

SURVEY OF KNOXVILLE MILK SUPPLY

by

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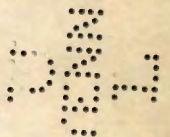
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SURVEY OF KNOXVILLE MILK SUPPLY

INTRODUCTION

The city of Knoxville has a population of 100,000 and consumes 5,000 gallons of milk daily. The quality and quantity of milk consumed per capita, has a direct bearing on the public health problem of a city. According to milk specialists of the United States Department of Agriculture the average consumption of whole milk in the United States is one pint per capita per day, this is an increase of 100% per capita since 1890. The consumption of whole milk in Knoxville during the year 1925 was .4 of one pint per capita per day.

The material offered in this paper constitutes a study of Knoxville's milk supply for the year 1925, and a general review of the milk

situation for previous years so far as available information will permit.

The plan of work is to show the source of supply; distance of the producer from the market; quantity of supply; seasonal variations of butter fat, and solids not fat in raw milk sold by producers; seasonal variation of quality of milk sold by producers to distributors and to consumers; channels of fluid milk from producer to consumer; seasonal variation of efficiency of pasteurization plants as regards reduction of bacteria count in milk received from producer, and relation of bacteria count to barn conditions, source of water supply, methods of sterilization, and storage facilities.

The results obtained are based upon information obtained from the following sources: records of the Bureau of Health of the city of Knoxville, milk surveys of other cities, State Agricultural Colleges, State Experiment Stations, United States Government Publications and personal investigations.

All milk samples were taken and tests conducted by trained officials representing the Knoxville Bureau of Health and in accordance with

standard Methods of the American Public Health Association. (11).

All records concerning location and number of dairies, number of cows, cows in milk, milk produced daily and products sold, were taken from earliest dairy inspection records made during the year 1925. Not less than two inspection reports were available for each dairy. Information regarding the channels of fluid milk from producer to consumer was determined by personal interview with each distributor and retail dairymen or their respective representative.

GENERAL REVIEW AND DISCUSSION
OF LITERATURE.

The author of this paper has been unable to find a published survey of a city milk supply taking up the problems discussed in this study. However considerable material is available discussing problems relative to City milk control.

Erdman (1) writes that, "The largest milk market in this country is that of New York City. In the fall of 1917 the New York City Department of Health reported that milk was received from 30, 934 dairy farms, was collected at 800 shipping stations, and supplied the city during the month of November with a daily average of 1, 627, 127 quarts. Of this New York State supplied 1, 402, 277 quarts and Pennsylvania supplied 114, 630 quarts. The balance came from New Jersey, Vermont, Connecticut, Massachusetts and Canada. The city is now said to reach out over five hundred miles in some instances. The bulk of its supply however, comes from about two hundred miles outside the city."

The following is a summary of the Kansas City milk supply as given by North (4).

"Statistics of Entire Supply summarized

Tables 1-2-3-4

Total Number Pairies	1,199
Total Number Cows	15,415
Quantity of Milk Produced	138,016 quarts
Quantity of Milk sold	106,520 quarts
Number of distributors	184
Milk samples under 100,000 and over 500,000 bacteria per c.c.	

Table 24

Class of Producer	Under 100,000	Over 500,000
Delivering to country shipping stations	53%	22%
Delivering to Pasteurizing Plant by truck	33	34
Direct shippers by Railroad	23	41
Retailers of Grade "A" Raw Milk	65	8

The results of all tuberculin tests for
the year 1920-21 were as follows:

Table 42

Number of tuberculin tested animals from latest test records, 1920-1921 in all active and inactive Missouri (raw and pasteurized)	17,499
Reactors reported in above tests	118
Per Cent of reactors	0.067
Total number of tuberculin tested animals from latest test records, 1920-1921, in all active and inactive Kansas herds (raw and pasteurized)	7,046
Reactors reported in above tests	30
Per cent of reactors	0.043

Total number of animals in herds producing	
Grade A Raw Milk and Certified Milk	7,046
Total number of reactors	30
Per cent of reactors	0.054

The following is a partial report of the statistics from the Report of Rochester Milk Survey by North (5).

Table No. 7

Total Number Dealers	136
Quarts Received Daily	82,075
Total Sales Daily	77,579
Number Dairy Farmers	779

In making conclusions concerning marketing milk in the Chicago district Ross (10) says. "The greater part of Chicago's milk supply comes from regions in Northern Illinois and Southern Wisconsin, where a large proportion of the land is tillable. Crop-growing competes with dairying for labor, and this, together with the relatively high winter prices for milk which prevailed until 1919, has resulted in overdevelopment of winter dairying, while not enough milk is produced in late summer and early fall."

The above mentioned publication dealt largely with the price and surplus problem of the Chicago Milk Supply.

From a report of the Chicago and Washington Milk Supply 1911 Whitaker (14) says, "The District of Columbia consumes about 76,000 quarts (19,000) gallons of milk a day or about 0.4 of a pint per capita. This is produced on 1,091 dairy farms from 17,688 cows. A few years ago when the number was 16,272 they were located as follows:

District of Columbia	734
Maryland	8,448
Virginia	6,428
Pennsylvania	137
New York	525
Total	16,272

In drawing conclusions concerning a study of factors and methods in profitable production of Sanitary Milk, Nichols (6) says, "To keep down the bacterial contamination of the air in the stable where cows are milked, the room must be kept well cleaned and every effort must be made to keep down all dust.

Dusty bedding must be avoided and, if bedding is used, dust should be laid by sprinkling.

Since cow hairs are laden with bacteria, all loose hairs should be removed from the cows by currying in order to prevent them from falling into the milk. However, sufficient time should elapse after currying to permit the dust and bacteria to settle to the floor.

before milking begins.

The cows udders should be carefully washed with tepid water and a clean cloth before milking begins. Wiping the udder with a clean, damp cloth greatly reduces bacterial contamination of the milk.

In feeding mill feeds and hay, care should be taken to raise as little dust as possible."

In studying factors at the barn as influencing bacteria counts Prucha and Webster (8) say, "The study of three barns shows that even under wide extremes in barn conditions it is possible to produce milk with a germ content of less than 10,000 bacteria per cubic centimeter when the utensils are properly prepared.

The intensive studies made at the Illinois and at the New York Agricultural Experiment Stations, together with accordant observations upon twenty-five ordinary dairy barns by the former institution and upon thirty-four dairy barns by the latter institution make it plain that when the influence of utensils is excluded, the dairy barns exert little measurable influence upon the germ content of the milk."

Considerable material is available concerning variations of butter fat and solids not fat in milk. The general conclusion is that the winter months have the higher test and the summer months the lower.

White and Jenkins (15) report that,

"Eckles after tabulating and studying the records of the Missouri and Iowa Experiment Station herds from the standpoint of fat in the milk says, 'It may be stated in general that regardless of where these locations begin they follow a general curve for the year which is less in June or July and gradually rises to the highest point in December or January usually December and then gradually declines again until mid summer. These curves are modified by the evident tendency for the percentage of fat to rise materially during the last two or three months of a milking period. We have these two factors combined to be taken into account.' "

Richmond (9) says, "Long drouth in summer affects both the quality and quantity of milk, solids not fat while usually low in August, September and July were unusually deficient in 1911. The lowest fat occurred in May and June and the highest in October and November; the drop in solids not fat so often found in July and August was scarcely noticed in 1910----- The period when cows yield milk below standard, appears to be extending into April and July."

White and Jenkins (15) say, "Milk tests lower for both fat and solids not fat in the summer than in the

winter months.

Wylie (16) in a study of 2900 Register of Merit records concerning seasonal variation of butter fat says, "The highest tests were for November to January inclusive with an average of 5.73 per cent fat. There was a very gradual decline in test from January to July the lowest month with an average of 5.20 per cent fat and this was followed by a more rapid increase in November."

SOURCE AND QUANTITY OF KNOXVILLE'S MILK SUPPLY
PREVIOUS TO THE YEAR 1925.

It is noted from bulletin 70 United States Bureau of Animal Industry, issued February 1905, that reference is made to the milk supply of Knoxville, Tennessee. The writer states that Knoxville is an ideal country for dairying, but there is no particular evidence that the city milk supply is benefited by these favorable conditions. This publication states that two good dairies supplied a small portion of the milk consumed and that one of these dairies was that of the State Experiment Station. There was no milk or dairy inspections at the time this bulletin was published.

A survey of the Knoxville milk supply (12) made by the 1912 Advanced Dairy Class of the University of Tennessee gives the following records: "An ordinance was passed by the City Council of Knoxville providing for inspection of dairies, milk depots, wagons, etc. and stipulating certain standards for milk sold in the city.

During the year 1908 and 1909 a very simple form of score card was used in which the dairies were ranked as good, fair and bad. The scores were made up

of two parts one relating to conditions of barns the other the milk houses.

The results of the first two years work is summarized in the following table.

Table A

Year	Barns				Milk Houses				
	Total Number Scored	Good No.-%	Fair No.-%	Bad No.-%	Total Number Scored	Good No.-%	Fair No.-%	Bad No.-%	Average bacteria per c.c.
1908	19	9-46	6-32	4-21	15	9-60	4-27	2-14	647.3
1909	75	12-16	50-67	11-17	64	37-58	22-34	5-18	697.3

In February 1910 the numerical score card was adopted, the following is a summary of three years use of this card:

Table B

Year	Total Number dairies scored	Excellent No.-%	Good No.-%	Medium No.-%	Poor No.-%	Average Number bacteria per c.c.
		No.-%	No.-%	No.-%	No.-%	
1910	35	3 - 9	14-40	12 - 34	6 - 17	245.312
1911	14	0 - 0	3-21	10- 72	1 - 7	625.012
1912	68	2 - 2	33-48	27- 39	7 - 10	528.470

The following is a table showing the average daily sale of dairy products in Knoxville for year 1912."

Table C

Average daily sale of Dairy Products in Knoxville year 1912

	Gallons
Milk, wholesale	1,993
Milk, retail	547
Milk, wholesale and retail	2,540
Cream, wholesale and retail	50

Dairy inspection service continued from 1912 to 1924 with very little change in methods of enforcing regulations. Dairy scores and records of analyses over this period are not in such form as to be available for this publication.

Counties Supplying Milk to Knoxville .

In Table 1 and Figure 1 are records of eleven counties supplying Knoxville with milk. These eleven counties have 531 dairies with 6418 cows of which 5451 were in milk. From the above dairies the city receives daily 6901 gallons sweet milk, 2830 gallons milk sold as butter milk, and 130 gallons sold as sweet cream making a total of 9861 gallons.

Out of 531 dairies supplying the city of Knoxville with milk, 437 are located in Knox County. Union County joining Knox on the north has 30 dairies the second greatest number for any county supplying the city. Loudon has 12, Blount 11, Monroe 9, and Anderson 9.

Table 1 and figure 1 also show the relative number of cows in each county supplying milk or milk products to Knoxville.

Sevier County joining Knox County on the South-east and Anderson on the North-west are among the counties named on the chart other than Knox County that are nearest the city, however they supply a smaller

amount of dairy products than any other two counties.

Sweet cream supplied by Knox and Jefferson counties does not represent the city's consumption of that product, the greater portion being supplied from whole milk separated by milk plants and sold as sweet cream and buttermilk.

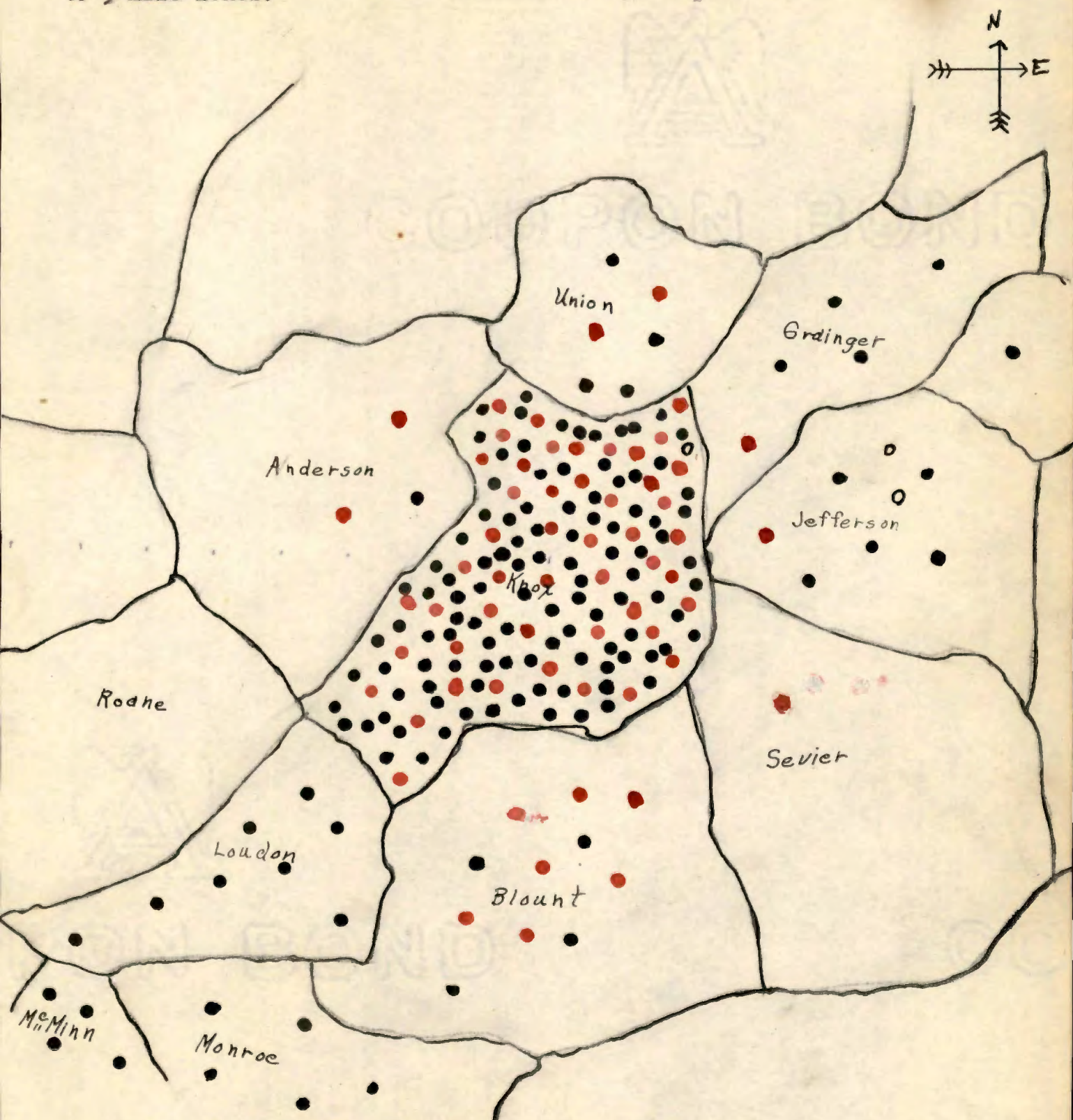
The more distant counties supply only sweet milk. Due no doubt to the fact that most all buttermilk and butter is delivered directly by the producer.

Table 1.

Knorrville's Milk Supply According to Counties.

Name of County	No. dairies	No. cows	No. cows in milk	Gal. milk prod. daily	Gal. sold as whole milk	Gal. sold as butter and B. milk cream	Gal. sold as butter and B. milk cream
Knox	437	5074	4304	7682	5294	2351	37
London	12	221	191	364	364	0	0
Monroe	9	154	136	238	238	0	0
McKin	4	83	78	163	163	0	0
Anderson	9	54	44	80	20	60	0
Union	30	199	167	279	181	98	0
Craininger	8	100	88	172	169	2	0
Jefferson	8	234	184	360	225	42	93
Hamblen	2	40	23	47	47	0	0
Sevier	1	18	17	25	0	25	0
Blount	11	241	219	452	200	252	0
Total	531	6418	5451	9861	6901	2830	1301

Distribution of Production of Knoxville's Milk Supply According to 5 mile Zones.



● = Fifty gallons sweet milk

● = Fifty gallons butter milk

○ = Fifty gallons sweet milk sold as sweet cream

Milk Supply Produced in Consecutive
Five Milk Zones Surrounding the City.

Since the figures in table 2 are taken from the same source as in table 1 there is a duplication of the totals. Table 2, and figures II and III show that the greatest number of dairies are located in zone III which has a total of 220, followed by zone II with 160, zone IV, with 86 and zone I with 30. However the greatest number of cows, a total of 2,247, are located in zone II followed by zone III with 1,911, zone IV with 901, and zone I with 708.

It will be noted that all milk sold as butter and butter-milk and sweet cream is produced within zones I, II, III, IV and V, representing a distance of 25 miles from the city. All milk produced outside the above mentioned zones is shipped in by trucks or railroad. A very small proportion is shipped by the latter.

Figure IV shows the greatest amount of milk sold as butter and butter-milk being produced on the roads leading into Knoxville from the territory North-east of the city. The territory South-west sells its products as sweet milk almost entirely.

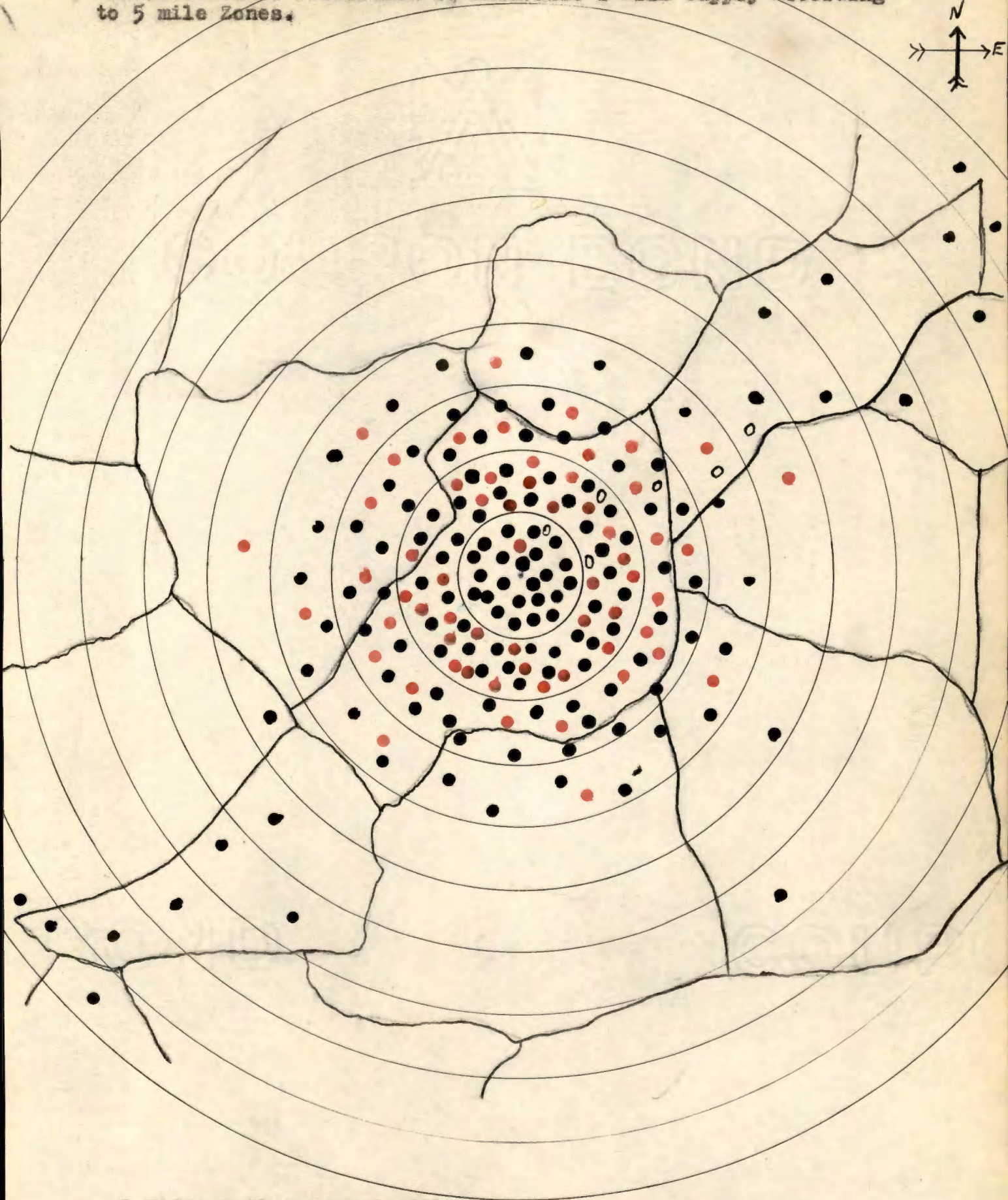
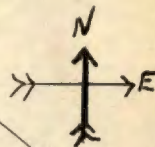
As is shown in figure 1 a very small amount of dairy products is produced for the city in the territory North-west and south-east.

Table 2.

Knoxville's Milk Supply According to Five Mile Zones Surrounding City.

No. of Zone	Miles from City	No. of dairies	No. of cows in milk	Gal. milk daily	Sold as whole milk	Sold as B. milk	Sold as Sweet Cream
I	1 to 5	30	708	608	1172	1143	14
II	5 to 10	161	2247	1880	3378	1826	1478
III	10 to 15	220	1911	1636	2949	1996	942
IV	15 to 20	86	901	749	1343	1020	303
V	20 to 25	10	149	128	249	146	93
VI	25 to 30	4	83	77	139	236	139
VII	30 to 35	7	153	135	236	30	236
VIII	35 to 40	2	21	19	30	93	30
IX	40 to 45	3	80	70	93	272	93
X	45 to 50	8	165	149	272	272	272
Total		531	6418	5451	9861	6901	2830
							130

Distribution of Production of Knoxville's Milk Supply According to 5 mile Zones.



- Fifty gallons sweet milk
- = Fifty gallons butter milk.
- = Fifty gallons sweet milk sold as sweet milk.

Figure III

Points on Various Pikes Leading into Knoxville Designating Limits of the First Five,

Five Mile Zones.

	5 miles	10 miles	15 miles	20 miles	25 miles
Lowes Ferry Pike	Asylum	B. L. Armstrong River	Paragut	County Line	Lenoir City
Kingston Pike	Bearden	R. L. Peters	Reagan's	Alexander's	Solway
Middlebrook Pike	Joe Akers	J. O. Byrd	Reagan's	"	"
Ball Camp Pike	3rd Creek	Headcreek	Byington	"	"
Byington Pike		L. H. Walker	Byington	Clinton	
Clinton Pike	Louis Schaad	Bell's Bridge	Byington	"	
Central Avenue Pike	Geo. L. Callahan	Seymour	Heiskell		
Dry Gap Pike	J. O. sterchi	M.S. Copeland	Bull Run Creek		
Maynardsville Pike	Ft. City	A. I. Smith	"	Maynardsville	Sharp's Chapel
Taswell Pike	George's	Harbison's	Granvaston	Luttrell	Powder Springs
Washington Pike	Dairy Farm	Cross Roads	Gerryton	Blaine	
Rutledge Pike	Mrs. R.H. Bell	J.R. Murphy's	Blaine	Jopps	Rutledge
Straw Plains Pike	Love's Creek	Ellistown	Strawberry Plains	New Market	Jefferson City
Sevierville Pike	Boyd's Bridge	John Bankhill	Seymour		Sevierville
Neubert Springs Pike	Ford's Sta.	J.W. Yinger			
Martin Hill Pike	Ford's Sta.	Neubert's Station		Greenback	McChes
Maryville Pike	Pork of Neubert and Martin Mill Pike				
	Mount Olive Church	Rockford	Wildwood Maryville		

Milk supply Produced on seventeen
Different Roads and Tributaries
Loading into the City.

Figures in table 3 are taken from the same source as in tables 1 and 2 therefore we have here a duplication of totals.

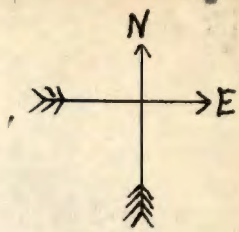
Table 3 shows that the greatest number of dairies, 97 in all, supplying the city are located on the Taswell Pike, followed by the Strawberry Plains Pike with 84, Washington and Maynardville Pikes with 65 each, and Kingston Pike with 57. However the greatest number of cows, a total of 1064, is found on the Strawberry Plains Pike, followed by Kingston Pike with 1034, Washington 774 and Taswell with 676. The greatest amount of milk, 1719 gallons, is produced on the Strawberry Plains Pike, followed by Kingston Pike with 1660, Washington Pike, with 1242 and Taswell Pike with 1006.

Table 3.

Knoxville's Milk Supply According to Roads Leading
Into the City

Name of Pike	No. Dairies	No. Cows	No. Cows in milk	Gal. Milk prod. daily	Sold as whole milk	Sold as B. milk	Sold as Sweet Cream
Lowes Ferry Pike	9	220	182	272	250	10	12
Kingston Pike & Sweetwater Valley	57	1034	871	1660	1627	16	17
Middlebrook Pike	8	145	126	192	151	41	
Ball Camp Pike	11	141	126	201	155	46	
Byington Road	24	287	221	402	212	190	
Clinton Pike	14	260	225	417	387	30	
Central Avenue Pike	28	277	239	411	319	92	
Dry Gap Pike	19	240	209	327	283	44	
Maynardsville Pike	65	486	396	649	324	325	
Tazwell Pike	97	676	585	1006	614	392	
Washington Pike	65	744	667	1242	1012	230	
Rutledge Pike	18	203	183	353	353		
Strawberry Plains Pike	84	1064	914	1719	842	776	101
Sevierville Pike	8	167	150	266	126	140	
Neubert Springs Pike	8	183	142	230		230	
Martin Mill Pike	3	40	28	49	18	31	
Maryville Pike	13	251	187	465	228	237	
Total	531	6418	5451	9861	6901	2830	130

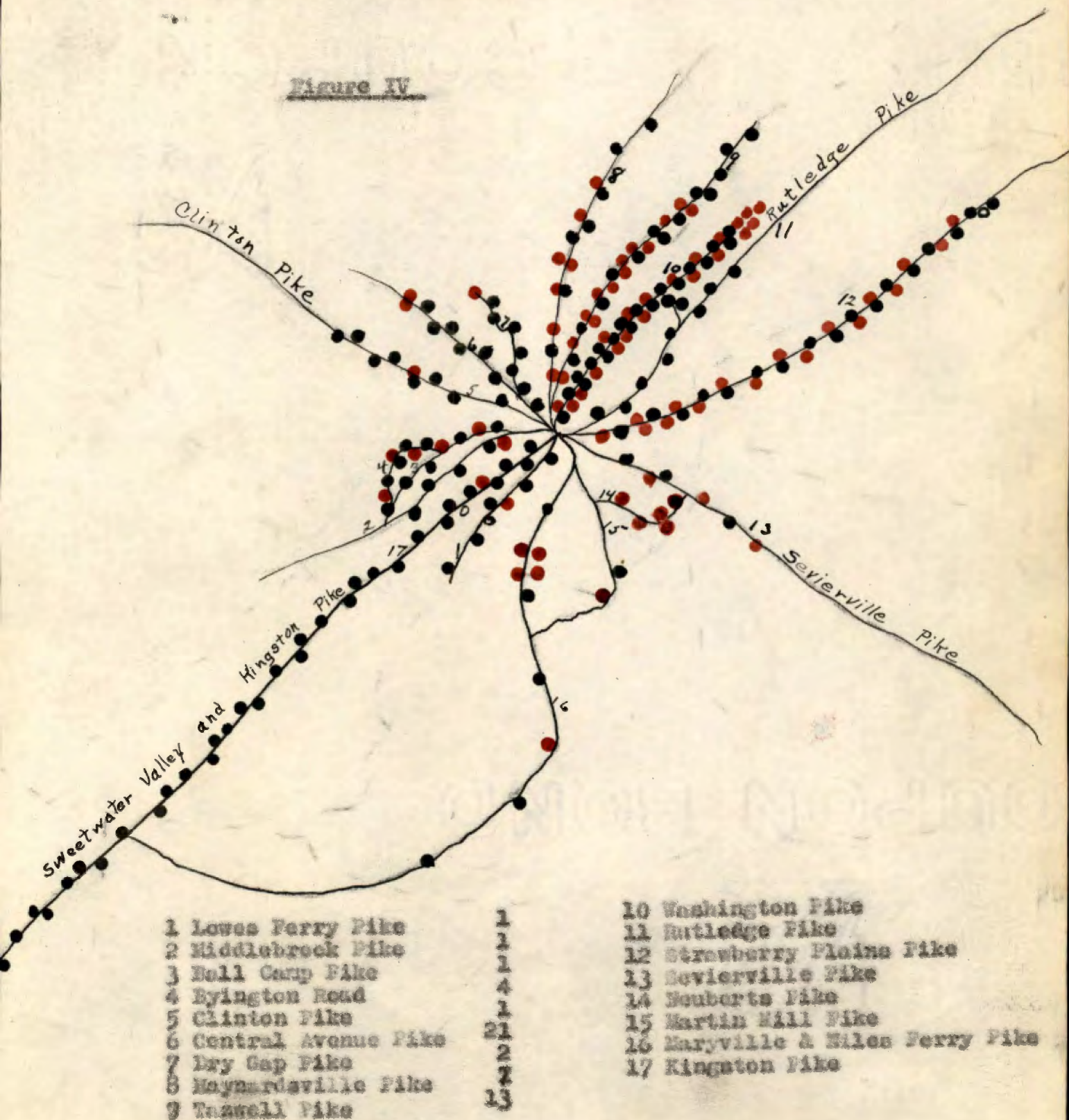
Distribution of milk production according to roads leading to city of Knoxville.



Legend:

- Fifty gallons sweet milk
- Fifty gallons butter milk
- Fifty gallons sweet milk sold as sweet cream

Figure IV



Butter Fat Content of Milk Supply

Butter Fat Content of Retailed Raw Milk

Table 4 and figure V show 913 analyses of retailed raw milk made during the year 1925 with an average test of 4.44 per cent fat. All averages were arrived at by dividing the total of all tests for the given period by the number of analyses.

The above mentioned table and figure shows the highest average butter fat test to be 4.88 per cent for the month of November and the lowest 4.14 per cent for the month of March, with a gradual increase until July, then a decrease until September, with 4.29 per cent, the lowest test since the spring months, followed by a gradual increase until the high month November is reached.

Butter Fat Content of Shipped Milk
by Months.

Table 5 and figure 6 show 2134 analyses of shippers milk for butter fat to give an average of 4.63 per cent for the year 1925. All averages were figured as in table 4.

Shippers milk averages .19 per cent higher for the year than that of the producers of retail raw milk. July is the only month in which the retailers average test is greater than that of the shippers and then by only .02 per cent.

With the exception of the low test in the fall months for the retail milk the general curve of the shippers test is the same as that of the retailer.

The high month is November with 5.25 per cent with a gradual decrease until April with 4.27 per cent, followed by a gradual increase until the high month November, with the exception of June which showed .03 per cent less than May.

Butter fat content of retailed raw and shipped milk.

Table 6 and figure VII show a combination of tables 4 and 5 and figures V and VI respectively. In

In table 6 and figure VII the average per cent of fat from 3047 analyses of both retailed raw and shipped milk is 4.57 per cent for the year 1925. averages were figured as in table 4 and figure V.

The high month for all analyses is November with 5.12 per cent fat. The per cent of fat gradually decreases until April, with 4.26 per cent a slight rise is noted up to the summer months, where it remains almost constant for July, August and September followed by a rapid increase to the high month November.

Table 4.

Butter Fat Content of Retailed Raw Milk by Months .

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number													
Analyses	36	78	91	76	84	70	74	78	75	84	86	78	913
Average													
Per Cent	4.70	4.46	4.14	4.23	4.26	4.31	4.49	4.42	4.29	4.49	4.88	4.73	4.44

Table 5.

Butter Fat Content of Shipped Milk by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number													
Analyses	78	179	157	203	192	206	204	184	179	198	180	174	2134
Average													
Per Cent	4.91	4.61	4.6	4.27	4.42	4.39	4.47	4.48	4.55	4.83	5.25	5.06	4.63

Table 6.

Butter Fat Content of Retailed Raw and Shipped Milk by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number													
Analyses	114	257	248	282	276	276	278	262	254	282	266	252	3047
Average													
Per Cent	4.84	4.57	4.46	4.26	4.37	4.37	4.47	4.46	4.47	4.72	5.12	4.96	4.57

Figure V.

Butter fat content of retailed raw milk by months.

6
%

5

4

3

2

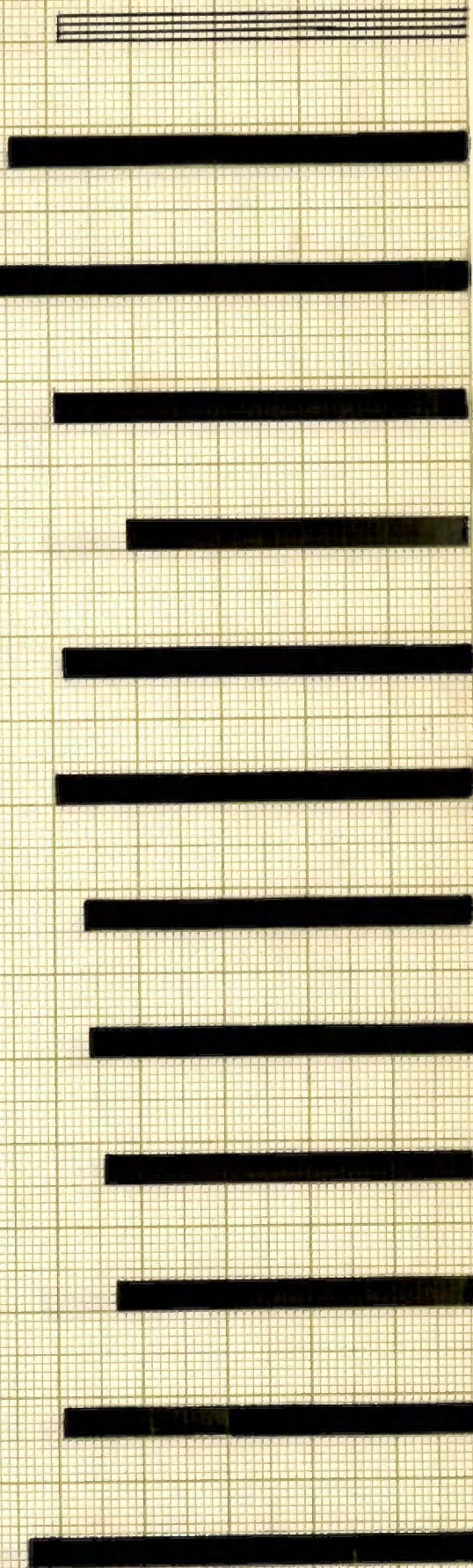


Figure VI

Butter fat content of shipped milk by months.

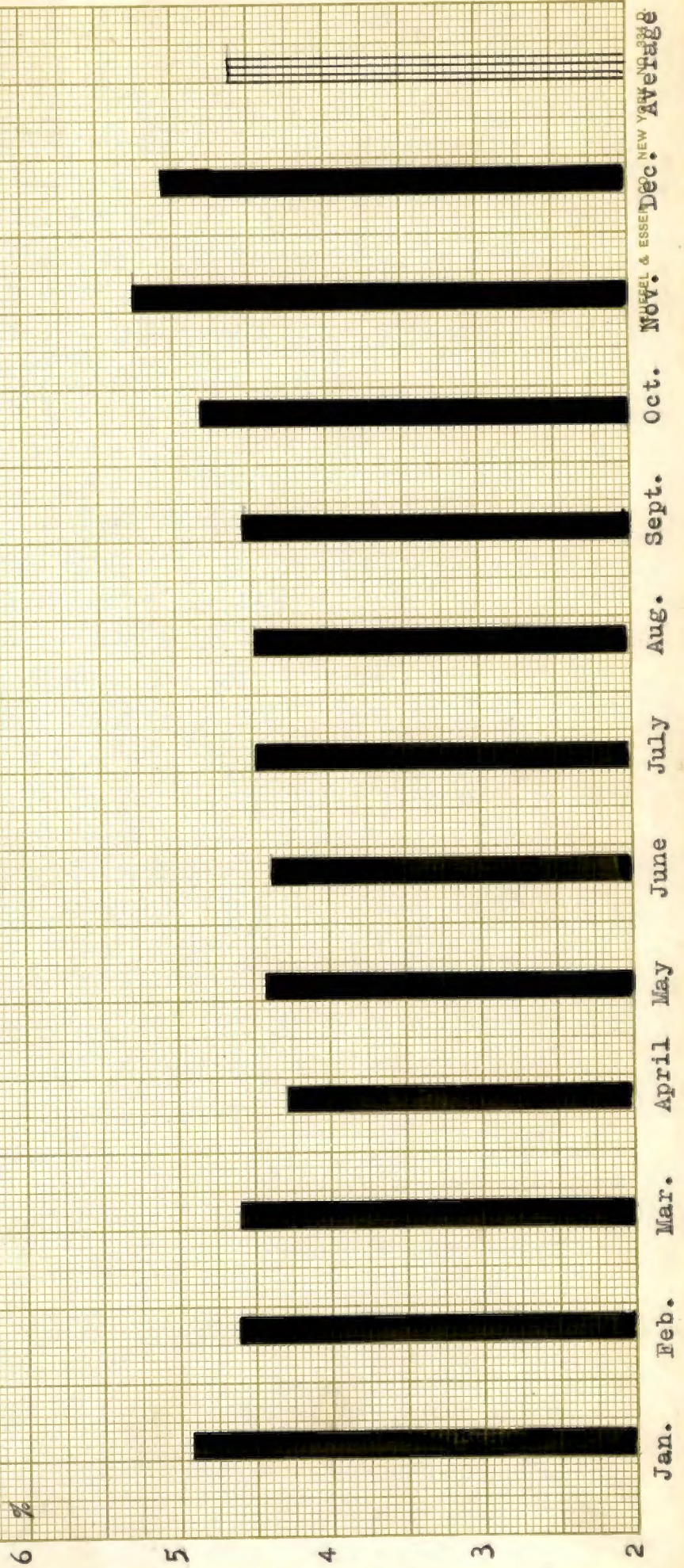
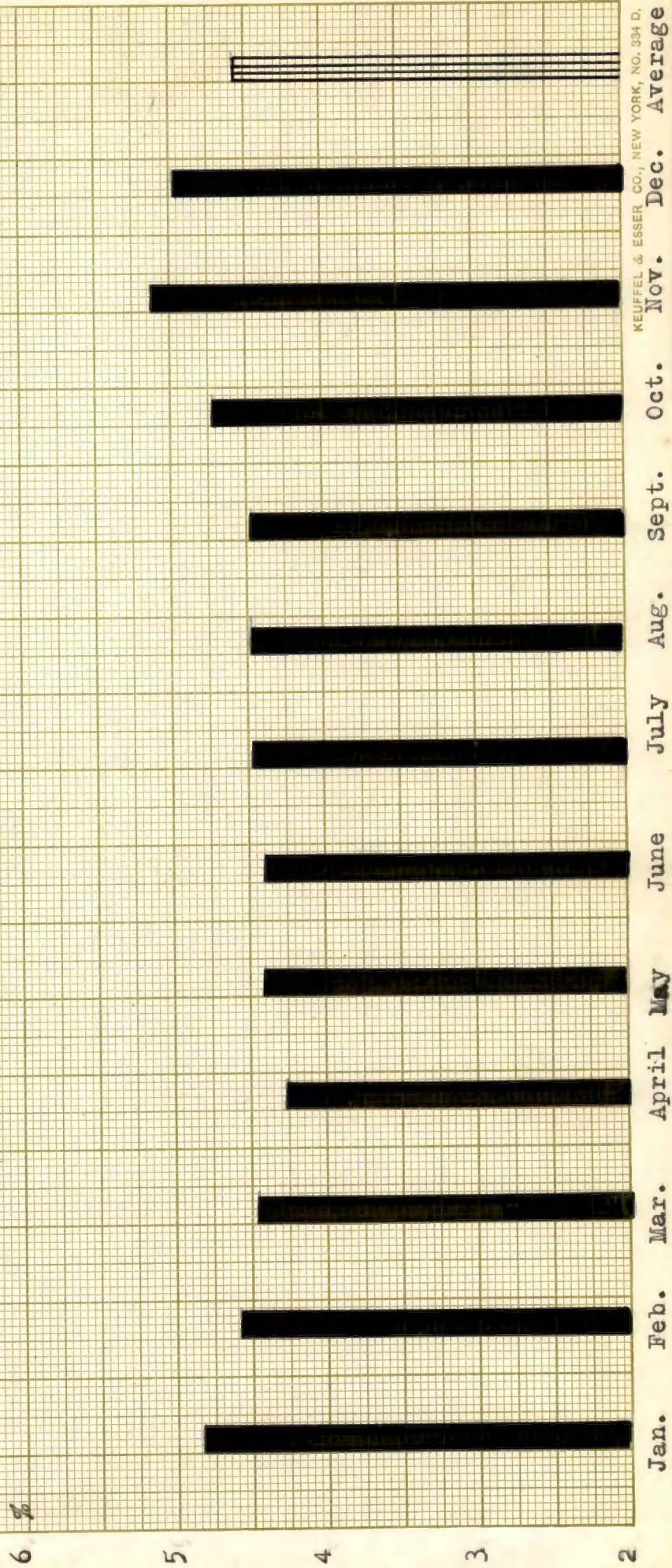


Figure VII

Butter fat content of retailed raw and shipped milk by months.



Solids Not Fat Content of Milk Supply .

Solids Not Fat Content of Retailed Raw Milk by Months.

Table 7 and figure VIII show the average, solid not fat, per cent, as determined by 784 analyses, to be 8.78 for the year 1925. All averages included in this report were arrived at by dividing the total per cent of solids not fat by the number of analyses.

It is noted from the above mentioned table figure that the solids not fat average is lowest in March and highest in May with a tendency to remain constant. A drop in the fall and high again in the early winter with a tendency to drop in the late winter and early spring.

Solids not fat content of shipped milk by months.

Table 8 and figure IX show the same general curve as table 7 and figure VIII, with hardly as pronounced drop in the fall months. The low test of 8.35 per cent coming in February and the high 9.30 per cent coming in May with a 9.29 per cent test in November. The average of the 1925 analyses for the year being 9.03 per cent.

Solids not fat of retailed raw and shipped milk by months.

Table 9 and figure IX is a combination

of the reports found in tables 7 and 8 and figures VIII and IX. The same general curve as noted in the above mentioned tables and figures is noted in tables 9 and figure X. The summer and early winter months being high, with late winter, early spring and fall being low.

The solids not fat monthly averages as set forth in table 9 and figure X tend to show the same curve as the Butter fat Monthly averages as shown in table 6 and figure VII .

Table 7.

Solids Not Fat Content of Retailed Raw Milk By Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number													
Analyses	32	65	74	69	74	62	68	75	60	71	73	61	784
Average													
Per Cent	8.62	8.57	8.52	8.79	9.02	8.80	8.96	8.87	8.66	8.66	8.90	8.75	8.78

Table 8.

Solids Not Fat Content of Shipped Milk by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number													
Analyses	67	142	135	190	173	190	184	170	162	185	164	162	1924
Average													
Per Cent	8.64	8.35	8.59	8.95	9.10	9.17	9.22	9.02	9.08	9.01	9.29	9.18	9.03

Table 9.

Solids Not Fat Content of Retailed Raw Milk and Shipped Milk by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number													
Analyses	99	207	209	259	247	252	252	245	222	256	237	283	2708
Average													
Per Cent	8.63	8.56	8.57	8.90	9.22	9.10	9.14	8.98	8.97	8.91	9.17	9.06	8.95

Figure VIII

Solids not fat content of retailed raw milk by months.

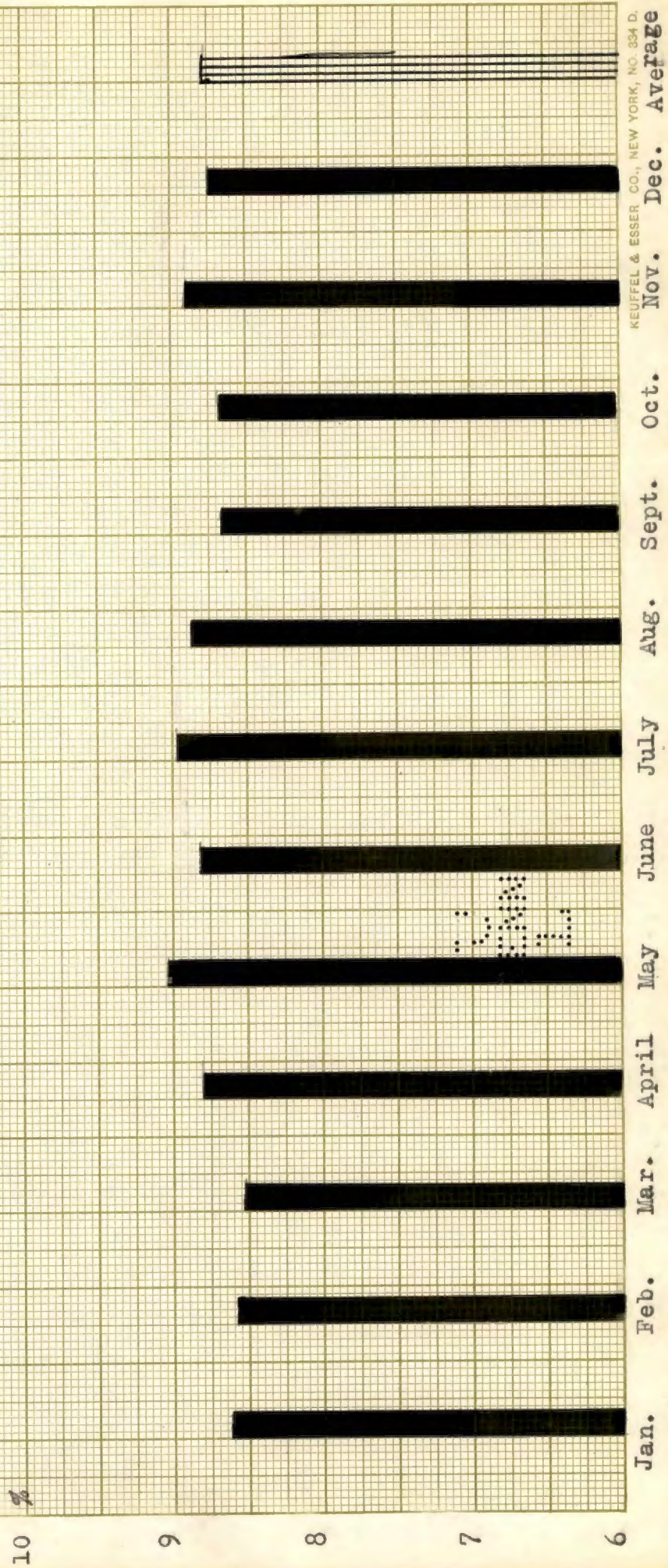


Figure IX

Solids not fat content of shipped milk by months.

10 %

9

8

7

6

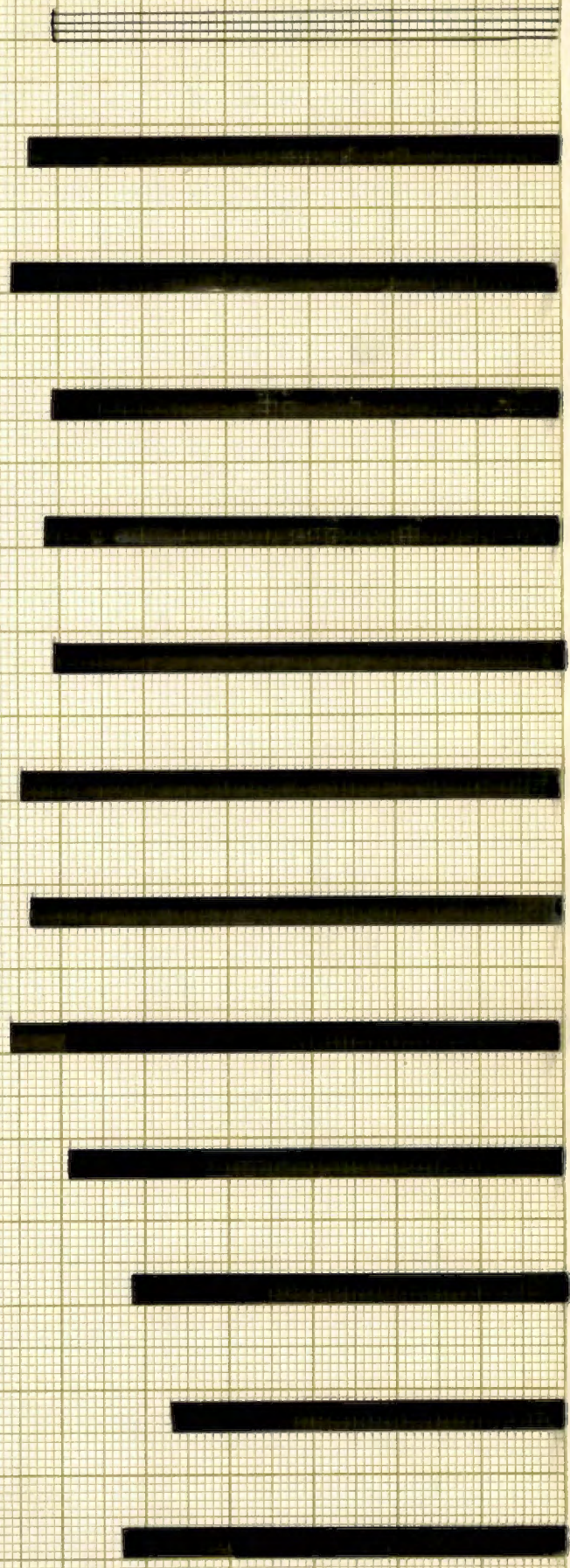


Figure X.

Solids not fat content of retailed raw and shipped milk by months.

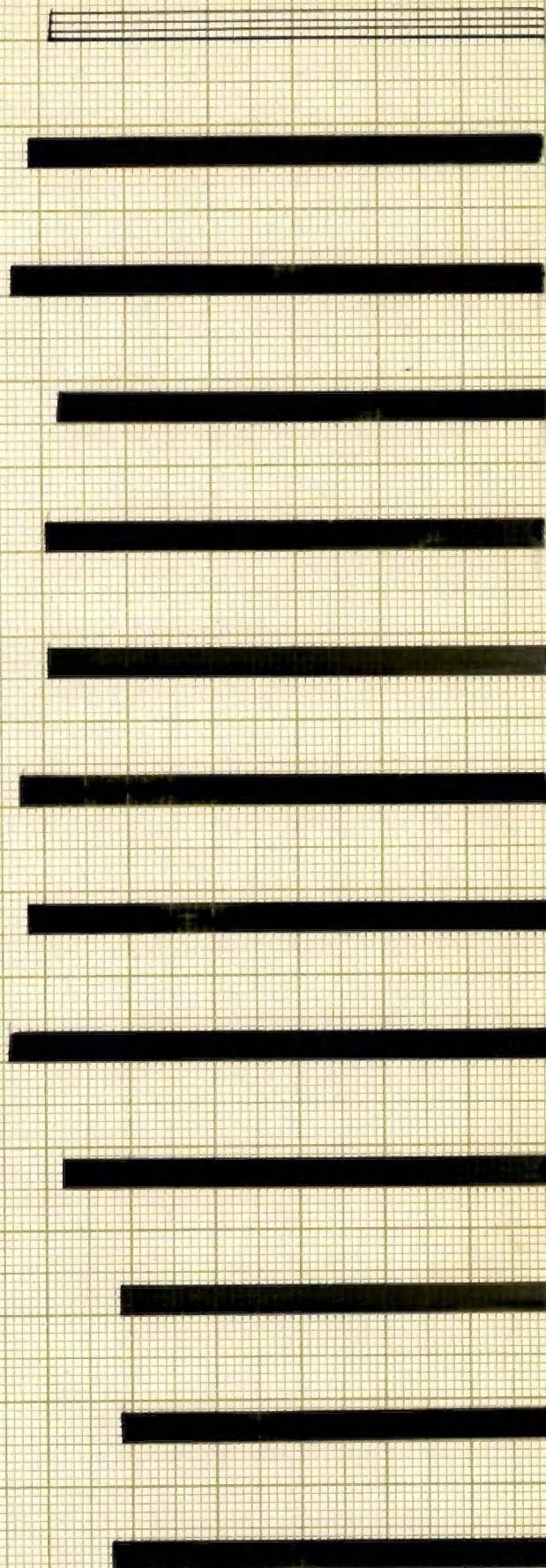
10 %

9

8

7

6



Bacteria Count of Milk as Received in City from Producer.

All averages bacteria counts reported in this paper were arrived at by dividing the total number of bacteria reported by the total number of analyses. All figures showing monthly and yearly averages of bacteria are represented by the same scale.

Table 10 and figure XI show the average bacteria count of 854 analyses of retailed raw milk made during the year 1925 to be 107,850. The highest averages being for the months of June, July, August, September and October. Only January and April are within the bacteria requirements of the Knoxville Milk Ordinance (1) for Grade A raw milk.

Average Bacteria Count of All Shipped Milk by Months

In table 11 and figure XII is shown that 2150 analyses of shipped milk have an average bacteria count of 1,096,814 per c.c. The high months for the year being the same as in table 10 and figure XI.

Table 10.

Average Bacteria Count of Bottled Raw Milk by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number													
Analyses	38	73	86	79	81	66	67	74	68	78	78	66	854
Average													
Per Cent	21842	50684	45811	39092	51548	176303	229410	117149	252510	202362	42063	66197	107853

Table 11.

Average Bacteria Count of All Shipped Milk by Months.

Month	Jan.	Feb.	March	April	May	June
Number						
Analyses	84	191	160	213	192	207
Average						
Per Cent	79,285	148,350	111,740	191,021	869,229	1,239,428

Table 11. Continued

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number							
Analyses	204	185	171	195	178	170	2150
Average							
Per Cent	1,488,879	1,995,918	2,411,122	1,401,409	153,856	116,896	1,096,814

Figure XI

Average bacteria count of retailed raw milk by months.

2,600,000

2,400,000

2,200,000

2,000,000

1,800,000

1,600,000

1,400,000

1,200,000

1,000,000

800,000

600,000

400,000

200,000

0

Jan.

Feb.

Mar.

April

May

June

July

Aug.

Sept.

Oct.

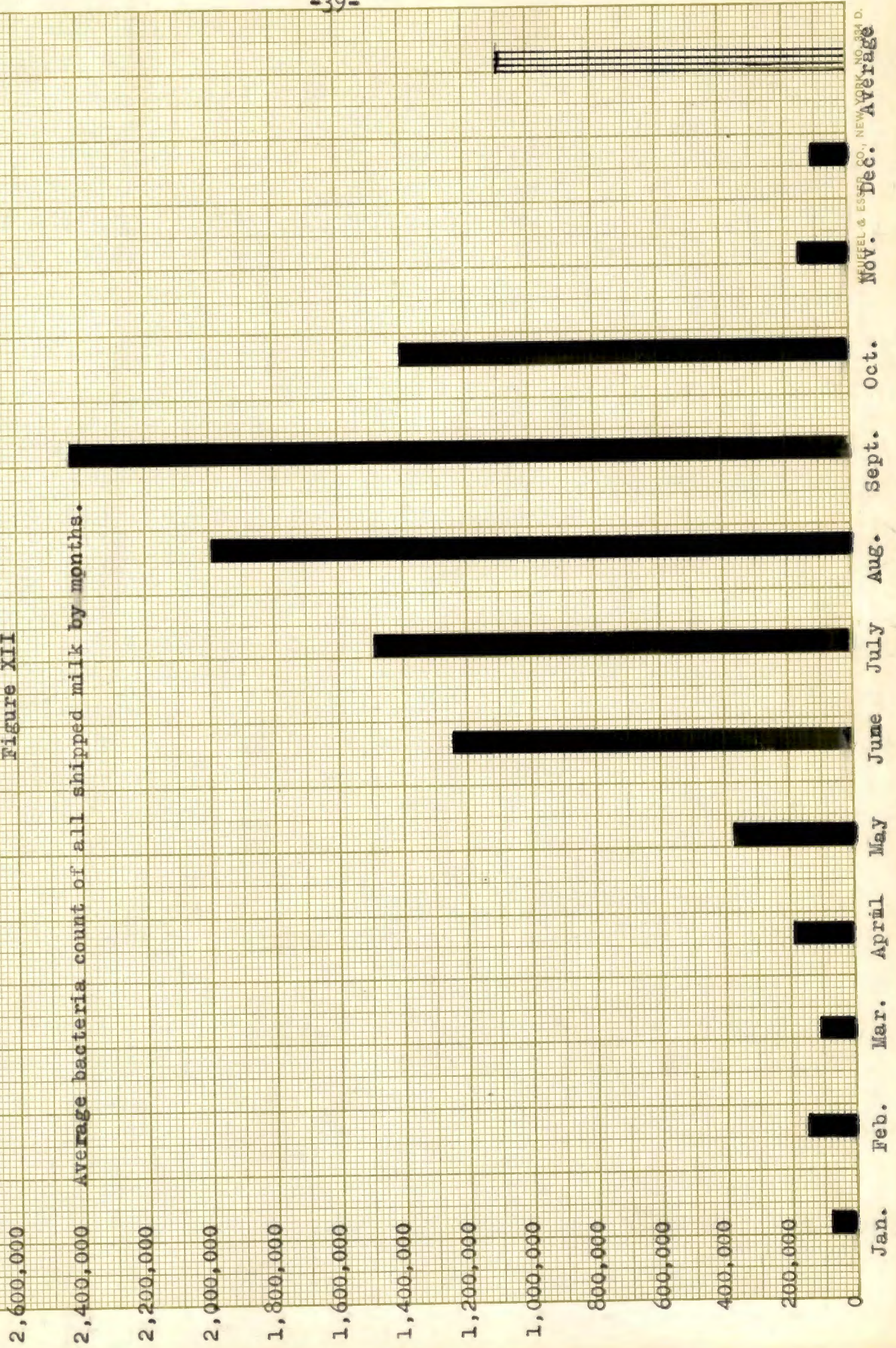
Nov.

Dec.

Average

Figure XII

Average bacteria count of all shipped milk by months.



Channels of Knoxville's Fluid Milk from
Producer to Consumer.

In reviewing table 12 and figure XIII it is found that Knoxville consumes 4960 gallons of fluid milk daily. Only a small portion, 1410 gallons of this amount is handled by distribution; more than one-third of the fluid milk is delivered directly by the producer to the consumer. More than one-third of the consumers supply goes through grocery stores, either being furnished the store by distributors or producer. Hardly one-fifth of the supply reaches the consumer through eating places and a very small amount is delivered directly by distributors to consumer.

Records of Pasteurization Plants as Regards the Reduction
of Bacteria.

During the year 1925 six milk plants sold pasteurized milk in the city of Knoxville. The names of the shippers whose milk was used for pasteurization each month by the different plants was secured by personal interview with the managers of the milk plants. The following record cannot be considered a direct index as to the

Table 12.

Producer Distributor

Knoxville's Fluid Milk Supply from Producer to Consumer. 1925

No. of Producers	175
Gal. of Milk Produced Daily	4960
Gal. Sold by Producer to:	
Milk Distributing Plants	1410
Stores	1179
Eating Places	589
Consumer	1782
Gal. Sold by Distributor to:	4960
Stores	723
Eating Places	331
Consumer	356
Gallons of Milk Received Daily	1410
by Consumers from:	
Producers	1782
Stores	1902
Eating Places	920
Distributing Plants	356

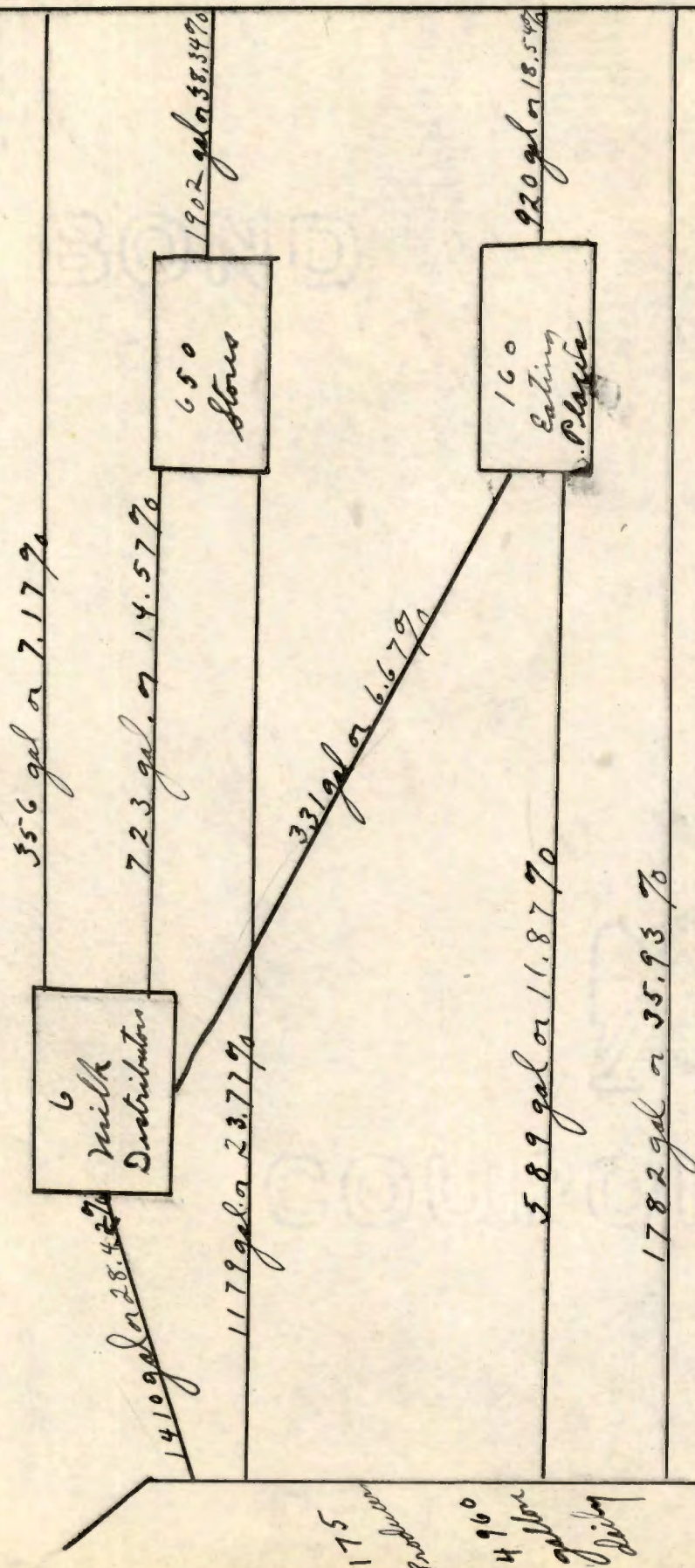
Note:

All milk handled by distributors is pasteurized with exception of one plant which handles 140 gallons Grade "A" Raw Milk daily, 125 gallons sold through stores and 15 gallons through eating places.

100,000

Coccyzus

IX 03174



channels of Knoxville's fluid milk supply from Producer to Consumer. 1925

efficiency of the plant in the reduction of bacteria since the analyses of the shippers milk vary from day to day and very few of the milk plant averages represent analyses of shippers milk after pasteurization. However tables 15, 18, 21, 24, 27, 30 and 33 give a fair index on the efficiency of pasteurization in the reduction of bacteria in Knoxville for the year 1925, since from table 11 and figure XII it is found that all shipped milk follows a rather regular curve and it would be expected that all the shipped milk used for pasteurization would follow the same general curve.

According to Kelley and Clements (2) pasteurization should be practically 99% efficient in the reduction of ordinary types of bacteria found in milk. It may be found in table 33 that the average percentage of efficiency for all plants of Knoxville in the reduction of bacteria is 72.32 per cent, the range being from 32.6 to 95.1 per cent. However it is noted in table 24 that the efficiency of plant D in the reduction of bacteria was greater than 99% for the months of September and October being 99.1 and 99.5 respectively. However the efficiency in the reduction of bacteria of the above mentioned plant for the year was only 74.3 per cent.

Average bacteria count of milk, by months, shipped to plant A and average bacteria count of pasteurized milk from plant A.

Tables 13 and 14 and figure XIV show that plant A is very irregular in the reduction of bacteria, having for the period of operation a reduction of slightly more than one-third. During the months of September and November there was an actual increase over the average of the shippers for the same months.

Average bacteria count by months of milk shipped to plant B and pasteurized milk sold from plant B.

Tables 16 and 17 and figure XV show that plant B operated only the first four months of the year 1925. No analyses of the plant's milk was made for the month of January according to the above mentioned tables and figures. The efficiency of the plant in reducing bacteria was very poor.

Average bacteria count of milk, by months, shipped to plant C and pasteurized milk sold from plant C.

Tables 19 and 20 and figure XVI show a rather consistent record in the reduction of bacteria with the exception of the months of July and November.

Table 13.

Average Bacteria Count by Months of Milk Shipped to Plant A.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number						
Analyses						
Average						
Count						

Table 14.

Bacteria Count of Pasteurized Milk from Plant A by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number						
Analyses						
Average						
Count						

Table 15.

Plant A's percentage of Efficiency as Regards Bacteria Count Production.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Per Cent						

Table 13. (Continued)

Average Bacteria Count by Months of Milk Shipped to Plant A.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Number Analyses	6	5	5	4	6	6	32
Average Count	676,166	362,000	912,000	651,250	75,750	16,416	428,281

Table 14. (Continued)

Bacteria Count of Pasteurized Milk from Plant A by Months.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Number Analyses	2	2	3	2	2	2	20
Average Count	406,500	282,500	1,210,000	89,500	97,750	18,011	274,730

Table 15. (Continued)

Plant A's percentage of Efficiency as regards bacteria Count Reduction.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Per Cent	25.0	21.9	32.6 +	86.2	29.0 +	50.5	35.8

+ Percentage increase in bacteria count.

Legend XIV

Average bacteria count of shippers to plant A by months.

Average bacteria count of plant A's pasteurized milk by months.

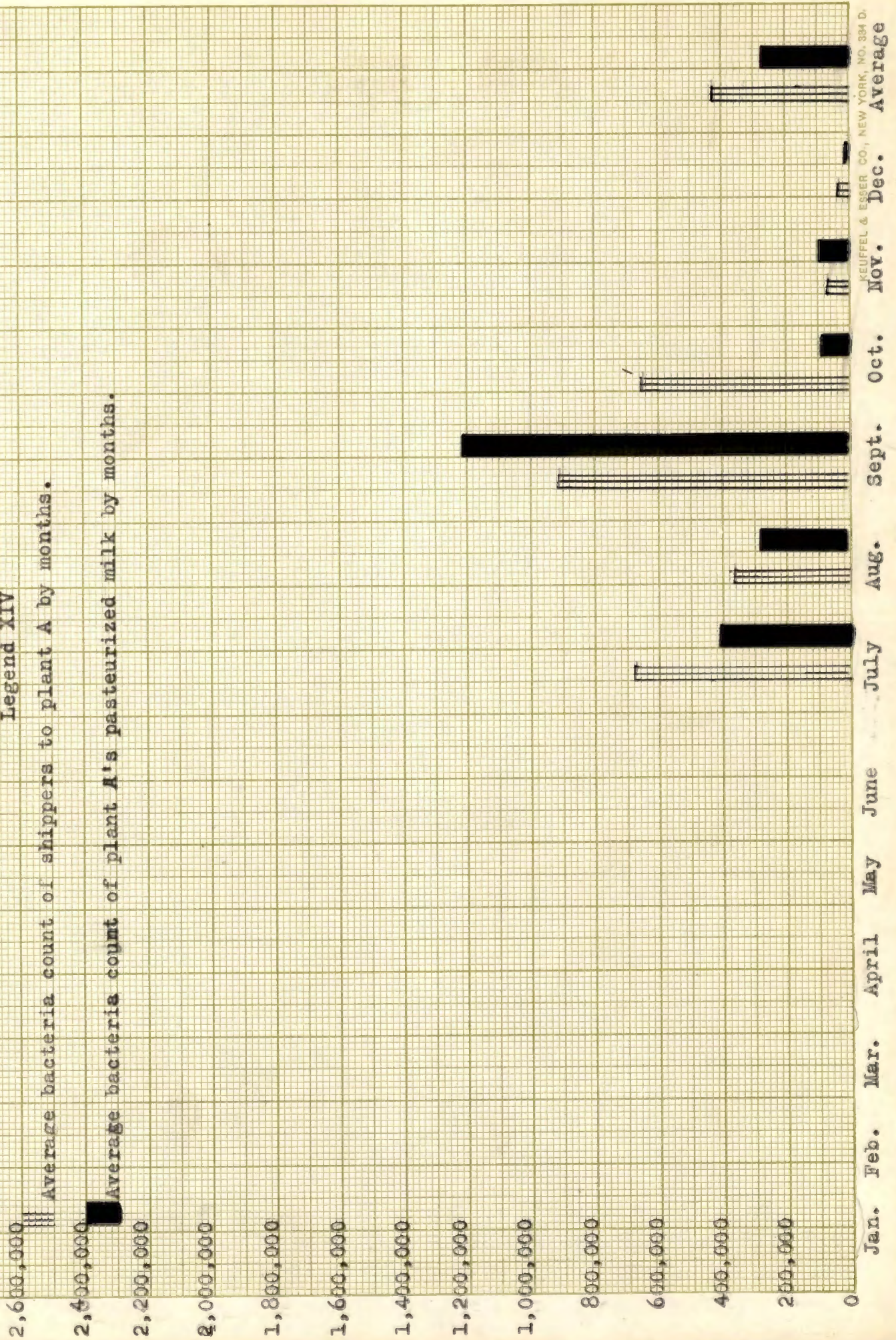


Table 14.

Average Bacteria Count by Route of Milk Shipped to Plant B.

[illegible]

Table 17.

Bacteria Count of Pasteurized Milk from Plant B by Methods:

[illegible]

table 18:

Plant D's percentage of efficiency as regards bacteria count.

[illegible]

Legend

2,600,000

2,400,000

2,200,000

2,000,000

1,800,000

1,600,000

1,400,000

1,200,000

1,000,000

800,000

600,000

400,000

200,000

0

m

Table XV

Average bacteria count of shippers to Plant B by months.

Average bacteria count of plant B's pasteurized milk by months.

Jan.

Feb.

Mar.

April

May

June

July

Aug.

Sept.

Oct.

Nov.

Dec.

Average

Table 19.

Average Bacteria Count by Months of Milk shipped to Plant C.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number						
Analyses					19	23
Average					34,000	309,260
Count						

Table 20.

Bacteria Count of Pasteurized Milk from Plant C by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number						
Analyses					3	2
Average					3,866	27,000
Count						

Table 21.

Plant C's Percentage of Efficiency as regards Bacteria Count Reduction

Month	Jan.	Feb.	Mar.	Apr.	May	June
Per Cent					80.6	91.2

Table 19.

Average Bacteria Count by Months of Milk Shipped to Plant C.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number Analyses	21	29	39	44	40	41	256
Average Count	974,523	1,549,189	2,213,410	884,068	133,077	916,414	807,223

Table 20.

Bacteria Count of Pasteurized Milk from Plant C. by Months.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number Analyses	1	3	1	3	2	2	17
Average Count	500,000	145,666	160,000	63,000	58,000	21,500	88,858

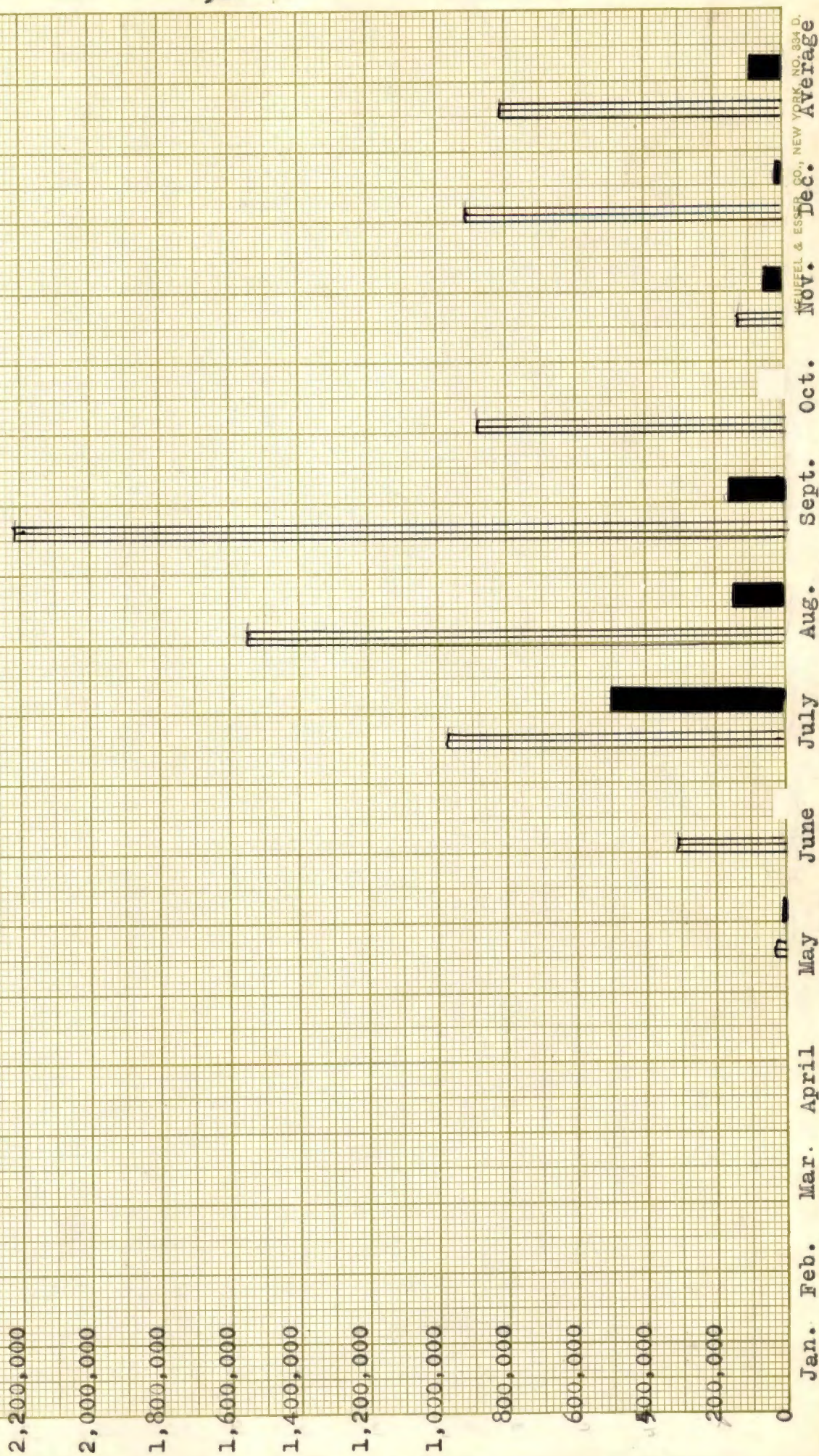
Table 21.

Plant C's Percentage of Efficiency as regards Bacteria Count Reduction.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Per Cent	48.6	90.6	92.7	92.8	56.4	97.6	79.1

Legend

Table XVI
Average bacteria count of shippers to plant C by months.
Average bacteria count of plant C's pasteurized milk by months.



The July average would no doubt be greatly improved had more analyses been made.

Average bacteria count of milk, by months, shipped to plant D and the pasteurized milk sold from that plant.

Tables 22 and 23 and figure XVII show no averages in January for either the shippers or plant, there were no analyses made, however the plant was in operation. According to the above mentioned tables and figure, plant D shows considerable reduction in bacteria count for the months of April, May, August, September, October and December. Other months included are very poor.

Average bacteria count of milk, by months, shipped to plant E and pasteurized milk sold from plant E.

Tables 25 and 26 and figure XVIII show very irregular efficiency in reducing bacteria. During the period of operation the plant average was higher than that of the shippers for the months of April, October and November.

Taking the plant's record for the period operated during the year, the pasteurized milk has an average bacteria count practically as high as the shippers' milk.

Table 22.

Average Bacteria Count by Months of Milk Shipped to Plant D.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number Analyses		11	12	28	11	14
Average Count		24,969	10,333	18,483	853,909	635,571

Table 23.

Bacteria Count of Pasteurized Milk from Plant D by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number Analyses		2	2	2	2	2
Average Count		16,000	4,750	4,750	21,000	428,500

Table 24.

Plant D's Percentage of Efficiency as regards Bacteria Count Reduction

Month	Jan.	Feb.	Mar.	Apr.	May	June
Per Cent		35.7	54.0	97.4	97.5	32.5

Average Bacteria Count by Months of Milk Shipped to Plant D.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number Analyses	19	10	24	15	17	13	174
Average Count	648,736	505,500	1,758,125	1,986,466	63,379	129,530	666,412

Table 23.

Bacteria Count of Pasteurized Milk from Plant D by Months.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Number Analyses	4	2	3	2	2	1	24
Average Count	75,750	18,250	15,000	8,225	60,750	2,600	61,460

Table 24.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Per Cent	88.3	96.3	99.1	99.5	4.14	97.8	74.3

Legend

Figure XVII
Average bacteria count of shippers to plant D by months.
Average bacteria count of plant D's pasteurized milk by months.

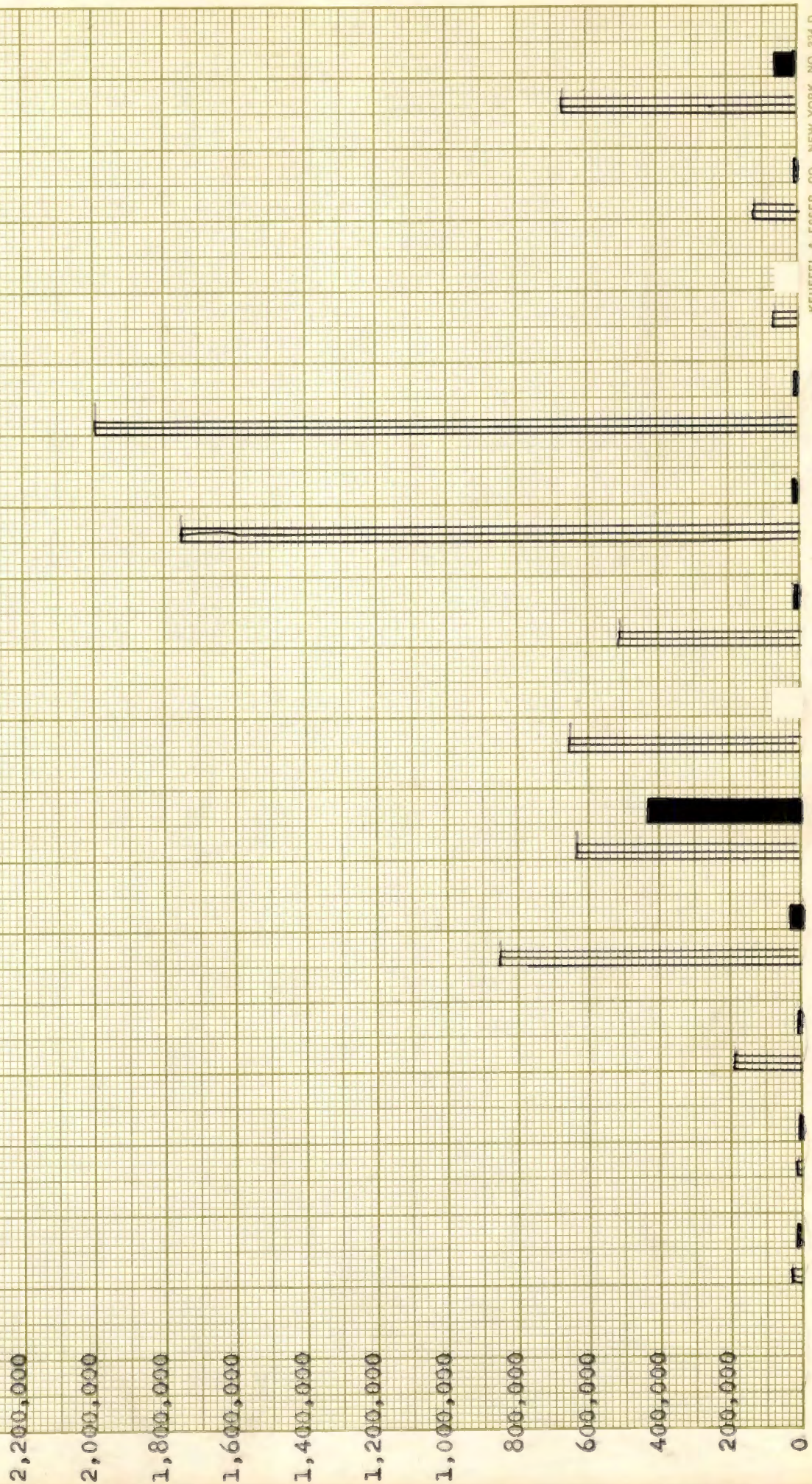


Table 25.

Average Bacteria Count by Months of Milk Shipped to Plant E.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number Analyses				14	20	18
Average Count				19,964	60,000	565,500

Table 26.

Bacteria Count of Pasteurized Milk from Plant E by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number Analyses				3	2	2
Average Count				70,100	10,750	107,500

Table 27.

Plant E's Percentage of Efficiency as regards Bacteria Count Reduction

Month	Jan.	Feb.	Mar.	Apr.	May	June
Per Cent				39.78	82.08	80.99

+ Percentage Increase in Bacteria Count.

Table 25. (Continued.)

Average Bacteria Count by Months of Milk Shipped to Plant E.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number Analyses	19	19	20	22	20	21	173
Average Count	233,384	245,526	1,000,500	1,172,045	10,427	65,300	393,830

Table 26. (Continued.)

Bacteria Count of Pasteurized Milk from Plant E by Months.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number Analyses		1	1	3	2	1	15
Average Count		90,000	62,000	1,647,600	19,900	5,000	372,426

Table 27. (Continued.)

Plant E's percentage of Efficiency as regards Bacteria Count Reduction.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Per Cent		63.35	94.80	39.01+	90.86+	92.34	5.43

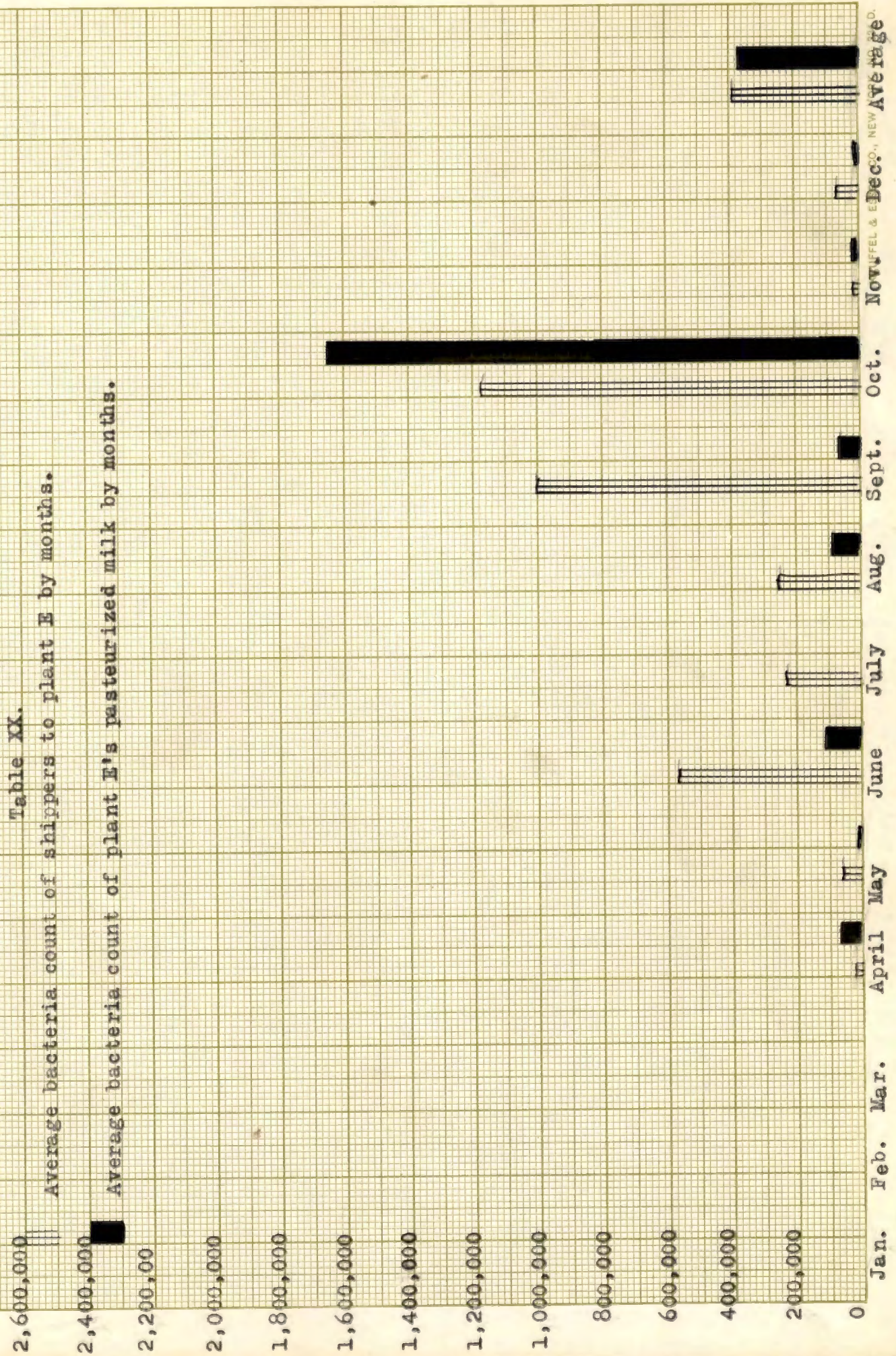
+ Percentage Increase in Bacteria Count

Legend

Table XX.

Average bacteria count of shippers to plant E by months.

Average bacteria count of plant E's pasteurized milk by months.



Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Average

Average bacteria count of milk shipped to plant F and pasteurized milk sold from plant F.

Tables 28 and 29 and figure XIX show greatest margin between average bacteria count of the milk shipped to the plant and the milk sold by the plant, than the records of any of the other plants included in this study.

The reduction from month to month shows a wide variation.

Average bacteria count of milk, by months, shipped to pasteurizing plants and all pasteurized milk sold by plants.

Tables 31, 32 and 33 and figure XX show the efficiency in the reduction of bacteria to vary from 31.5 per cent in November to 95.1 per cent in May.

The average bacteria count for all pasteurized milk met the requirements of the Knoxville Milk Ordinance (1) for the months of January, May and December.

926 analyses were made of milk which was to be pasteurized, termed shipped milk, showing an average bacteria count of 562,103 per c.c.

109 analyses of pasteurized milk were made showing an average for the year of 155,607 bacteria per c.c.

Average Bacteria Count by Months of Milk Shipped to Plant F.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number Analyses	15	14	15	13	12	13
Average Count	41,133	66,428	63,333	154,184	162,500	1,213,753

Table 29.

Bacteria Count of Pasteurized Milk from Plant F by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number Analyses	2	1	3	2	2	3
Average Count	24,500	13,000	21,666	47,500	9,000	115,333

Table 30.

Plant F's Percentage of Efficiency as regards Bacteria Count Reduction.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Per cent	40.4	80.4	67.3	69.2	94.9	90.4

Table 28. (Continued.)

Average Bacteria Count by Months of Milk Shipped to Plant F.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number Analyses	13	13	14	23	24	22	190
Average Count	1,097,692	924,613	2,730,714	124,772	459,895	81,986	510,775

Table 29. (Continued.)

Bacteria Count of Pasteurized Milk from Plant F by Months.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number Analyses	2	3	2	3	2	2	28
Average Count	143,000	297,667	79,500	19,300	24,850	95,500	93,428

Table 30. (Continued.)

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Per Cent	86.7	68.8	97.0	93.9	94.5	14.1+	81.8

+ Percentage Increase in Bacteria Count.

Legend

Table XIX

Average bacteria count of shippers to plant F by months

Average bacteria count of plant F's pasteurized milk by months.

2,600,000

2,400,000

2,200,000

2,000,000

1,800,000

1,600,000

1,400,000

1,200,000

1,000,000

800,000

600,000

400,000

200,000

0

Jan.

Feb.

Mar.

April

May

June

July

Aug.

Sept.

Oct.

Nov.

Dec.

Average

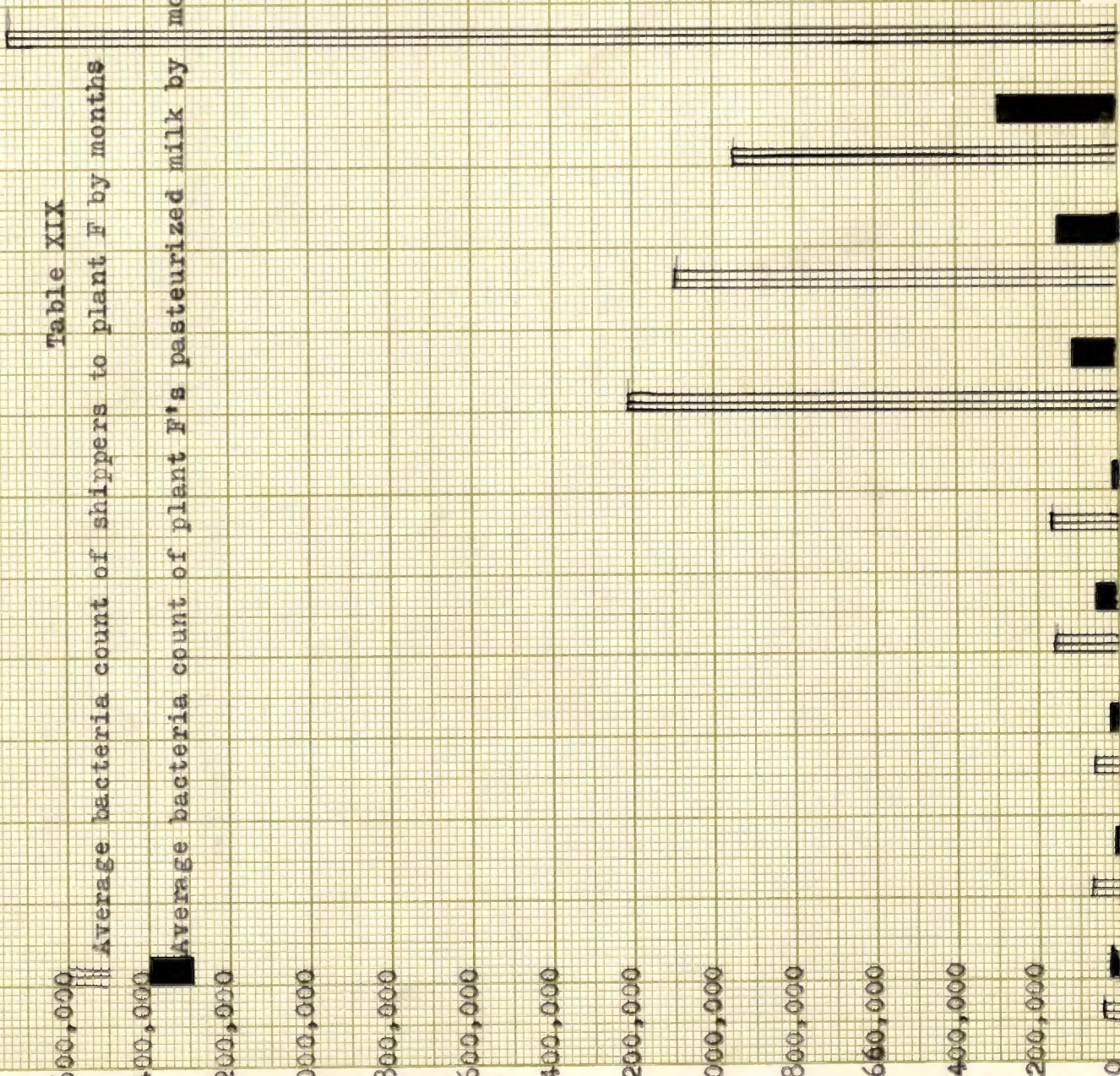


Table 11.

Average Bacteria Count by Months of Milk Shipped to Pasteurizing Plants.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number Analyses	29	58	51	85	62	68
Average Count	36,379	88,681	752,745	219,717	216,213	617,188

Table 32.

Bacteria Count of All Pasteurized Milk by Months.

Month	Jan.	Feb.	Mar.	Apr.	May	June
Number Analyses	2	5	7	9	9	9
Average Count	24,500	42,800	19,928	71,644	10,144	163,555

Table 33.

Pasteurizing Plants Percentage of Efficiency as regards Bacteria Count Reduction

Month	Jan.	Feb.	Mar.	Apr.	May	June
Per Cent	32.6	51.7	94.6	67.1	95.1	71.4

Table 11. (Continued)

Average Bacteria by Months of Milk Shipped to Pasteurizing Plants.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number Analyzed	78	76	102	107	107	103	926
Average Count	712,200	906,184	1,875,666	972,065	76,294	84,631	562,103

Table 12. (Continued)

Bacteria Count of All Pasteurized Milk by Months.

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Number Analyzed	9	11	10	13	10	15	109
Average Count	211,333	176,110	405,600	414,242	52,250	26,913	155,697

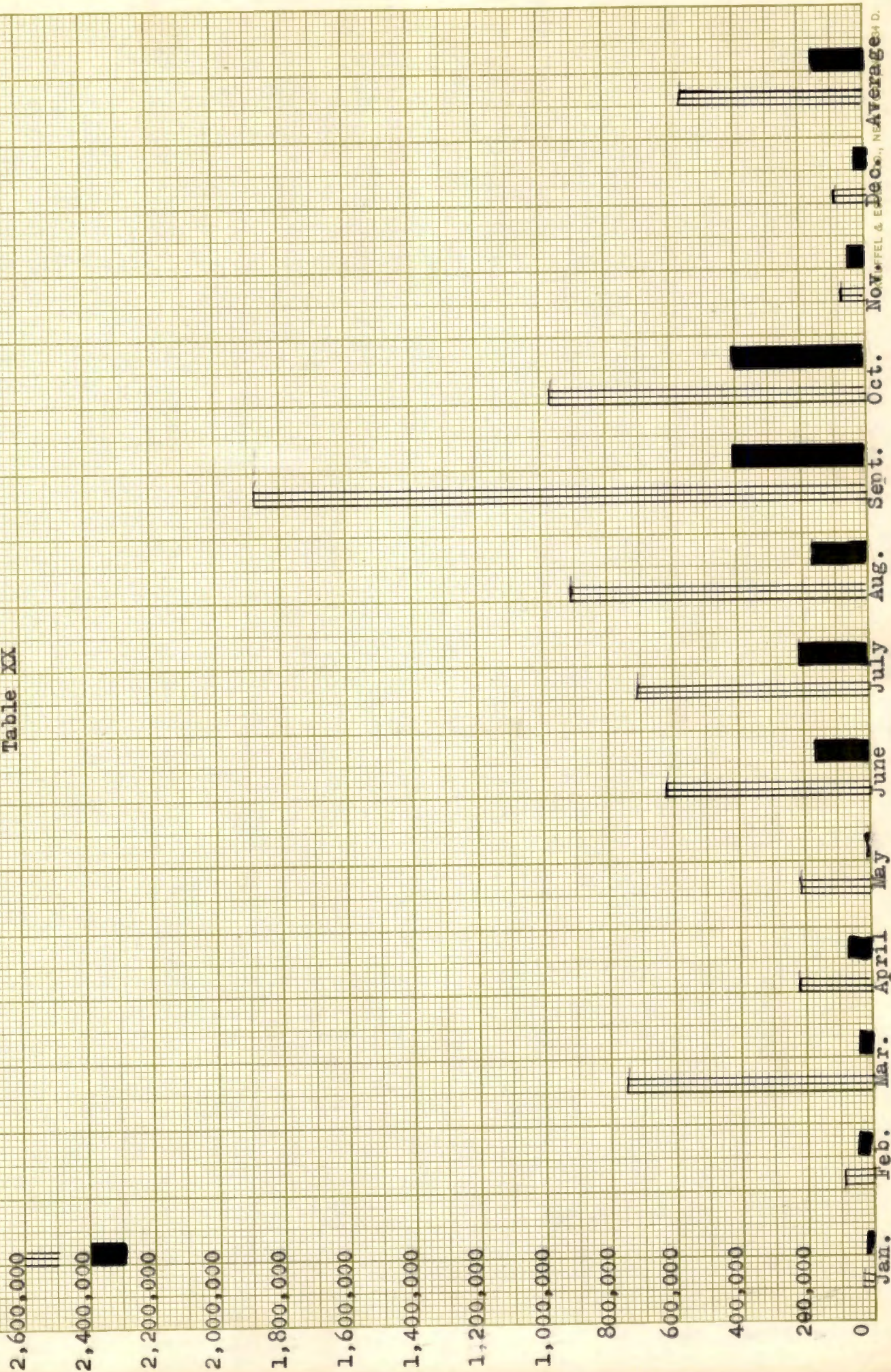
Table 13. (Continued)

Pasteurizing Plants Percentage of Efficiency as regards Bacteria Count Reduction

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Per Cent	68.9	80.5	78.3	57.3	31.5	68.1	72.32

Legend

Table XX



Nov. 1944 D. Average

Relation of bacteria count to Condition of
Barn, source of Water Supply, Method of
sterilization and Storage Facilities.

Yearly average bacteria count of all Grade "A"
Raw Milk furnished by producers with barns classed as
modern, passable and poor.

Table 34 and figure XXI indicate that barn con-
ditions had no relation to bacteria count.

The table shows very few barns taken into
consideration in either of the groups especially the
modern barn group.

Yearly average bacteria count of all Grade "A"
Raw Milk Producers having as their source of water
supply either a well, spring or cistern.

Table 35 and figure AXII show few dairies
taken into consideration in this study. The results
of spring and well water is hardly what would be ex-
pected where conditions other than the water supply are
taken into consideration.

Yearly Average bacteria count of all Grade "A"
Raw Milk producers having steam and hypochlorite,
boiling water, or hypochlorite solution as a means of
sterilization.

Table 36 and figure AXIII show very few
dairies and results different from what would ordinarily
be expected if other influencing conditions were being
considered. The dairies using Steam and Hypochlorite
used the hypochlorite largely as a means of sterilizing
bottles, and steam for buckets, cans etc. No dairies used
steam alone.

Yearly average bacteria count of all Grade "A"
Raw milk Producers with, Ice Box, Spring or Crates as
storage facilities.

Table 37 and figure XXIV show results
quite contrary to the common opinion of dairymen that
a spring is ideal for storage. Although this result is
obtained from the consideration of very few dairies and
might be materially changed by eliminating other influ-
encing factors.

Storage in crates is practised by dairymen
who use considerable ice and while they obtained good
results the practice is expensive.

Yearly Average Bacteria Count of All Grade "A" Raw Milk Producers With:
 Table 14.

Barns

	Modern	Passable	Foot	Well	Spring	Cistern
Number Farms	6	50	23	43	32	3
Number Analyses during year						
Average Yearly Bacteria Count	92	548	152	442	344	17
	173,161	107,933	70,002	120,648	20,189	41,404

Yearly Average Bacteria Count of All Grade "A" Raw Milk Producers With:
 Table 15.

Storage

	Sterilization	Boiling Hypochlorite Water	Hypochlorite	Ice Box	Spring	Crate
Number Farms	12	8	54	48	17	9
Number Analyses	163	66	550	485	198	91
Average Yearly Bacteria Count						
	114,645	92,903	109,690	97,081	156,109	60,356

2,600,000

Figure XXI

Yearly average bacteria count of all grade A raw milk producers with barns classed as modern, passable or poor.

2,000,000

1,800,000

1,600,000

1,400,000

1,200,000

1,000,000

800,000

600,000

400,000

200,000

0

Modern

Passable

Poor

Well

Spring

Cistern

Figure XXII

Yearly average bacteria count of all grade A raw milk producers with well, spring or cistern as water supply.

Figure XXIII

Yearly average bacteria count of all grade A raw milk producers having steam and hypochlorite, boiling water, or hypochlorite as a means of sterilization.

2,000,000

1,800,000

1,600,000

1,400,000

1,200,000

1,000,000

800,000

600,000

400,000

200,000

0

Steam &
Hypochlorite

Boiling
water

Hypochlorite

Ice Box

Spring

Figure XXIV

Yearly average bacteria count of all grade A raw milk producers with icebox, spring or crates as a place for milk storage.

Crates

SUMMARY

There is only limited published materials available covering sanitary supervision of milk supplies for different cities hence it is not sufficient upon which to base the formulating of an ordinance or the establishing of an acceptable program for general dairy inspection service.

Knoxville receives the greater portion of its milk supply from Knox County, considerable being produced in the adjoining counties, especially those counties on the North-east and south-west. Small amounts also come in from the above mentioned directions, especially counties just outside the tier of counties joining Knox. Outside the fifteen mile limit, small amounts of dairy products are supplied Knoxville from south-east of the city.

Butter fat content of milk produced for Knoxville is highest in November and lowest in April with a tendency

to rise in May and maintain practically the same level through the summer months and rise again in the fall to its highest point in November.

Solids not fat Content of Knoxville's milk supply follows very much the same curve as the Butter Fat Content, having the highest per cent in November and May with rather high per cent during all the summer months and lowest during January, February and March.

Average bacteria count of the City's milk is fair with the exception of June, July, August, September and October. A higher count for the year 1925 would be expected due to the extremely high temperature and drought during the summer and fall months. Such results indicate that the greatest problem in supplying a city with low bacteria milk is maintaining a low temperature of the product during the warm months of the year.

Channels of the City's fluid milk supply show more than one-third of the supply going direct from producer to consumer, more than one-third supply reaching consumer through grocery stores and very small amount going direct from distributor to consumer. Approximately 10% of the milk consumed goes through public eating places.

Pasteurization plants when properly operated are capable of reducing the high number of bacteria found in shipped milk, however the plants of Knoxville for the

year 1925 showed a great variation of efficiency from month to month.

There seems to be no relationship between sanitary condition of Grade "A" Raw Milk producers barns and their yearly average bacteria count, indicating that methods as well as equipment are an important factor in control of bacteria in milk.

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