15	3.13		70
7.0	11.5	2.18	2.01	4.69	108.3	78
7.5	12.2	2.5	2.24	3.58		84
8.0	10.6	2.53	2.17	3.37	97.5	75

\*Based on measurements of 25 to 50 individual bacteria.

Graph 9-A Primary Temperature 20C; Secondary Temperature 38C  
Average Number of Flagella per Individual



Graph 9-B Primary Temperature 20C; Secondary Temperature 38C  
Average Distance Between Flagella

4.5

4.0

3.5

3.0

2.5

2.0

1.5

1.0

0.5

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

0.0

Distance Between Flagella in Microns

1

2

3

4

5

6

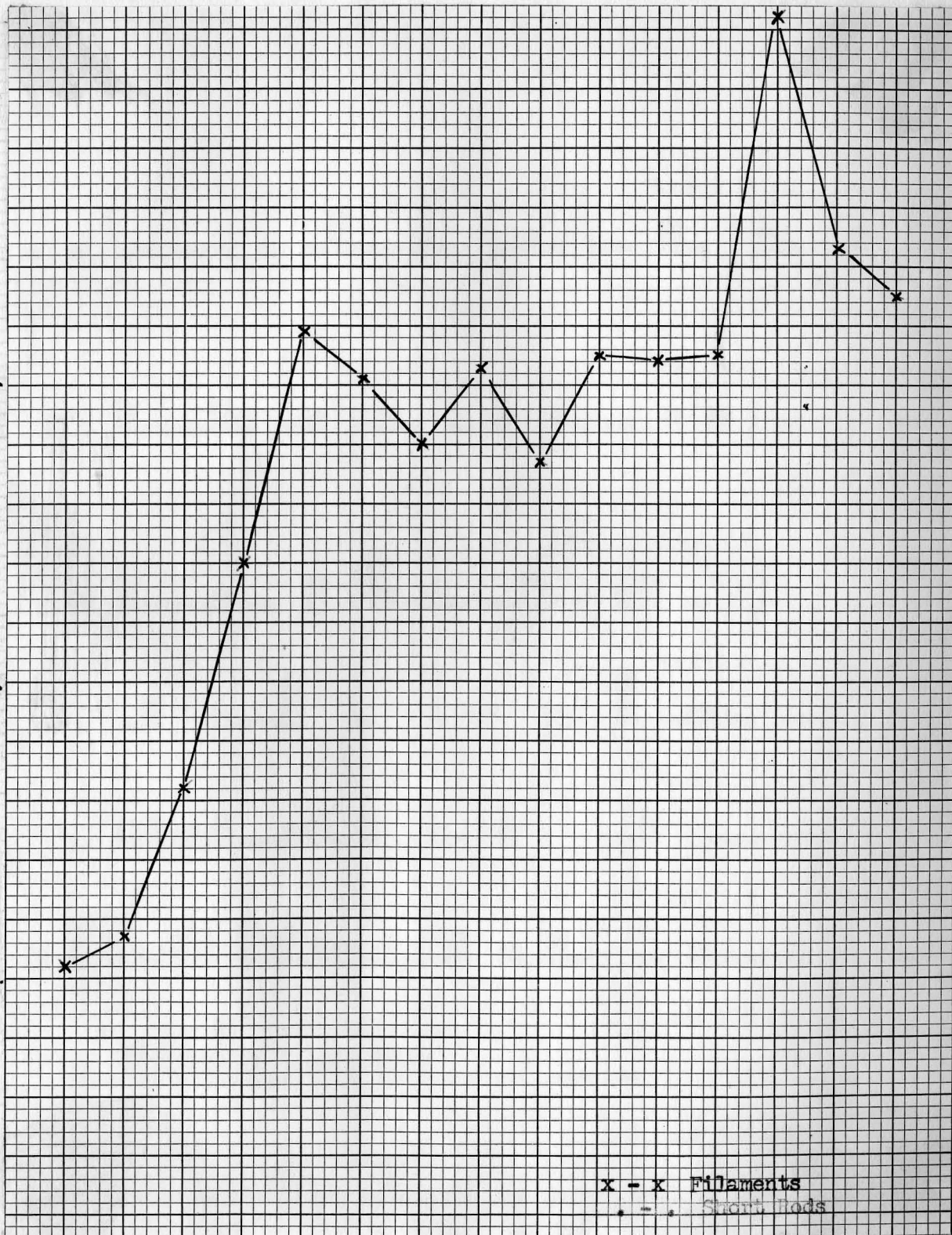
7

8

Time in Hours

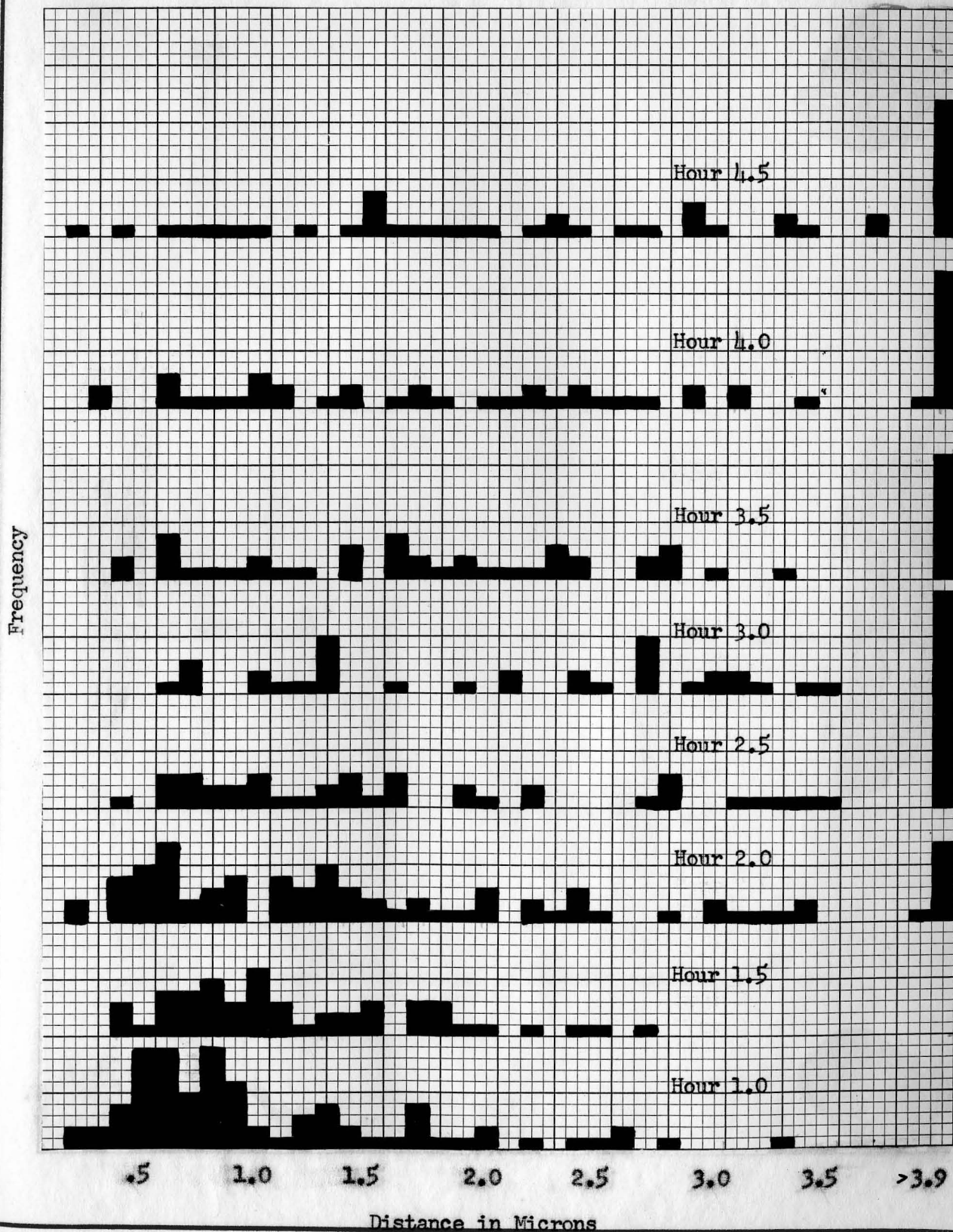
x - x Filaments

Short Rods





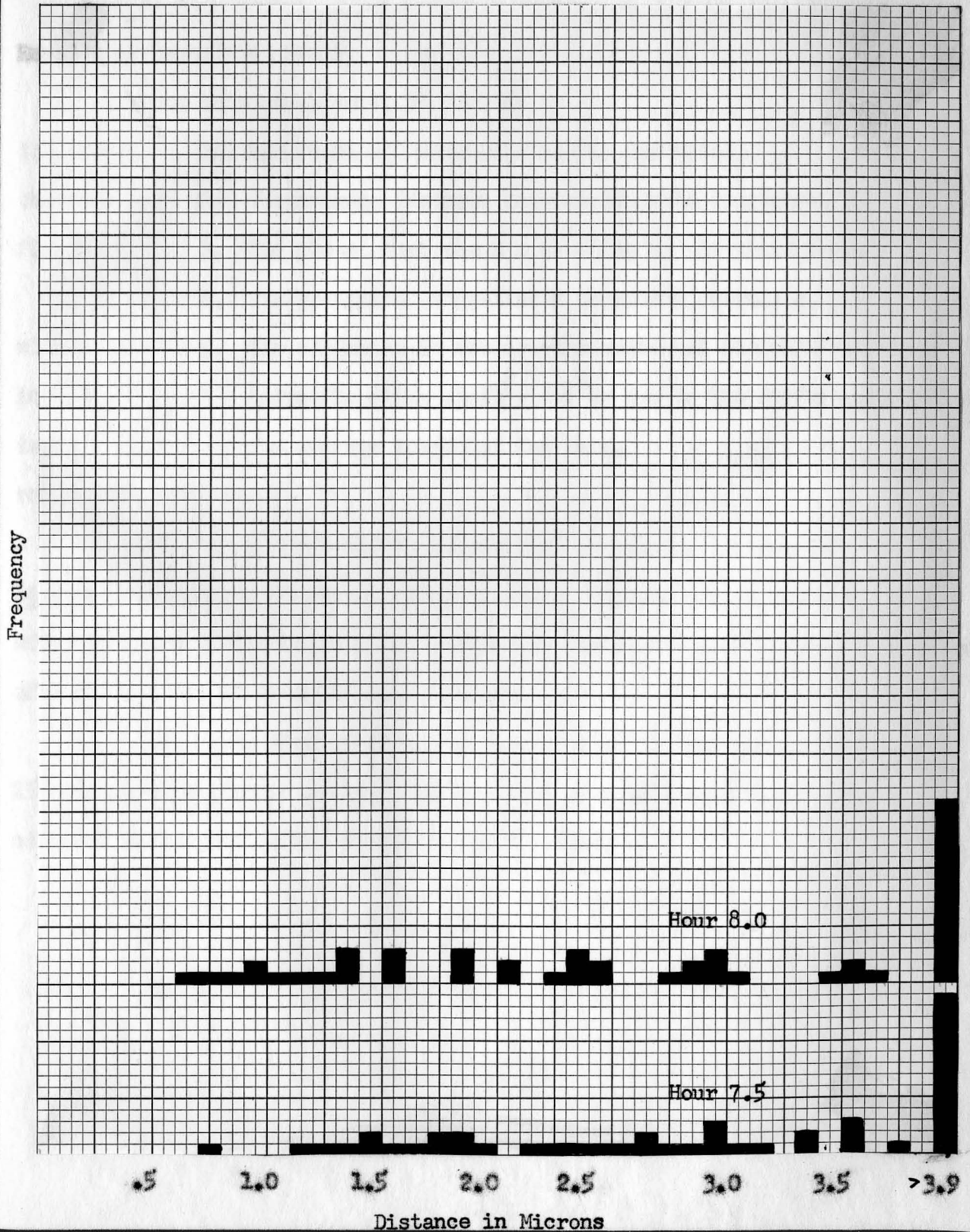
Graph 9-C Secondary Temperature 38C  
Frequency Distribution of Distance Between Flagella





Graph 9-C (Continued)

Frequency Distribution of Distance Between Flagella



### Results of Experiment No. 9

From this experiment, it is seen

1. The average number of flagella decreases.
2. The average distance between flagella increases.
3. The plate count shows a doubling by the third hour.
4. The percent of flagellated organisms decreases.
5. The variation in the average number of flagella and the intra-flagellar spacing may be due to the differences in the average length of the soma.

Experiment No. 10

In the experiments in which the primary temperature was 20° C. and the secondary temperature was 38° C. it seemed necessary to show that the decrease in the average number of flagella was not due to falling off of flagella.

Four tubes of caseitone broth (volume = 10 ml.) were inoculated with a loopful of L. monocytogenes. Two tubes were placed in a 20° C. incubator, and two were placed in a 38° C. incubator. Every two days, the cultures were centrifuged and the supernate decanted and returned to the respective incubator.

When the broth would no longer support growth, another loopful of Listeria was inoculated as a further control. When no growth was evident after 96 hours of incubation, the medium was inoculated with a heavy suspension of cells and placed in a 38° C. incubator.

This suspension of cells was grown at 20° C. and washed twice for 15 minutes with sterile water. Plate counts were made and aliquots for staining were taken at the first and eighth hour.

Experiment No. 10-A

The medium was exhausted at 38° C; the secondary incubation was 38° C.

Experiment Number: 10 A

239

Incubation Time at 1st Hour at 38 C.

Plate Count: 115.7 colonies from ml. x 10<sup>6</sup>

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.6	3		
2.4	5		
2.5	1		
2.1	2		
3.9	1		
3.5	1		
3.5	3		
3.4	4		
4.9	3		
6.7	9		
5.1	8		
6.3	4		
5.3	4		
9.0	10		
9.2	9		
6.1	9		
6.0	4		
6.9	3		
11.9	10		
Average 5.32	5.2		

Experiment Number: 10 A

Incubation Time at 8th Hour at 38 C.

Plate Count: 94 colonies from ml. x  $10^6$ 

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
1.5	1		
2.4	1		
2.3	4		
2.3	4		
3.3	3		
3.0	2		
3.2	2		
3.1	7		
4.7	2		
4.0	5		
4.3	2		
4.1	3		
4.3	8		
5.3	6		
5.7	7		
12.0	10		
7.2	7		
9.8	9		
6.4	5		
7.6	11		
Average 4.83	5.0		



Experiment No. 10-B

The procedure was the same as in Experiment No. 10-A.

Experiment Number: 10 B

Incubation Time at 1st Hour at 38 C.

Plate Count: 76 colonies from ml. x  $10^6$ 

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
4.2	4		
15.8	17		
3.9	6		
4.5	7		
3.3	5		
4.2	5		
5.5	9		
4.4	5		
5.4	7		
6.6	7		
6.5	5		
3.3	4		
2.0	2		
8.4	5		
6.7	3		
7.2	6		
5.2	4		
3.9	3		
13.8	6		
4.2	4		
Average 5.95	5.7		

Experiment Number: 10 B

243

Incubation Time at 8<sup>th</sup> Hour at 38 C.

Plate Count: 47.5 colonies from ml. x 10<sup>6</sup>

<u>Soma</u> Length	<u>Flagella</u>		
	Number	Length	Distance Between
6.5	5		
4.7	3		
10.6	8		
7.0	3		
7.2	6		
6.4	8		
4.2	1		
3.8	4		
4.6	2		
4.1	2		
2.6	4		
7.0	4		
4.8	8		
12.2	10		
4.0	2		
4.1	4		
3.1	3		
4.2	4		
16.9	1.4		
4.8	1		
Average 6.14	4.8		

Experiment No. 10-C

The medium was exhausted at 20° C.; the secondary incubation was 38° C.

Experiment Number: 10 C

Incubation Time at 1st Hour at 38 C.

Plate Count: 151 colonies from ml. x  $10^6$ 

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
4.7	6		
7.3	2		
4.7	6		
4.6	8		
9.4	8		
12.9	9		
3.1	5		
4.4	5		
16.5	15		
3.2	3		
14.6	16		
8.5	18		
3.3	4		
3.4	6		
9.4	8		
3.9	2		
2.2	2		
4.1	2		
7.5	3		
9.5	13		
Average 6.86	7.1		

Experiment Number: 10 C

Incubation Time at 8th Hour at 38 C.

Plate Count: 94.5 colonies from ml. x  $10^6$ 

<u>Soma</u>	<u>Flagella</u>			
	Length	Number	Length	Distance Between
5.6	4			
7.6	9			
6.5	8			
6.9	7			
22.4	10			
11.4	14			
3.1	2			
4.0	4			
3.2	1			
3.1	2			
4.0	4			
5.4	6			
3.4	1			
2.1	1			
6.5	4			
8.9	11			
10.1	8			
11.4	17			
10.3	8			
3.5	4			
Average 6.97	6.3			

Experiment No. 10-D

The procedure was the same as in Experiment No. 10-C.

Experiment Number: **10 D**Incubation Time at **1st** Hour at **30** C.Plate Count: **100 colonies from ml. x 10<sup>6</sup>**

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
3.6	6		
4.7	6		
3.8	7		
2.5	2		
2.9	5		
1.9	3		
3.1	2		
4.2	6		
4.6	3		
11.0	12		
3.0	2		
4.7	2		
4.3	4		
3.8	1		
14.7	15		
4.4	4		
4.5	7		
7.5	3		
4.5	4		
6.2	5		
Average 5.00	5.0		



Experiment Number: 10 D

Incubation Time at 8th Hour at 38 C.

Plate Count: 86.5 colonies from ml. x  $10^6$ 

<u>Soma</u>	<u>Flagella</u>		
	Length	Number	Distance Between
2.7	2		
6.7	5		
7.3	3		
4.4	4		
3.0	3		
11.0	10		
2.9	3		
3.2	2		
4.6	2		
3.2	5		
15.2	18		
4.0	5		
9.4	6		
5.3	4		
7.5	4		
2.4	6		
3.7	3		
11.3	10		
4.8	5		
2.5	1		
Average 5.76	5.1		

**Results of Experiment No. 10:**

From these experiments, it is seen that

1. The Flagella do not fall off the organism when incubated for eight hours at 38° C.
2. The viable cell count decreases during this eight hour interval.
3. The variation in the averages of the number of flagella seems to be due to the differences in the length of the *scans*.

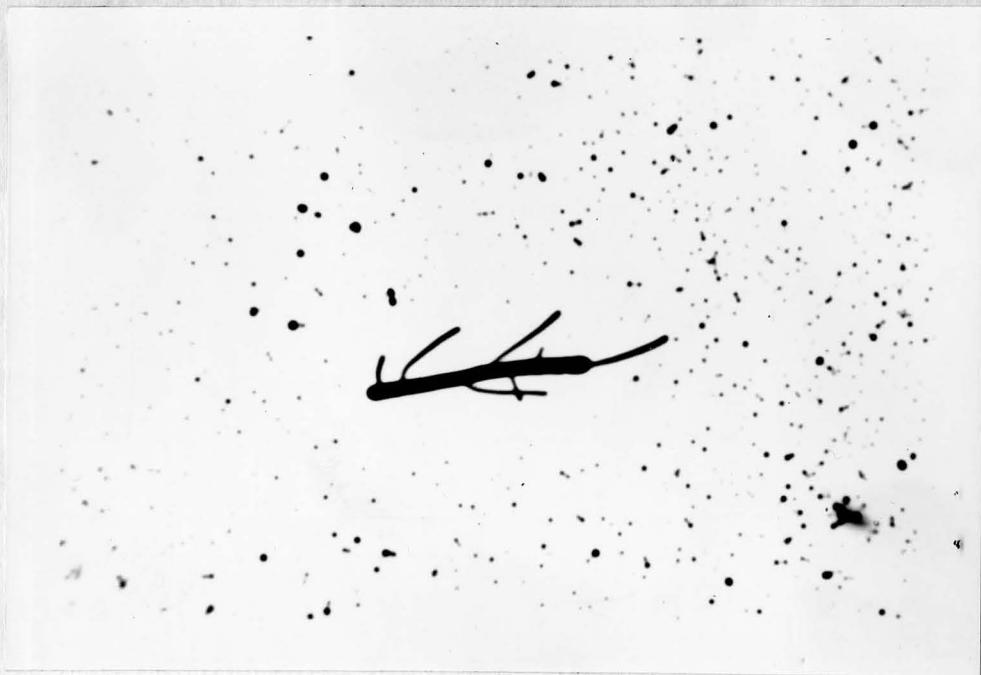


Photograph 1  
Hour 1.0  
Primary incubation Temperature 20C; Secondary Temperature 38C.  
Sample taken before culture was placed in the 38C incubator.



Photograph 2  
Hour 2.0  
Primary incubation Temperature 20C; Secondary Temperature 38C.

Photograph 4  
Hour 5.0  
Primary Temperature 20C; Secondary Temperature 38C.



Photograph 3 Hour 4.0  
Primary Temperature 20C; Secondary Temperature 38C.



Photograph 4 Hour 5.0  
Primary Temperature 20C; Secondary Temperature 38C.

Flagella,

In the  
length will  
in an



Photograph 5  
Hour 4.25  
Primary incubation Temperature 38C; Secondary Temperature 20C.

Photographs 1 through 4 show a decrease in the number of flagella, and an increase in the distance between the flagella.

Photograph 5 shows the beginning of flagellar appearance. In the following hours, the number of flagella will increase, the length will increase, and the flagellar spacing will decrease, resulting in an organism similar to photograph 1.

Experiment No. 11

The purpose of this experiment was to determine the increase in length of flagella per unit time. A loopful of Listeria was inoculated into 200 ml. of casitone broth, and incubated at 38° C. until turbidity was evident. The culture was transferred to a 20° C. or 30° C. incubator and aliquot drawn. At the critical hour in which flagella appear, samples were drawn every five minutes for a period of thirty minutes. Slides were prepared and stained.

Hour	Temperature	Length of Flagella
8:45	38° C.	No flagella visible.
9:45	20° C.	No flagella visible.
10:45	20° C.	No flagella visible.
11:45	20° C.	No flagella visible.
11:55	20° C.	.3 - .3 - .2 - .3 - .1 - .2 - .3 - .1 - .2 - .1 - .1 .3 - .4 - .7 - .2 - .3 - .3 - .6 - .1 - 1.0 - .2 - .4 .5 - .4 - .4 - .1 - .2 - .5 - .7 - .4 - .4 - .2 - .9 .7 - .3 - .2 - .2 - .1 - .1 - .2 - .2 - .4 - .4 - .2 .3 - .3 - .5 - .6 - .5 - .7 - .3 - .7 - .4 - .3 - .4 - .2 - .4 - .4 - .4 - .6 - .5 - .2 - .3 - .7 - .1 - .3 .5 - .3 - .7 - .3 - .2 - .3 - .3 - .3 - .3 - .1 - .2 .3 - .3 - .2 - .1 - .2 - .2 - .2 - .3 - .4 - .4 - .5 .8 - .3 - .4 - .4 - .2 - .5 - .2 - .4 - .2 - .6 - .1 .6 Average: .38
12:00	20° C.	.4 - .4 - .3 - .8 - .6 - .5 - .5 - .5 - .3 - .4 - .3 .5 - .4 - .3 - .3 - .3 - .3 - .7 - .3 - .5 - .5 - .3 1.2 - .4 - .3 - .4 - .5 - .4 - .5 - .3 - .5 - .4 - .9 .5 - .4 - .5 - .6 - .4 - .4 - .4 - .3 - .5 - .2 - .4 - .5 - .3 - .4 - .4 - .6 - .4 - .3 - .4 - .6 - .3 - .6 .6 - .4 - .7 - 1.0 - .5 - .3 - .6 - .6 - .8 - .4 - .5 .1 - .7 - .5 - .4 - .3 - .3 - .6 - .5 - .3 - .6 - .4 .5 - 2. - .4 - .4 - .2 - .4 - .6 - .5 - .5 - 1.0 - .8 .5 - .6 - .8 - .7 - .6 - .6 - .5 - .4 - .3 - .5 - .7 .4 - .4 - .5 Average: .48
12:05	20° C.	1.2 - 1.4 - .6 - .6 - .6 - .5 - 1.0 - .5 - .7 - .8 - .8 .5 - .3 - .3 - .7 - .4 - 1.0 - .4 - .8 - .4 - .4 - .6 1.7 - 1.2 - .9 - 1.1 - .4 - .5 - .8 - .2 - .4 - 1.0 1.3 - .6 - .4 - .3 - .5 - .7 - .6 - 1.4 - 1.4 - .6 - .6 .8 - .9 - 1.0 - 1.0 - 1.0 - .9 - .9 - .9 - .8 - 1.0 - .4 .8 - .5 - .3 - .3 - 2.6 - .6 - .7 - 1.0 - 1.6 - 1.1 - .7 1.2 - 1.7 - .5 - .9 - 1.0 - .5 - 1.5 - .6 - 1.2 - 1.1 .8 - .8 - .6 - .7 - .3 - .8 - 1.0 - 1.0 - 1.6 - 1.2 .7 - 1.1 - .5 - .3 - .7 - .5 - .4 - .4 - .5 - .9 - .4 2.4 - .7 - .4 - .7 - 1.5 Average: .82

Hour	Temperature	Length of Flagella
12:10	20° C	1.2 - .8 - .3 - .9 - .6 - 1.5 - 3.0 - 1.6 - 1.8 - 1.9 .7 - .9 - .3 - .5 - 1.6 - .7 - 1.3 - .6 - .6 - 1.3 - 1.0 - 1.7 - 1.5 - .6 - .6 - 1.4 - 1.3 - .6 - 2.0 - .5 .4 - 1.0 - .3 - 1.4 - 1.5 - .8 - .6 - 1.0 - .5 - .3 - 2.4 - .5 - .7 - .6 - .6 - .5 - .4 - 1.1 - .3 - .4 - .7 .5 - 1.5 - 1.2 - .6 - .6 - .7 - .5 - 1.0 - .9 - .6 - .6 1.6 - 2.0 - .4 - .6 - .7 - .4 - .6 - 2.7 - 2.3 - .9 - 1.3 - .3 - .5 - .7 - .2 - 1.3 - 1.0 - .5 - 1.1 - .8 - .6 1.5 - 1.0 - .7 - 1.3 - 1.7 - .4 - 1.0 - 1.3 - .3 - 2.1 1.3 - 1.2 - .4 - .8 - 2.0  Average: .99
12:15	20° C.	1.0 - 1.3 - 2.1 - 1.0 - .5 - 1.9 - 1.2 - .5 - .9 - 2.1 1.7 - .9 - 2.0 - 1.2 - 1.6 - 2.2 - 2.4 - 1.8 - .2 - 2.1 1.1 - .4 - 2.4 - 2.3 - 1.5 - 1.7 - 1.8 - 1.2 - .9 - 2.1 .3 - .9 - .8 - 1.0 - .3 - 2.0 - .9 - .9 - .9 - 1.9 1.9 - 2.3 - .9 - 1.7 - 2.6 - .5 - .3 - .4 - .4 - .7 - .7 - 1.9 - 2.0 - 1.3 - .7 - 1.5 - .6 - 1.2 - 1.6 - 1.2 1.1 - 1.1 - .6 - 1.1 - .8 - 1.2 - 2.2 - .5 - .7 - .5 .6 - .7 - 1.5 - .6 - .5 - .9 - .3 - 1.7 - 1.0 - .7 - .7 1.2 - .9 - .5 - 1.9 - .9 - 2.0 - 1.5 - .5 - .6 - .3 .8 - .9 - 1.0 - 1.0 - .8 - .6 - .8 - .7 - .9  Average: 1.15
12:20	20° C.	2.0 - .6 - 1.4 - 1.7 - 1.1 - 1.1 - 1.0 - .4 - .3 - 1.4 1.8 - 2.7 - .7 - .8 - .8 - .7 - 1.6 - 1.9 - 1.5 - .8 1.7 - 1.0 - 2.5 - 1.7 - 1.6 - .4 - 1.7 - 1.0 - 1.4 - .7 .7 - .9 - 2.0 - 2.0 - 1.3 - .9 - 1.1 - 2.4 - 1.9 - 1.6 .6 - .5 - 1.9 - 1.0 - .4 - .7 - 1.1 - 1.4 - 1.7 - 2.1 .6 - 1.1 - .7 - .5 - 1.8 - 2.2 - 1.8 - 2.5 - 1.1 - 1.4 1.6 - 1.1 - 2.0 - 1.3 - .7 - 1.3 - 1.8 - .8 - .8 - .7 1.2 - 1.5 - 1.3 - 1.8 - 1.4 - 1.1 - .8 - .4 - 2.0 - .9 1.6 - 1.4 - .6 - 1.0 - .5 - 1.1 - 1.9 - 1.4 - 1.5 - 1.1 1.3 - .5 - 1.5 - .7 - 1.0 - 1.2 - .3 - 1.0 - 2.2  Average: 1.25



## Experiment No. 11 - A Continued

Hour	Temperature	Length of Flagella
12:25	20° C.	3.5 - 1.4 - .6 - 1.2 - 1.4 - .7 - 1.8 - 1.3 - 2.1 1.4 - .6 - 1.2 - 1.1 - 2.0 - 1.1 - 1.3 - .7 - 1.5 - 1.1 .4 - 1.0 - .4 - .8 - .5 - 2.3 - 1.4 - 2.8 - 1.7 - 1.6 .5 - .9 - .7 - 1.2 - 1.4 - 2.4 - .9 - 2.2 - .7 - 1.1 1.6 - .9 - 2.3 - 1.1 - 3.3 - .8 - 2.8 - 1.0 - .7 - 1.6 1.3 - .2 - 1.3 - 1.8 - 2.3 - 1.0 - 2.0 - 2.2 - 2.6 3.3 - .8 - .4 - 1.6 - 2.6 - .4 - 1.4 - .3 - .6 - 1.7 .9 - .8 - .6 - .4 - 1.8 - .5 - 1.3 - .3 - 3.0 - 1.4 .5 - 1.7 - 2.8 - 2.0 - 1.4 - .7 - 1.6 - .8 - .5 - 2.0 2.5 - 1.4 - 1.1 - 1.0 - 2.0 - .8 - 1.2 - 1.9 - .8 - 2.2  Average: 1.38
12:30	20° C.	.9 - 1.7 - 1.7 - .7 - 1.1 - 1.0 - 1.4 - 1.4 - 1.5 - 2.0 .7 - 3.0 - 2.8 - 1.9 - .9 - 1.5 - .6 - 2.6 - 1.8 - .4 2.0 - 2.2 - 1.3 - 1.8 - 2.5 - 1.2 - 1.7 - 2.3 - 1.2 - .4 - 1.5 - 2.6 - 1.0 - .6 - 1.0 - 1.1 - .5 - 1.2 - 1.3 3.3 - 1.8 - 1.0 - 1.7 - 2.2 - .7 - 2.3 - 1.7 - 2.4 - .9 .4 - 1.1 - .9 - 1.0 - 2.0 - 1.4 - 1.4 - 1.3 - 1.1 - 1.8 .9 - 1.5 - 1.0 - .9 - 2.1 - 1.5 - 1.6 - 2.2 - 1.4 - 2.0 .4 - 2.1 - .3 - .7 - 1.8 - .9 - 1.9 - .5 - 1.0 - .7 1.5 - 2.4 - 1.3 - 2.7 - .6 - 1.8 - 1.4 - 2.7 - 2.5 - 3.1 1.5 - 1.7 - 1.2 - 1.0 - .8 - .8 - 2.3 - 1.1 - 2.8 - 1.2 2.1  Average: 1.49

Experiment 11 - B

Hour	Temperature	Length of Flagella
9:00	38° C.	No flagella visible.
10:00	30° C.	No flagella visible.
10:40	30° C.	No flagella visible.
10:45	30° C.	.6 - .7 - .3 - .3 - .8 - .7 - .2 - .2 - .3 - .8 .5 - .1 - .1 - .5 - .1 - .8 - .2 - .3 - .2 - .6 .3 - .5 - .4 - .2 - .3 - .8 - .3 - .2 - .4 - .3 .4 - .6 - .3 - .2 - .3 - 1.2 - .3 - .3 - .2 - .2 .3 - .3 - .4 - .3 - .4 - .2 - .4 - .3 - .2 - 1.2 .2 - 1.8 - .7 - .6 - .7 - .3 - .7 - 1.0 - .7 - .9 1.1 - .5 - .3 - .2 - .1 - .5 - .6 - .6 - .4 - 1.6 .3 - .3 - .3 - .3 - .3 - .4 - .2 - .6 - .2 - .3 .7 - .2 - .4 - .3 - .3 - .4 - 1.4 - 1.3 - .1 - .3 .7 - .2 - .4 - .3 - .2 - .5 - .4 - .3 - .2
		Average: .47
10:50	30° C.	1.0 - 2.3 - 2.0 - .3 - 2.2 - .3 - .8 - .4 - 1.4 1.1 - .4 - 2.2 - 3.1 - .3 - .4 - 2.4 - .8 - 1.4 .2 - .2 - .8 - .6 - .4 - .3 - .4 - .3 - .3 - 2.3 .6 - 2.3 - 1.3 - 2.7 - .3 - .3 - 1.8 - .4 - 2.6 .6 - 1.5 - 1.1 - 1.3 - 1.5 - .9 - .3 - 1.8 - .8 .6 - 1.9 - 1.5 - 2.2 - 2.8 - .9 - 1.4 - .4 - .3 .3 - .3 - .4 - .4 - .2 - .2 - .7 - .4 - .4 - .5 .4 - 2.5 - .3 - .4 - .5 - 1.3 - .3 - 1.4 - .3 1.3 - .5 - .8 - 1.4 - .6 - 1.0 - 2.2 - .6 - .9 1.3 - 1.4 - 1.0 - 1.5 - .8 - 1.6 - 1.7 - 1.3 - 1.0 - 1.2 - 1.9 - 1.2 - .3 - .4 - .7 - .4 - 1.5
		Average: 1.01
11:00	30° C.	.2 - 1.8 - .6 - .6 - 1.8 - 1.9 - 1.2 - 1.2 - 1.6 .2 - .4 - 1.1 - 3.4 - .9 - .3 - 1.6 - 1.8 - 2.8 .2 - .4 - 1.5 - 2.6 - 2.5 - .3 - 2.3 - 2.2 - 1.5 1.4 - .4 - .8 - .9 - 2.0 - .8 - 1.4 - .9 - 1.9 .3 - .3 - .3 - .3 - .5 - .6 - 1.0 - 2.6 - .6 2.6 - .2 - 1.4 - .6 - 1.3 - .3 - .6 - .3 - 1.5 .4 - .4 - .6 - 1.9 - .9 - 1.4 - .2 - .2 - 1.0 .7 - 1.6 - .6 - .9 - .7 - 2.2 - 1.5 - 1.5 - .5 .5 - 1.1 - .4 - .4 - 3.1 - .2 - 1.2 - .4 - 1.0 .4 - 1.5 - 1.2
		Average: 1.11

Hour	Temperature	Length of Flagella
11:05	30° C.	.6 - .2 - 2.4 - .8 - 2.1 - .4 - .3 - .5 - 1.4 .6 - 1.2 - .2 - .2 - .5 - .5 - 1.0 - 1.7 - 2.0 1.5 - 1.0 - .4 - 1.0 - .8 - 1.1 - .9 - 1.4 - 1.0 .9 - 2.7 - .4 - 2.5 - 1.6 - .9 - .5 - 2.1 - 2.1 .7 - 1.3 - 1.2 - 1.6 - 1.0 - .3 - .9 - .8 - .8 2.2 - .8 - 1.1 - 1.4 - 2.4 - .5 - .9 - 1.1 - 2.0 .3 - .5 - 1.0 - 2.2 - 1.3 - 1.1 - .5 - 1.2 - 1.1 2.3 - 2.2 - 1.7 - .8 - 1.4 - 1.4 - 1.9 - .4 - .6 1.0 - .5 - .2 - 1.2 - 1.8 - .5 - 1.3 - 3.1 - 1.3 2.1 - .8 - 2.1 - 2.4 - .5 - .2 - 1.4 - .5 - .7 1.1 - 1.5 - .7 - .7 - .9 - 1.1 - 2.7 - 1.2 - 1.9 .3 - 1.5 - 1.0 Average: 1.16
11:10	30° C	2.3 - 2.0 - 1.1 - 1.6 - 2.0 - .3 - 2.1 - .5 1.7 - 2.0 - .6 - 2.2 - 2.2 - .8 - 3.6 - 1.4 - .5 1.3 - 3.1 - .3 - 2.7 - 1.6 - 1.5 - .2 - 2.5 - 1.4 1.0 - 1.4 - 2.0 - 1.7 - 1.2 - 1.9 - 1.0 - 3.9 2.4 - .6 - .2 - 1.8 - .7 - 1.3 - .4 - .5 - 1.2 .4 - .9 - 1.8 - .3 - 2.2 - .5 - 1.1 - 1.9 - 2.8 .8 - .5 - 1.1 - 1.6 - .5 - .4 - 1.1 - 1.8 - .2 2.4 - 1.2 - .7 - 1.0 - 1.6 - .7 - 1.3 - 3.4 - 2.0 1.8 - 2.4 - 1.9 - .5 - 1.3 - .7 - .4 - 1.5 - 1.0 2.2 - 1.7 - 1.5 - 1.5 - 1.6 - 1.1 - .3 - .8 - .7 .9 - 1.1 - 1.0 - .3 - 1.2 - .3 - .6 - 2.7 - .6 .4 Average: 1.35
11:15	30° C.	2.7 - .8 - 1.8 - 2.5 - 1.6 - 1.3 - 3.8 - 1.7 .7 - .6 - .1 - .8 - .2 - .5 - 1.5 - 1.5 - 2.7 .7 - .3 - .9 - 1.6 - 1.6 - 2.5 - .7 - .4 - .5 2.4 - 1.0 - .4 - 2.4 - 1.1 - .9 - .4 - .7 - .5 .6 - 1.8 - .3 - .5 - 1.4 - 1.0 - .5 - 2.1 - 1.9 .4 - 1.4 - 1.3 - 2.1 - .7 - 2.1 - 2.6 - .6 - 1.4 1.8 - 2.4 - 2.1 - .9 - 1.2 - 2.4 - 1.7 - 1.5 - 1.2 - 1.4 - .8 - 1.5 - 2.8 - 1.3 - 2.6 - .6 - .9 .9 - 3.5 - .8 - .9 - 1.9 - 1.6 - 2.3 - .5 - .7 1.4 - 1.6 - 2.2 - .9 - 2.4 - 1.7 - 1.2 - 2.2 - 1.6 - 3.3 - .4 - 1.6 - .8 - 1.5 - 1.3 - .3 - .6 1.6 - .5 - 1.1 - 1.1 - .7 Average: 1.35

Experiment 11 - B Continued

Hour	Temperature	Length of Flagella
11:20	30° C.	1.1 - .8 - .8 - 2.7 - .4 - .9 - 3.8 - 2.6 - .6 .4 - .5 - 1.5 - .7 - 1.9 - 1.0 - 2.9 - 2.7 - .4 2.9 - 1.6 - .3 - .6 - 1.3 - 2.0 - 2.2 - 1.7 - .7 2.4 - 4.5 - 2.1 - .9 - 2.2 - .8 - 1.0 - 1.3 - 1.2 1.2 - .6 - 1.4 - .5 - .8 - 1.2 - 1.0 - 1.4 - 1.2 .4 - 1.2 - 2.4 - 1.8 - 1.4 - 1.3 - .4 - 2.4 3.6 - 1.6 - .7 - 1.4 - 1.4 - 3.1 - 1.0 - 1.6 1.0 - 3.0 - 1.8 - 1.2 - 2.6 - .9 - 1.2 - 2.2 2.0 - .5 - 1.3 - 3.1 - 2.5 - 2.2 - .7 - 1.6 - .4 1.7 - 2.6 - .5 - 3.0 - .5 - 4.4 - .7 - .9 - 1.8 2.0 - .8 - 1.9 - .6 - 3.4 - 1.4 - 1.5 - 1.5 - 1.5 2.4 - .6 - 1.0 - 1.0 - .4 - .9 - 3.6 - 2.0
		Average: 1.56

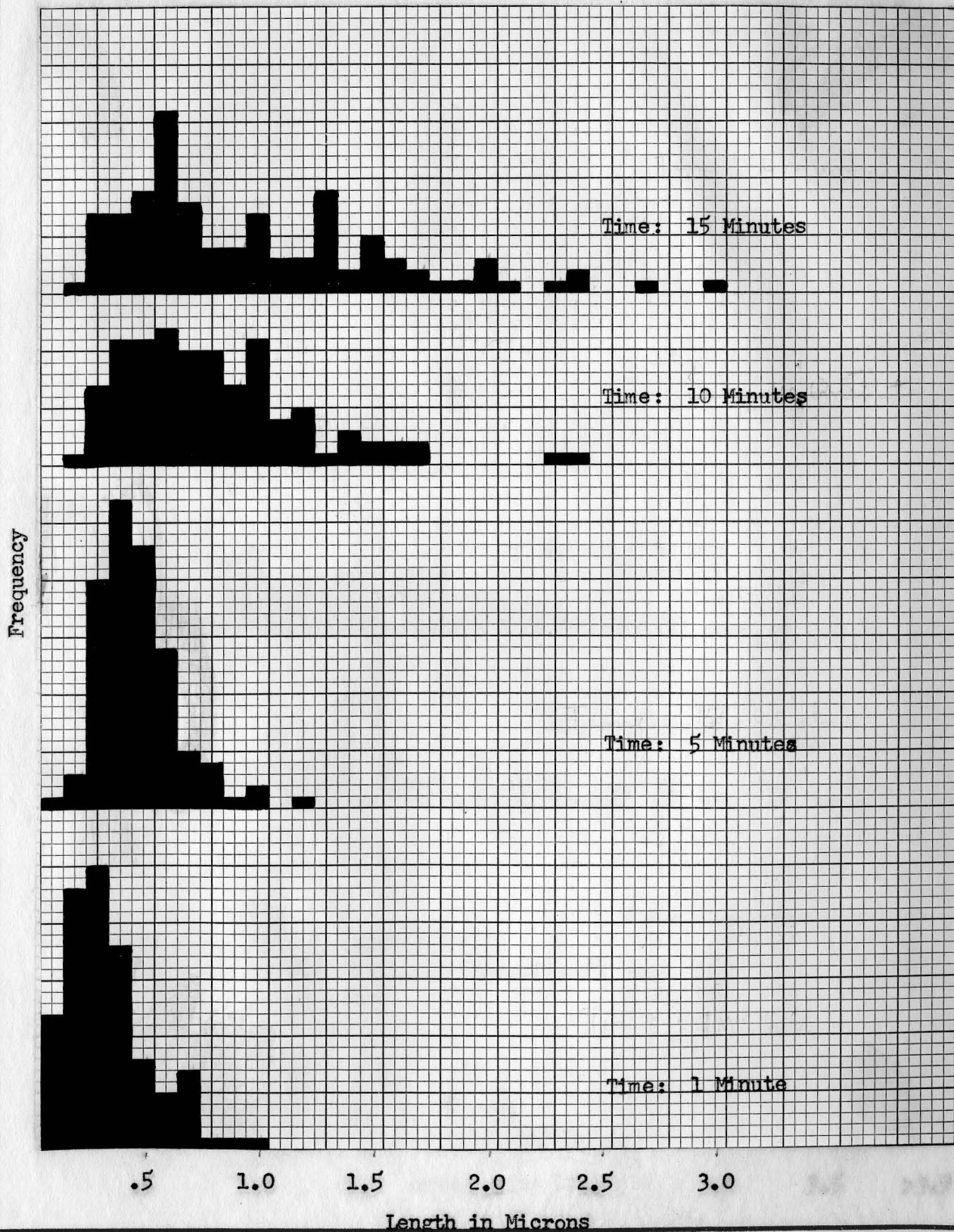
Experiment 11 - C

Hour	Temperature	Length of Flagella
9:30	38° C.	No flagella visible.
10:30	30° C.	No flagella visible.
11:00	30° C.	No flagella visible.
11:10	30° C.	.5 - .5 - .5 - .2 - .3 - .8 - .5 - .2 - .1 - .2 .1 - .3 - .4 - .5 - .4 - .4 - .2 - .5 - .4 - .5 1.2 - .4 - .7 - .4 - .3 - .4 - .2 - .3 - .4 - .7 .3 - 1.0 - .3 - .3 - .2 - .3 - .1 - .2 - .6 - .3 .3 - .3 - .3 - .2 - .3 - .3 - .1 - .4 - .2 - .1 .4 - .3 - .5 - .7 - .2 - .2 - .3 - .8 - .4 - .8 .6 - .3 - .2 - .4 - .4 - .3 - .1 - .4 - .2 - .5 .3 Average: .40
11:15	30° C.	.2 - .3 - .5 - .3 - .2 - .4 - 1.6 - .2 - .9 1.5 - .5 - .3 - .4 - .4 - .5 - .5 - .3 - .5 - .4 .3 - .3 - .2 - .1 - .2 - .3 - .2 - .2 - .1 - .1 1.2 - .2 - .2 - .3 - .3 - .4 - .3 - .6 - .6 - .5 .4 - .4 - 2.4 - .4 - .4 - .3 - .4 - .6 - .6 - .2 .2 - .7 - .3 - .8 - .8 - .4 - .4 - .3 - .6 - .5 .2 - .1 - .5 - 1.1 - 1.7 - .6 - .3 - .4 - .6 .3 - .2 - .4 - .7 - .3 - .3 - 1.8 - .5 - .2 Average: .48
11:20	30° C.	.8 - .2 - .3 - .3 - .3 - .6 - .4 - .9 - .2 - .3 .4 - .9 - .5 - .2 - .4 - .6 - .3 - .4 - .3 - 1.0 2.0 - .8 - .3 - .5 - .5 - .3 - .8 - .3 - .9 - 1.0 - 1.5 - 1.0 - 1.4 - .6 - .7 - .4 - .4 - .2 .2 - .5 - .5 - 2.4 - 1.0 - 1.0 - .9 - .5 - .4 .5 - 1.3 - .9 - .6 - 2.2 - .4 - 1.5 - 1.3 - 1.3 1.3 - .4 - .4 - .2 - .2 - .3 - .7 - .6 - .4 - .2 .5 - .4 - .4 - .3 - .2 - 1.5 - 2.4 - .4 - .3 1.8 - 1.0 - .9 - 2.1 - .7 - 2.0 - .7 - .6 - 1.5 2.0 - .2 - .6 - 1.4 - .2 - .2 - .4 - .5 - .4 - .4 .3 - .3 - .7 - .2 - 1.4 Average: .73

Experiment 11 - C Continued

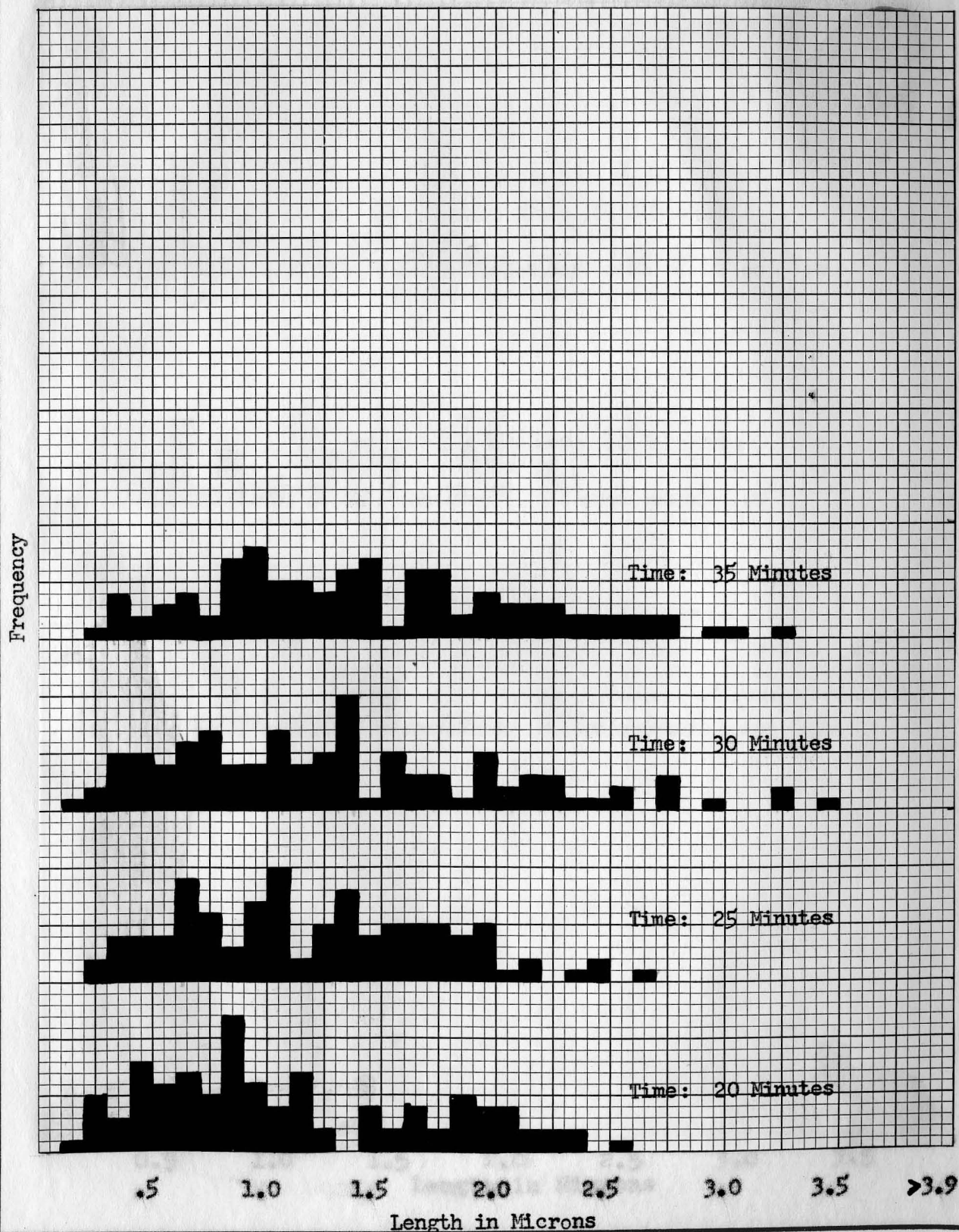
Hour	Temperature	Length of Flagella
11:25	30° C.	1.5 - .8 - .3 - .8 - .8 - .7 - .6 - .3 - .3 - .8 1.0 - .6 - .5 - .5 - .6 - .9 - 1.8 - .5 - .3 .4 - 1.6 - .3 - 1.4 - 1.7 - 1.3 - .5 - .6 - .3 .5 - .2 - 1.0 - .9 - 1.1 - .8 - .5 - 1.6 - 1.3 .4 - 2.1 - 1.9 - 2.0 - 1.0 - .9 - .7 - 1.2 - 1.2 .4 - 2.9 - .3 - .4 - 2.2 - .7 - .4 - .2 - 2.3 2.3 - .5 - 1.6 - 1.3 - .3 - .6 - .4 - 1.2 - .8 1.5 - 1.0 - .3 - .8 - .5 - .4 - .9 - .2 - 2.1 1.8 - .4 - .4 - .4 - 1.3 - 1.0 - 1.0 - 2.0 - .3 .7 - 1.9 - .4 - .3 - 1.9 - .2 - .3 - .7 - .6 1.7 - .2 - 1.3 - 2.6 - 1.9 - .5 - .2 - .4 - .1 .4 Average: .91
11:30	30° C.	1.8 - 2.5 - .4 - 1.1 - .4 - .5 - .6 - 2.3 - .2 1.6 - .4 - .6 - 1.1 - 1.7 - 1.2 - 1.5 - 1.2 - 1.0 .3 - .7 - .3 - 1.7 - .4 - .9 - .3 - .1 - 1.0 - .4 .3 - .4 - 1.3 - 1.2 - 1.3 - .5 - 1.1 - 1.3 - .6 .3 - .7 - .5 - .2 - .3 - .6 - .5 - .4 - .2 - .3 1.0 - 2.0 - .2 - .4 - .2 - 1.0 - 1.1 - .2 - 1.2 .4 - .3 - .4 - .6 - .2 - .3 - .5 - .3 - 2.4 - .3 3.5 - 1.1 - 1.1 - .6 - .7 - .4 - .4 - 2.1 - 1.7 .4 - 1.9 - 1.1 - 2.0 - 1.0 - 1.2 - .5 - 1.0 - 1.0 - .7 - .4 - 1.0 - 2.0 - .3 - 1.2 - .4 - 2.4 Average: .90
11:35	30° C.	1.0 - .4 - 1.3 - 1.5 - 2.0 - 1.3 - 1.0 - 1.0 1.6 - 1.6 - .6 - 1.4 - .2 - .5 - .7 - .9 - .3 .4 - .4 - 1.0 - 2.4 - 1.9 - 1.3 - .9 - 1.5 - .3 1.8 - .2 - 1.4 - .3 - 1.5 - .5 - .6 - .8 - .3 .4 - .8 - 1.2 - .6 - .3 - .4 - .8 - 2.0 - .9 - .2 1.2 - 1.7 - .4 - 1.7 - 1.2 - .4 - .4 - 2.7 - .4 1.5 - 1.7 - .4 - 1.1 - .7 - 1.6 - .8 - .8 - .5 1.6 - 1.0 - 1.7 - .6 - 1.2 - .3 - 1.2 - .8 - .3 .3 - 1.3 - 1.2 - .2 - 1.4 - .2 - 1.0 - .5 - .6 1.4 - .6 - 2.5 - .2 - .3 - .5 - .3 - .3 - .5 1.4 - .4 - 1.7 - 1.2 - 1.2 - 1.4 - 1.9 - 1.8 2.6 - 1.3 - 2.5 Average: 1.00

Graph 11-A Secondary Temperature 20C  
Frequency Distribution of Length of Flagella



Graph 11-A (Continued)

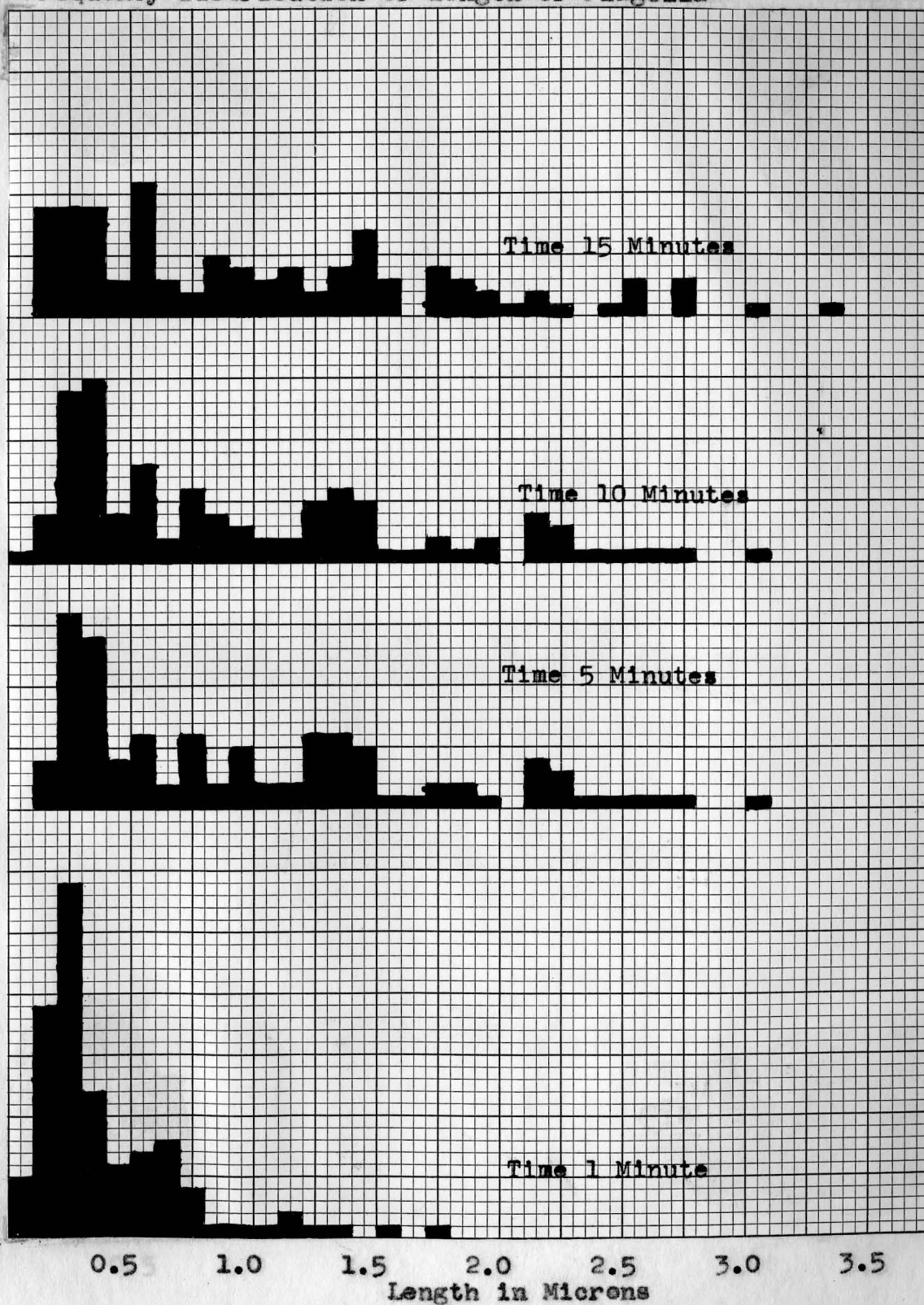
Frequency Distribution of Length of Flagella





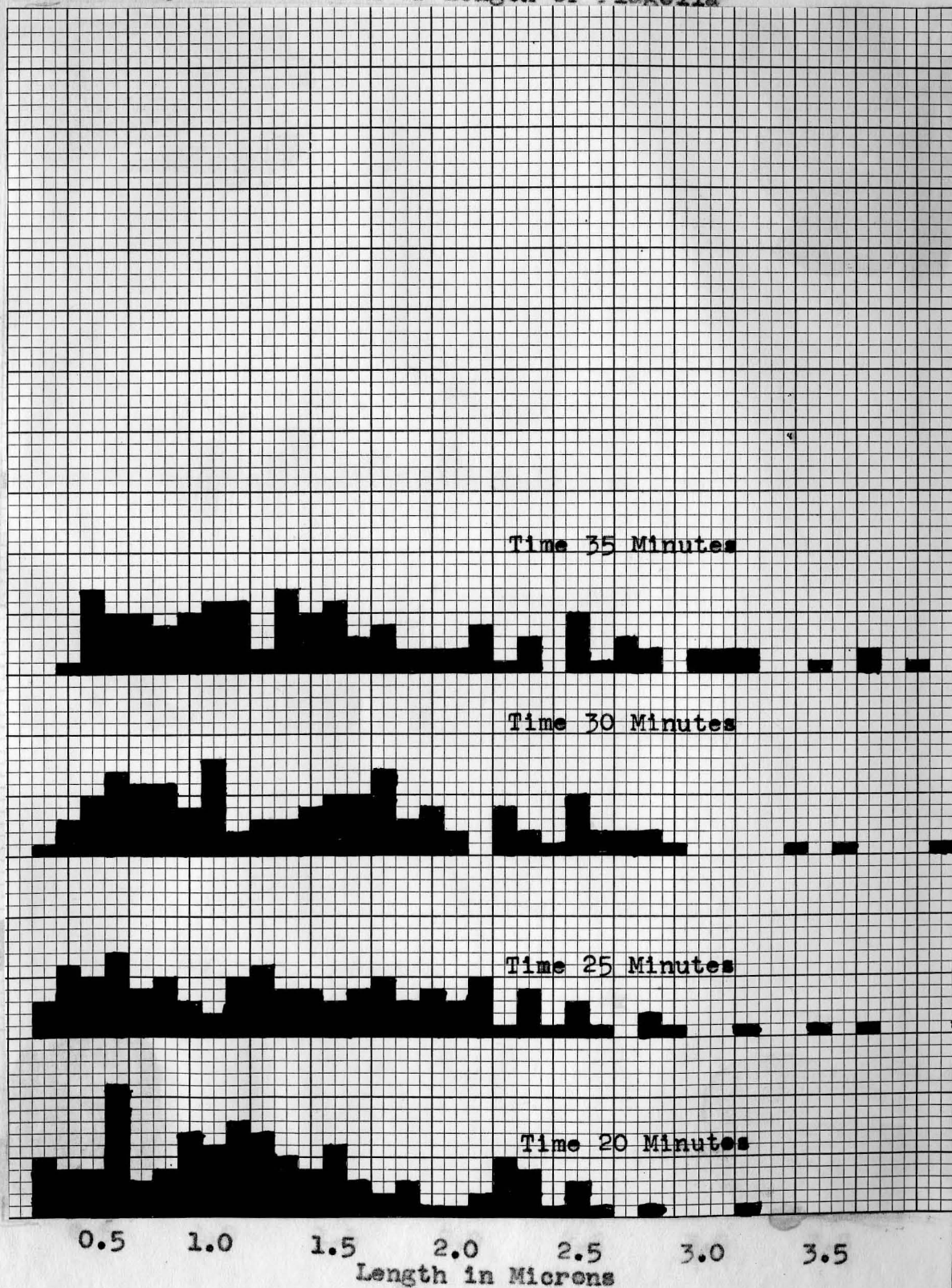
Graph 11-B

Frequency Distribution of Length of Flagella



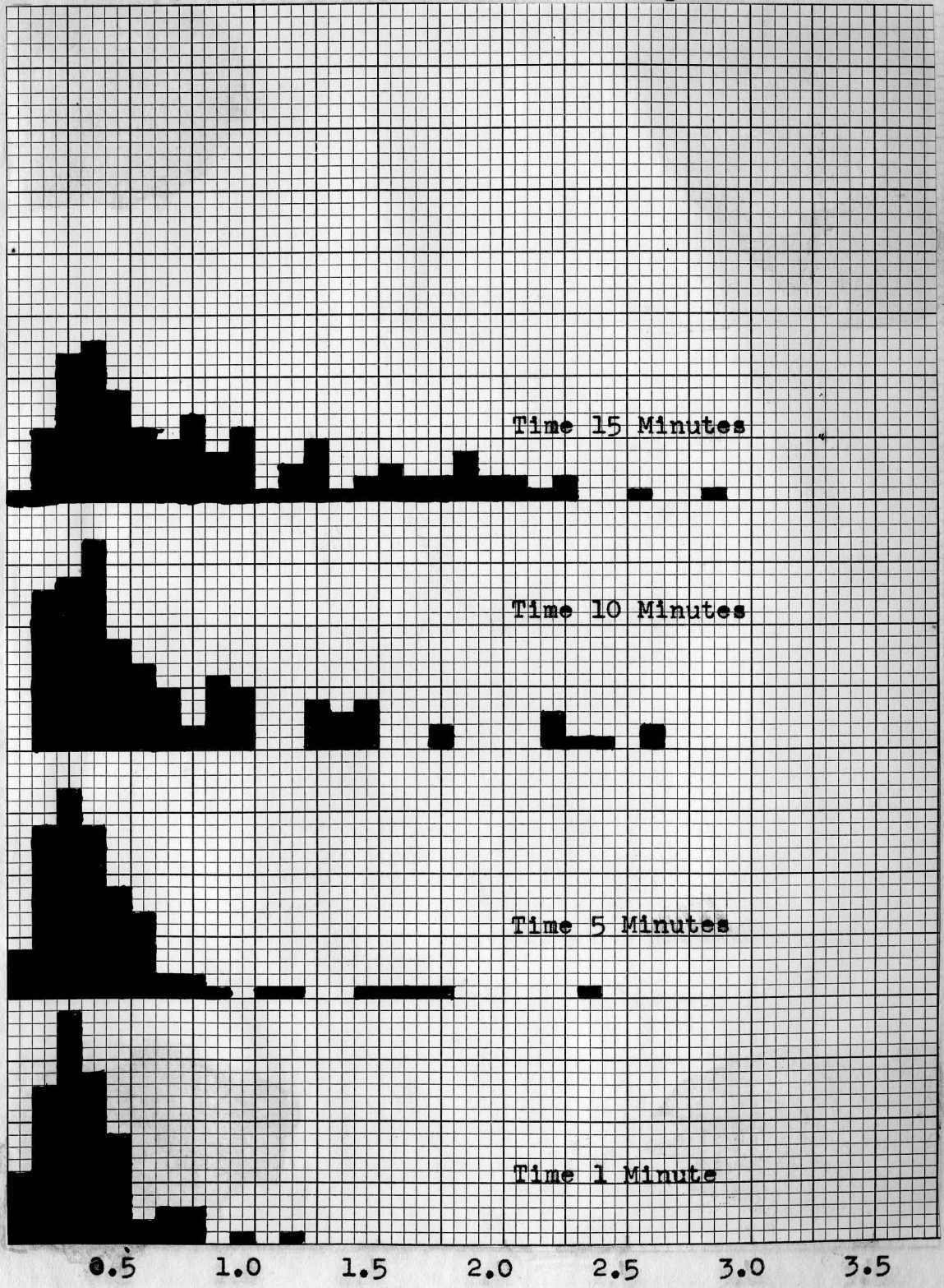
Graph 11-B ( Cont.)

Frequency Distribution of Length of Flagella



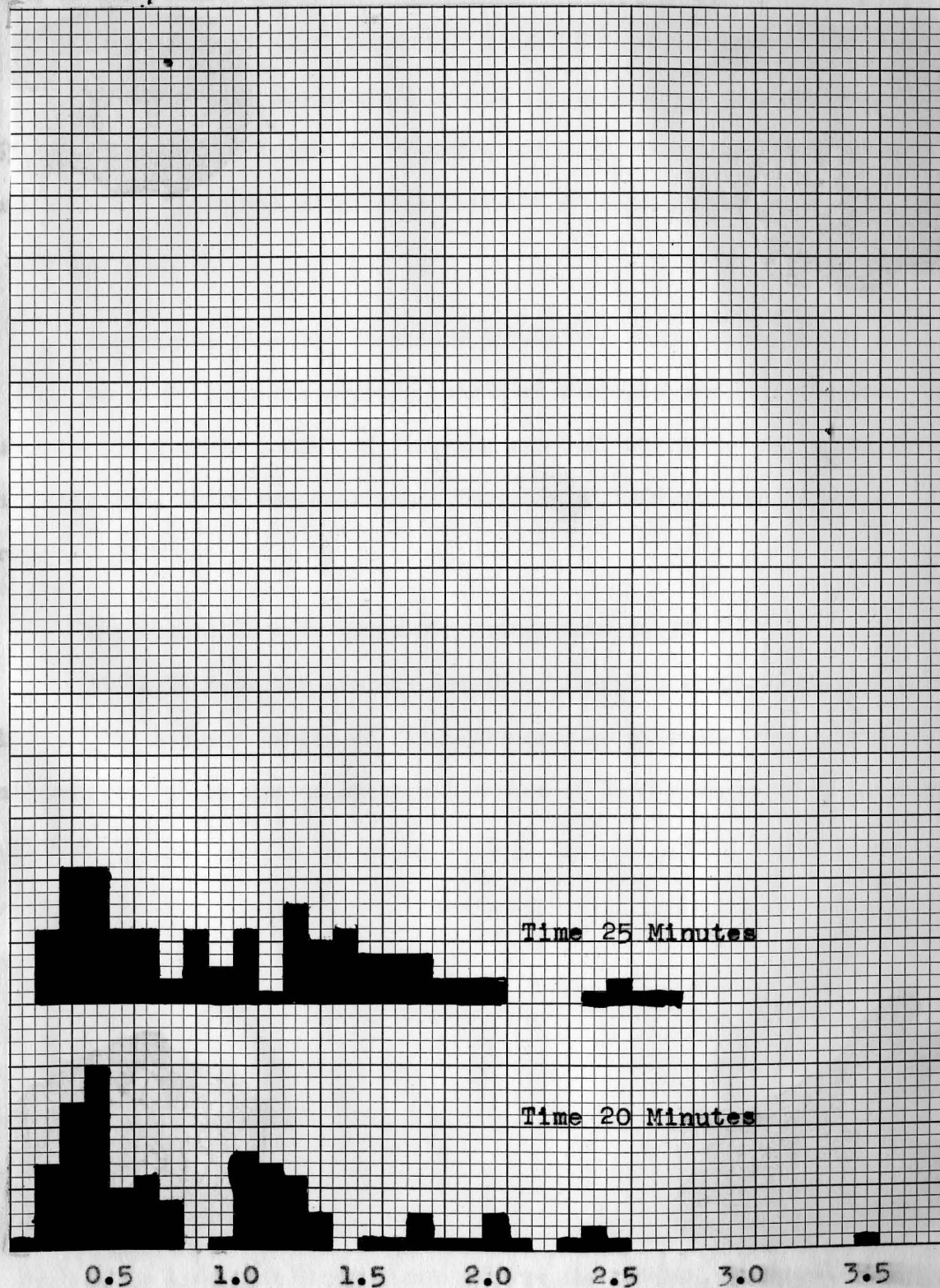
Graph 11-C

Frequency Distribution of Length of Flagella



Graph 11-C ( Cont.)

Frequency Distribution of Length of Flagella



## Results of Experiment No. 11

Experiment 11 - A: Secondary incubation temperature is 20° C.

At 12:30 P.M. the average length of flagella was 1.49 microns. At 11:55 A.M. the average length of flagella was 0.38 microns. For a thirty-five minute interval there was an average increase of 1.11 microns or 0.032 microns per minute.

Experiment 11 - B: Secondary incubation temperature is 30° C.

At 11:20 A.M. the average length of flagella was 1.56 microns. At 10:45 A.M. the average length of flagella was 0.47 microns. For a thirty-five minute interval, there was an average increase of 1.09 microns or 0.031 microns per minute.

Experiment 11 - C: Secondary incubation is 30° C.

At 11:35 A.M. the average length of flagella was 1.00 microns. At 11:10 A.M. the average length of flagella was 0.40 microns. For a twenty-five minute interval there was an average increase of 0.60 microns or 0.024 microns per minute.

## CHAPTER IV

### DISCUSSION

The purpose of this research was to determine the mode of bacterial growth, using a strain of Listeria monocytogenes. In this paper, growth is defined as the addition of new substance to the cell which is manifested by an increase in the length of the cell.

Several hypotheses can be advanced concerning the mode of bacterial growth. 1) Growth occurs at the tip of the individual organism. 2) Growth occurs within the cell in a random manner. 3) Growth occurs within the cell at specific points or areas.

The first hypothesis to be considered is that concerning growth at the tip of the organism. In the experiment in which the primary incubation temperature was 20° C. and the secondary temperature was 38° C. one would expect normal intraflagellar spacing on part of the organism and an abnormal spacing on the rest of the organism. After one generation approximately fifty percent of the organisms would be non-flagellated, while the rest remained normally flagellated.

The average distance between the flagella remains fairly uniform over the length of the soma as seen from the frequency distribution graphs of Experiments 4 and 9. These histograms indicate that there is an increase in the average distance between flagella as the incubation time increases. From Experiment 9, the relative number of viable organisms, based on plate count, has doubled in less than three hours and yet the percent of flagellated organisms remained constant.

From this evidence it seems unlikely that growth occurs at the tip of the individual.

The second hypothesis is that growth may occur within the organism in a random manner. If this is the case, one would expect that the intraflagellar spacing would uniformly decrease when the secondary temperature is 20° C. Likewise, it would be expected that these spacings would uniformly increase when the secondary incubation temperature is 38° C. The histograms of the distances between the flagella do not show a completely random distribution of intraflagellar distances but this may be due to chance.

The third hypothesis is that growth may occur within the cells at specific areas. Some histograms, especially Experiment 1 through 3, show some evidence of definite groupings of the intraflagellar spacing. This indicates, to a limited degree, that growth of the soma is occurring at specific areas within the organism.

To further support the second and third hypotheses, cultural conditions were adjusted so that flagellated organisms remained viable for an eight hour period without undergoing multiplication. From Experiment 10, it has been shown that the average number of flagella per individual organism remains almost constant for an eight hour period. Within this period the relative number of viable cells based on plate counts decreases.

Therefore in Experiments 4 and 9, the decrease in the average number of flagella is not due to the flagella falling off the cell. Rather, it seems that given a certain number of flagella per individual at a temperature at which the cell divides but no new flagella appear, the decrease

in the number of flagella is due to a diluting out of the flagella among new progeny.

From Experiments 7 and 8 in which plate counts were made, it seems that there is a relation between the appearance of flagella and the fission rate of the soma. It has also been shown that, when the flagella first appear, the plate count has doubled. This simultaneous appearance of flagella and increase in colony count may be coincidence or there may be an essential relationship between them. The effect of the change in temperature in these experiments might affect the lag phase of flagellar growth and the lag phase of somatic fission for the same time interval merely by chance. However, there may be an essential relation between flagellar growth and multiplication of the cell. It may be that flagella appear on the cell only while there is active division of the organism, if the incubation temperature is such that flagella can grow. For example, in Experiment 8, the greatest decrease in flagellar spacing occurred when the fission rate was the highest. This indicates there is no growth of flagella in a resting suspension, i.e., without division of cells. It would seem that, in those experiments in which the primary incubation temperature was 20° C. and the secondary temperature was 38° C., there may also be a relation between the fission of the cell and the disappearance of flagella.

As a corollary, samples were removed for staining and the length of the flagella were measured at five minute intervals to determine the increase in length per unit time. It seems that the flagella increase at a rate of 0.02 to 0.03 microns/min. It is realized that, in the determination of the



rate of increase in length, the new flagella are being included in every sample. For lack of a more accurate method, the rate has been determined in this manner, justifying it in that the smaller measurements will cancel out in the total computation of the rate of flagellar increase. Therefore, it may be said that an average increase of 0.028 microns per minute may be a fair estimate of the increase of flagellar length.

## CHAPTER V

## SUMMARY

From preliminary experiments, it was found that L. monocytogenes (Strain 3-E) was non-flagellated at 38° C.; and was well flagellated at 20° C. By varying the incubation temperatures, the average number of flagella and the average number of flagella and the average distance between flagella per individual were measured. An analysis of the intraflagellar spacing indicates that growth does not occur at the tip of the individual. There is some indication that growth occurs at specific points within the cell.

Evidence has been presented which indicates the flagella appear on the cell only while there is active multiplication of the cells, i.e. the plate counts show an increase at a rate of 0.02 to 0.03 microns per minute.

CHAPTER VI

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APPROVAL SHEET

The thesis submitted by Robert Lee Muldoon has been read and approved by three members of the Department of Microbiology.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Science.

Date May 29, 1957

Einar Leijon  
Signature of Advisor