

A STUDY OF CATTLE "TEMPERAMENT" AND ITS MEASUREMENT.

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INTRODUCTION.*

The present phase of this problem has been evolved from an attempt to correlate the so-called "dairy temperament" with milk production. The term "dairy temperament" was first promulgated by Ex-Gov. Hoard of Wisconsin in 1886, in a lecture on "Nervous or Dairy Temperament in Cattle." He called it a predisposing tendency in the animal to convert its food either into milk or flesh." He called that temperament pertaining to dairy cattle, "dairy temperament." A later definition of the term was expressed by Prof. Hæcker, of Minn.: "An animal whose nervous system dominates the vital system, has the inherited tendency to convert the nutriment in food into milk." "Dairy temperament" today, is one of the strongest points of the dairy cow score card. The term and its definition are based on indications only, such as "eye full and expressive," "clean face," "large nostrils," "long, light neck," "sharp withers," "prominent spinal column," etc.

The word "temperament" is perhaps a rather ambiguous term to apply to cattle, but it was employed, no doubt, for want of a better word. The usual definition of the word characterizes it as a mental condition, or "special type of mental constitution and development or mixture of characteristics, supposed to have its basis in the bodily organism and to be transmissible by inheritance,"† or again a "natural disposition." Speaking of disposition, psychologically it is a "tendency left behind by an experience, to give rise on suitable stimulation, to a reaction which shows the influence of that experience, especially as applied to explain the phenomena of memory." The

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†Funk and Wagnalls, New Standard Dictionary, 1914.

term "dairy temperament," as it has been used, is based entirely upon physical characteristics of the animal, and as such is abstract and unusable. It is the purpose of this study to attempt to measure "temperament" in cattle, and so place it upon a quantitative basis.

Historical.—In the study of human psychology, many experiments have been carried on by which various emotions, and mental and nervous disturbances have been registered. According to C. S. Stumpf—"our conscious states, without our willing it—indeed, even in spite of us—are accompanied by bodily changes, which very often can be detected only by the use of extremely fine graphic methods." (10) These have been based mainly, but not solely on respiration. Respiration in animals is controlled almost entirely by the nervous system, the respiratory center being located in the medulla oblongata. Connected with it is the vagus center, which in turn receives nerves from the lungs, heart and stomach. The respiratory movements are controlled primarily by the nerves to the intercostal muscles and diaphragm. The nerves supplying these muscles do not come from the respiratory center, but come from the cells of the grey matter of the spinal cord. It is by influencing the activities of these cells, that the respiratory center controls the act of respiration. In its turn the respiratory center is under control of the higher nerve centers of the brain. Due to the afferent nerves from the viscera and sense organs, as well as from the higher brain centers, respiration is influenced by the heart beat, activities of the stomach, and internal organs, as well as by external changes. The automatic activity of the respiratory center is chiefly regulated by the amount of acid in the blood and the temperature of the blood. Therefore the respiratory movements are also regulated by the metabolic activities of the animal. As the rate of the heart beat accelerates, so, too, does the rate of respiration. Respiration then is not a separate activity, but is in harmony with, and closely allied to various other physical and mental activities. Respiration has been found to be a good index to the nervous reactivity and "temperament" of an animal, and has formed the chief basis of this study, being used as a means of measuring "temperament" or nervous reactivity. As Zoneff and Neumann say: "Insoeben wurde ich bei gelegentlichen Versuchen, auf den Unterschied aufmerksam, den das Athem mit

dem Brustkorb und die Zwerchfellathmung beim Ausdruck der Gefühle zeigen. Ueberall, wo in unsern Versuchen der Athem charakteristische Veränderungen aufweist, finden sich analoge Erscheinungen im Puls." (12).

It can be shown by suitable curves recorded while the animal is resting, that there is a fundamental rhythm in the respiratory movements, which is peculiar to each individual. Ordinarily this rhythm is obscured because external and internal stimuli affect respiration to a very large extent. It has been our experience, that those animals which were least

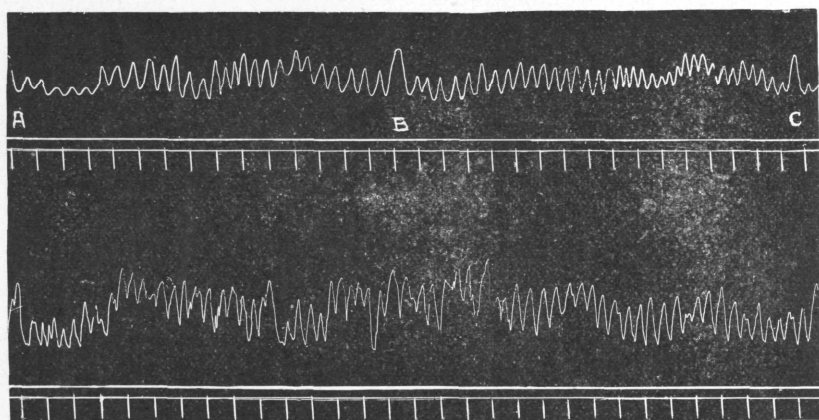


Fig. 1. Respiration tracings of 7H (above) and 2H (below) recorded while feeding. At A, B and C are shown the deep expirations. This type of respiration recalls the Cheyne-Stokes breathing sometimes seen in man, and is typical of resting animals or those which have a stolid disposition. The contrast between these tracings illustrates very well the difference between the respiration of a stolid and nervous cow. Time intervals, five seconds.

nervous and most easily handled, showed this fundamental rhythm very often; and further, that the fundamental rhythm of these very stolid animals showed a very low variability when compared with rhythms of more nervous ones, (see Figure 1). As a result of considerable preliminary work and experience with animals concerned, we have confined this study to the measurement of the variability of the depth of breathing, shown by four Holstein cows, which were tested as nearly as possible under the same normal stable conditions.

METHODS AND PROCEDURE.

An apparatus, similar to that used upon human beings, was employed, with but a few minor modifications which adapted it to use with cattle. This consisted of a pneumograph, kymograph, tambour, electric clock and signal magnet, which were connected in the usual manner. The tambour registered the respiratory activities upon a drum fitted with smoked paper, which revolved at a convenient rate. The speed was so timed that the curves were easily read, and showed the minutest variations. In all curves, the signal magnet registered five second intervals below each curve. In every curve the up stroke indicates expiration and the downstroke inspiration. These pneumographic tracings, (see Figure 1), not only registered respiratory movements, but also outward movements of the animal's body, such as kicking, moving about, movements of the head, switchings of the tail, etc. The pneumograph was attached about the barrel of the animal, nearly over the diaphragm. In this position, all or nearly all of the movements were recorded. As has been shown, every movement is controlled by the nervous system and so has a direct bearing upon the measurement of nervous activity. Thus a restless animal showed a greater number of variations in its curve than a more quiet one.

Four registered Holstein-Friesian cows were experimented with—Seven H, Three H, Two H, and Five H. Three periods of the day were selected for experimentation, which represented three given conditions—before feeding, during feeding and after feeding. Curves were made with the different animals on different days under these conditions, over a period of three months. After becoming familiar with the apparatus and subject, each variation in the curve proved significant of some definite activity. We were soon able to recognize kicks, swallowing, switching of tail, etc., as recorded on the drum. Our experience is in accord with that of Neumann, who says: "Es zeigte sich bei diesen Versuchen, dass der Athem das empfindlichste Reagens bei Gefühlschwankungen bildete, und das bei richtiger Behandlung der pneumographischen Registrierapparate die Athemveränderungen als sicherstes Kennzeichen alle Veränderungen der Gefühlslebens dienen können." (12.)

RESULTS.

Treatment.—After sufficient data had been collected, (about 150 curves), a method of interpreting the pneumographic tracings was used, whereby respiratory activities and the corresponding variations were taken into account. The amplitude of each inspiration and expiration was measured in millimeters, and these measurements were tabulated statistically, and the data plotted in the form of a frequency polygon, where the amplitudes of respirations were plotted against their frequencies. The mean (M), standard deviation (S. D.), coefficient of variability (Cv.), and their corresponding probable errors, were calculated according to the usual formulæ.

Many such frequency polygons were made of the different subjects, under different conditions, and taken from different days selected at random. After a sufficient number of such polygons from each animal were plotted, the entire number of polygons of each individual under a given condition, were constructed into a composite curve or polygon, which latter was taken as characteristic of that animal under the given condition. The composite was constructed in the following manner. The means of the individual polygons were superimposed upon each other, and then each polygon was plotted about its own mean. Then, for example, where the various lines of amplitude 4 crossed the different frequency lines, a simple average was taken, and this average represented the average frequency of amplitude 4, and was plotted as such upon the composite. From the composite, another set of figures was derived, and this taken as characteristic of the given subject under the given condition. And so the mean, standard deviation, and coefficient of variability of the composite were taken as representative. This method of constructing composites was made necessary by the curious moving of the mean up or down (see below), and by variations in pressure in the pneumograph and tambour due to changes in tension and positions of the same.

TABLE I.

Showing the means, M., standard deviations, S. D., and coefficients of variability, Cv., of the respiration composites of the four cows under the experimental conditions, before, during, and after feeding.

ANIMAL NUMBER	BEFORE FEEDING	FEEDING	AFTER FEEDING
Seven H.....	M. 6.4101 \pm .067 S.D. 2.025 \pm .047 Cv. 31.59 \pm .813	M. 10.422 \pm .080 S.D. 2.581 \pm .057 Cv. 24.76 \pm .579	M. 5.349 \pm .077 S.D. 2.204 \pm .054 Cv. 41.20 \pm 1.17
Three H.....	M. 6.698 \pm .089 S.D. 2.570 \pm .063 Cv. 38.369 \pm 1.06	M. 9.122 \pm .084 S. D. 2.607 \pm .067 Cv. 28.57 \pm .791	M. 7.21 \pm .100 S.D. 3.042 \pm .070 Cv. 42.19 \pm 1.14
Two H.....	M. 6.732 \pm .133 S.D. 3.098 \pm .094 Cv. 46.02 \pm 1.669	M. 9.971 \pm .132 S.D. 3.796 \pm .094 Cv. 38.07 \pm 1.064	M. 9.093 \pm .137 S.D. 3.458 \pm .097 Cv. 38.02 \pm 1.213
Five H.....	M. 8.227 \pm .155 S.D. 4.154 \pm .109 Cv. 50.49 \pm 1.67	M. 11.97 \pm .174 S.D. 5.162 \pm .123 Cv. 43.124 \pm 1.20	M. 7.92 \pm .120 S.D. 3.096 \pm .085 Cv. 39.08 \pm 1.22

Individual Variation.—For clearness and convenience, two sets of comparisons will be made; first, variations within the individual, and second, variations within the group. As stated above, each subject was experimented upon under three different conditions, before, during and after feeding. In order to facilitate comparisons, all three polygons have been plotted upon one sheet, i. e., those which pertain to the individual animal; and at the same time the coefficients of these curves, the mean, standard deviation and coefficient of variability with their probable errors are shown in Table I.

The general appearance of the composites of all the individuals would lead one to believe that the coefficient of variability is the key to their interpretation. The coefficients do bear a relation to the shape of the curve, but in their interpretation they cannot be considered alone, but must be interpreted in terms of the mean and standard of deviation, otherwise they are misleading. For example, the after feeding polygons of Seven H and Three H, (Fig. 3) are entirely different, and a single glance would tell that the polygon of Three H is more variable than that of Seven H, and yet their coefficients of variability are practically the same, 42.19 and 41.20 respectively. But considering the means and standard deviations, this is easily

explained, that Three H is more variable than Seven H under the same condition. The mean of Three H is 7.21 and that of Seven H is 5.34, which shows that Three H had a large number of respirations about 7 mm. in length, while Seven H had a large number of respirations about 5 mm. in length. Their standard deviations, 3.04 and 2.20 respectively, are more significant, since they show that Three H deviated more from its mean, than Seven H did from its mean. Now combining the respective means and standard deviations of each individual, it is seen that the mean and standard deviation of Three H increased in about the same ratio, and hence the coefficients of variability are practically alike, since by formula:

$$\text{—coefficient of variability} = \frac{\text{standard deviation}}{\text{mean}} \cdot 100.$$

But the fact remains that Three H is more variable than Seven H, under the given condition, even though their coefficients of variability do not show as marked difference as the polygons themselves indicate.

Further, the fact that the mean and standard deviation of Three H increased in the same ratio, is explained by the condition under which the tracings were made. This was not constant. Above it was stated that the animals were subjected to like conditions, but these conditions were not constant so far as the time element is concerned. For sufficient reasons, as will be explained later, the after feeding condition was not always taken at a specific interval after the regular feeding time. This, as will be seen, affects the means of the polygons, and in turn the coefficient of variability. As the pneumographic tracings of the after feeding condition were taken farther from or nearer to the regular feeding time, the resulting polygons here plotted moved farther from or nearer to the "o" ordinate, due to the increasing or decreasing depths of breathing as the case may be. The reason that the mean should vary directly with the time of taking the after feeding tracings, is probably due to the metabolism of the animal which also varies as the after feeding condition draws near to or farther from the actual feeding time. Consequently, the time element not being constant, the means varied to such an extent as to make the coefficients of variability misleading, and so the standard deviation is of more consequence than the mean in interpreting

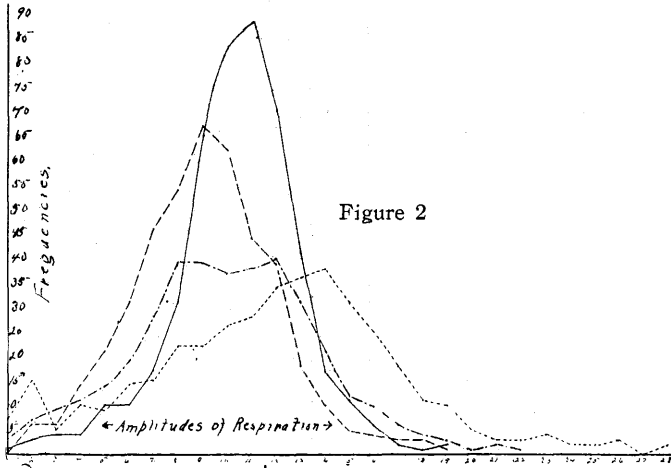


Figure 2

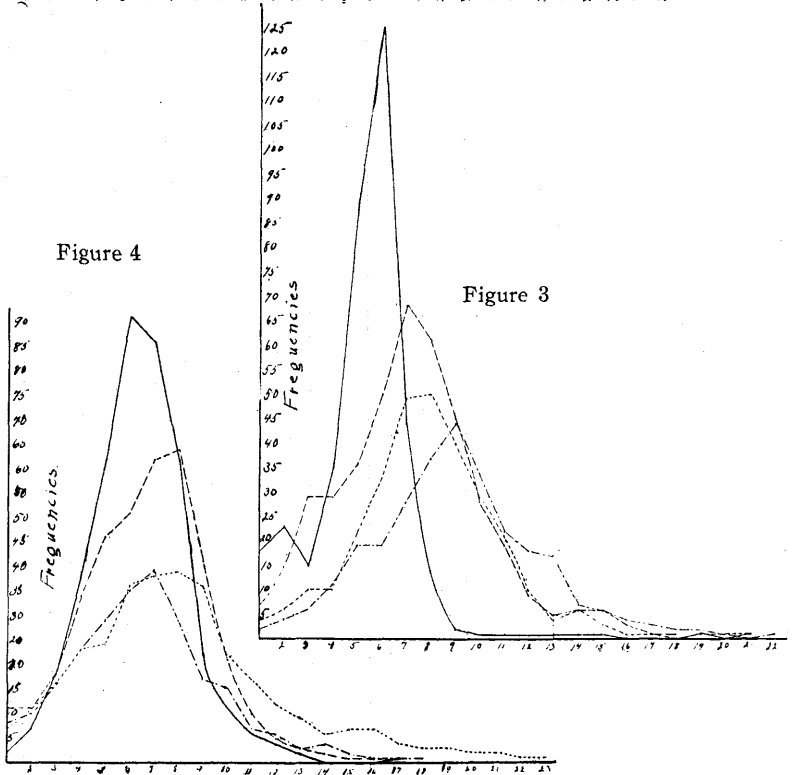


Figure 4

Figure 3

- Fig. 2. Curves showing respiration in the four cows while feeding: — Seven H; — — — Three H; ····· Two H; - - - - Five H. (All figures are drawn to the same scale.)
 Fig. 3. Curves showing respiration in the four cows after feeding.
 Fig. 4. (Below). Curves showing respiration in four cows before feeding.

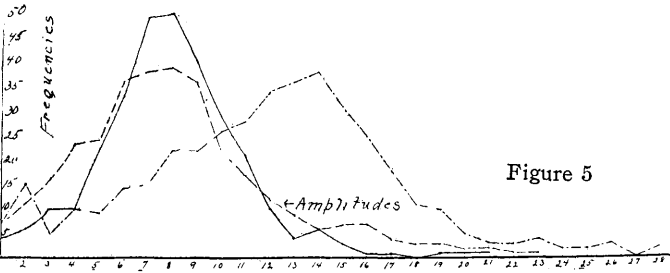


Figure 5

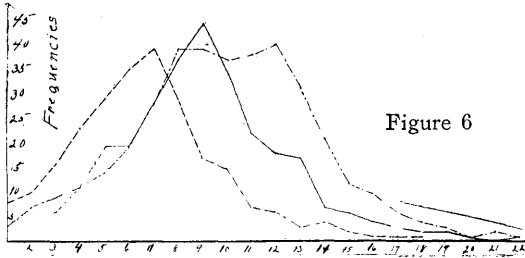


Figure 6

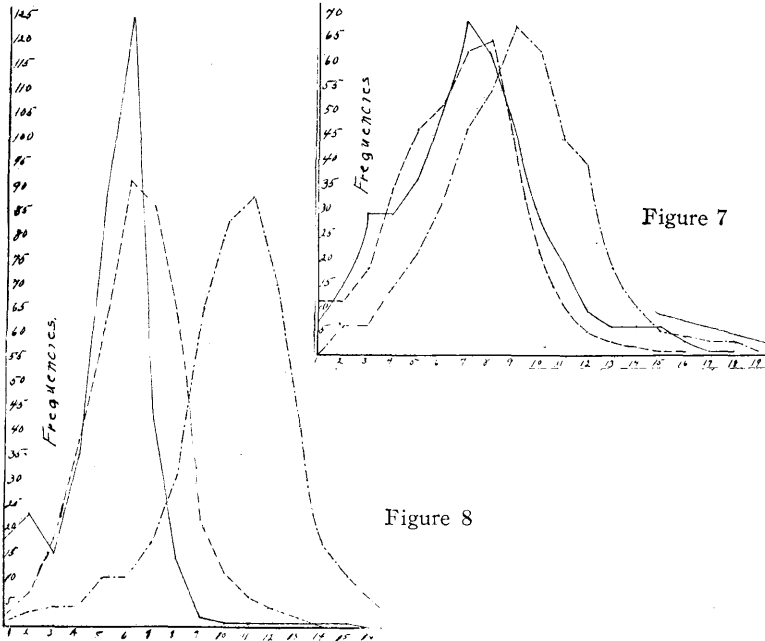


Figure 7

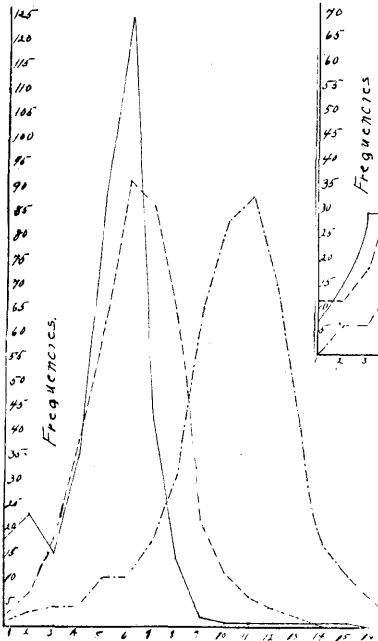


Figure 8

- Fig. 5. Respiration curves of cow Five H under three conditions: ---- before feeding; - - - - feeding, and ——— after feeding.
- Fig. 6. Respiration curves of cow Two H, under the three conditions.
- Fig. 7. Respiration curves of cow Three H, under the three conditions.
- Fig. 8. Respiration curves of cow Seven H, under the three conditions.

the results. A further explanation of this will be given later, as the specific cases come up for discussion. Finally, the appearance of the composites themselves are clearly indicative of the nervous reaction or "temperament of the animal.

The variations within each individual are beautifully illustrated by the polygons themselves. Beginning with Seven H, (Fig. 8), it will be seen that a marked difference is shown between the feeding condition as compared with those of before and after feeding. The composite of the former lies considerably to the right of the other two, which explains the fact that the mean has increased from 6.41 in the before feeding condition to 10.42 in the feeding condition, or the length of respirations increased, which indicates that feeding acted as a stimulus to the animal. Comparing the standard deviations, it will be seen that the feeding condition is the more variable. The composite of after feeding is the most uniform, the mean having gone down to 5.34 and the standard deviation to 2.20, the latter figure is perhaps a little high because of a few respirations of extreme length. The results indicate that during feeding, increased nervous activity or nervous reaction accompanied the feeding stimulus, and that before and after feeding the animal was more quiet and not so nervous.

The composite of Three H, (Fig. 7), shows the same results, but not as marked as with Seven H. The mean increased during feeding, but the standard deviation remained nearly the same as in the before feeding condition, while after feeding it increased slightly as compared to the other two conditions. The stimulus of feeding upon this animal did not show as marked effects as upon Seven H, merely increasing the mean or amplitudes of respiration, and so moving the polygon a little to the right. Not much difference is displayed between the before and after feeding conditions, both in appearance of the composites and their respective means and standard deviations. As a whole all three composites are very similar, which leaves the impression that Three H, is not easily disturbed and that her nervous make-up is of a stolid nature.

In the case of subject Two H, (Fig. 6), a more evident result is evinced, namely, that the animal has a marked tendency to be less active before feeding than after, which was not so marked in Seven H and Three H. The mean 6.73, and the standard deviation 3.09, in before feeding increased to 9.09 and

3.45 respectively in the after feeding condition. The condition of feeding also showed an increase of the mean, 9.97, and the standard deviation, 3.79, showing a marked reaction to the stimulus of feeding, more so than was shown in Three H and very nearly as great as in Seven H. Consequently, the nervous activity of Two H increased during feeding.

Finally, studying the composite of Five H, (Fig. 5), we see that a very nervous animal is indicated, which is readily shown by the conformation of the three polygons. Many variations exist and the polygons appear irregular and straggling. Here again the feeding stimulus shows its effect in increasing the nervous activity of the animal. The mean and standard deviation, (8.22 and 4.15), in the before feeding condition, increased to 11.97 and 5.16 respectively, in the feeding condition. Comparing the before and after feeding conditions, the mean 8.22 and standard deviation 4.15 in the before feeding condition decreased to 7.92 and 3.09 in the after feeding condition, instead of increasing as was shown in the former subjects. This may seem contradictory, but may be explained by the fact that the pneumographic tracings of Five H in the after feeding condition were taken too far away from the regular feeding time. Consequently, the mean decreased instead of increased. Had the after feeding condition been recorded nearer the feeding condition, the mean probably would have increased, and so established a like condition as in the first three animals. Taking the after feeding record farther away from the regular feeding time, up to a certain point, the nervous activity decreased, and with it the mean, as has been before explained. Because of the time element then the after feeding condition in this case would tend to indicate less nervous activity than in the before feeding condition.

In this connection an interesting fact might be brought out regarding all the subjects studied. Looking at all the polygons of the feeding condition, it will be noted they extend to the right of the others and are wider and flatter. Then in the after feeding condition the polygons move toward the left and become higher and narrower. And in the before feeding condition the polygons are a little to the right of the after feeding condition and slightly wider and flatter than in the after feeding condition, with the exception of Two H, where the before feeding tracings were taken farther from

the regular feeding time. Owing to inconveniences in obtaining the subjects at definite times of the day, it was impossible to work with them at stated intervals before and after feeding. But had the pneumographic curves been taken at definite times and alike for each subject, the above fact would probably have been illustrated more clearly, and would have shown that each individual possessed a cycle of nervous activity, being greatest at feeding, diminishing after feeding and continuing to diminish until the before feeding condition was reached, and then gradually increasing in nervous activity again until the feeding condition had been reached, when it would be at its height, and then this cycle would be repeated as the next feeding time approached. Each animal of course would have a definite point, which would be characteristic of that individual, at which point the nervous activity would begin to increase or decrease, depending on the nervous make-up of the animal in question. The times at which these tracings were made are different, but the attempt was made to choose approximately, a definite time, in so far as existing conditions would permit.

A general comparison of all the composite polygons mentioned may also be made. It will be seen that each individual has its own characteristic polygon, and that each is distinctly different from that of any other. Those of Seven H appear rather long and narrow. (It will be noted that all the polygons are plotted to the same scale.) Those of Three H are shorter and broader and more irregular, while the polygons of Two H are still shorter and broader and rather flat, with about the same amount of irregularities as those of Three H. Lastly, those of Five H are the most irregular of the four and do not show much symmetry, but are spread over the entire width of the page. Thus each animal shows its individuality in its respiration polygons, even under three different conditions, and the peculiar conformations and variations are distinctly characteristic of this one individual and not of any of the others. All of the composites seem to possess a common feature, namely: the shorter amplitudes show a higher frequency than those of extreme length; in other words, the long respirations do not occur as often as the short ones, which gives the polygons an abrupt slope to the left and a more gradual slope toward the right.

Variations Within the Group.—In making comparisons of variations within the group of animals studied, the composites of all the animals under a given condition were plotted on one sheet, thus facilitating the interpretation of results and making the comparisons more vivid. The following pages then represent the four animals under the same condition, i. e., before during and after feeding. Studying the polygons of the before feeding condition, (Fig. 4), it will be seen that each individual is represented by a distinct composite different from the others. The general conformation and appearance of each would lead to the conclusion that Seven H is the most quiet and Five H the most nervous, and Three H more nervous than Seven H and less so than Two H. In the order of their nervous activity then, they follow, Five H, Two H, Three H, and Seven H, as is indicated by the height, symmetry and narrowness of each polygon. This interpretation based on observation is entirely in accordance with the actual results. The mean and standard deviation of Seven H is 6.41 and 2.02 respectively, which increase to 6.69 and 2.57 in Three H, to 6.73 and 3.09 in Two H, and to 8.22 and 4.15 in Five H. A curious fact is here brought out that the coefficients of variability indicate the same order. They follow, Seven H, 31.59, Three H, 38.36, Two H, 46.02, and Five H, 50.49. This is because of the fact that the means and standard deviations do not increase in the same ratio, and the reason they do not increase in the same ratio, no doubt is due to the fact that the before feeding tracings of all the subjects were taken very nearly at the same time before the regular feeding time. (See above.)

Turning to the polygons of the feeding condition, (Fig. 2), the interesting fact heretofore mentioned is made more striking, that the stimulus of feeding increases the nervous activity of the animal. Comparing the shape of the polygons, the same order of nervous activity is seen, namely—Five H, Two H, Three H and Seven H. The same result is verified by the respective means and standard deviations of the respective animals. Here again the coefficients of variability read directly and conform to the order of nervous activity given above—beginning with 24.76 in Seven H and increasing to 43.12. It will be noted that the coefficients of variability in the before feeding conditions (Fig. 4), are as a whole relatively higher

than those in the feeding condition. This fact might be explained in that the means of the feeding condition are in turn greater than those of the before feeding condition, and as a result lower the coefficients of variability in the feeding condition. The pneumographic tracings of the feeding condition were taken under fairly uniform conditions, because here the time element was practically the same, since the tracings were made at the regular feeding time. Therefore these results are very significant and indicative of the degree of nervous activity or reactivity of the four animals.

Lastly, taking up the after feeding polygons, (Fig. 3), we see the results are somewhat different from those previously studied. Taking into consideration the conformation and appearance of the composites, the curves of Seven H indicate the least nervous condition and next Three H, and Five H appears less active than Two H. Turning to the actual results of the means and standard deviations, the explanation for the difference will be found. Seven H has a mean and standard deviation of 5.34 and 2.20, which are increased to 7.21 and 3.04 in Three H and to 9.09 and 3.45 in Two H, while in Five H the mean and standard deviation decrease to 7.92 and 3.09 as compared to Two H. This may be due again to the same time element, which was explained above, when all the polygons of Five H were discussed. It is again brought out that the tracings of the after feeding condition of this animal, were taken too far from the regular feeding time, and so decreased the mean and standard of deviation. While the coefficients of variability of the before feeding and feeding conditions were in accordance with the order of nervous activities of the animals, in the after feeding condition they are not. They follow, Seven H, 41.20; Three H, 42.19; Two H, 38.02, and Five H, 39.08. Now here again the time of taking the pneumographic tracings causes this result. The after feeding polygons were taken in the morning, following the morning feeding, but they were taken at various times and not at a stated interval after feeding. This probably caused a variation of results because of the changing nervous activities of the animals, as the after feeding condition approached or withdrew from the feeding time.

DISCUSSION AND CONCLUSIONS.

The purpose of this study was primarily to try to establish a method whereby the nervous activity of cattle, or so-called "dairy temperament," might be measured. The results as given would indicate that by means of the pneumographic tracings the various nervous activities of cattle can be measured and placed upon a quantitative basis. Under the three conditions mentioned, the results point to the conclusions that animal Five H was the most nervous, next Two H, then Three H, and Seven H the least nervous. All the subjects reacted similarly, differing only in the degree of intensity of nervous reaction. And from the degree of intensity of nervous reaction arose the conclusions as to which animal was the more nervous.

Throughout the discussion, the term "temperament" and "dairy temperament" have been avoided as much as possible, and the term nervous activity used instead. Nervous activity or reactivity as shown by these results, is the response to every-day stimuli through external and internal sensory connections with the respiratory center. As has been mentioned in the introduction, temperament, by definition is a mental condition or development. Now "dairy temperament," today is usually defined as a "predisposing tendency to convert food into milk." We are not satisfied that this definition has any quantitative basis. It is simply a deduction made from a combination of physical characteristics. Our work takes no cognizance of physical characteristics or outward indications, it deals only with the actual reactivity of the animal. Physical characteristics as applied to "dairy temperament" have not been standardized, since they mean different things to different men, and what one man may call a prominent eye, another may not consider as such. It would be better then to speak of desirable physical characteristics, as dairy form, etc., alone, and not involve them with "dairy temperament." Instead of using this latter term, it might be better to speak of the degree of nervous activity or reactivity which an animal possess.

Whether this study, if continued, will produce results of importance remains to be seen, but it is to be hoped that an interest in this special line of experimentation may be developed that will pave the way for further investigation. The conclu-

sions drawn at best, can be but tentative, since but few animals were studied. To come to definite conclusions further study is necessary with more data. Only when several hundred animals have been investigated, can the real value of this method be determined. We would suggest that provisional measures of "temperament" may be obtained from the standard deviations of frequency polygons taken from several animals which are studied at the same time under the same conditions (preferably while feeding). Correlations between the "temperament" or reactivity of animals and their milk producing abilities would, it seems to us, yield definite information as to the value to be placed on the "temperament" or reactivity of dairy animals.

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