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Factors Affecting the Percentage of Fat in Cows' Milk

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ABSTRACT.—The studies reported in this bulletin take into consideration two fundamental classes of factors which cause variations in the composition and yield of milk produced by dairy cows. Data are reported showing the hereditary variations due to differences in the genetic make-up of breeds and individuals. The bulk of the data included in this report, however, has to do with variations due to physiological changes in the individual animal caused by such factors as time of milking, interval between milkings, completeness of milking, the effect of exercise, season of the year, temperature, condition at calving, effect of underfeeding, effect of pasture, influence of heat period, effect of feed and of drugs on the percentage of fat, the effect of age and of the advance of lactation.

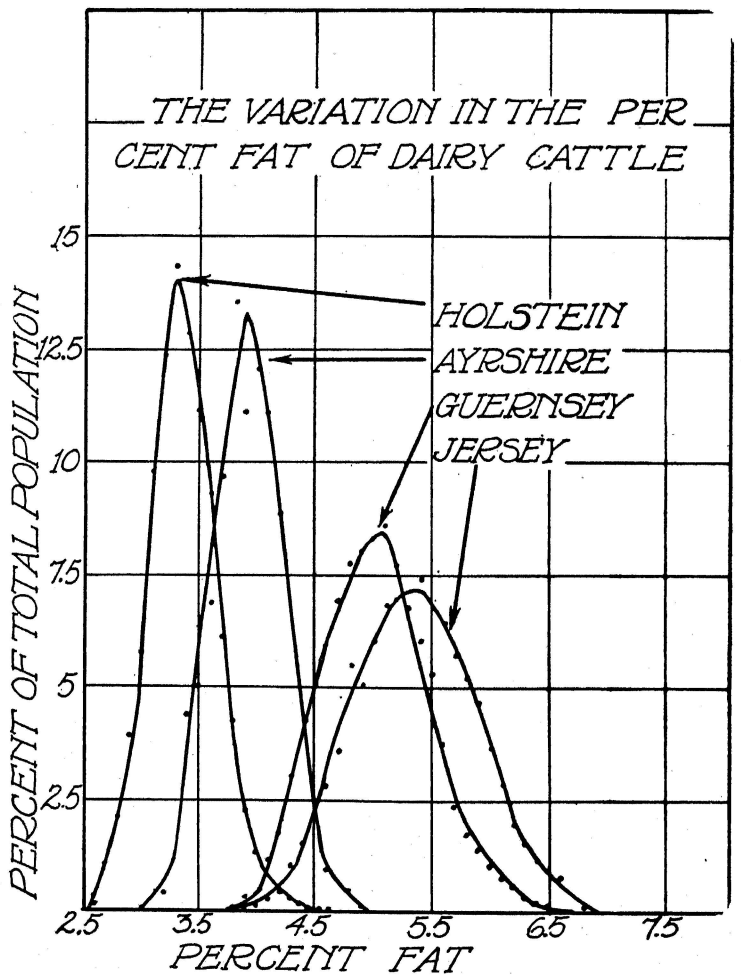

Fig. 1.—The variation in the percentage of fat of the various breeds of dairy cattle. It will be noted that the range of variation in the fat content of the milk of Holstein and Ayrshire cows is much less than of Guernsey and Jersey cows. The Holsteins for example average 3.4% with a minimum of 2.5% and a maximum of slightly over 4.5% a range of 2%. The Jerseys on the other hand average 5.35% with a minimum of about 3.7% and a maximum of over 7% a range of more than 3%.

Factors Affecting the Percentage of Fat in Cows' Milk

C. W. TURNER

The great variation in the composition and yield of milk produced by dairy cattle is a matter of common observation. Because these variations are of great practical interest many studies have been made during recent years in an attempt to find their cause.

These studies indicate that there are two fundamental causes of the variations affecting the composition and yield of milk. The first is the hereditary variation due to the genetic make-up of the breed and individual. This is well illustrated by the variation in the average yield and composition of the milk of the several breeds. Included with this is the individual variation within the several breeds. The present view held by animal breeders is that each animal inherits a fairly definite maximum capacity for milk production of fairly definite composition. The milk yield of the individual, however, is subject to much greater variation than is the composition of the milk.

The second cause of variation in the yield and composition of milk appears to be due to physiological changes in the animal caused by such factors as management, environment, lactation, and age, and these will be discussed in this bulletin.

THE BREEDS

As the genetic make-up of animals within each breed is similar, it might be expected that the variation in the percentage of fat of individual animals within the breed would be small and that the milk produced by each breed would have a characteristic fat content.

The average yield and composition of milk produced by the several dairy breeds as shown by Advanced Registry records is presented in Table 1. It appears that there is a relation between the amount and composition of the milk. In general, breeds producing the larger amounts of milk have the lower percentage of fat. The relation between the fat content and total solids is also shown.

While the milk of each breed of dairy cattle is more or less definite in average composition and yield, still the milk of the individuals within the breeds vary quite widely. The individual variation in the percentage of fat of the four principal breeds of dairy cattle is shown in figure 1. It will be seen that the Holstein and the Ayrshire vary less than do the Guernsey and the Jersey. In other words, the average figure for the

TABLE 1.—BREED VARIATIONS IN MILK SECRETION
(Advanced Registry Data)

Breed	No. cows	Av. yearly milk yield lbs.	Av. % fat	Av. % total solids*
Ayrshire	4695	9963	3.97	12.61
Brown Swiss	357	11536	3.99	13.27
Guernsey	13657	9281	4.99	14.49
Holstein	12110	15344	3.40	12.00
Jersey	17548	8047	5.35	14.70
Red Poll	357	9121	4.27	-----
Shorthorn	1515	8424	3.91	13.38

*From various sources

percentage of fat given in Table 1 is more typical of the breed for the Holstein and Ayrshires than for the others.

There is also a definite relation between the percentage of fat and the yield of milk within each breed. On the average, as the production of milk increases, the percentage of fat decreases. In Table 2 is presented

TABLE 2.—RELATION BETWEEN MILK YIELD AND PERCENTAGE OF FAT IN JERSEY COWS, 2 TO 3 YEARS OLD

No. cows	Yearly milk yield (lbs.)	Av. percentage fat
15	8883	4.1
56	8580	4.3
161	7877	4.5
277	7799	4.7
418	7654	4.9
558	7479	5.1
673	7261	5.3
709	7157	5.5
591	7057	5.7
508	6819	5.9
344	6642	6.1
201	6332	6.3
127	6339	6.5
54	6592	7.6
26	6346	6.9
10	6650	7.1

data tabulated at the Missouri Experiment Station showing this relation for Jersey cows between two and three years of age.

The data show that for an increase of one per cent in fat content, the milk yield is decreased about 800 pounds.

In breeding for an increased fat content of milk nothing will be gained if the increase is made at the expense of a lowered milk yield. While it is apparent that there is fairly close relation between yield and composition of milk, it is well known that the milk production of a cow cannot be estimated from a knowledge of the percentage of fat.

THE INDIVIDUAL

While there are wide variations in the milk yield and the percentage of fat from individual cows, the average percentage of fat during an

entire lactation period is fairly constant from year to year. The average percentage of fat is an inherited trait and is subject only to minor variations. On the other hand, while maximum milk production is fixed fairly definitely by heredity; feeding and management influence the quantity of milk produced very decidedly. In other words, the yield of milk is subject to greater variations than the percentage of fat.

The various factors which cause a change in the composition of milk of individual cows follows:

VARIATION BETWEEN NIGHT AND MORNING MILK

Even though cows are milked at equal intervals there appears to be a slight variation in the percentage of fat between the night and morning milkings. Indermuhl[1] found that the evening milk averaged 4.06% and morning 3.78% during the summer season when the milkings were 12 hours apart. He ascribes the higher fat test of the evening milk to greater activity in the body of the animal during the daytime.

These observations were verified by Gowen[2] of the Maine Station who found that the morning milk was between 0.68 and 0.72 per cent lower in butterfat (depending upon the stage of lactation) than in the evening milk. The cows, however, were milked at 4:45 A. M. and 3:45 P. M.

Eckles and Shaw,[3] on the other hand, concluded from observations on a limited number of cows that the fat content of morning milk is usually slightly higher. When cows are milked three and four times per day, the milkings during the middle of the day are higher in fat than those at night or morning.

These diurnal variations may be due to exercise or atmospheric temperature in which case the discordant results may be explained by differences in the season of the year or management of the cows.

INTERVAL BETWEEN MILKINGS

It has been widely observed that the greater the interval between milkings the less will be the percentage of fat and the greater the amount of milk. Thus if cows are milked 11 and 13 hours apart the milk produced after the 11-hour interval will usually contain the larger percentage of fat. The amount of milk, however, would be less. Ragsdale, Turner and Brody[4] at this Station studied the effect of the interval between milkings on the rate of secretion and composition of milk. Their results are shown in figures 2 and 3. It will be observed that milk secretion is very rapid immediately following milking, but at a constant-

[1]Jahersber Landw. Schule Rutti, 1908.
[2]Jour. Agr. Res., Jan. 20, 1919.
[3]U. S. Bur. of An. Ind. Bul. 157.
[4]Jour. Dairy Sci., Vol. VII, p. 249.

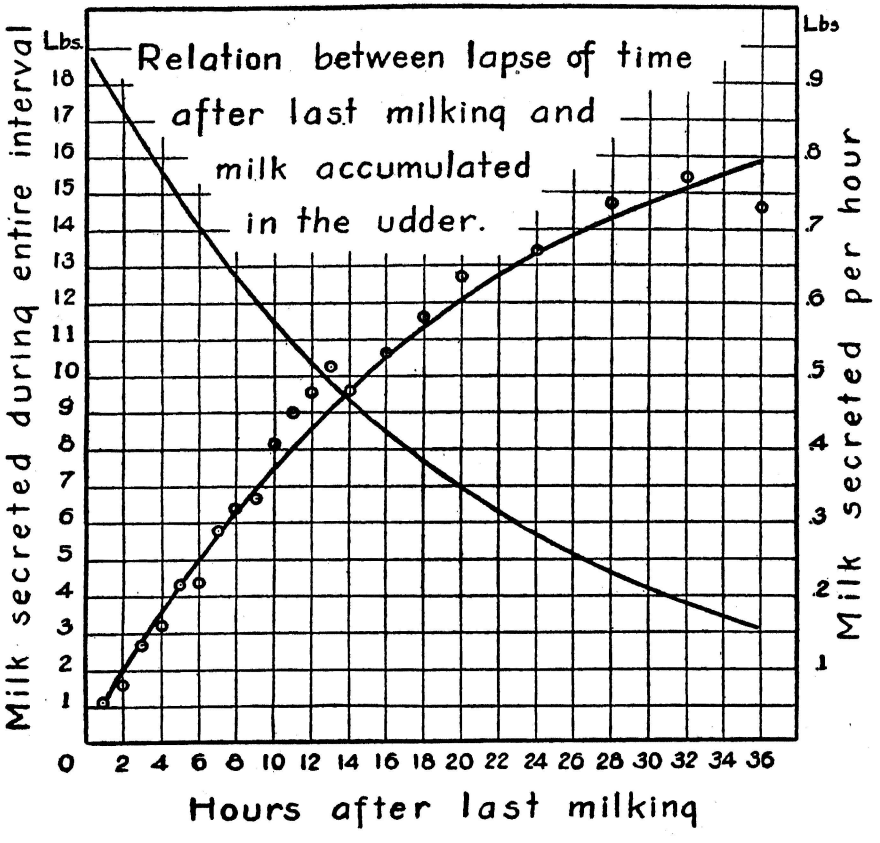

Fig. 2.—The rising curve represents the total milk obtained at the end of each time interval. The declining curve represents the milk secreted per hour at successive intervals. Each hour's milk production is shown to be 95 per cent of the production for the preceding hour.

ly decreasing rate as milk accumulates in the udder. The percentage of fat is very high after the short intervals, but gradually decreases as the time between milkings increases. This work explains the advantage of frequent milking. It would seem reasonable to expect a slightly higher percentage of fat and yield of milk when cows are milked three and four times a day. The data shows in fact that cows milked three times a day (8-hour intervals) produced 10 per cent more milk and cows milked four times a day (6-hour intervals) 16 per cent more milk than cows milked twice a day.

COMPLETE MILKING

If, for any reason, part of the milk in a cow's udder is not completely removed the composition of the milk will be altered. Van Slyke[5] at the

[5]Jour. Am. Chem. Soc. XXX, p. 1166.

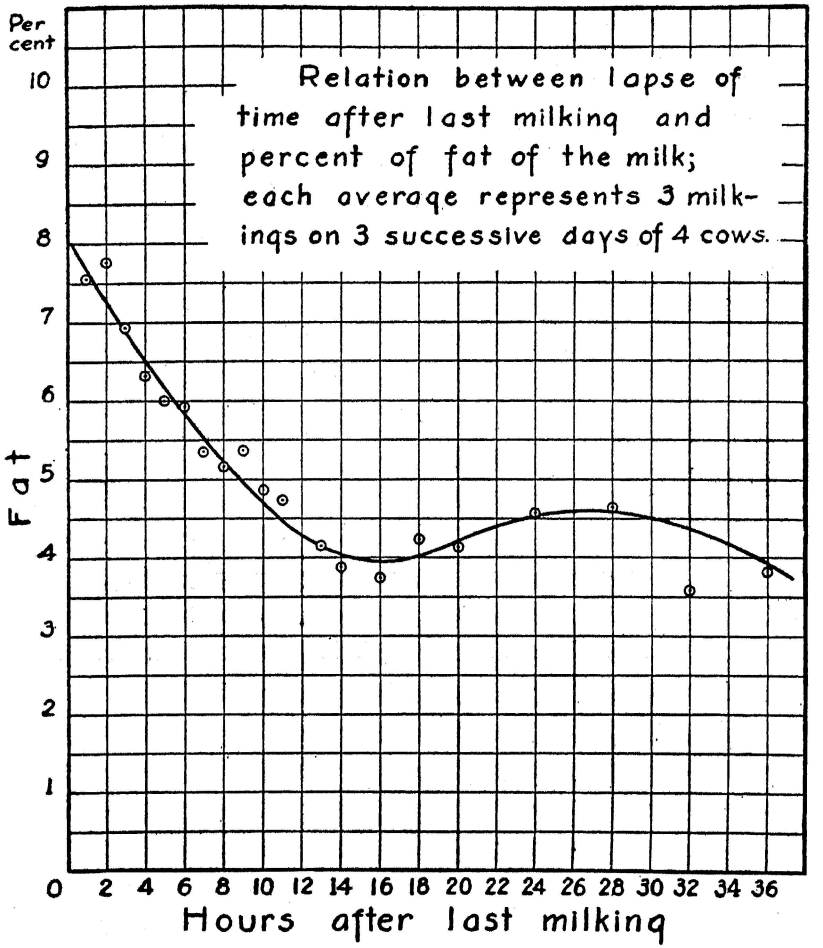

Fig. 3.—The curve shows a gradual decrease in the per cent of fat in the milk at varying time intervals following the preceding milking.

New York (Geneva) Station gives the following composition of the successive portions of milk drawn from a Guernsey cow:

Portion	Milk—lbs.	Fat %	Fat—lbs.
1	3.2	0.76	.0243
2	4.1	2.60	.1066
3	4.6	5.35	.2461
4	5.8	9.80	.5684
TOTAL	17.7	5.34	.9454

The variation in the composition of milk between the first and last drawn samples was shown by Eckles and Shaw to be confined to the fat as the milk plasma remains practically constant.

The difference in the percentage of fat has been explained since Heidenhain's time by the statement that the forward movement of the fat globules are retarded through congestion and friction and come down completely only as the last portions of the milk are removed.

That the cause of successive portions of milk gradually increasing in fat is partially at least due to the action of gravity, is shown by Ragsdale, Brody, and Turner[6] at this Station.

As shown in Table 3 they found that if a Jersey cow was milked immediately after coming into the barn and successive 100-c. c. portions of the milk from one quarter were tested, that the variation between first and last drawn milk was much less than if the cow was allowed to stand quietly for two hours. If, however, the udder of the cow after standing two hours was thoroughly massaged, the variation was much less than in either of the previous trials. For comparison, the composition of successive portions of milk drawn from a large cylinder is presented.

TABLE 3.—VARIATION IN SUCCESSIVE SAMPLES OF COWS MILK

	Cow's Udder			Cylinder	
Sample number	Upon coming into barn	After Standing 2 hours	Standing 2 hours and manipulation	After Standing 1½ hours.	After Standing 3 hrs.
	%	%	%	%	%
1	3.1	1.4	6.3	4.4	1.6
2	3.2	1.5	6.1	5.4	2.7
3	4.7	1.9	6.4	5.7	3.6
4	5.4	3.0	6.5	5.8	4.2
5	5.9	3.4	6.5	5.9	4.9
6	6.6	4.1	6.8	6.0	5.4
7	6.9	4.8	7.2	6.0	5.9
8	6.5	7.8	7.5	6.3	6.8
9	6.8	11.0 (ap)	8.2	6.7	12.0

Since the effect of leaving a quantity of milk in the udder of the cow is of special interest to those engaged in the supervision of semi-official tests, a number of Stations[7] have worked on this problem. It has been shown that incomplete milking increases the yield of milk, the fat test and the yield of butterfat during the regular two-day test.

THE EFFECT OF EXERCISE

The amount of exercise it is desirable to allow dairy cows is an unsettled question. From the standpoint of the continued health of dairy cattle some exercise is desirable but if the amount of exercise is increased, cows producing at a maximum will decrease in production with a corresponding increase in the percentage of fat. Wood[8] of the

[6]Jour. Dairy Sci. Vol. IV, p. 448.
[7]Jour. Dairy Sci., Vol. IV, p. 495; V, p. 259, Vol. VI, p. 292; and Penn. Bul. 176.
[8]Nineteenth Dept. Bur. of An. Ind. 1902.

Maine Station gives a report of a number of experiments conducted in Germany in which a number of cows were driven a considerable distance in some cases up a mountain, and the milk analyzed for a number of days before and after the trip. In all of these experiments it was shown that heavy exercise influenced both the quantity and quality of milk. The decrease in milk yield was noticeable in the first milking after the trip, and was very decided in the second milking. The water content decreased in the first milking and more in the second milking then gradually returned to normal. The casein content increased in the first and second milkings and then gradually returned to normal. The percentage of fat increased in the first two milkings and then gradually returned tonormal.

Woodward[9] of the U. S. Dairy Division conducted an experiment to determine the effect of a daily walk of three miles on the percentage of fat of dairy cows. In all but two instances out of 22 comparisons there was an increase in test when changed from rest to exercise and a decrease when changed from exercise to rest.

TABLE 4.—EFFECT OF EXERCISE ON THE PERCENTAGE OF FAT

Percentage fat (av. 4 cows)		Percentage fat (av. 4 cows)	
Rest	5.25	Exercise	5.07
Exercise	5.52	Rest	4.95
Exercise	5.28	Rest	4.80
Rest	4.97	Exercise	5.27

In further experiments Woodward found that during a period of exercise (50 days) the feed consumption was increased, the milk production maintained, and the percentage of fat increased over a corresponding period of rest. During the period of exercise the cows were forced to walk three miles daily, while during the period of rest they were not allowed out of the stanchion except to be led to the scales. This indicates that a cow adjusts her food consumption to cover the increased maintenance requirement rather than to permanently reduce milk production.

SEASON OF YEAR

The relation between the season of the year and the percentage of fat in milk was first shown by Eckles[10] from a study of 240 lactation periods of cows in the Missouri and Iowa Station herds. He found that regardless of when the lactation began, the percentage of fat was lowest during June and July and gradually rising to the highest point in December and January and then again declining until midsummer. The curves were found to be modified by the tendency for the percentage of fat to rise during the course of the lactation period. Whate and Judkins[11] found that the same relation exists between the solids-not-fat and season.

[9]Jour. Dairy Sci., Vol. 6, p. 466.
[10]Milch Zentralblatt, Vol. V., p. 448, 1909.
[11]Conn. (Storrs) Bul. 94.

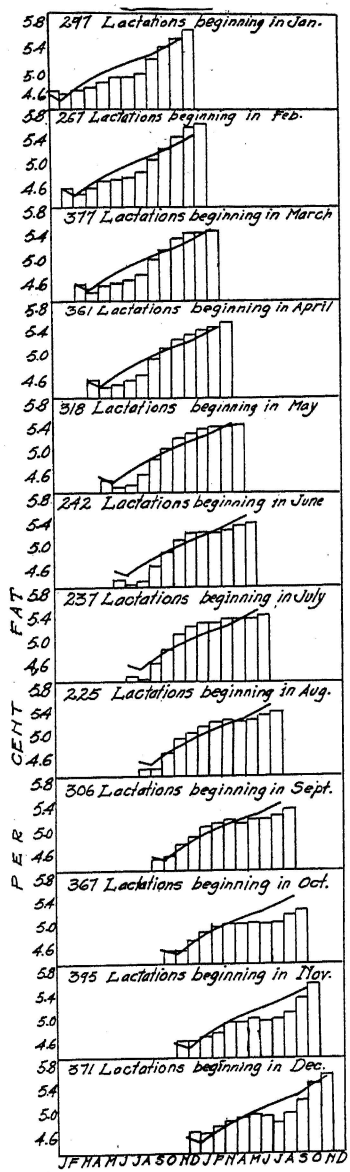

Fig. 4.—Influence of the season of the year on the per cent fat in cow's milk (Guernsey). Continuous lines show influence of the stage of lactation on the percentage of fat. The columns show seasonal variations in percentage of fat for cows grouped according to the month in which the lactation began.

Ragsdale and Turner[18] of this Station studied the effect of season on the percentage of fat in cow's milk. Their results are presented in figures 4 and 5. The records were separated as to the month of calving so that the effect of the advance of lactation could be shown in conjunction with the seasonal effect. This data is combined in Table 5 showing the effect of the season on the percentage of fat irrespective of the stage of lactation. Figure 5 shows very clearly the effect of season on the per-

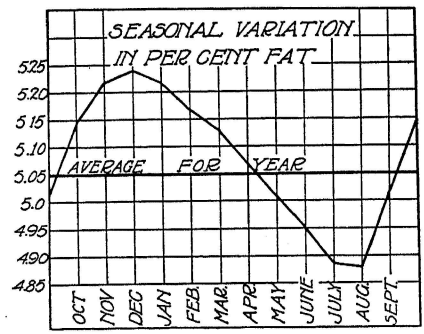

Fig. 5.—Seasonal variation in the per cent of fat in cows' milk. (Guernsey). The per cent of fat gradually increases in the fall and winter reaching a maximum during December then gradually declines until August.

TABLE 5.—INFLUENCE OF THE SEASON OF THE YEAR ON THE PERCENTAGE OF FAT IN COW'S MILK

Month	Guernsey 3763 cows	Jersey 299 cows	Holstein 95 cows
January	5.22	5.77	3.19
February	5.17	5.50	3.26
March	5.13	5.38	3.26
April	5.07	5.31	3.21
May	5.01	5.21	3.13
June	4.95	5.17	3.00
July	4.89	5.03	3.03
August	4.88	5.03	3.05
September	5.02	5.37	3.05
October	5.15	5.55	3.12
November	5.22	5.58	3.26
December	5.24	5.76	3.25
Average	5.08	5.39	3.15

[12]Jour. Dairy Sci., Vol. 5, p. 544.

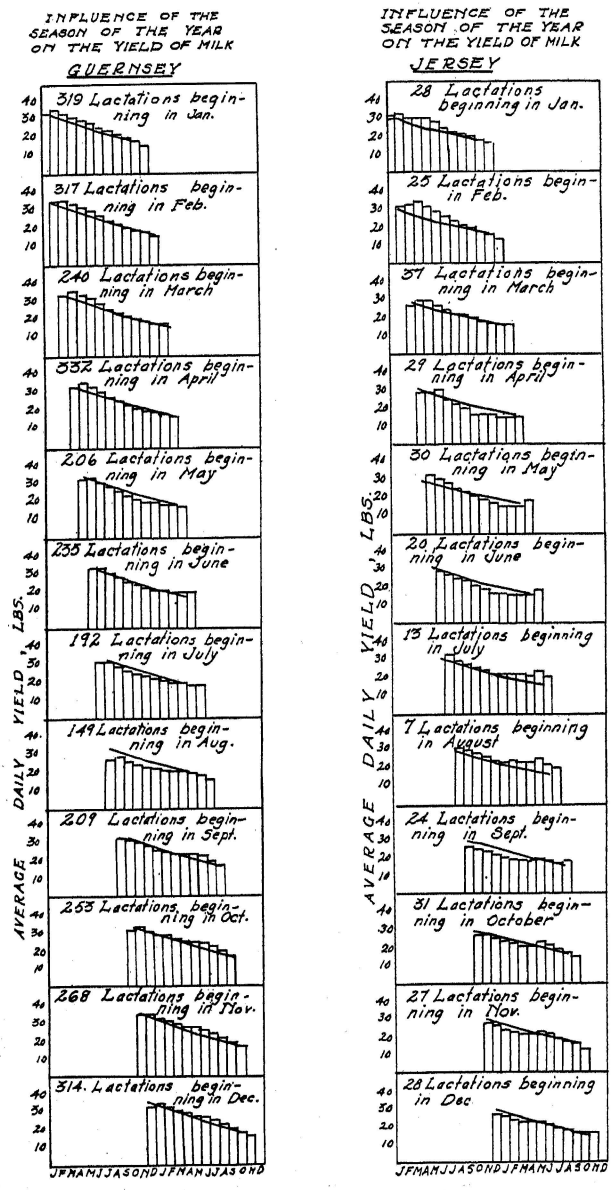

Fig. 6.—Influence of the season of the year on the yield of milk (Guernsey and Jersey cows). The continuous lines show the influence of the stage of lactation on the yield of milk. The columns show the seasonal variation in yield of milk for cows grouped according to the month in which the lactation began. The only apparent effect of season is to slightly depress the production of cows calving in July and August and to either increase slightly or at least maintain the production of milk of cows in all stages of lactation during the spring pasture season.

centage of fat. The test gradually rises in the fall and winter, reaching a maximum during December, then gradually declines until August.

Season does not appear to affect the quantity of milk produced as it does the quality. In a study of this question by the writer[13] at this station, the only apparent effect of season is to slightly depress the production of cows calving in July and August and to either increase slightly or at least maintain the milk production of cows in all stages of lactation during the spring pasture season. These facts are presented in figure 6. This verifies the common opinion of diarymen that spring pasture stimulates milk production.

McDowell[14] of the U. S. Dairy Division made an interesting study of the influence of season of freshening on production and income from dairy cows using cow testing association records. These data are summarized in Table 5. The cows that freshened in the fall months ranked highest in average yearly production of milk and butterfat, in cost of feed and in income over cost of feed. On an average the cows that freshened in the spring produced the least milk and those that freshened in the summer produced the least income over feed cost.

TEMPERATURE

The cause of the seasonal variation in the percentage of fat has been considered by some as being due to variations in feed and other similar causes. That temperature, however, is the controlling factor has been shown in work by Ragsdale, and Brody[15] of this Station. It was found

TABLE 6.—INFLUENCE OF SEASON OF FRESHENING ON PRODUCTION

Season	No. of cows	Milk production	Fat production	Cost of roughage	Cost of grain	Cost of feed	Income over feedcost
		lbs.	lbs.				
Spring-Mar., Apr., May	3196	5842	236	$37.51	$19.22	$56.73	$70.73
Summer-June,July,Aug.	1328	5941	236	37.62	22.48	60.10	66.59
Fall-Sept., Oct., Nov.	2862	6689	268	38.94	28.45	67.39	76.65
Winter-Dec., Jan., Feb.	3484	6439	258	37.65	25.51	63.16	75.66

that when other conditions are the same, the lower the environmental temperature, the higher the percentage of fat in cow's milk. There was an increase of almost 0.2 per cent in the fat for a decrease of 10 degrees F. in the temperature between the limits of 30° to 70° Fahrenheit.

The effect of giving cold baths to dairy cows during hot weather was also tried.[16] It was found by sponging off the cows at two-hour intervals during the day that there was a tendency for the percentage of fat and total fat in the night's milk to increase. The baths, however, apparently exerted no influence on the milk secreted during the night.

[13]Jour. Dairy Sci., Vol. 6, p. 198.
[14]U. S. D. A. Bul. 1071.
[15]Jour. Dairy Sci., Vol. 5. p. 212.
[16]Missouri Experiment Station Bul. 197, Director's Report, 1921-22.

CONDITION AT CALVING TIME

From experience, breeders know that it is advisable to have cows in good condition at calving time. The reserve of flesh aids in maintaining production during the early part of the lactation period. When a cow is in a high condition of flesh she can start producing milk at a higher level than is possible if she is in a poor condition of flesh. Eckles[17] at this

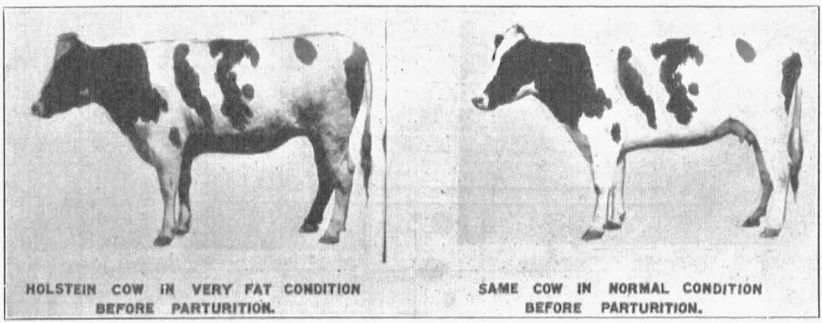

Fig. 7.—Influence of the fatness of the cow at parturition upon the percentage of fat in the milk. A Holstein cow calving in a very fat condition averages 5.1% fat for 7 days and 3.3% for the year. The same cow in normal condition averages 3.8% fat for 7 days and 3.1% fat for the year.

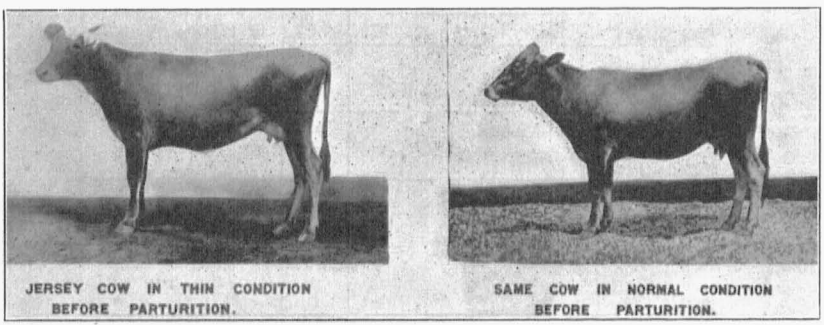

Fig. 8.—Influence of the fatness of the cow at parturition upon the percentage of fat in the milk. A Jersey cow calving in a very thin condition averaged 3.1 % fat for seven days and 4.97% fat for the year. Calving again in normal condition she averaged 4.8% fat for 7 days and 5.07% fat for the year.

Station has shown the favorable effect of a high condition of flesh on the percentage of fat in cows' milk. The results are shown in figs. 7 and 8.

[17]Missouri Experiment Station Bul. 100.

THE EFFECT OF UNDERFEEDING ON MILK SECRETION

It has been shown by Eckles and Palmer[18] of this Station that underfeeding has a marked influence on the composition of milk. They recognized three types of underfeeding: (a) the withdrawal of a certain portion of the total food of the animal, (b) the reduction to a normal plane of animals on a supernormal plane of nutrition, and (c) the physiological underfeeding resulting from the strong stimulus for milk

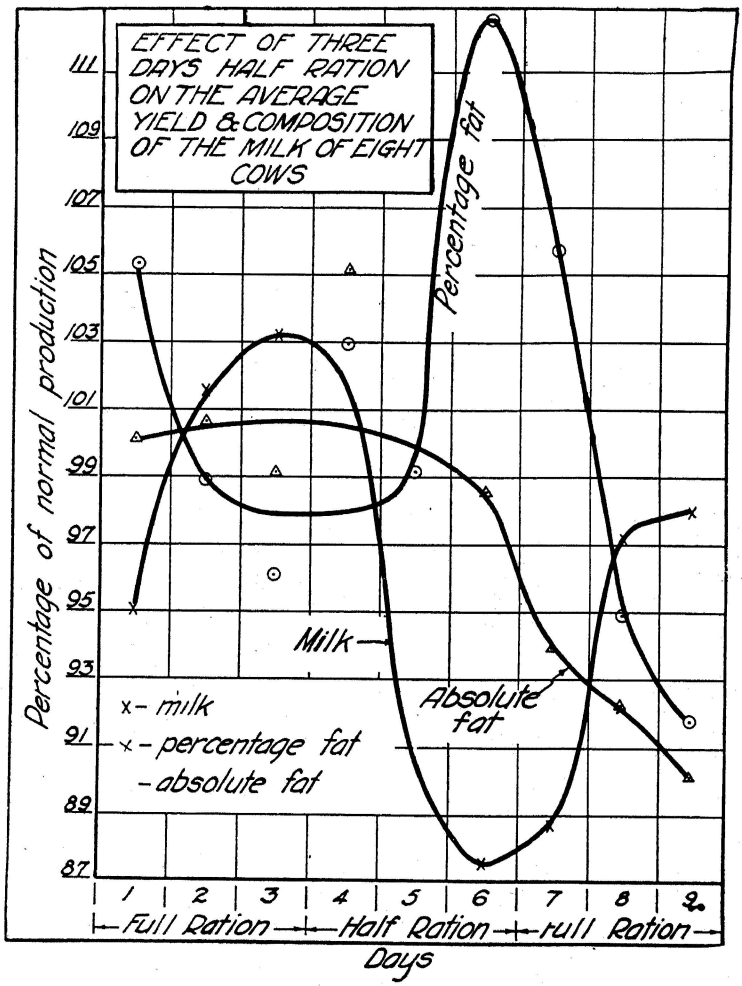

Fig. 9.—The effect of reducing the ration one-half on the average yield and composition of milk. The percentage of fat showed a very decided increase by the third day on the reduced ration.

[18]Missouri Research Bulletin 25.

secretion during a number of days after parturition when it is not possible for the appetite of the cow to supply the demands for nutrients to support both the milk flow and body weight.

It was found in all of their experiments that a high fat test accompanied the reduction in the plane of nutrition and the effect was greatest in the cases of greatest reduction. The increase in the percentage of fat was especially marked when the cow had been on the supernormal plane of nutrition for a considerable period before the reduction of the plane. The influence of physiological underfeeding has been recognized in making large, short time official records during which time abnormally high tests result.

Ragsdale and Turner[19] of this Station conducted an experiment to determine the effect of a 50 per cent reduction of feed on the yield and composition of the milk. The percentage of fat showed a very decided increase by the third day on the reduced ration. This increase was followed by a decrease in the percentage of fat shortly after the feed was returned to normal. The results are presented graphically in figure 9.

THE EFFECT OF PASTURE ON MILK SECRETION

The favorable influence of spring pasture on the milk production of cows and its fat content is well known to dairy farmers. It is not unusual for individual cows to increase four pounds of milk or more per day for the first two weeks after they are let out on pasture and at the same time the percentage of fat in the milk is likely to be increased. With this increased production, there is a decided loss of body weight.

Humphrey and Woll[20] of Wisconsin present data for nine years showing the influence of pasture on production and body weight.

TABLE 7.—INFLUENCE OF PASTURE ON PRODUCTION AND BODY WEIGHT

Year	Last Two Weeks in Barn				First Two Weeks on Pasture				No. Cows included
	Pounds Milk	Butter Fat Pounds	Butter Fat Per cent	Weight of cows pounds	Pounds Milk	Butter Fat Pounds	Butter Fat Per cent	Weight of cows pounds	
1903	368.2	14.86	4.04	976	+33.5	+2.26	+.22	− 8	20
1904	335.9	14.09	4.28	1024	+18.6	+1.25	+.04	− 1	29
1905	366.4	14.49	3.95	1019	+15.2	+ .63	+.01	−20	31
1906	457.6	17.94	3.92	1097	− 1.9	+ .52	+.17	−51	16
1907	310.6	12.49	4.04	1026	+ 8.2	+ .88	+.17	−95	31
1908	337.3	14.56	4.32	1025	+29.1	+1.82	+.15	−31	22
1909	344.8	14.90	4.33	1092	+39.1	+2.29	+.15	−63	28
1910	381.4	16.73	4.38	1068	+25.0	+1.16	+.02	−29	28
1911	421.6	17.27	4.10	1081	− 6.7	+ .34	+.14	−38	27

[19] Jour. Dairy Sci., Vol VI, p. 251.

[20] Wisconsin Bul. 217.

The favorable effect of pasture is also shown in figure 6. It appears from the data presented that fresh pasture grass is a stimulant to milk secretion. Because this grass contains insufficient nutrients to furnish the material for the milk secreted, there results a type of underfeeding which causes an increase in the percentage of fat and a loss of body weight. Increased exercise may also be a cause of the increased percentage of fat. Cows on official test which are being fed to the maximum will not respond to pasture grass as do cows fed ordinary rations. They are unable to secure sufficient nutrients to hold up their production.

THE EFFECT OF FEED ON THE PER CENT OF FAT

The belief is widespread that feed is one of the causes of the variation in the percentage of fat. Many experiments have been conducted in the past to find some feed or feeds which would permanently increase the fat content of milk. These experiments without exception have failed. When cows are being fed so as to maintain live weight, no feeds have been found which will cause a permanent increase in the percentage of fat. Rapid changes in the kind or quality of feeds generally produce changes in the yield and composition of milk until the cows become accustomed to the changed conditions but no permanent effect has yet been thoroughly demonstrated. A few feeds will change some of the physical properties of butterfat causing hard or soft butter. In all cases changes which have been thought to be due to the feed, may be explained in other ways. The reader is referred to the excellent summary of McCandish[21] of the Iowa Station covering the experiments on the effect of high protein feeds on milk secretion.

THE EFFECT OF DRUGS ON MILK AND FAT PRODUCTION

It is a very common opinion of dairymen that milk and fat production can be favorably influenced by the use of certain drugs. It is undoubtedly true that some unscrupulous feeders of test cows have "drugged" their cows in an effort to increase their records. This has led the public to become suspicious of the exceptionally large records.

Studies have been reported by Henderson[22] of the Pennsylvania Station, McCandish[23] of the Iowa Station and Hays and Thomas[24] of the Delaware Station, which indicate that certain drugs have a temporary effect in altering the rate of secretion and thus changing the composition to some extent. In some cases the use of drugs caused the animals to refuse feed. In these cases the change may be due to underfeeding rather than to the drugs.

[21] Jour. Dairy Sci. Vol. 4, p. 310.
[22] Penn. Ann. Rpt. 1916, p. 393.
[23] Jour. Dairy Sci., Vol. I. p. 475
[24] Jour. Agr. Res., Vol. 19, p. 123.

A study of the individual records indicates that the effect of the administration of drugs is not always the same, sometimes acting favorably while at other times reducing production. It must be concluded that the use of drugs to increase the production of milk and fat is a very uncertain means of accomplishing the results desired.

THE INFLUENCE OF THE PERIOD OF HEAT

During the period of heat or oestrum, it is sometimes thought that the milk becomes abnormal, and unfit for consumption by infants and invalids. Doane[25] of the Maryland Station made a chemical study of the milk of five cows before, during, and after the period of heat. In no case was the percentage of fat lower than normal during the period of heat, and in only two instances was there any increase. The other constituents of milk did not vary from the normal. Doane concludes from these results that the milk from cows during the period of heat is in a practically normal condition and is fit for human consumption.

At the Kentucky Station Hooper and Bacon[26] found from a study of the records of 29 cows that fat production declined on an average 0.1 pounds, and milk production 1.5 pounds, on the day of most evident heat. A few cows appeared more sensitive or nervous and were greatly affected by the heat period, one cow for example, produced milk containing 3.7 per cent of fat in the morning of the heat period, 1.9 per cent at night, and the next day 7.3 per cent.

YIELD AND COMPOSITION OF MILK FROM DIFFERENT QUARTERS OF THE UDDER

The milk from each quarter of the udder has been collected separately by several investigators to determine the variation in composition and yield. Van Slyke[27] of the New York Station found that the composition varied somewhat depending upon the order in which the quarters were milked. Beach[28] of the Storrs Station found only a slight average variation between the quarters. Fitch and Copeland[29] of the Kansas

TABLE 8.—MILK AND FAT YIELDS FROM DIFFERENT QUARTERS OF THE UDDER
(Five cows)

Quarter of udder	Milk yield (lbs.)	Fat content %
Right Front	2.2	4.66
Left front	2.4	5.18
Right rear	3.7	5.12
Left rear	3.1	4.84

[25]Maryland Bul. 95.
[26]Kentucky Bulletin 234.
[27]Jour. Amer. Chem. Soc. Vol. 30, p. 1166.
[28]Storrs (Conn.) Rept. 1904.
[29]Jour. Dairy Soc., Vol. 7, p 222

Station determined both the yield and composition of each quarter of 5 cows. The results are presented in Table 8.

From a study of the records, it appears that there is no definite relation between the yield and composition of the milk and that the variation between quarters is an individual characteristic.

EFFECT OF ADVANCE OF LACTATION ON PERCENTAGE OF FAT

The effect of the advance of lactation on the composition of milk has been studied by a number of investigators. Van Slyke[30] of the New York Station found that the percentage of fat and protein dropped in the second month of lactation, as compared with the first, and then began to increase from month to month during the entire period of lactation. In the tenth and eleventh months of lactation, the increase of fat and of protein is more marked than during the preceding months.

Eckles and Shaw[31] of this Station found in a study of eleven cows of four breeds that there was a decline in the percentage of fat during the first three months, followed by a period of from four to five months with little change. From this period on to the end of the lactation period the fat increases rapidly reaching the maximum at the close. They also conclude that there is, in general some relation between the amount of milk and the percentage of fat. When there is a sudden decline in the amount of milk secreted for any reason, the percentage of fat with few exceptions increases sharply. In Table 9 are facts compiled by Ragsdale and Turner[32] of this Station which show the influence of the stage of lactation on the percentage of fat.

TABLE 9.—INFLUENCE OF THE STAGE OF LACTATION ON THE PERCENTAGE OF FAT IN COWS MILK

Month of lactation	Guernsey (3763) % fat	Jersey (299) % fat	Holstein (95) % fat	Guernsey (900) non-pregnant	Guernsey (370) bred 3 and 4 months of lactation
1	4.63	4.98	3.24	----	----
2	4.59	4.82	3.01	4.58	4.68
3	4.71	4.88	2.99	4.71	4.80
4	4.85	5.10	3.02	4.83	4.90
5	4.97	5.13	3.01	4.89	4.92
6	5.08	5.26	3.08	5.07	5.03
7	5.16	5.40	3.11	5.14	5.17
8	5.22	5.43	3.16	5.21	5.27
9	5.29	5.50	3.19	5.29	5.40
10	5.39	5.58	3.27	5.35	5.52
11	5.49	5.60	3.32	5.43	5.74
12	5.60	5.73	3.49	5.51	6.17

[30] Jour. Amer. Chem. Soc. Vol. 30, p. 1166.
[31] U. S. Bureau An. Ind. Bul. 155.
[32] Jour. Dairy Sci., Vol. V, p. 22.

It will be noted that the percentage of fat declines for a time, probably, due to the fatness of the cow at the time of parturition. The milk then gradually increases in fat content fairly uniformly with the decline of the milk yield. The effect of pregnancy on the fat content of milk is also shown in the case of the cows bred the third and fourth months of lactation. The increase is especially rapid the last two months of lactation (figure 10).

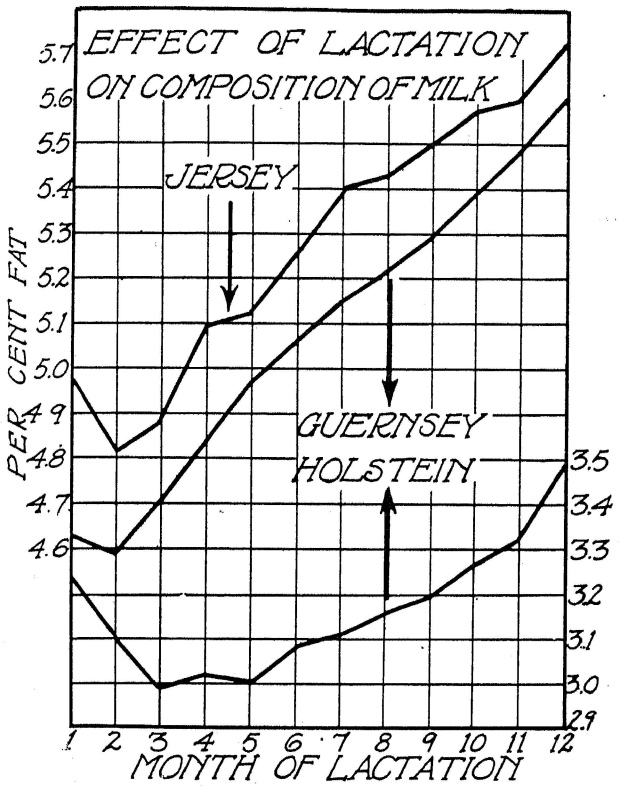

Fig. 10.—The effect of the stage of lactation on the composition of milk.

INFLUENCE OF AGE ON THE PERCENTAGE OF FAT

While the percentage of fat in cows' milk is fairly definitely fixed by inheritance, there appears to be a slight tendency for the percentage of fat to decline slightly with age. The total decline is very slight and is of little practical importance. Data on this subject are summarized in Table 10 and figure 11.

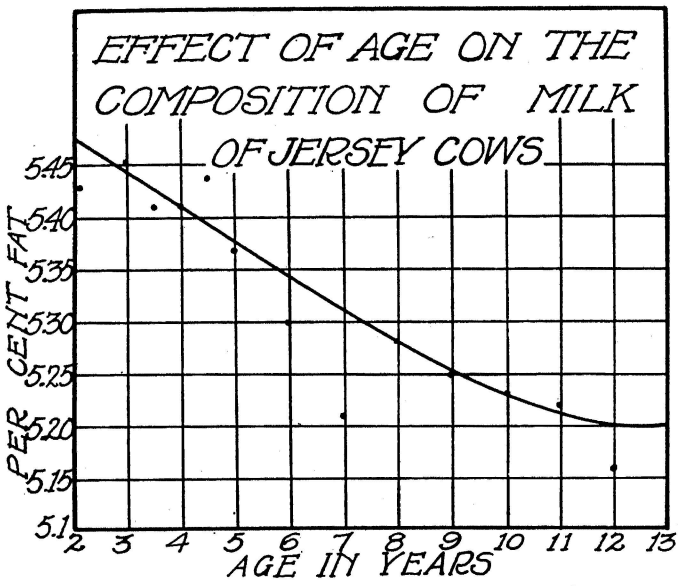

Fig. 11.—The effect of age on the composition of milk of Jersey cows.

TABLE 10.—INFLUENCE OF AGE ON THE PERCENTAGE OF FAT

Class	Jersey		Guernsey*		Holstein	
	No. of animals	Fat per cent	No. of animals	Fat per cent	No. of animals	Fat per cent
Yearling	947	5.43				
2-2½	2829	5.43	4593	4.99	2454	3.37
2½-3	1261	5.46	2208	5.02	1523	3.38
3-3½	1271	5.41	1801	5.02	1238	3.38
3½-4	992	5.41	1533	5.05	1116	3.36
4-4½	878	5.44	1407	5.04	835	3.37
4½-5	809	5.37	1156	4.99	583	3.38
5-6	1487	5.30	1041	4.99	396	3.34
6-7	1067	5.21	833	4.98	232	3.29
7-8	837	5.28	522	4.96	111	3.41
8-9	565	5.25	338	4.98	59	3.31
9-10	355	5.23	246	4.90	37	3.37
10-11	200	5.22	115	4.85	11	3.26
11-12	108	5.16	60	4.86	4	3.18
12-13	58	5.21	29	4.89	4	3.06
13-14	31	5.32	21	4.71	2	3.03
14-15	13	5.21				
15-16	8	5.48				
16-17	5	5.55				
17-18	1	5.95				
18-19	1	5.44				

*Maine bulletin 311